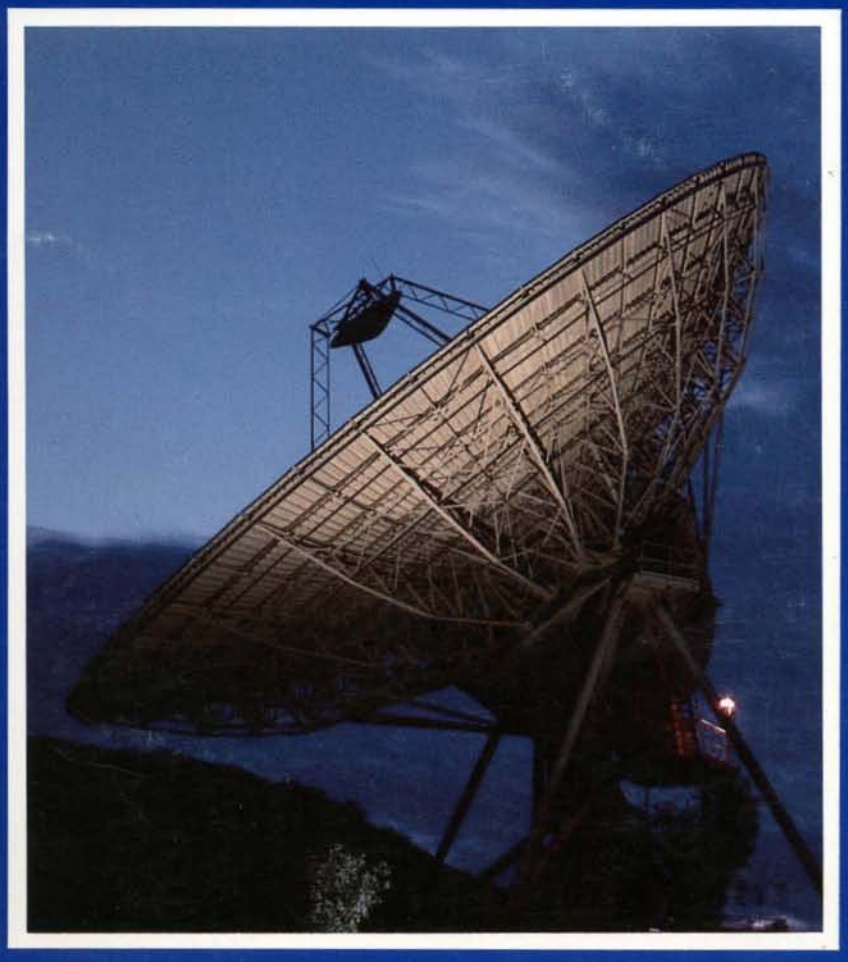
The Hidden Signals on Satellite TV

Third Edition

Thomas P. Harrington



- Stereo Subcarriers
- Telephone Channels
- World News Services
- Audio Subcarriers
- Teletype News-Press
- Commodity News
- Radio Channels
- Stock Market Reports
- Teletext (VBI)
- Single Channel Per Carrier
- Multiplex Data Channels

Plus Many Other "HIDDEN" Services

The Secret Signals On The Satellites

TUNE THE HIDDEN SIGNALS ON SATELLITE TV

THE SECRET SIGNALS ON SATELLITE TV

THIRD EDITION

THOMAS P. HARRINGTON W80MV

PUBLISHED AND DISTRIBUTED BY
UNIVERSAL ELECTRONICS, INC.
4555 Groves Road, Suite 13
Columbus, Ohio 43232, U.S.A.
614-866-4605
FAX 614-866-1201

PLEASE NOTE

This work is published for the commercial field to increase their awareness of the many non-video opportunities existing in the satellite communications field. The publisher and its author do not condone any individuals, company or groups misuse of any of this information in any way.

Section 605 of the Communications Act of 1934, as amended, generally warns you that non-broadcast-class communication signals are considered 'private' communications. The 1934 act was designed to establish guidelines to prevent unauthorized 'third parties' [i.e., anyone not associated directly with the 'private communications'] from setting out to intercept such private communications. Section 605 warns that any person not authorized to intercept such transmissions and who does so, either on purpose on accidentally, shall not divulge to any other party any of the following: (a) that such a transmission exists, (b) the content of the transmission 'intercepted'. In another section of the FCC rules, the FCC Treats al microwave [i.e., satellite] communications in the 3.7 to 4.2 GHz band as 'common carrier' transmissions, and thereafter confirms by definition that all common carrier transmissions are considered non-broadcast [as in private] transmissions. These rules were adopted at a time when the primary concern was with 'eavesdropping' on private overseas and domestic telephone communications and in studying the debate of the era it would appear that the real concern was with employees of the telco/common carrier who might have access in their work routines to these circuits. The Congress clearly was worried primarily about common carrier employees eavesdropping. In the intervening 46 years the whole nature of communications has changed including the use of some common carrier transmission frequencies for non-common carrier type signals.

ISBN #0-916661-04-0

Copyright MCMXCII by Universal Electronics, Inc. All rights reserved. No part of this book may be reproduced or reprinted or used in any form by any reproduction means, including photocopy, mechanical or recording without permission in writing from the publisher.

Printed in the United States of America.

ACKNOWLEDGMENTS

We wish to thank the many companies and individuals who furnished us with reference materials and photographs:

GTE, for the full-color cover photo, — The Harris Corp. — Comtech Data Corp. — Microdyne Corp. — Avcom of Virginia, Inc. — Southern Satellite Systems, Inc. — Wegener Communications Co. — Leaming Industries, Inc. — Videostar Connections, Inc. — Equatorial Communications Co. — Genesis Research Corp. — R. L. Drake Co. — Digital Electronic Systems — Conifer Corp. — Macom, Maco, Inc. — Paradigm Manufacturing — United Satellite Systems — Westat Communications — Japan Radio Co. — Trio-Kenwood — Hughes Communications — Mark L. Lewis for Teletext Section — Reuters — Commodity Communications Corp. — Satellite Syndicated Systems, Inc. — Bonneville Telecommunications — Scientific Atlanta, Inc. — United Video, Inc. — Dow-Jones Cable News — SSS Cable Text — Modulation Associates, Inc. — Winegard Company — RCA — A. T. & T. — Dick Smith Electronics — Mark Long — CommTeck, Inc. — Apple Computer — Dave Kelce — John Fellin — DTN

Prater Design & Graphics

"The public's tax dollars were critical to the development of satellite communications."

Senator Barry M. Goldwater

PREFACE

Most satellites and their transponders are known by their video transmissions, however; satellites also carry large amounts of non-video products that range from audio news services, news teletypewriter channels, high speed data systems, long distance telephone circuits, teletext services, stock market reports, business data channels, plus many other types of services.

Most satellite receive-only owners are aware of the many additional audio channels available on their receivers equipped with tunable audio subcarrier sections. A popular addition to a well-equipped TVRO setup is a quality stereo tuner which tunes the stereo audio contained in the subcarrier section of the satellite signal. These signals are in addition to the regular video programs audio section which is contained within this full subcarrier section.

In "HIDDEN SIGNALS," we will look at most of the non-video signals on the various satellites. Many of these can be received with simple, readily-obtainable equipment. Other types of services require complex computer and microprocessors to obtain the proper signal and receive intelligible copy. Most of these hi-tech services will be outlined and covered in this book.

Please be advised that the Communications Act of 1934, Section 605, which covers the rules and regulations for the interception of all private communications broadcast over (RF) radio frequencies, applies to interception from satellite transmissions as well. Contents of these transmissions are not to be divulged to anyone.

Section 605 of the Communications Act of 1934, as amended, generally warns that non-broadcast-class communication signals are considered "private" communications. The 1934 act was designed to establish guidelines to prevent unauthorized "third parties" (i.e., anyone not associated directly with the "private communications") from setting out to intercept such private communications. Section 605 warns that any person not authorized to intercept such transmissions and who does so, either on purpose or accidentally, shall not divulge to any other party any of the following: (a) that such a transmission exists, (b) the content of the transmission intercepted. In another section of the FCC rules, the FCC treats all microwave (i.e., satellite) communications in the 3.7 to 4.2 GHz band as "common carrier" transmissions, and thereafter confirms by definition that all common carrier transmissions are considered non-broadcast (as in private) transmissions. These rules were adopted at a time when the primary concern was with "eavesdropping" on private overseas and domestic telephone communications. In studying the debate of the era, it would appear that the real concern was with employees of the telco/common carrier who might have access in their work routines to these circuits. The Congress clearly was worried primarily about common carrier employees eavesdropping. In the intervening 46 years the whole nature of communications has changed, including the use of some common carrier transmission frequencies for non-common carrier type signals.

TABLE OF CONTENTS

PREFACE **PAGE iii**

CHAPTER 1 **PAGE 1**
UNDERSTANDING THE SATELLITE SIGNAL
- Modern Methods of Communications 1
- Multiple Audio and Data Subcarriers 4
- Various Types of Satellite Transmissions 4
- The Satellite Signal Spectrum From 0 to 30,000 MHz 4
- Satellite Spacing Plan 7
- Brief History of U.S. Satellite Communications 9
- Where the "Hidden Signals" are Located 10

CHAPTER 2 **PAGE 25**
AUDIO SUBCARRIERS (SBC/FM)
- Audio Subcarriers on Satellite TV 25
- Where to Find the Audio Subcarriers 26
- Equipment to Receive Stereo Audio Subcarriers 29
- Four Basic Stereo Formats Used on Satellite Transponders 37
- Matrix-Multiplex and Discrete Formats 38
- Optimizing Subcarriers for Satellite Transmission 41
- A Further Look at Satellite Subcarriers 44
- "In-Touch" Reading Service 50
- Galactic/Tempo Sound 50

CHAPTER 3 **PAGE 53**
SATELLITE TELEPHONE SYSTEMS (SSB/FDM)
- Look But Don't Touch 53
- How It Works 54
- At the Uplink 57
- At the Downlink 57
- The Other Approach 59
- How To Receive All Of This 60
- The Ideal SSB Receiver 61
- The Hookup Of Equipment For Telephone Reception 61
- Connection Problems 65
- What is Multiplexing ? 66
- What Will We Hear? 67
- Location of Satellite Telephone Systems 67
- Important Points on SSB/FDM 68

CHAPTER 4 **PAGE 71**
SINGLE CHANNEL PER CARRIER (SCPC)
- FM/SCPC— What Is It? 71
- Radio Networking 71
- The System 75
- SCPC/FM Equipment, General 80
- Harris Corporation 80
- Harris SCPC/FM Networks 80
- Receive-Only Networks 80
- TDMA In Brief 82
- Harris TDM Networks 82
- Microdyne Corporation 87
- Comtech Data Corporation 91
- Avcom of Virginia, Inc. 92
- How to Receive International Satellite Audio on SCPC 98
- Narrow Band SCPC Equipment 98
- Another Narrow Band SCPC-FM/SCPC/FDM Service 99
- Multiplexing and Frequency Division Multiplexing (FDM) 99
- How to Set Up To Receive FM/SCPC/FDM Data Services 103
- What Is Teletype (RTTY)? 103
- A User-Friendly FM/SCPC Receiver 106
- Build an FM/SCPC System for Under $100.00 107
- Where to Find SCPC Services 113
- A Summary of SCPC 114
- Companding 115
- Frequency Locations of SCPC Services 116
- SCPC Scanner Receiving System 122
- Heil SC-One SCPC Receiver 127
- The SCPC System 128

CHAPTER 5 **PAGE 131**
SATELLITE NETWORKS
- History of Data Communications 131
- Teleconferencing Via Satellite 131
- Digital Radio Networks Via Satellite 134
- Digital Satellite Network Equipment (ADDS) 135
- Modulation Associates Corporate Data Network 140

Spread-Spectrum Technology 140
Interactive Data Communications Network Services by Equatorial Communications Company 142
FSK Data on Subcarriers (SbC) 149
FSK Data Equipment 149
"Sun Outage"—The Satellite Data Networks' Problem 152
FM Squared Technology 153
New FM Cubed Broadcast Service 154
Data Transmission Network (DTN) 155

CHAPTER 6 PAGE 157
TELETEXT BASICS
Videotext: A Primer 157
Television and VBI 157
Are You Ready For Teletext? 158
Short History of Teletext 160
The Satellite-Delivered Services 162
Major Teletext Services 162
Availability of Decoders 165
Here Are the Problems 167
Keyfax and Other Teletext Services 169
Zenith Teletext Service 170
Another Overview of Teletext 174
New DSE Teletext Decoder Kit 176

CHAPTER 7 PAGE 179
OTHER VBI SERVICES
Other VBI (TxT/VBI) Services 179
Program Information Network (PIN) 180
Dow-Jones News Service 180
AP News Cable 181
Unique Satellite Services: Genesis, SSS Stock Market Service, Beets Data Systems, and Bonneville Data Systems 181

CHAPTER 8 PAGE 185
MISCELLANEOUS SATELLITE SERVICES
Reuters Services 185
Reuters Small Dish Service (SDS) 185
Reuters News-View Service 186
Commodity Communications Network 186
The Galaxy Data System—Present and Future 191
Hughes Satellite System Description 195
Press Services Via Satellite (SCPC/FM/FDM)—UPI News Services (RTTY) 199
AP News Service 199
Copying Satellite FDM Signals With a Personal Computer 200
Commodity Quotations, Inc. 200
Commodity World News Network 204
United Video Systems 206
Bonneville Satellite Systems 207
PC-Quote System 207
Satellite Broadcast Network (SBN) 207
Zephyr Weather Information Service 208
Satellite Data Network (SDN) 211
Sportsticker Service 215
Bonneville/Apple Financial Service 216
Agri-Sat Agricultural Service 216
Potpourri of "Hidden Signals" 219

CHAPTER 9 PAGE 221
Ku-BAND AND HIDDEN SIGNALS
Broadcast Services and Ku-Band 221
The Future of Ku-Band 221
Equipment for Ku-Band 230

EARTH STATION GLOSSARY OF TERMS 231
APPENDIX A—
Future Domestic Satellite Belt 1995 235
APPENDIX B—
North American C-Band Satellite Frequency/Transponder Conversion Table 236
DATA COMMUNICATIONS GLOSSARY 237

CHAPTER ONE

UNDERSTANDING THE SATELLITE SIGNAL

MODERN METHODS OF COMMUNICATION

Until recently, man has been blind to all but those forms of radio waves known as light and infrared heat rays. As technology has improved, so has our ability to communicate. Morse code rapidly evolved to radio, television, and now to satellite telecommunication in less than a century. The same principles underlie all forms of radio wave communications.

ANALOG AND DIGITAL SIGNALS-CODING THE MESSAGE

Any message, whether it be the image and voice of an entertainer or details of stock-market transactions, must first be changed into a form that can be relayed by radio waves. If an analog coding method is used, the pattern of a message is mimicked by electrical voltages. For example, a voice can be changed into an analog signal by a microphone that creates a voltage determined by the loudness of the sound. The louder the sound, the higher the voltage. A digital coding method uses the numbers 0 and 1 to convey all information. For example, a voice could be expressed in digital form if the loudness at each point in time was expressed by numbers, or patterns of 0's and 1's. A photograph can also be described by a long series of 1's and 0's that are coded so that some impart information about the location of the dots composing the picture and others determine the brightness and color of the dots. Computers exclusively use digitally coded information.

Uplinks can relay either digital or analog forms of the same message. Converters that can translate between these two languages are available. For example, conversations between computers relayed by satellite are always digital, while most TV broadcasts are expressed in analog form. However, the trend is to use digital broadcasts as newer and higher-quality television is developed and as satellites are packed with more sophisticated electronics allowing higher amounts of information to be transmitted.

MODULATION—ADDING THE MESSAGE TO RADIO WAVES

Analog or digital signals can be added onto radio waves by a process called "modulation." Once the message is modulated onto a radio wave (known as the carrier wave because it carries the information), it can be relayed from a sending to a receiving antenna. Radios, televisions, and other communication equipment demodulate the signals they receive; i.e., they extract the original message from the carrier wave See **Figure 1.0**.

The simplest method to modulate a carrier wave is to switch it on and off. For example, Morse code is relayed as series of dots and dashes by turning the carrier wave on and off. The most familiar methods of modulation used today are amplitude modulation (AM) and frequency modulation (FM) as encountered, for example, in AM and FM radio. In amplitude modulation, the power of a carrier wave is varied in accordance with the message being relayed, while in frequency modulation the frequency of the carrier wave is varied.

Each type of modulation has advantages and disadvantages. AM messages must have high powers to travel long distances without being weakened too severely for clear reception. They are also more prone to picking up static than are FM messages. On the other hand, FM signals need relatively lower power for successful, long-distance transmission, but must use a substantially wider range of frequencies than AM messages would to carry the same amount of information. Satellite messages are frequency modulated for these reasons. As signals cover the long distances between earth-receiving-and-sending stations and satellites, the power becomes so low that AM relays would be unusable. Also, satellite communication relays use a very broad range of frequencies as is required by FM broadcasts.

BANDWIDTH-HOW MUCH INFORMATION CAN BE CARRIED?

Just as a large-diameter pipe can carry more water than a small one, a signal covering a wide band of frequencies can carry more information than can one covering a narrow band. This range of frequencies of radio waves is termed the "bandwidth.' For example, if a television message is relayed in the frequency range from 54 million cycles per second (abbreviated 54 megahertz) to 58.2 megahertz, it would have a bandwidth of 4.2 megahertz. Each type of communication medium uses a characteristic bandwidth. Media such as television require a substantially wider bandwidth than do radio or telephone because much more information is necessary to recreate a picture than to recreate music or a voice. For example, a TV communication channel of the satellite Galaxy 1 is located between the frequencies of 3.70 and 3.74 billion cycles per second, abbreviated as gigahertz. This channel therefore has a bandwidth of 40 megahertz. Voice channels, however normally require a bandwidth of only 3,000 to 4,000 cycles per second for quality sound reproduction.

AMPLIFICATION-INCREASING THE SIGNAL STRENGTH

Messages beamed into space from an uplink antenna are weakened on their voyage to a satellite as the signal becomes spread out and is absorbed by water vapor, clouds, and other materials. This weakening is called "attenuation." Amplification, the opposite process, increases the signal strength. In the same fashion that a photograph is enlarged but not changed, amplification retains the original message. All televisions, radios, stereos, and other communication equipment amplify a signal before they demodulate carrier waves.

NOISE-HINDERING CLEAR COMMUNICATION

In a perfect communication system, the signal would be relayed with no interference or noise. However, television or radio broadcasts are occasionally of poor quality or "noisy." Noise is present in all matter at temperatures above absolute zero, the temperature at which all molecular motion ceases. (There is no temperature colder than absolute zero). Noise is caused by the endless motion of the molecules that compose all matter. These small, vibrating charged particles generate radio waves that mask the organized signal sent by man. Noise from the environment becomes stronger as the temperature increases. Receiving antennas as well pick up more of this environmental noise as the signal bandwidth increases. Furthermore, noise is generated by internal heat in amplifiers, receivers, and other electronic equipment.

Noise is always present in satellite communication systems (see **Figure 1.1**). The quality of a communication is determined by the ratio of signal-to-noise power. For example, if a signal of 10 watts is received along with 5 watts of noise, the picture quality will be poorer than if a signal of 10 watts was received with 1 watt of noise. In the case of television, the signal must be at least 63,000 times the accompanying noise in order for a "high-quality," picture to be received.

The basic satellite video signal under the NTSC (National Television Standards Committee) standards for color television uses a channel band width of 6 MHz to carry all of the necessary picture information along with the audio section. This 6 MHz signal is spread over a basic 36 MHz bandwidth in order to reduce the possible terrestrial microwave interference.

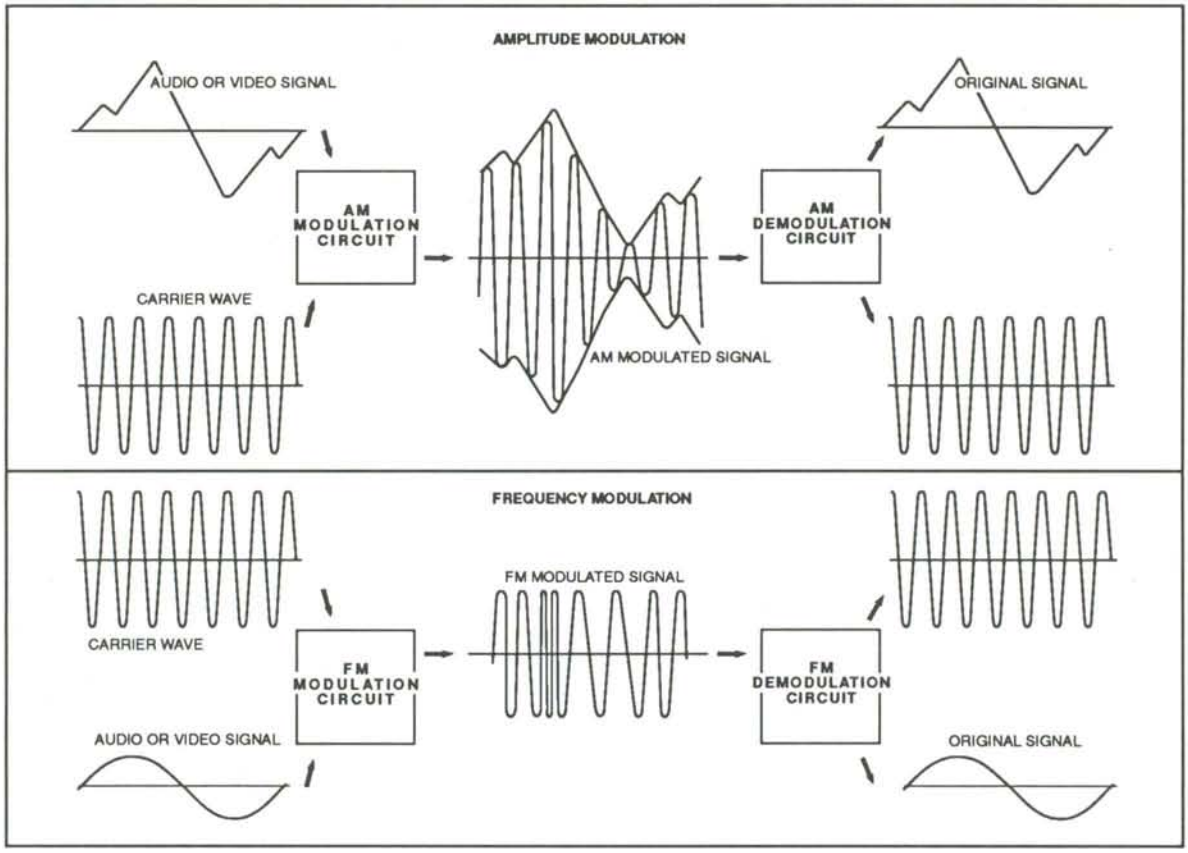


Figure 1.0 *Amplitude and Frequency Modulation of Signals. The modulated audio, video, or data signal can be relayed by cables, over-the-air, or by satellite.*

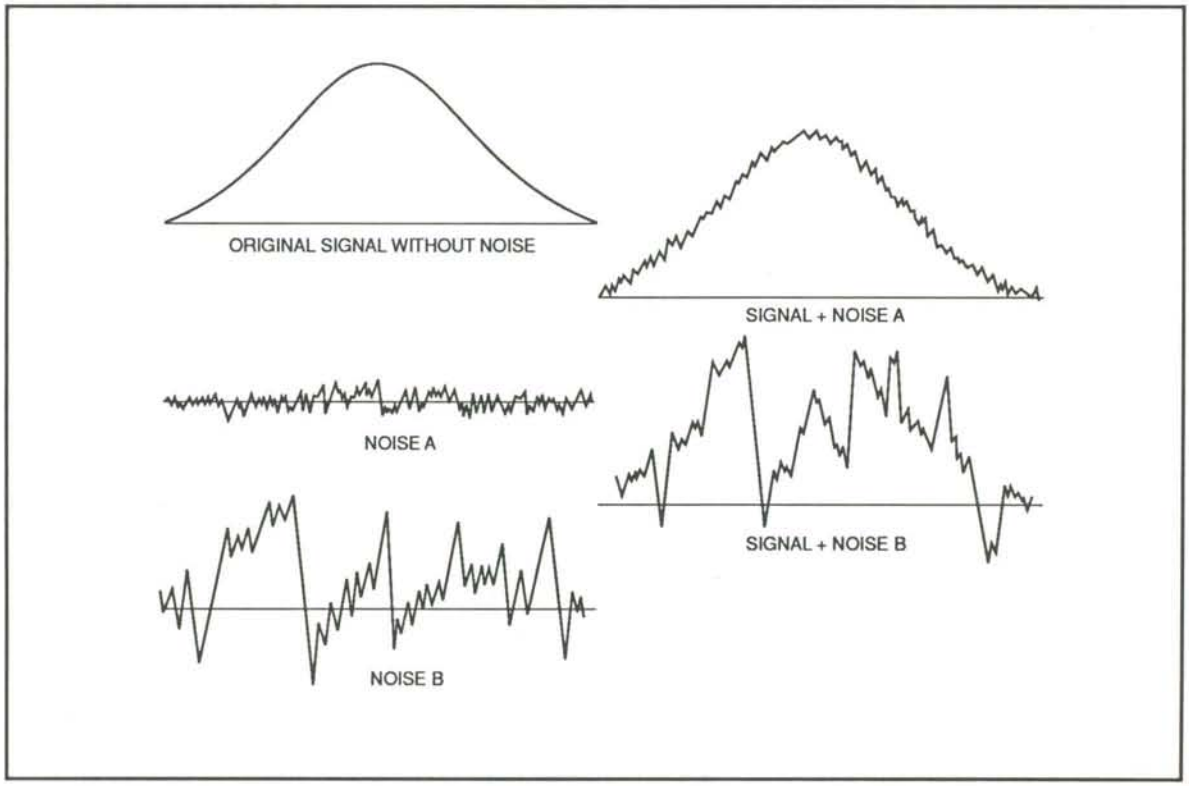


Figure 1.1 *The Effect of Noise on a Radio or Television Signal. If the level of noise is too high, as in case B, the signal is garbled or even unintelligible.*

The transponder spacing is at 40 MHz intervals, which allows a 2 MHz guardband between each side of the transponder or a total guard of 4 MHz.

An example is the frequency of the transponders on Galaxy 1-Transponder 1 is 3720 MHz and 3760 on Transponder 2, or a 40 MHz spread. Of this 40 MHz bandwidth, 36 MHz is used by the video and audio requirements, plus 2 MHz either side which makes up the full 40 MHz frequency spread. This results in an actual guardband total of 4 MHz, as each transponder is afforded 2 MHz each side of its transponders. See **Figure 1.2** and **Figure 1.3**.

Most transponders have an effective bandwidth of less than 10 MHz useable frequency spectrum. This allows the transponder to carry many other signals: this open area after the required 6 MHz color bandwidth for the TV segment is where we find the many "hidden signals" on the satellite. See **Figure 1.4.**

MULTIPLE AUDIO AND DATA SUBCARRIERS

Many transponders on the satellites do not produce a video picture and therefore are considered inactive, out of service or help as a spare to replace a defective transponder. Close examination of these transponders reveal them to be active in an audio or data use.

The data use is expanded when the many narrow band audio and data carriers replace the wide-band video carriers. Further expanded use is achieved by using frequency multiplexing systems; it is possible to stack thousands of data and/or audio signals, one on top of another, in frequency order.

The total amount of non-related signals carried is dependent upon the bandwidth of the particular signals. Narrow band voice and audio channels used in most telephone circuits are approximately 4,000 Hz wide; many of these one way or single circuits are combined with many other telephone channels to form a multi-channel group, which in turn, are combined into other groups until the entire useable frequency spectrum is full.

These multiplexing schemes have been used for many years in commercial high frequency radio-teletype work and are accepted standards set by most telephone systems around the world. The International Telecommunication Union in Switzerland is responsible for setting most world standards on all types of telecommunications systems. One standard audio multiplexing system used by the major telephone systems over satellite is shown in Figure 1.5. This system is capable of many thousands of simultaneous satellite telephone conversations over a full-use satellite transponder. These systems in the single sideband mode, must be demodulated to be decoded, and are covered in the frequency division multiplex (FDM) section of this book.

VARIOUS TYPES OF SATELLITE TRANSMISSIONS WITH THEIR SYMBOLS

The authors have spent several years work with these "Secret Hidden Signals" on the many satellites; each of us had many volumes of data, notes, and other information collected in our search of this new satellite spectrum. As we talked and started to compare our notes and findings, we realized there was a need for a new standard to describe the various services on the satellites. This was a new part of the satellite world without a common language. **Figure 1.6** lists this new standard language in a simple manner, which will allow the correct compilation of information from many sources in the future.

These symbols and standards will be used in all sections of this book.

UNDERSTANDING THE SATELLITE SIGNAL - The Spectrum From 0 To 30,000 MHz

The satellite frequencies of 3.7 GHz to 4.1 GHz make up the "C", band section, along With the KU band covering 11.7 to 12.7 GHz section of the spectrum. **Table 1-A.**

The "K", band section is to be used as future direct broadcast services (DBS). The Canadian Satellite ANIK-B was the world's first dual band satellite carrying 12 C-band transponders and 6 K-band transponders; future K-band traffic load to Canada's ANIK-C series and ANIK-D series. To further understand the full spectrum of frequencies from 0 MHz to 30,000 MHz, see **Figure 1.7**, The Full Electromagnetic Spectrum.

There seems to be considerable confusion regarding the many frequency designations, Hertz—Kilohertz, Megahertz, and Gigahertz. Below is a simple table that should clear up these designations. See **Figure 1.8.**

(A)	SINGLE SIDEBAND TYPE - DATA - FAX - MPX: SSB/SCPC
(B)	FM FORMAT TYPE - DATA - FAX - MPX: FM/SCPC
(C)	TELETEXT ON A SUBCARRIER: TxT/SC
(D)	TELETEXT ON VERTICAL BLANKING INTERVAL: TxT/VBI
(E)	DIGITAL MODULATION: DM/SCPC
(F)	SLOW SCAN TV ON VERTICAL BLANKING INTERVAL: SSTV/VBI
(G)	SPREAD SPECTRUM: SpS
(H)	SUBCARRIER USE: SbC/FM
(I)	FACSIMILE, CRT-VIDEO OR HARD COPY: FAX
(J)	MULTIPLEXING: MPX

Figure 1.6 *Language to describe the various satellite services.*

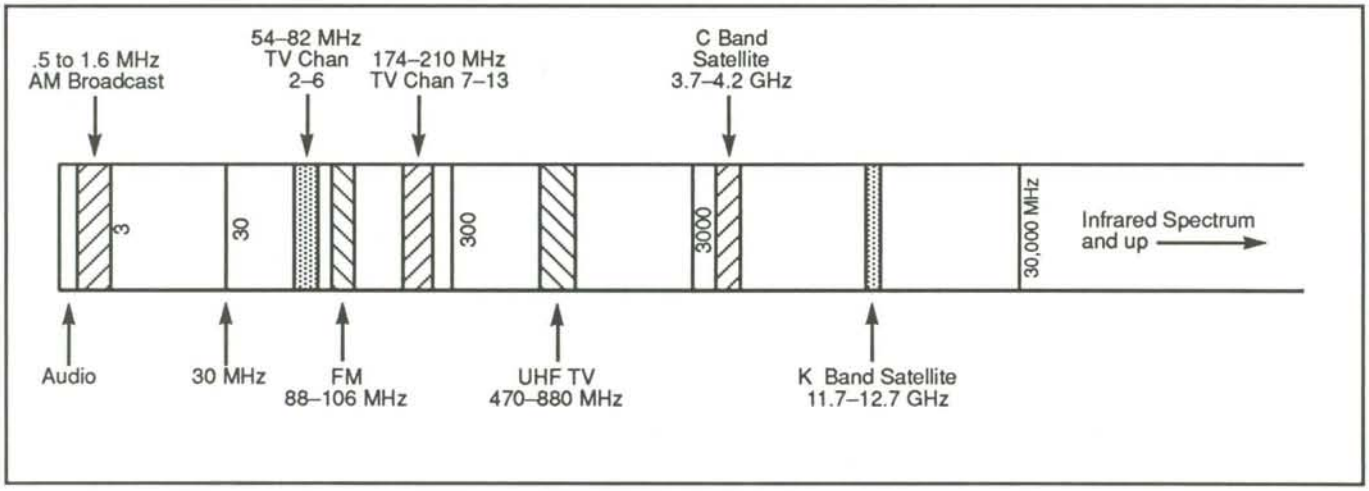


Figure 1.7 *The full electromagnetic spectrum from 0 to 30,000 MHz.*

Hz =	HERTZ =	Formerly known as cycles per second; now expressed as Hertz (cycles per second) 400 Hertz (400 cycles per second)
kHz =	KILOHERTZ =	One Thousand Hertz (cycles per second) 500,000 Hz, expressed as 500 kHz
MHz =	MEGAHERTZ =	10,000,000 Hz is expressed as 10 MHz
GHz =	GIGAHERTZ =	1,000,000,000 Hz is expressed as 10 GHz

Figure 1.8 *Frequency Designations.*

BRIEF HISTORY OF U.S. SATELLITE COMMUNICATIONS

1945 Arthur C. Clarke, British science fiction writer and scientist outlined in "Wireless World" a new idea of geosynchronous satellites located in space to effect long distance communications. The method was the relay from earth to space satellite and back to earth.

1957 U.S.S.R. launches first orbital satellite, Sputnik. This starts a race for outer space with the United States.

1958 Explorer I is successfully launched and placed in orbit by the United States. Plans proceed to launch other satellites by the U.S.A.

1962 American Telephone and Telegraph Company (AT&T) launches and orbits the first active communications satellite, Echo I.

1963 The Communications Satellite Corporation (Comsat) is formed to establish a series of communications satellites to create a global satellite network.

1964 First transpacific satellite TV relayed from the Olympic games in Japan using Syncom III. Intelsat system, the international satellite consortium is established to provide multicontent satellite services.

1965 The "Early Bird" satellite, Intelstat I, successfully launched and provides the first commercial satellite pathway between the United States and Europe.

1969 Series of Intelsat III satellites are placed in orbit over the Atlantic, Pacific, and Indian Oceans for worldwide commercial satellite communications.

1974 Westar 1 and Westar 2 launched by Western Union Company. These are the first U.S. commercial communications satellites in orbit.

1975 The start of entertainment programming via satellite begins with the first live transmission of a baseball game between the Texas Rangers and Milwaukee Brewers. The cable industry started its first satellite delivered programming with the launch of RCA's Satcom I. Also, the championship prize fight between Mohammed Ali and Joe Frazier was carried by HBO to its cable affiliates.

1976 First "superstation" via satellite is aired by Ted Turner from Atlanta, Georgia. The launch by Comsat of two communications satellites takes place, in use by AT&T and GTE. Bob Cooper, Jr. first to build and install a working home satellite TV system.

1979 RCA's Satcom F3 satellite is successfully launched and then disappears.

1980 Satellite Business Systems launched a new satellite and joins the satellite communications system users along with Comsat, RCA, and Western Union. SBS will later enter the satellite telephone business.

1982 NASA's space shuttle Columbia places the first payload into space with the placement of two satellites into orbit for Telsat and Satellite Business Systems. Final approval of direct broadcast satellite systems given by The Federal Communications Commission.

1983 Successful launch and operation of Hughes Galaxy One heralds the beginning of the new higher power "C" band satellites for 24 transponders of video. The under 10 foot antenna now in wide use in many states in the U.S.

1984 Ted Turner of superstation WTBS and CNN announces a possible joint venture with HBO for a "C" band Direct Broadcast Service (DBS) using galaxy I satellites.

1985 HBO, Showtime, and others start active scrambling tests, other services state their intention to scramble signals.

WHERE THE "HIDDEN SIGNALS" ARE LOCATED

This section is a "survey" of the existing domestic satellites in operation for North America. This report is a measurement tool to gauge the apparent "loading" of satellites, how busy the transponders are, and the services they carry.

The survey is done by cranking a TVRO/ARO receiving antenna toward each of the North American birds; including the ANIKs and then running through all the transponders on each satellite in both polarizations.

The basic reception equipment is a spectrum analyzer that allows the engineers to analyze and measure the content of the transponders. Video carriers, for example, have a distinctive signature pattern on a spectrum analyzer.

FDMA/FM, FDM/FM and Single Carrier Per Channel (SCPC) also have distinctive signatures. The length of the checks vary from a few minutes (ANIK A had a single transponder operation), to more than 90 minutes. The more complex the "loading scheme," the longer it takes to diagnose the type of loading present and "log," the information.

These reports miss the so-called spread spectrum transmissions (SPS). In spread spectrum, the actual frequency of the intelligence is varied up and down the transponder, or a major portion of the transponder (as much as a 2 MHz section). The receiver locks onto and follows the information as it "spreads" at a predetermined or pseudo-random rate within the assigned portion of the transponder(s). It is actual.y possible for spread spectrum transmissions (SPS) to fit into a transponder occupied by other more conventional modulation (carrier) formats.

Tests conducted with Intelsat birds, for example, revealed that spread spectrum data and voice could be transmitted on top of full and half transponder video, with no noticeable degradation to the video information; whereas normal "add-on" transmissions carry audio or data on subcarriers, (SbC), or on SCPC within an assigned transponder and on an assigned frequency. The spread spectrum approach literally "spreads" the transmitted information out over a big chunk of space or spectrum.

At any given frequency within the transponder, such as that occupied by the aural subcarrier for example, there is never enough, or at a level strong enough, for the user of the audio subcarrier to even notice that the spread spectrum signal is there, or was there.

On some data-only transponders, spread spectrum shares the regular format of Reuters News Service during the daytime weekday business hours to make possible the transmission of the Reuters Small Dish Service (2 foot dish).

In the loading tables which follow, you will notice the following information under the "baseband" column:

(A) Maximum baseband 3040 kHz, tells you how much of the transponder is in use, or was in use at the time of the check. A fully "loaded" transponder would have a baseband use in excess of 8 MHz (8,000 kHz). Therefore, the lower the kHz loading number, the lower the total amount of data being transmitted on that transponder.

(B) Subcarriers: 6.2, 6.8 MHz. This tells us that in addition to the baseband "video" carrier being detected, there were also (aural) subcarriers located at the frequencies shown. It may also tell you where the center carriers are located for an FM data audio (no video) system.

(C) Subcarriers: Where there are multiple audio subcarriers on such satellites as Galaxy 1 most program audio is carried on 6.8 MHz, while other subcarriers are listed as 6.2 MHz and can range from 5 MHz to as high as 8.15 MHz.

FORMAT EXPLANATION

Users should consider that some transponders noted inactive may be utilizing spot or regional beam coverage, and that emissions from these transponders may not be visible to the observing earth station.

DEFINITIONS

Baseband—The message to be transmitted or the band of frequencies transmitted. (See FDM/FM)

Digital—Wideband digital transmission of digitized voice, video, or data.

Emission—The type of radio frequency signal emitted.

Encoded—Used to indicate scrambling of the signal.

FDM/FM—A number of telephone channels are frequency division multiplexed (FDM) into a baseband which frequency modulates (FM) a carrier.

SC—Subcarrier. The total number of FM subcarriers.

SCPC—Single Channel Per Carrier. The transponder is channelized to provide a carrier for each single channel. Channels are occupied by both digital and FM carriers.

TBB—Top Baseband. The frequency of the highest baseband component.

TSC—Top Subcarrier. The frequency of the highest subcarrier.

TV/FM—A video signal (TV) and associated voice channels form a baseband which frequency modulates (FM) a carrier.

GEOSYNCHRONOUS SATELLITES

SATELLITE	WEST LONG.
SATCOM C-1	139.0
GALAXY 1	133.0
SATCOM F1	131.0
TELSTAR 303	125.0
WESTAR 5	122.5
SPACENET 1	120.0
MORELOS 2	116.8
MORELOS 1	113.5
ANIK D-2	111.0
ANIK D-1	104.0
WESTAR4	99.0
TELSTAR 301	96.0
GALAXY 3	93.5
GALAXY 6	91.0
SPACENET 3	87.0
TELSTAR 302	85.0
SATCOM F-4	82.0
GALAXY 2	74.0
SATCOM F-2	72.0
SPACENET 2	69.0

TRANSPONDER FREQUENCY/POLARIZATION

FREQUENCY	TRANSPONDER/POLARIZATION SCHEME				
	A	B	C	D	E
3720	1 V	1 H	1 H		1 H
3740	2 H	2 V		1 V	
3760	3 V	3 H	2 H		2 H/13V
3780	4 H	4 V		2 V	
3800	5 V	5 H	3 H		3 H
3820	6 H	6 V		3 V	
3840	7 V	7 H	4 H		4 H/14V
3860	8 H	8 V		4 V	
3880	9 V	9 H	5 H		5 H
3900	10H	10V		5 V	
3920	11V	11H	6 H		6 H/15V
3940	12H	12V		6 V	
3960	13V	13H	7 H		7 H
3980	14H	14V		7 V	
4000	15V	15H	8 H		8 H/16V
4020	16H	16V		8 V	
4040	17V	17H	9 H		9 H
4060	18H	18V		9 V	
4080	19V	19H	10H		10H/17V
4100	20H	20V		10V	
4120	21V	21H	11H		11 H
4140	22H	22V		11V	
4160	23V	23H	12H		12H/18V
4180	24H	24V		12V	

TRANSPONDER LOADING CHART

SATCOM C-1 139.0 W

TRANSPONDER	EMISSION	CAPACITY
1	TDMA - DIGITAL	
2	FDM/FM	161 Channels
3	FDM/FM	800 Plus
4	SCPC/FM	400 Plus
5	SCPC, QPSK, DIGITAL	
6	TV	
7	FDM/FM	Heavy Use
8	SCPC/FM	400 Plus
9	INACTIVE	
10	DIGITAL - SCPC/QPSK, SCPC/FM	
11	DIGITAL - QPSK SCPC	
12	DIGITAL - QPSK SCPC	
13	DIGITAL - QPSK SCPC	
14	DIGITAL - QPSK SCPC	
15	SCPC/FM	
16	SCPC/FM	Heavy Use
17	VIDEO - ENCRYPTED	
18	SCPC/FM - FDM	100 Plus
19	DIGITAL, SCPC	
20	DIGITAL, SCPC	
21	VIDEO	
22	FDM/FM	Heavy Use
23	SCPC	
24	VIDEO	

GALAXY 1 133.0 W

TRANSPONDER	EMISSION
1	VIDEO
2	VIDEO
3	VIDEO
4	VIDEO
5	VIDEO
6	VIDEO
7	VIDEO
8	VIDEO
9	VIDEO
10	VIDEO
11	VIDEO
12	VIDEO

TRANSPONDER LOADING CHART

(TELSTAR 303 CONT.)

TRANSPONDER	EMISSION
18	VIDEO
19	INACTIVE
20	INACTIVE
21	VIDEO
22	VIDEO
23	VIDEO
24	VIDEO

WESTAR 5 122.5 W

TRANSPONDER	EMISSION
1	VIDEO
2	VIDEO
3	VIDEO
4	VIDEO
5	VIDEO
6	VIDEO
7	VIDEO
8	VIDEO
9	SCPC
10	DIGITAL
11	VIDEO
12	SCPC
13	VIDEO
14	SCPC
15	VIDEO
16	VIDEO
17	VIDEO
18	VIDEO
19	DIGITAL
20	VIDEO
21	VIDEO
22	VIDEO
23	VIDEO
24	VIDEO

CHAPTER TWO

AUDIO SUBCARRIERS (SbC/FM)

AUDIO SUBCARRIERS ON SATELLITE TV

The video on satellite TV is frequency modulated (FM), and the audio is also FM. In the satellite field, the audio is transported from the uplink, through the satellite, to your receiver terminals as a "subcarrier." A subcarrier is an "extra" carrier, or signal, separated from the main carrier which transports the video modulation.

At the uplink transmitter, and at the output of your TVRO receiver, the video information occupies a "baseband" from approximately "0 MHz to 4.2 MHz." It is a mini-spectrum in itself. The frequency modulation spreads this baseband signal out for transportation to a wider spectrum. Because the video information baseband spectrum "stops" around 4.2 MHz, it is possible to add some additional information (modulation) if the added information functions on a frequency *higher than* the video information. See **Figure 2.0**.

At the uplink, additional carriers are created. Typically they will be 6.2 or 6.8 MHz, although in practice, worldwide *any frequency* between roughly 5.0 MHz and 8.0 MHz can be used for this purpose. In fact, several can be generated and carried along with the video signal. Russian gorizont transmissions often carry as many as four separate "audio subcarriers," one dedicated to each of four languages that may accompany the video program. See **Figure 2.1**.

At the receiver, the "higher-than-video" subcarrier frequencies are present through the full receiver, down to the output of the detector. There, using special combinations of low and high pass filters, the audio subcarriers are finally separated from the video. They are sent to a second detector, one that is specially tuned to extract their audio information from the frequency on which they operate, 6.8 MHz for example.

Some receivers supply a *tunable audio subcarrier detector.* This is actually a small FM (audio) receiver that may tune, for example, from 5.5 to 7.5 MHz; and as you turn the knob, you are tuning through that frequency range "searching for" audio subcarriers. Others supply two or more "present" audio subcarrier outputs and a panel switch that allows you to select which one of the present subcarrier frequencies you will hear.

Most of the cable programming services transmit their (program) audio on the "standard" subcarrier of 6.8 MHz. Many of the network feeds use the second "standard" subcarrier of 6.8 MHz for audio. Newer CATV multiple-audio-channel services, adding "stereo" to the satellite transmission, will use two or more audio subcarriers for that purpose, offering standard (non-stereo) audio on one subcarrier (6.8) and stereo audio on a pair of other subcarriers. (INTELSAT/GORIZONT feeds have their own "standard" feed for audio subcarriers: 5.8 MHz for western nations and 7.4 MHz for eastern block nations). A tunable audio subcarrier detector is recommended if you want to be sure to be equipped for all of the audio that may be "up there!"

The standard frequency plan provides up to four stereo channels, designated 1 through 4, in the baseband spectrum from 5.58 MHz to 7.56 MHz. The 6.8 MHz region is reserved for the television audio subcarrier. Other channel frequencies can be provided for special applications.

WHERE TO FIND THE AUDIO SUBCARRIERS

An accurate up-to-the-minute listing of all video and analog subcarrier audio programming services on the North American satellites is published six times a year, Jan-Feb, March-April, etc., by Westsat Communications—Satellite Channel Chart— Address: Box 434, Dept. HS, Pleasanton, CA 94566. A one-year subscription is $65. This publication gives all programming on the North American satellite channels, plus a very accurate listing of all active audio subcarrier services on each satellite. See **Figure 2.2B**.

SAT GUIDE'S yellow page section lists the main video satellites, along with each satellite's subcarrier auxiliary services each month. The majority of these services are in the audio subcarrier area. The information lists the name of the service, programming category, format, transmission form, along with other information.

A basic list of audio subcarriers is given in the following list:

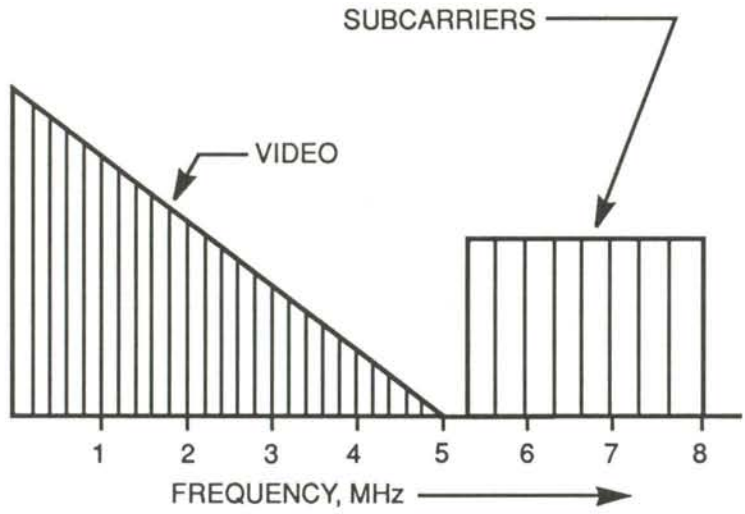


Figure 2.0 *The standard subcarrier frequency plan. 6.8 MHz for video sound with 8 more 15 kHz audio channels.*

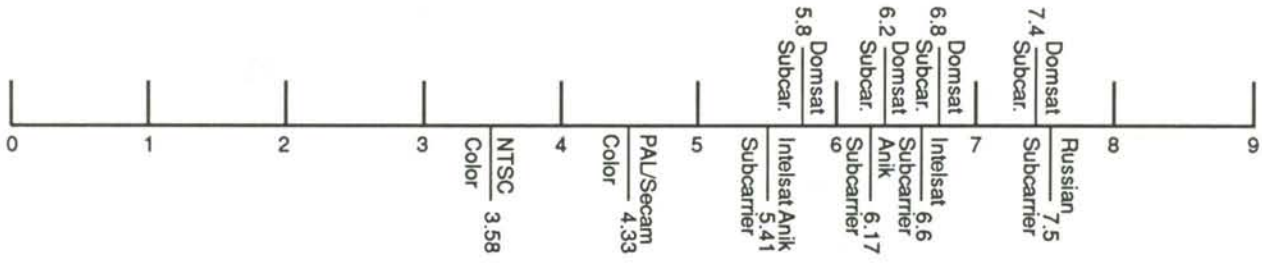


Figure 2.1 *The subcarrier spectrum.*

AUDIO SUBCARRIER SERVICES (SbC/FM)

GALAXY 1

TR-2 **WSM-AM**, Nashville, TN—(7.38/7.56 discrete stereo)

TR-3 **SEEBURG 1** (6.075 mono)
SEEBURG 2 (6.165 mono)

TR-7 **CNN RADIO NETWORK**—news radio feed (6.3)

TR-8 **CNN RADIO NETWORK**—news radio feed (6.3)

TR-11 **CBN RADIO NETWORK**—(6.12/6.30/6.48 discrete stereo)

TR-15 **WQXR-FM**—classical radio (6.3/6.48 discrete stereo)
THE GREEK NETWORK—Greek radio (7.33 mono)

SATCOM F-3R

TR-11 **CRN**—Cable Network (7.23 mono)

SATCOM F-1R

TR-11 **CRN**—Cable Network (7.2377 mono)

TR-14 **CBN RADIO NETWORK**—(6.3/6.48 discrete stereo)

TELSTAR 303

TR—5V(9) **SBCA INFORMATION NETWORK** (6.4)

WESTAR 5

TR-20 **WCCO-AM**—talk radio & news (6.2/7.695 mono)
KNOW AM—public radio news/talk (7.785 mono) (6.2 MONO)

SPACENET 1

TR-9(17) **INSTORE SATELLITE NETWORK**—(3.06/3.24/3.6/3.78/3.96/4.14/5.04/5.4/5.76/5.94/6.12/6.3/6.48/6.62/7.02/7.2/7.38/7.74/7.92/8.1/8.28/8.46 mono)
KISN-AM—talk radio (7.56)

MORELOS 1

TR-1N(2) **XEL-AM**, Mexico City (6.8/7.4)

TR-7N(14) **XEL-AM**, Mexico City—popular music (7.4)

ANIK D-2

TR-9A(17) **RADIO FRANCE INTERNATIONALE**-(5.41/6.12 mono)

ANIK D-1

TR-1B(2) **SELTECH**—radio programming (5.4/5.58 & 5.76/5.94 discrete stereo/7.515 mono)
CFNY-FM—Progressive rock (6.12/6.3 discrete stereo)
IBN (International Broadcast Network)—(7.605)
NEWSRADIO— (7.695/7.785)
STANDARD BROADCAST NEWS—(7.875)

TR-3B(6) **CHIN-AM**—multilingual popular music (6.845 mono)

TR-4B(8) **CHFI-FM**—MOR/Beautiful Music (6.8 mono)
TELEMEDIA BROADCAST SERVICES—(7.55)

TR-7B(14) **CITE-FM**—French music (5.76 mono)
CKAC—French music (6.435 mono)
CJMS-AM—French music (7.605 mono)

TR-8A(15) **RADIO CANADA**—(5.4/5.58/5.76 discrete stereo)

TR-8B(16) **CBC STEREO RADIO/FRENCH** (5.4/5.58 discrete stereo)
CBC STEREO RADIO/ENGLISH (5.76/5.94 discrete stereo)

TR-9B(18) **CJFW-FM**—country & western music (5.435 mono)
CKRW-AM—country & western music (6.8 mono)
CISN-FM—country & western (7.515/7.605) discrete stereo
CIRK-FM—progressive rock (7.785 mono)

CFWE-FM—country, pop, jazz music (7.875 mono)

TR-10B(20) **CBC STEREO RADIO/FRENCH** (5.4/5.58 discrete stereo)
CBM-AM—CBC Radio English Network (6.12 mono)

TR-11A(21) **CKNM-FM**—country & western/ rock music (5.41/6.8 mono)

TR-11B(22) **CBC STEREO RADIO/ENGLISH** (5.76/5.94 discrete stereo)
CBU-AM—CBC Radio English Network (7.425 mono)
HORIZON—music service (7.605 mono)

TR-12A(23) **CHON-FM**—country & western/ rock music (5.41/6.8)
CKRW-AM—country & western music (5.41/6.8 mono)
VOCM-AM—contemporary music (6.17 mono)

TR-12B(24) **CBC STEREO RADIO/FRENCH** (5.4/5.58 discrete stereo)
CBC STEREO RADIO/ENGLISH (5.76/5.94 discrete stereo)

GALAXY 3

TR-7 **SOUTHERN GOSPEL RADIO**—gospel music (5.445 mono)
KPLX-FM—country & western (5.58)
YESTERDAY USA SUPERSTATION-nostalgia radio progams (5.76 mono)
CHN (Hispanic News)—music, news & variety (5.94)
ACTS RADIO—religious (7.38 mono)

TR-8 **WCCO-AM**—talk, news radio (7.875)
BRN (Business Radio Network) (8.055 mono)
KNOW-AM—public radio news, talk (8.235)
IN TOUCH Reading for the blind (7.875)

TR-11 **SUPERADIO/AMERICA'S COUNTRY FAVORITES**—country music (5.04/7.74 discrete stereo)
SUPERADIO/PRIME DEMO—soft rock radio (5.22/5.4 discrete stereo)
SUPERADIO/SOFT SOUNDS—easy listening, big band (5.58/5.76 discrete stereo)

TR-2(3) **WROL-AM**—religious music (6.2 mono)

TR-3(5) **USA RADIO NETWORK** (5.76/5.94/6.12 mono)
CBN RADIO NETWORK (6.2/6.48)
NORTH AMERICA ONE (6.8 mono)

TR-5(9) **CNN RADIO NETWORK**—news radio (5.625 mono)
TRANSTAR III RADIO NETWORK—country & western music (5.76/5.94 discrete stereo)
NATIONAL BLACK NETWORK (6.3/6.48 discrete stereo)
C-SAT—home TVRO talk show (6.8 mono)

TR-7(13) **VCY AMERICA**—religious (.51)
SATELLITE MUSIC NETWORK—modern rock (1.05/1.59 discrete stereo)
SATELLITE MUSIC NETWORK/ Z ROCK—rock music (1.23/1.41 discrete stereo)
MOODY BROADCASTING NETWORK—religious (1.77/4.29 discrete stereo)
FARMER'S GRAIN & LIVESTOCK—agriculture information service (2.0175 mono)
SATELLITE MUSIC NETWORK/ STARDUST—MOR music format (2.13/2.31 discrete stereo)
SATELLITE MUSIC NETWORK/ HEART & SOUL—nostalgia music (2.49/2.67 discrete stereo)
SATELLITE MUSIC NETWORK/ PURE GOLD—golden oldies (2.85/3.03 discrete stereo)
SATELLITE MUSIC NETWORK/ THE WAVE—new age/jazz music (3.21/3.29 discrete stereo)
SATELLITE MUSIC NETWORK/ COUNTRY COAST-TO-COAST—modern country (3.57/3.75 discrete stereo)
SATELLITE MUSIC NETWORK/ STARSTATION—adult contemporary (3.93/4.11 discrete stereo)
AMBASSADOR RADIO—religious (4.47/4.65 discrete stereo)

INTERNATIONAL BROADCAST NETWORK (4.83 mono)
USA RADIO NETWORK (5.01/5.2 mono)

TR-8(15) **KLON-FM**—jazz music (5.58/5.76 discrete stereo)
AMBASSADOR RADIO—religious (5.94/6.3/6.48 mono)

TR-9(17) **SUN RADIO NETWORK** (1.05 mono)
SKYLIGHT—religious (.177/4.29 discrete stereo)
POP (Point of Purchase Radio Network) (.15/.915/2.265/2.355/2.445/2.535/2.625/2.715/2.805/2.895/4.155)
SATELLITE MUSIC NETWORK—golden oldies (3.21/3.39 discrete stereo)
SATELLITE MUSIC NETWORK/COUNTRY—country & western music (3.57/3.75 discrete stereo)
U.S. ADVERTISING (4.0425 mono)
AMBASSADOR RADIO—religious (4.47 mono)

SATCOM 4

TR-3 **RAI RADIO NET**—Italian Radio (7.38)
TR-5 **WRVL-FM**—religious (7.38 mono)
TR-8 **TIDEWATER RADIO NETWORK**—black religious programming (5.58/5.76 discrete stereo)
UNITED VIDEO BACKGROUND MUSIC (5.895 mono)
SOS RADIO NETWORK (KILA-FM) Las Vegas, NV—Christian music (7.38/7.56 discrete stereo)
TR-15 **LIN**—religious (5.81 mono)
YESTERDAY USA SUPERSTATION-nostalgia radio (6.2)
TR-21 **YESTERDAY USA SUPERSTATION**—nostalgia radio (6.2)
TR-23 **WMJX-FM**—soft rock (6.2)

SATCOM F-2R

TR-11 **WCIE-FM**—Christian radio (7.2/7.38 discrete stereo)
TR-22 **SUN RADIO NETWORK** (5.445)

SPACENET 2

TR-13L(2) **KUVC-FM**—Public radio (5.76/5.94 discrete stereo)
RADIO TALKING BOOK—Book and newspaper reading for the blind. (6.48 mono)
TR-12(23) **RADIO FRANCE INTERNATIONAL** (5.8 mono)

EQUIPMENT TO RECEIVE STEREO AUDIO SUBCARRIERS

Most modern satellite receivers now come equipped with tunable subcarrier control that will cover the entire audio subcarrier spectrum, 5 to 8 MHz in the monaural code, so the tuning of any subcarrier in mono mode is a simple matter of knowing what satellites and their transponders carry the audio subcarriers as an auxiliary service. Refer to the subcarrier list.

The second step in audio subcarrier recovery is the addition of one of the new stereo processors. Many receiver manufacturers now produce quality stereo units at a reasonable cost. Refer to **Figure 2.3** for details on the popular KLM Stereo Processor. The Drake stereo unit also produces studio quality stereo from all stereo audio subcarriers. See **Figure 2.4**.

The basic hookup of these stereo units is very simple and is covered in all of the user's manuals. Most stereo units are hooked up using easily obtainable audio cables with RCA fittings. The entire hookup to the satellite receiver takes only 15 minutes.

These stereo units produce exceptional sound when used in conjunction with high quality stereo amplifiers and a good set of quality speakers. Believe me, the sound is out of this world and well worth the added cost of any of the quality stereo processors. **Figure 2.5** shows a simple stereo hookup for your present stereo system.

Stand-alone stereo processors which are no longer manufactured can be obtained at satellite dealers at very reasonable prices. I have found units for as little as $25.00 to $30.00.

STEREO AND THE NEW SELF-CONTAINED IRD SATELLITE RECEIVERS

Several years ago most satellite receiver manufacturers built the newer IRD units which now incorporate the complete satellite system in one package, the dish actuating system, stereo system, satellite receiver and VC-II Plus encryption unit.

These IRD units work very well and produce high-quality audio (stereo and mono). The one slight drawback to the IRD unit is that these all-in-one units carry the audio subcarrier information in the system's memory bank. To change audio subcarriers, the user must go into the system and constantly reset the subcarrier frequency of the main satellite video and audio subcarrier each time one wishes to tune in other subcarriers on a satellite. This procedure was a bother to me so I recently purchased a well-known stereo processor from a mail order house for $29.00. This unit is very much like several units in this chapter.

Here is what I did with my $29.00 stereo processor. I simply placed a "Y" audio connection from my new IRD satellite receiver at the composite video output and plugged this into the stereo processor which now gives me complete knob-tuning capabilities on all of the subcarriers, both mono and stereo.

I now have an additional audio system with great flexibility, and I use it every day for good music and other subcarrier uses (and with no commercials).

After this new subcarrier system was set up, I ran a cable down stairs for a second stereo processor for music in my office, this took place after a visit to a local satellite dealer who had no fewer than seven good, high-quality, working stereo processors he was going to junk. My cost for three of the best units was only six dollars each! He was glad to get rid of them, and guess what I am going to do with them?

MY NON-VIDEO SATELLITE SYSTEM

I have three great stereo/mono processors to use in this system. Another trip to a dealer turned up two good Drake ESR-324, 70 MHz satellite receivers at $10.00 each and a small six-foot dish for $20.00 which completes my audio satellite system for my office all for under $50.00. All of this is hooked up to a stereo amplifier/tuner for a great second system.

I have found that dealers have so much of this kind of equipment, they do not know what to do with it. Make trips to several dealers in your area, they will be happy to part with these good workable units for a few dollars. With the introduction of the microprocessor IRD units, thousands of TVRO owners have upgraded their systems and have simply let the dealers cart away the old 70 MHz systems.

I still like the old equipment because there are so many things one can do with these units. The same goes for SCPC work. This equipment (70 MHz center) can be used for audio subcarrier systems at little cost. They can also be used on SCPC systems because the scanners and receivers used in SCPC work are inexpensive (because they only tune from 50 MHz to 90 MHz) so any scanner that tunes this range will work well.

Finally, do not look down on some of the older 70 MHz receivers or the older units that are no longer manufactured. What about service on these units? Just buy an extra one for a few dollars as a spare. Get the point? See **Figure 2.2A** for a piggy-back stereo subcarrier hookup from a modern IRD receiver.

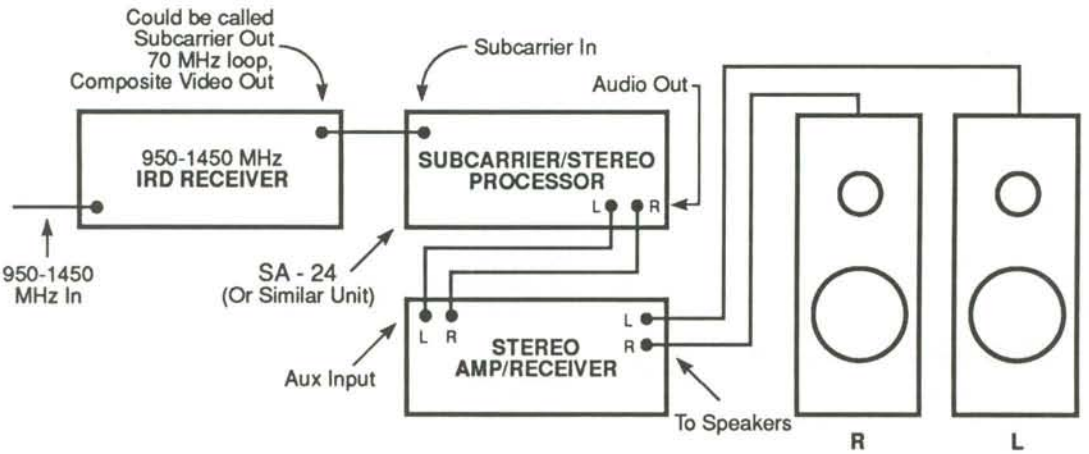


Figure 2.2A Piggy-back subcarrier processor hookup to modern 950-1450 MHz block IRD satellite receiver.

THE OFFICIAL WESTSAT COMMUNICATIONS SATELLITE CHANNEL CHART®

THE MOST ACCURATE AND UP-TO-THE-MINUTE LISTING OF ALL VIDEO, SCPC, DATS & ANALOG SUBCARRIER AUDIO PROGRAMMING SERVICES ON THE NORTH AMERICAN C & KU BAND SATELLITES

Vol. 11, No. 2

HUGHES GALAXY 1 (134°W)



Polarization: ODD—Horizontal EVEN—Vertical

TR—1 **THE COMEDY CHANNEL**—24 hr/day all-comedy programming (fully encrypted/ GI VIDEOCIPHER II)(ends 3-31-91)
CTV: THE COMEDY NETWORK—24 hr/day all-comedy programming (East) (fully encrypted/ GI VIDEOCIPHER II) (begins 4-1-91)

TR—2 **THE NASHVILLE NETWORK**—premium country music/entertainment (fully encrypted/GI VIDEOCIPHER II)

TR—3 **WGN-TV,** Chicago—Midwest's leading independent station (fully encrypted/GI VIDEOCIPHER II)

TR—4 **THE DISNEY CHANNEL** (East)—premium family entertainment from the Disney studios (fully encrypted/ GI VIDEOCIPHER II)

TR—5 **SHOWTIME** (East)—first-run movies & entertainment specials (fully encrypted/GI VIDEOCIPHER II)

TR—6 **ESPN BLACKOUT NETWORK & PROMO CHANNEL**—part-time alternate sports programming for regional blackout applications (fully encrypted/GI VIDEOCIPHER II)

TR—7 **CNN** (Cable News Network)—24 hr/day news (fully encrypted GI VIDEOCIPHER II)

TR—8 **CNN HEADLINE NEWS**—CNN newsbrief headline service (fully encrypted/GI VIDEOCIPHER II)

TR—9 **ESPN**—24 hr/day sports programming/Nation's Business News (fully encrypted/GI VIDEOCIPHER II)

TR—10 **THE MOVIE CHANNEL** (East)—24 hr/day first-run movies (fully encrypted/GI VIDEOCIPHER II)

TR—11 **THE FAMILY CHANNEL** (East)—religious/general family entertainment (fully encrypted/GI VIDEOCIPHER II)

TR—12 **A & E CABLE NETWORK**—performing & cultural arts programming (fully encrypted/GI VIDEOCIPHER II)

TR—13 **CMTV** (Country Music Television)—country music videos (5.58 & 5.76 discrete stereo/6.8 mono)

TR—14 **THE MOVIE CHANNEL** (West)—24 hr/day first run movies (fully encrypted/GI VIDEOCIPHER II)

TR—15 **WWOR-TV,** Secaucus, New Jersey—the Northeast's top-rated independent station (fully encrypted/ GI VIDEOCIPHER II)

TR—16 **SHOWTIME** (West)—first run movies & entertainment specials (fully encrypted/GI VIDEOCIPHER II)

TR—17 **TNT** (Turner Network Television)—classic movies entertainment service (fully encrypted/GI VIDEOCIPHER II)

TR—18 **SUPERSTATION TBS**—Ted Turner's Superstation from Atlanta (fully encrypted/GI VIDEOCIPHER II)

TR—19 **HOME BOX OFFICE CINEMAX** (East)—time-structured HBO (fully encrypted/GI VIDEOCIPHER II)

TR—20 **GALAVISION**—premium Spanish oriented entertainment programming (6.2/6.8)

TR—21 **USA NETWORK** (East)—syndicated variety and sports events programming (fully encrypted/GI VIDEOCIPHER II)

TR—22 **DISCOVERY NETWORK**—science/nature documentary programming (fully encrypted/GI VIDEOCIPHER II)
VIDEO SHOPPING MALL—Shop-at-home service (6.2/6.8)

TR—23 **HBO** (Home Box Office) (East)—first run movies, sports events and entertainment specials (fully encrypted/GI VIDEOCIPHER II)

TR—24 **THE DISNEY CHANNEL** (West)—premium family entertainment from the Disney studios (fully encrypted/GI/VIDEOCIPHER II)

Subcarrier Audio Services on GALAXY 1

TR—2 **WSM-AM,** Nashville TN—country & western music format (7.38/7.56 discrete stereo)

TR—3 **AEI 1**—easy listening background music (6.075 mono)
AEI 2—easy listening background music (6.165 mono)
WFMT-FM, Chicago—fine arts/classical radio (6.3/6.48 discrete stereo)

TR—7 **CNN RADIO NETWORK**—all news radio feed (6 3)

TR—8 **CNN RADIO NETWORK**—all news radio feed (6.3)

TR—11 **CBN RADIO NETWORK** (6.12/6.30/6.48 discrete stereo)

TR—15 **WQXR-FM,** New York—classical radio format (6.3/6.48 discrete stereo)

Figure 2.2B

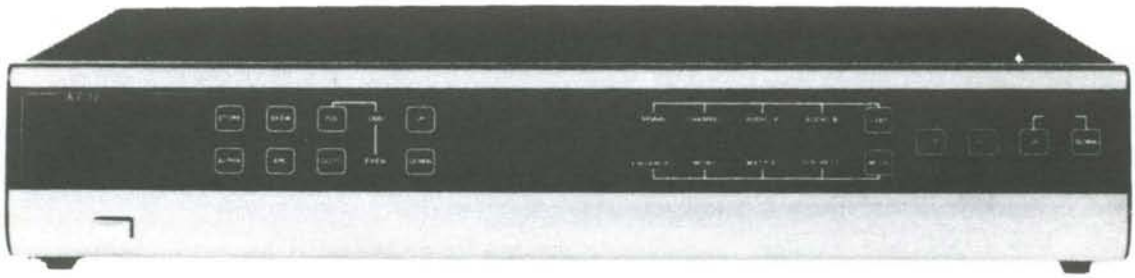


Figure 2.3 *KLM receiver with full stereo capabilities.*
These units are no longer being manufactured but are on the used market at very low prices.

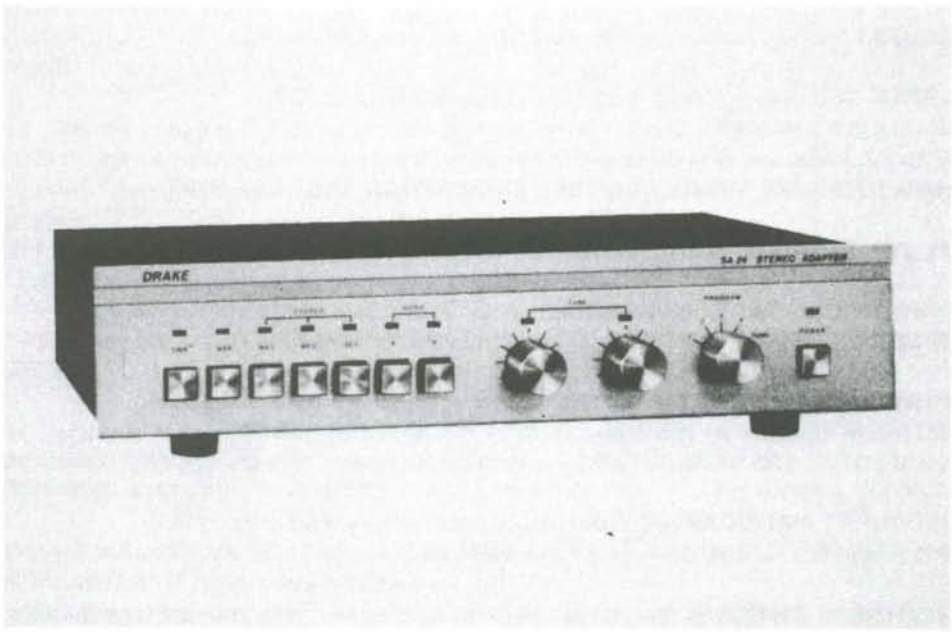


Figure 2.4 *Drake Stereo Unit*
These units can be found at your dealers at low prices.

The latest trend in TVRO receivers is the self-contained stereo processor, satellite receiver with stereo audio subcarrier all in one package.

DRAKE SA-24 STEREO ADAPTER

This modern stereo unit is very "user friendly" and simple to hookup to almost any TVRO receiver that has the subcarrier output to make the proper connection to this unit. This must be composite video or baseband output.

If you enjoy the Nashville Network, the Movie Channel, the Disney Channel, MTV, or ESPN, you can receive beautiful stereo sound to complement your great video. These networks carry stereo audio signals that can be used with your present HI-FI stereo gear. It is a real pleasure to enjoy full stereo sound that accompanies most of the most motion pictures being shown on satellite TV.

In addition to the main service carried on the subcarriers, you will find many enjoyable sound and music services such as country and western, classical, jazz, music of the 50's and 60's' plus much more.

The Drake SA-24 processes the three methods used to broadcast stereo over satellite. The first is the Matrix Method which uses two separate subcarriers, one subcarrier for the right channel and another for the left channel.

The second method is Multiplex Stereo which, utilizes an FM subcarrier for left *plus* right audio and a double sideband suppressed AM subcarrier for the left minus right stereo signal. Within this system is a synchronizing signal that is used for a stereo demodulator reference.

The third system is the Discrete Method, and in this system, the right channel is transmitted on one subcarrier, the left channel is on another subcarrier, with a third subcarrier containing the audio intelligence.

The Drake SA-24 unit processes the three stereo systems, plus the monaural as well, and has the following front panel controls. See **Figure 2.6**.

DNR —	Dynamic Noise Reduction System to Reduce Background Hiss
NAR —	Narrow Filter on IF
MAT —	Selects Matrix Stereo Decoding Circuits
MPX —	Multiplex Mode Switch
SEP —	Separate Mode — Selects Discrete Stereo Mode
MONO-A —	Selects A Tuning Control
MONO-B —	Selects B Tuning Control
TUNE A —	Subcarrier Tune Channel A
TUNE B —	Subcarrier Tune Channel B
PROGRAM —	Selects One of Four Preset Channels, or Tune
POWER-SWITCH	Switches AC Power On and Off

REAR PANEL

Power Cord	
Slow Blow Fuse Holder	
Subcarrier —	In
Subcarrier —	Out
A/L —	Audio To Left Channel Amplifier
A/R —	Audio To Right Channel Amplifier

DRAKE SA-24 SPECIFICATIONS

IF FREQUENCY	10.7 MHz
IF BANDWIDTH	150 or 500 KHz
TUNING RANGE	5.5 to 8.0 MHz
INPUT IMPEDANCE	72 Ohms
SENSITIVITY	25 Microseconds
	75 Microseconds Multiplex
FREQUENCY RESPONSE	15 Hz — 15 KHz
HARMONIC DISTORTION	<1% THD

OUTPUT	
IMPEDANCE	600 Ohms Unbalanced
OUTPUT LEVEL	250 Microvolts, Nominal

This unit performs very well, has a nice appearance, comes with a well-written user instruction book, and all in all is a nice sounding unit. Available on the used market.

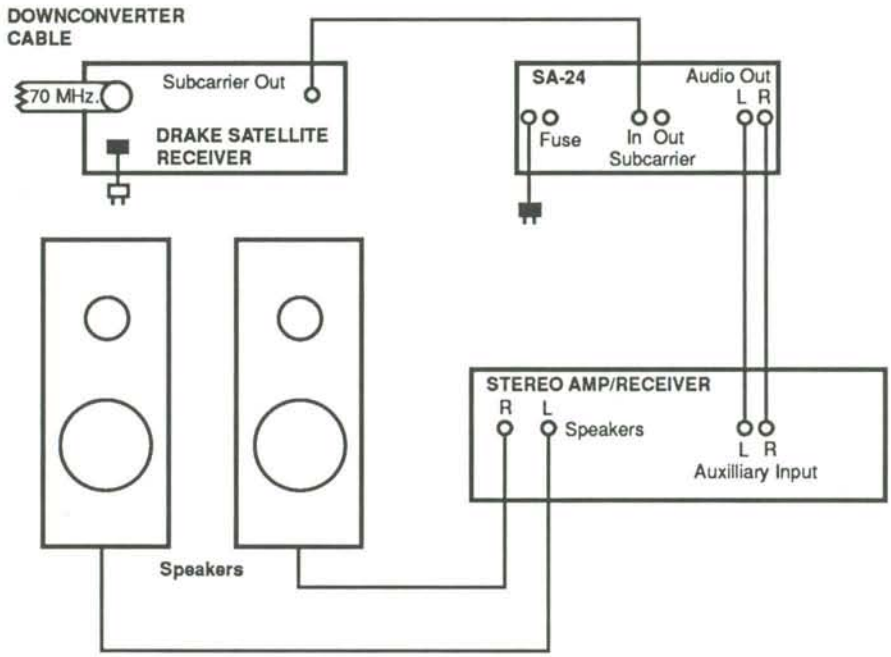


Figure 2.5 *Satellite Stereo Hookup*

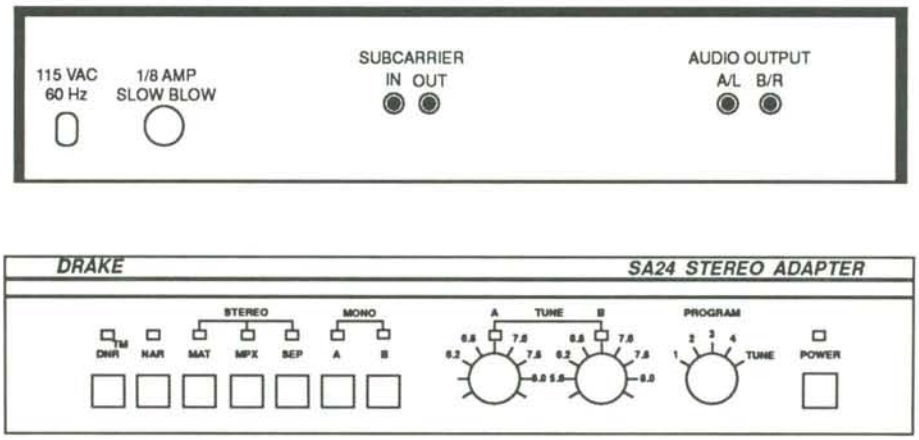


Figure 2.6 *Front controls and rear panel connections on Drake SA-24 Stereo Unit.*

MASPRO SSP-1 STEREO PROCESSOR

USS/Maspro receiver will permit you to see a brilliant satellite picture and hear the same brilliance in stereo sound.

The SSP-1's continual adjustment deviation control will also allow you to receive a vast variety of narrow to wide audio subcarrier signals that you are not able to receive on either AM or FM bands. You will open an entirely new world of audio entertainment with the SSP-1.

The SSP-1 will serve as a tuning link to your stereo system. It will allow you to use your existing amplifier and speaker system to produce the same high quality stereo sounds you are receiving from your stereo tuner, tapes, or records.

The SSP-1 utilizes three LED lights for extremely user friendly and exact tuning. Simply locate the subcarrier signal desired, (the lights indicate when the signal is most efficiently tuned). And, the SSP-1 incorporates an automatic AFC control for the lowest signal distortion possible.

To provide extremely low-noise audio reception the SSP-1 employs a noise reduction circuit that allows the total enjoyment of soft and solo performances without the annoying static and hiss commonly found with tapes, records or FM stereo reception. **Figure 2.7** and **Figure 2.8**.

ARUNTA SSP-318 STEREO PROCESSOR

Arunta's Stereo Processor series now in its fifth generation remains the state-of-the-art in stereo audio processing. Adaptable to any receiver the SSP-318 decodes audio transmissions in monaural, multiplex, adaptive deviation multiplex, matrix and discrete formats.

Twin frequency agile tuners cover the audio spectrum from 5.0 to 8.5 MHz and bandwidth selectors with automatic deviation circuitry handle all popular ranges. The dual center tuning meters simplify audio tuning. Dynamic noise reduction, dynamic range expansion, drift-free AFC, and Canadian low pass filtering complement the advanced audio circuitry. Compact 9.5" W x 2.5" H x 10.25" D size and attractive brushed aluminum and black insert face panel. **Figure 2.8**.

SSP-318 features are:

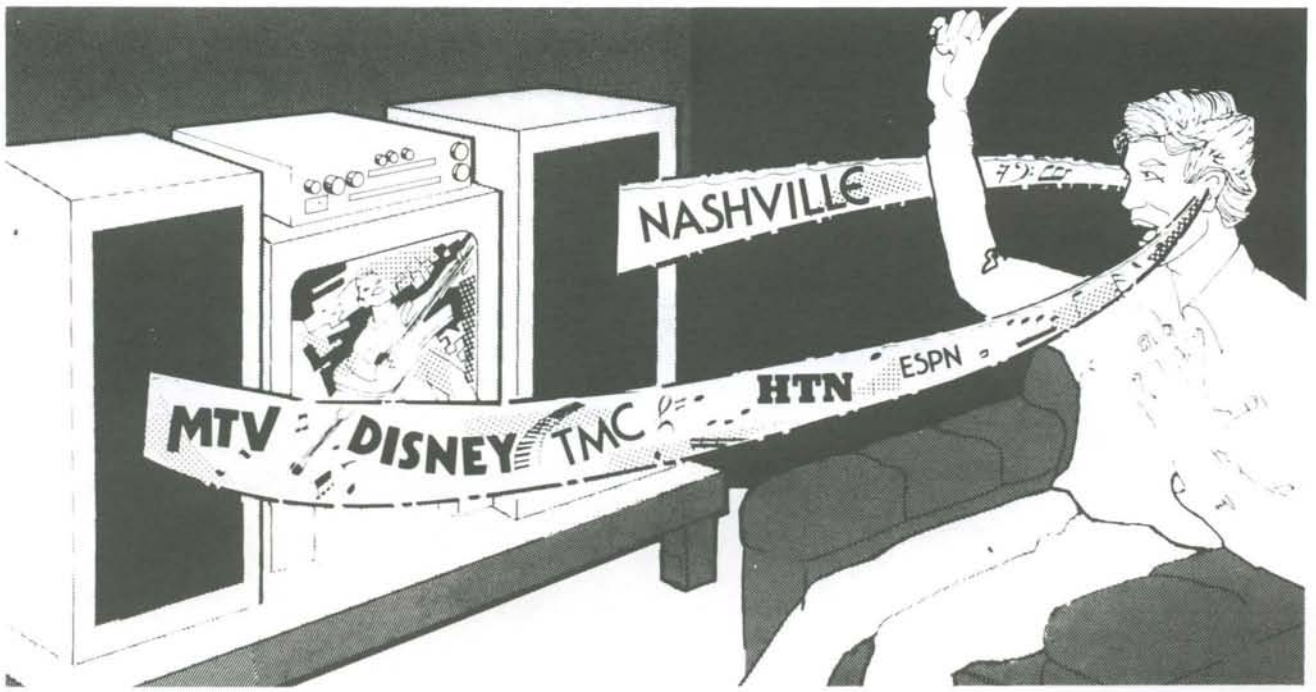
- Solid State IC Circuitry
- Drift-free AFC
- Fully tunable from 5.3 mHz to 8.5 mHz
- Loop-through composite video interface
- Multiplex stereo indicator light
- Single or Dual subcarrier demodulation
- Matrix or Discrete mixing
- Left, Right, Monaural channel outputs
- Narrow or Wide I.F. deviation selection
- Dynamic range expansion
- Canadian Filter
- Twin center tuning meters
- Automatic Volume Compensation
- DNR



Figure 2.7 *NSS/MASPRO SSP-1 Stereo Processor. One of the better units.*

Stereo Mode	Discrete	Matrix	Multiplex
Frequency Range		5 to 8 MHz	
Input Level		More than 50 dBm	
Deviation Control Range		75 to 300 KHz	
		(Continuously)	
Separation (at 1 KHz)	More than 50 dB	More than 40 dB	
Distortion (at 1 KHz,	Less than 0.05%	Less than 0.08%	Less than 0.1%
75 KHz deviation)			
S/N (CCIR-weighted	More than 50 dB		More than 45 dB
at 16 dB C/N			
75 KHz deviation)			
Audio Frequency Response	20 Hz to 20 KHz		20 Hz to 10 KHz
Noise Reduction		10 dB	
Power Consumption		6W at 117V AC/60 Hz	
Operating Temperature		32° to 104°F	
		(0° to 40°C)	
Dimensions (H x W x D)		2.76" x 15.75" x 9.53"	
		(70 x 400 x 242 mm)	
Weight		Approx. 6.6 lbs. (3 kg)	

Figure 2.8 *MASPRO SSP-1 Stereo Processor specifications.*



Excitement grows when you hear satellite TV stereo sound.
Courtesy, Learning Industries



Figure 2.8 *Arunta SSP-318 Stereo Processor*

THE FOUR BASIC STEREO FORMATS USED ON SATELLITE TRANSPONDERS

There are four basic stereo formats used on satellite transponders, plus the normal monaural sound found on most subcarriers used as the audio section for the video programming on each transponder. We will cover these four stereo formats as follows: (a) the Multiplex System — by Learning Industries, (b) the Sum/Difference System, known as the Warner-Amex System (Matrix), (c) the Discrete Format — or Wegener System, and (d) the Times Mirror Stereo Transmission — similar to the Wegener System, except that the Wegener System uses very narrow deviation. The Times Mirror System will be treated as a basic Wegener System — Discrete.

STEREO SYSTEMS — FORMAT

SYSTEM	FORMAT	NAMES USED
Learning Industries	Multiplex	Multiplex
Warner Amex System	Sum/Difference	Matrix SEP - A and A+
Wegener System	Discrete	Discrete
Times Mirror System	Discrete	Discrete

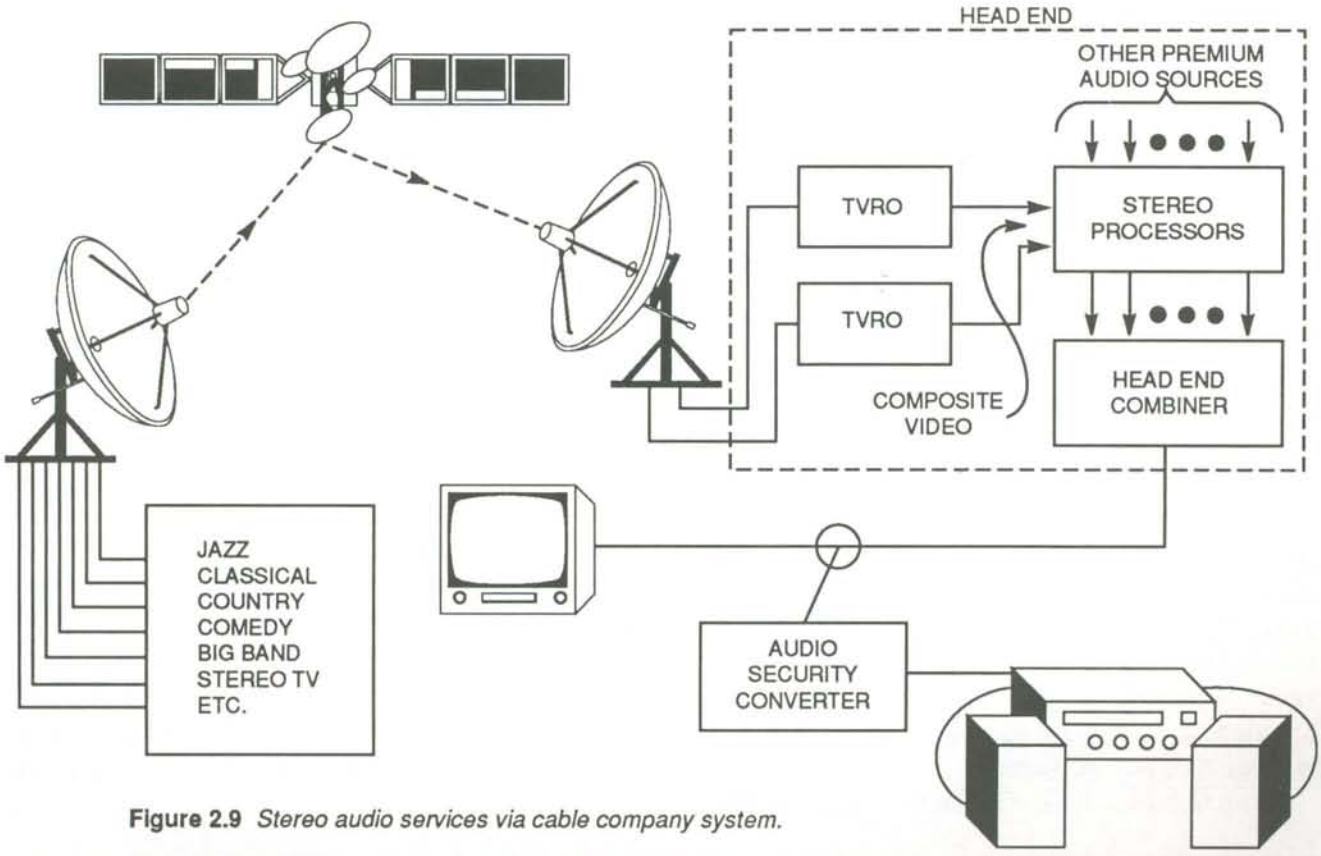


Figure 2.9 *Stereo audio services via cable company system.*

MATRIX — MULTIPLEX AND DISCRETE FORMATS

Matrix Format

The Matrix (Warner-Amex) uses a dual subcarrier system for transmission of the stereo services. Left channel plus right channel audio is transmitted on one subcarrier and the left channel minus the right channel audio is transmitted on another subcarrier. Peak deviations of ± 200 kHz are used on each subcarrier. The main carrier deviation by the subcarrier is about 2 MHz.

The two subcarriers each employ 75 microseconds of pre-emphasis and deemphasis. The design of this system is such that remodulation on FM with 75 microsecond pre-emphasis will make the signal almost identical to a dolby-FM broadcast. See **Figure 2.10** for a typical CATV receiving set-up.

All of the stereo processors do a good job of processing the matrix stereo signals on the transponders. Most units have three controls; you would select matrix (MAT) on the popular Drake SA-24 unit.

Multiplex Format

The Multiplex Format (Leaming Industries) provides two audio channels on a single multiplexed subcarrier within the subcarrier region.

The audio baseband is of the conventional FM stereo broadcast format, with additional constraints. The left plus right (L + R) audio is sent from 50 to 15 kHz. The left minus right (L - R) is then transmitted as a double sideband suppressed carrier signal centered at 38 kHz; also transmitted is a 19 kHz pilot/signal. This pilot/signal eliminates the need to regenerate a pilot at the receiver end. The deviation on the subcarrier is ± 400 kHz; this composite multiplex subcarrier is then used to modulate the main carrier levels of 3 to 4 MHz peak deviation.

Signal reception then goes through these steps: First, demodulation of the composite wideband subcarrier, then baseband composite deemphasis and re-modulation of the FM band carrier by composite signal.

A switchable "whistle filter" is used to eliminate any audible beat notes that could occur between the 15.734 kHz sync multiples and the 19 kHz pilot/signal. This "whistle filter" has deep notches at the baseband at 15.734, 31.468 and 47.202 kHz points to prevent beats from forming.

The Multiplex System is used widely on the 5.8 and 6.8 MHz segment by Home Theater Network (HTN); also by BRAVO Service. See **Figure 2.11**, Leaming Composite Subcarrier Stereo System.

DISCRETE FORMAT Wegener Communications

This popular format was introduced in 1981 and has found wide use in the industry. The basic system transmits a discrete left and right audio as individual low level subcarriers. These subcarrier levels, deviation and spacing have been optimized for good spectrum efficiency, consistent with full-range fidelity program quality. With the Wegener System, it is possible to transmit eight monaural or four stereo pairs in the subcarrier carrier area along with the video and the regular 6.8 MHz program audio.

Since the levels of these subcarriers are 4 to 6 dB lower than the recovered 6.8 MHz program audio, the spacing is only 180 kHz and subcarrier deviations of only ± 50 kHz are used.

The conventional TVRO subcarrier demodulator does not provide satisfactory reception of these low levels signals, consequently a stereo processor must be used to optimize the signal. See **Figure 2.0** for this Standard Frequency Plan. The Wegener System is the Series 1600 Audio Transmission System. For further information, see **Figure 2.12** Standard Discrete Frequency Plan: also **Figure 2.13** on the Wegener 1600 FM Stereo Transmission System.

In summary, in the hookup of any of the systems covered in Chapter One, an important point must be made. The type of video output from the satellite receiver must be the correct one. What is this? There is more than one type of video output? Yes, there can be — it all depends on your receiver. The correct video output or port is the one that contains *the entire baseband video in an unfiltered, unclamped condition with video deemphasis.* Such a port is usually called and labeled *composite out*. Some receivers have two video out ports — as we said, the correct one is *composite video out.*

If there is a video out port, this will have video with clamping and video deemphasis. Also, this port will contain additional filtering to roll off the high end of the baseband above 4.2 MHz.

If in doubt, consult the Owner's Manual or your dealer to determine which connection will give you the correct *composite video out*. When a receiver does not have a proper composite video out port, one can be added to the back of your set by any dealer in a few minutes with several small parts. You may also want to consult the receiver manufacturer if your dealer is not close at hand. See **Figure 2.14**.

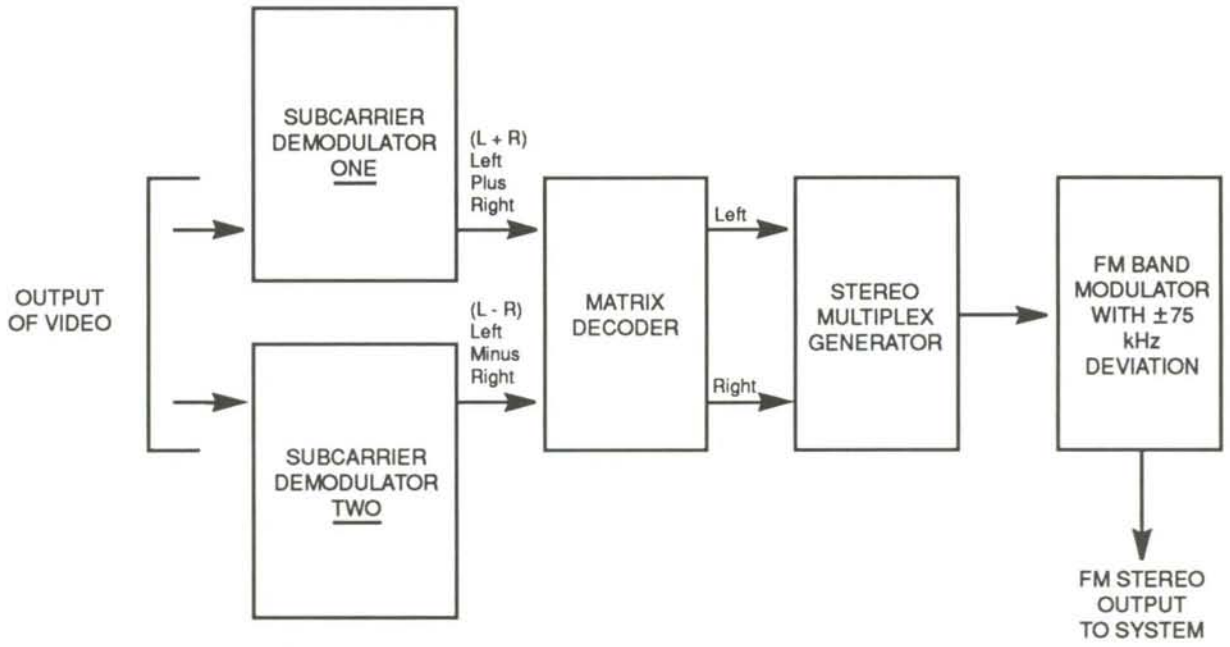


Figure 2.10 *Warner Amex System used in a CATV plant.*

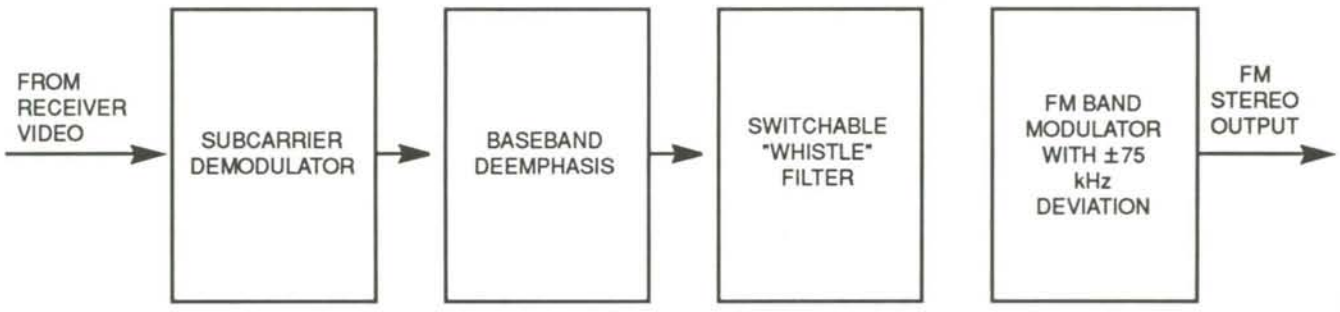


Figure 2.11 *Learning composite subcarrier stereo system.*

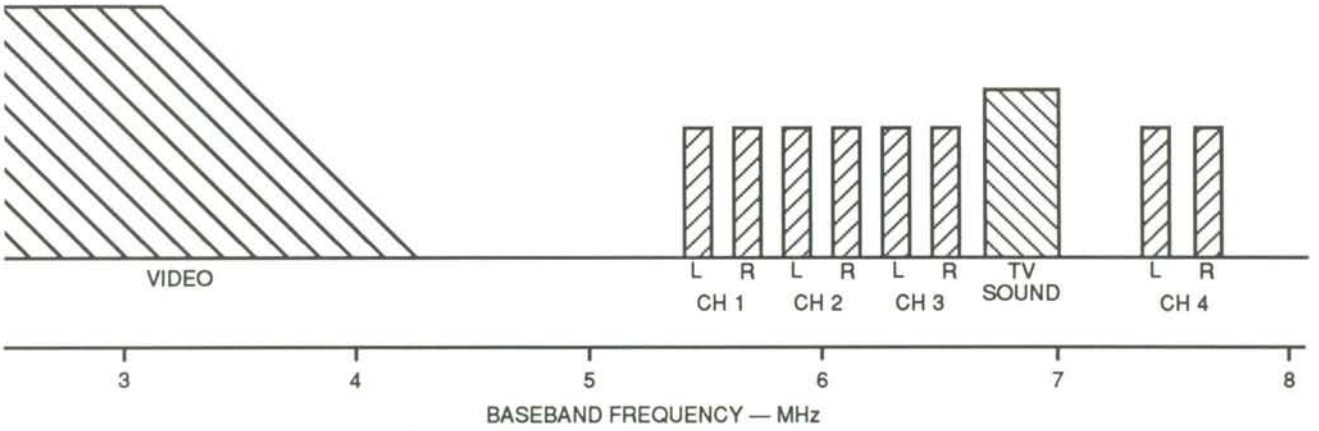


Figure 2.12 *Standard stereo discrete subcarrier plan.*

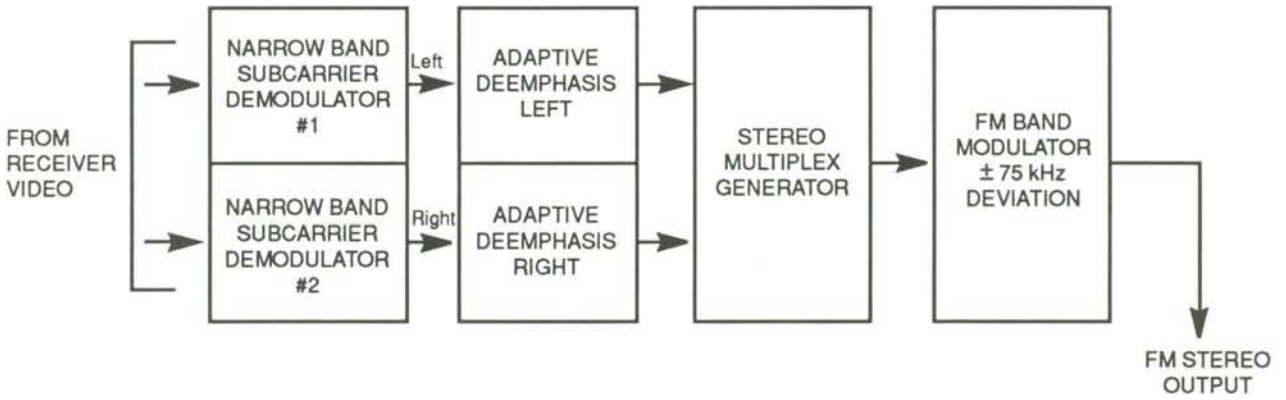


Figure 2.13 *Wegener 1600 FM stereo transmission system (discrete)*
Courtesy Wegener Communications

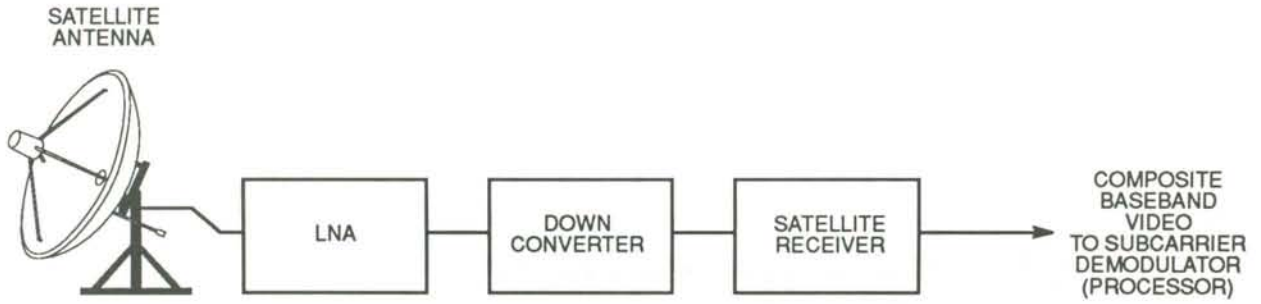


Figure 2.14 *The basic satellite receiver must provide wideband baseband signal.*

OPTIMIZING SUBCARRIERS FOR SATELLITE TRANSMISSION

ABSTRACT

The use of subcarriers to deliver auxiliary services has evolved rapidly in the cable television satellite distribution network. Employing spectrum efficient transmission techniques when adding subcarriers over video can greatly increase the information throughout of the satellite channel while minimizing impact on the primary video service. This paper discusses the conceptual basis and practical aspects of the new subcarrier technology.

INTRODUCTION

The CATV industry in the last six years has created a vast communications network linked by satellite that can deliver entertainment and information to over half the homes in the United States. As a result of new technology, the satellite network can be a source of even more services to the home such as high quality audio, slow scan video, and data. In today's CATV satellite distribution system, the availability of auxiliary services can provide an additional incentive for new customers to subscribe.

STANDARD SUBCARRIERS

Canada pioneered domestic distribution of video via satellite and used a single 6.8 MHz subcarrier above video to carry three multiplexed audio channels. When satellite delivered video service was introduced to the CATV industry in 1975, the single 6.8 MHz TV sound subcarrier format was adopted by the industry as the standard. Use of additional subcarriers to provide auxiliary services soon followed. Southern Satellite Systems introduced the UPI Newstime service in 1978 using two subcarriers in addition to the standard 6.8 MHz subcarrier.

The fact that three subcarriers could successfully be transmitted along with video led to consideration of further channel expansion. The initial expansion took the form of adding multiplexed channels to the three subcarrier scheme. Multiplexing permitted channels to be added without increasing subcarrier power, thereby improving the efficiency of subcarrier power utilization. Compandors were used in the multiplexed channels to reduce the subcarrier bandwidth. This evolution was a major step toward the concept of spectrum efficient subcarriers.

Although these techniques increased spectrum efficiency for narrow bandwidth channels, conventional multiplexing could not provide many high quality 15 kHz audio channels. This led to the development of narrow bandwidth, low deviation subcarriers for transmission of high quality audio.

SPECTRUM EFFICIENT SUBCARRIERS

There is not a precise definition of a spectrum efficient subcarrier, but there are some guidelines that may be applied. The baseband spectrum that may be used for subcarrier transmission is limited, approximately bounded by 5.4 MHz on the low end and 8.0 MHz on the high end. The subcarrier power that may be delivered into this spectrum is limited by available satellite power, earth station size, and overall RF bandwidth of the satellite channel. With this in mind, a spectrum efficient subcarrier may then be defined as one which:

a) Uses a modulation technique which is efficient for the type of information transmitted.
b) Uses signal processing techniques to improve modulation efficiency where possible.
c) Optimizes power and bandwidth of the subcarrier within the constraints of the satellite transmission system.

The following spectrum photographs illustrate the application of spectrum efficient subcarriers. All photographs are of baseband spectrums as received off the satellite and are centered on the 6.8 MHz TV sound subcarrier. In all cases, the 6.8 MHz subcarrier deviation is 2.0 MHz peaks.

Figure A illustrates the current baseband arrangement of Southern Satellite System's transponder 6 on the old Satcom I. From left to right, the first two subcarriers are a 15 kHz stereo channel, located at 5.58 and 5.76 MHz, using the WCI Series 1600 Audio Transmission System. The next subcarrier is a multiplexed subcarrier using the WCI 1585A Audio-Plexor. It provides an 8 kHz slow-scan video channel and a 5 kHz audio channel for the North American Newstime service. The 7.4 MHz subcarrier is also multiplexed using the WCI Series 1100 Multiplex System. It provides a 10 kHz color slow-scan video channel for "The Women's Channel," and five 5 kHz audio channels.

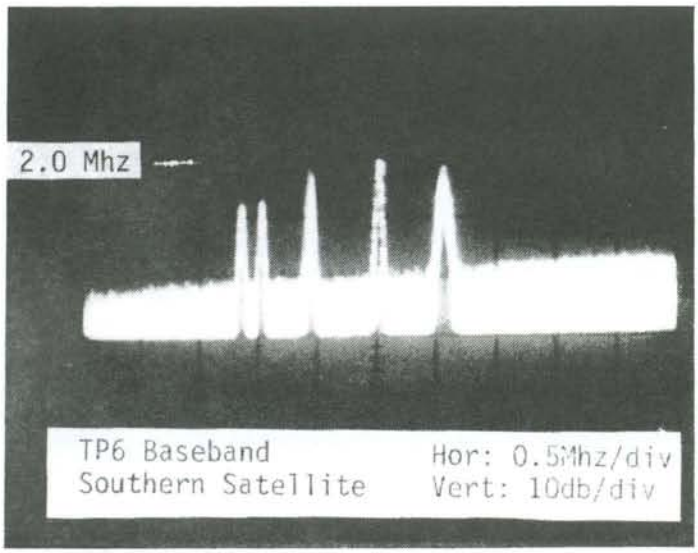


Figure A

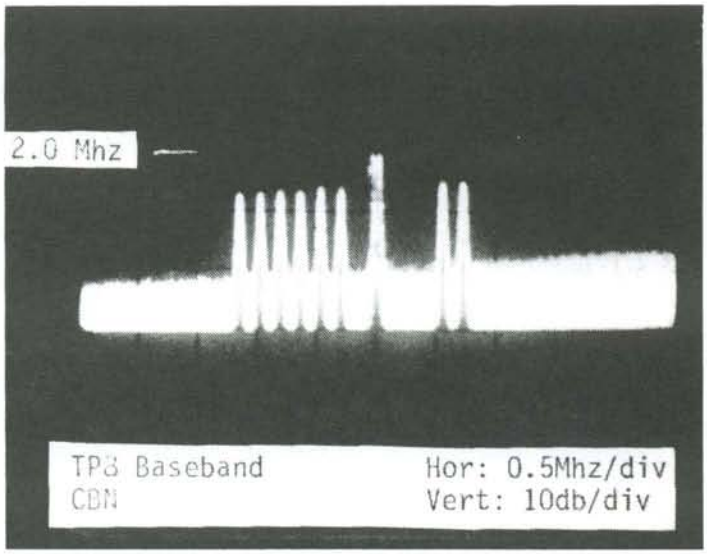


Figure C

Figure B shows the subcarrier baseband configuration of United Video's Transponder 3. At 5.8 MHz on the left is a multiplexed stereo subcarrier for WFMT. Next are two narrow bandwidth subcarriers at 6.30 and 6.48 MHz, also providing a stereo channel for WFMT. At the extreme right is a conventional 7.6 MHz monaural subcarrier for the Seeburg Lifestyle music service.

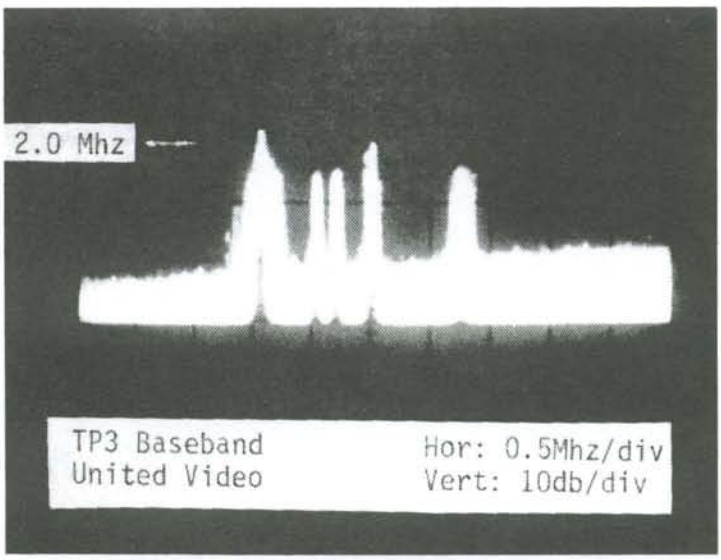


Figure B

Figure C is the current baseband of CBN's Transponder 8. It contains eight narrow bandwidth subcarriers providing three 15 kHz stereo channels and two 15 kHz monaural channels.

The narrow bandwidth subcarriers provided by the 1600 Audio Transmission System represent a major advance in high efficiency subcarrier technology. These subcarriers have been optimized for transmission of high quality 15 kHz audio channels. Using one-fourth the subcarrier power and one-half of the bandwidth of a standard subcarrier, they deliver approximately a 5 dB better signal-to-noise ratio than a standard subcarrier. This dramatic improvement in efficiency is made possible by the development of a specialized compandor which functions as an adaptive pre-emphasis system to provide 18-20 dB of signal-to-noise improvement. Because of the signal-to-noise advantage, subcarrier power and bandwidth can be reduced. The end result is a system that can deliver four very high quality stereo channels in addition to TV video and sound.

The use of a system that transmits eight additional subcarriers raises many obvious questions. On multiple subcarrier systems, especially those using equally spaced subcarriers, there were early concerns about intermodulation. Third order intermodulation products are produced on the same frequencies as the subcarriers. Second order products are produced in the video baseband with the potential of video interference. However, due to the excellent linearity of the satellite video channel, intermodulation products are very low. Third order products are typically less than 50 dB below the subcarriers and the second order products are 65-70 dB below video. These levels are well below the point at which the intermodulation products degrade the audio or video.

Another key question concerns the RF bandwidth required for transmission of nine subcarriers. An increase in bandwidth could have considerable impact on the performance of existing video receivers. To further complicate matters, it is known that the present method of predicting the RF bandwidth of a video signal with subcarriers is imperfect. Lab and satellite testing must be used for all multiple subcarrier configurations to be sure that the resultant RF spectrum will not degrade the network. **Figures D-G** illustrate the effect on RF spectrum of nine subcarriers compared to one subcarrier. **Figures D** and **E** show the spectrum produced by a color bar test signal with one and nine subcarriers. The video deviation is 10.75 MHz for the single subcarrier case and 9.75 MHz for the nine subcarrier case.

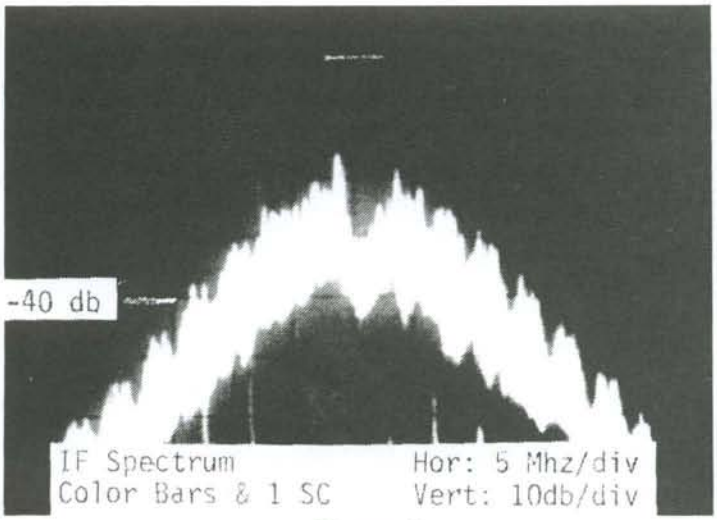


Figure D

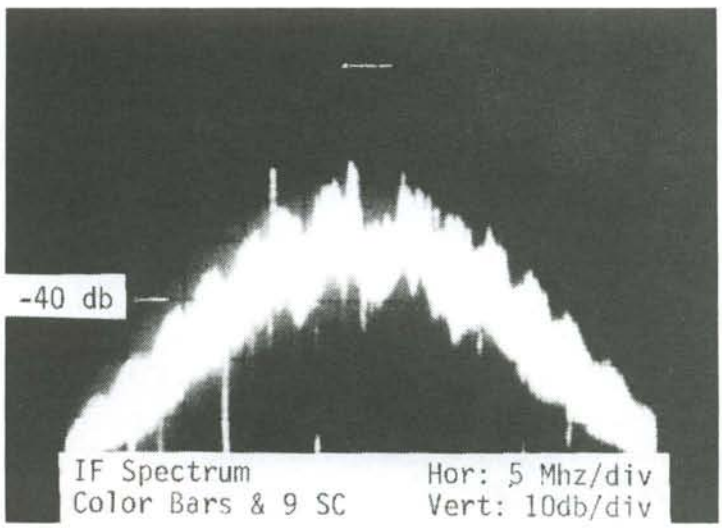


Figure E

The above photos show very little difference in the -40 dB bandwidth of the spectrum. **Figures F** and **G** illustrate the one and nine subcarrier spectrum with a typical video program.

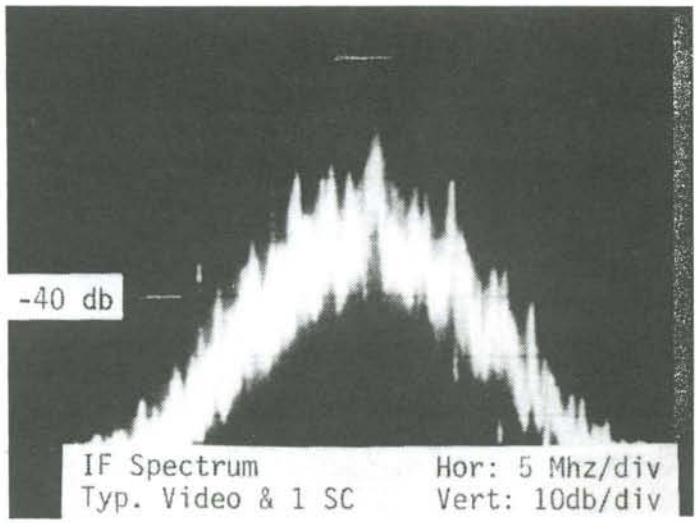


Figure F

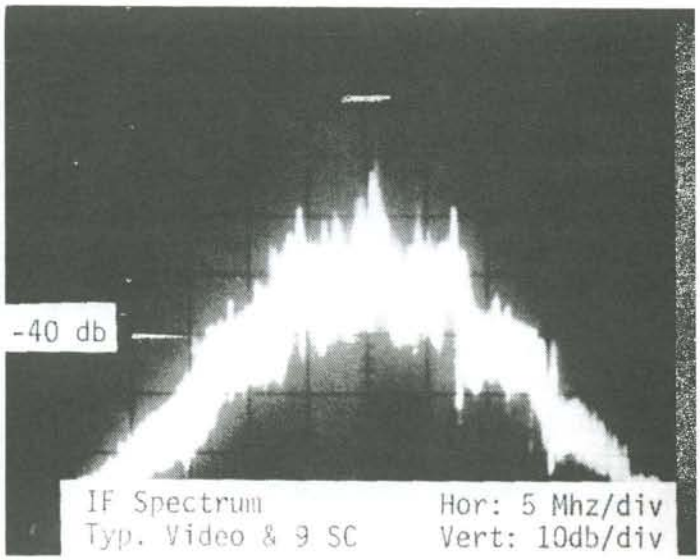


Figure G

TESTING

The spectrum characteristics shown above indicate that a nine subcarrier system does not produce a spectrum much different from a one subcarrier system. The 1600 Audio Transmission System was exhaustively tested to prove that a nine subcarrier system is compatible with the existing CATV network. Tests were conducted on six different transponders used by networks totalling nearly 30 million subscribers. In all cases, no degradation of network service was reported.

NOTE:

This abstract by Elias Livaditis, Bob Placek and Heinz Wegener. Courtesy Wegener Communications.

A FURTHER LOOK AT SATELLITE SUBCARRIERS (SbC/FM)

180 kHz AT 4 GHz

Most of the popular, often-utilized video transponders transmit their audio to receiver locations by "marrying" the audio to the video signal as a subcarrier. Let,s see how this works.

Our standard satellite television format sends signals into space in the 6 GHz region; the uplink. Inside the satellite these incoming signals are "mixed" to a new set of frequencies, in the 4 GHz region, amplified, and re-transmitted back to earth through a downlink transmit antenna.

The original video signal is a baseband signal occupying a frequency range between 0 MHz and perhaps 4 MHz. This is the type of signal which you could view by connecting it to a video "monitor." A monitor differs from a video receiver in that a receiver tunes in the initial frequency as a radio frequency (RF) *carrier*, while a monitor tunes in the *information* being carried by the radio frequency carrier. It can do this at two points in the chain from uplink to you: before the original video signal is "married to" a radio frequency carrier, or at the opposite end of the chain, *after* the radio frequency carrier has been received at the downlink, and the original video information extracted from the radio frequency carrier.

A *standard television receiver* combines the features of a radio frequency carrier receiver and a monitor. The radio frequency portion takes the signal out of the air and amplifies the signal, converting the radio frequency carrier to a lower frequency so that the modulation or video information can then be detected or extracted from the radio frequency carrier. You can convert, or change the frequency just about as often as you wish, and the modulation or original baseband information will stay right with the radio frequency carrier.

In the satellite television format, the transmission mode is FM or frequency modulation. This means that the radio frequency carrier is married to the video information by varying the frequency of the radio frequency carrier. In terrestrial television formats, the video is normally transmitted in an AM or amplitude modulation format. That means the amplitude or strength of portions of the signal (a sideband) are varied by the content of the modulation information (i.e., video).

A frequency modulated signal uses up more "spectrum" or "space" to transmit the same picture information than an amplitude modulated signal. However, for high quality transmission systems, FM has many advantages which offset the wasteful use of spectrum.

Our satellite video and our satellite audio are all transmitted by FM. The video signal occupies approximately 50% of the width of a normal 36/40 MHz wide transponder. This leaves the remaining 50% or so of the transponder width to stick in one or more audio channels associated (or not associated) with the video being transmitted.

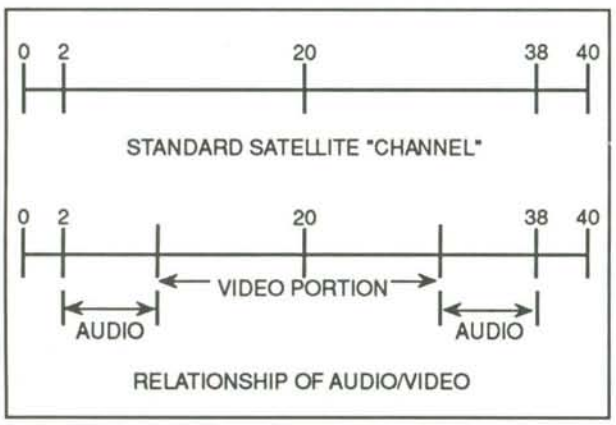
To more fully appreciate what is being done with the audio, it is imperative that we study the make-up of a baseband format. This would be the same format at either the uplink, before the baseband (raw video and raw audio) is married to the radio frequency carrier; or at the downlink, after the receiver has received the 4 GHz downlink signal, converted that signal to a lower IF (such as 70 MHz), and finally demodulated or extracted the video and audio signal(s) from the radio frequency carrier.

There is a handy rule of thumb which can be used to study the way a baseband signal ends up modulating a radio frequency carrier is of interest to us. Satellite engineers consider 36 MHz of a 40 MHz wide transponder useful. They look upon the remaining 4 MHz as a pair of two MHz wide "guard bands" at opposite ends of the 40 MHz wide transponder channel. Guard bands are avoided to insure that there is not interference between transponders which are adjacent, in frequency or the spectrum, to one another. Now remember that with FM, it is the frequency which the baseband signal is modulating. That means, for ease of understanding, *if not literally*, that it is the frequency of the radio frequency carrier which is shifted or moved about by the presence of the video (and audio) information. If our baseband video information occupies 4 MHz (0 to 4 MHz is the same as being 4 MHz wide), and we have 36 MHz to modulate, in theory we could force the 4 MHz wide video to deviate or "swing" the radio frequency carrier over a 36 MHz wide region. The ratio between 36 and 4 is "9." However, we have other considerations to be concerned with, including leaving enough room to send along an audio carrier (or more than one audio carrier). Space in that 36 MHz wide channel must be saved for the audio.

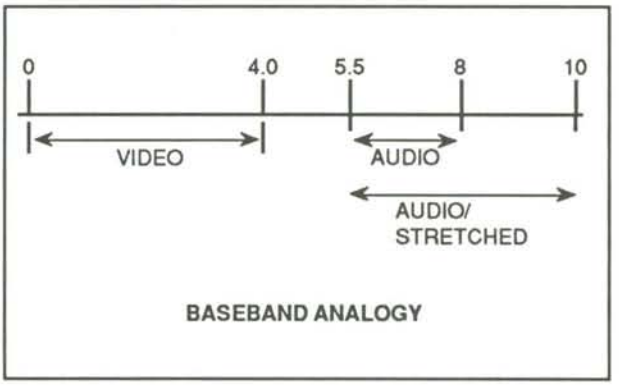
To save spectrum, it was determined that approximately 20 to 22 MHz of the 36 MHz wide channel would be adequate for video, and the balance would be reserved for the transmission of audio and other data. It was also determined that the most economical use of the original baseband spectrum would be in a region from 0 MHz to approximately 8 MHz. All of this worked out so that the center 20/22 MHz Of a 36 MHz wide channel would be reserved for the video, while the outside edges of the transponder, another 14 to 16 MHz of transponder space, would be left for audio. It makes a little more sense if we diagram it, and if we do not take the previous explanation too *literally!*

The modulation process is akin to a multiplication process. We have a baseband spectrum from 0 to 8 MHz, and we have a final transponder width of 36 MHz. We have to make the 8 MHz baseband spectrum "fill" the 36 MHz wide spectrum so we end up increasing the width of each part of the original 8 MHz wide spectrum by approximately 4.5 times. And to keep the video and audio separate, at both ends, we arbitrarily assign a segment of the 0 to 8 MHz wide baseband spectrum to audio. We already know that the video is approximately 4 MHz wide, so that means that the audio will end up being above the 4 MHz width-point of the video.

Just as a full transponder requires a guard band between transponders, so too does a baseband "transition" between the video information and the audio information. In this Case our "guard band" extends from approximately *4 MHz to approximately 5.5 MHz.* That is designed to ensure that the video information does not "crawl up" into the audio portion of the signal, and that the audio does not "crawl down" into the video. Of the two "crawls" it is the video going up which presents the biggest engineering challenge because the video signal is "wideband" by nature, while the audio signal is a (relatively speaking) quite narrow band.



The audio signal has to have a carrier of its own to ride along on or it would wander about. Designers take the baseband frequency spectrum from 0 to 8 MHz and assign specific audio carrier frequencies to audio carriers. Because these audio carriers are secondary to the main video carrier, they are called "sub" carriers. Common subcarrier frequencies are 5.8, 6.2, 6.8, and 7.4 MHz. You will note that these audio subcarrier frequencies are spaced apart by at least 0.4 MHz and can be as much as 0.6 MHz apart. Again, there has to be adequate separation or *space between the audio subcarriers* to keep them from interfering with one another and to make it possible for the receiver at the downlink to separately and individually tune in the different audio "sub" carriers.



One of the happy characteristics of an FM transmission system is that it is possible to send a subcarrier along with the video carrier for a very small additional "price." The entire system is designed to carry the primary or main carrier. Once everything is in place, from the uplink transmitter to the satellite, to the downlink receiver system, the audio subcarriers can be added for very little additional money. This is the primary reason why you see firms that use satellites to sell video services, such as United Video's carrying WGN in Chicago, and providing more and more audio subcarrier services. They have the full system in place, and they are paying for it with the transmission of video. *Now* they can add audio subcarrier services for a tiny fraction of the original cost, although not serving very many users per audio subcarrier in the process. Because the BIG price has already been paid for the transmission of the video, the audio becomes a very economical "add-on" service.

There is a price for adding audio of course, even if it appears to be small. There is additional equipment, and *there is a penalty paid* by the primary or main video carrier. How does that work?

Every satellite transponder has a full rated transmitting power. For example, on G1, WGN on transponder 3 has a maximum output power of 8.5 watts. That 8.5 watts is available to relay from space back to earth the WGN video carrier, and the WGN audio carrier (6.8 MHz). Now, what happens if United Video adds additional subcarriers at 5.8 and 6.2 MHz? Each of these additional carriers will consume some of the available 8.5 watts of power. It turns out that each subcarrier uses between 0.5 and 0.75 dB of transmission power available. Or to put it another way, if your actual footprint from WGN was 34 dBw, with one audio subcarrier present (the program audio channel) when they added two additional (and non-video program related) audio subcarriers, your footprint signal level would *decrease* by 2 times .5/.75 or from 1 to 1.5 dB. That is not an insignificant reduction in power since it comes close to being the difference in antenna gain between a 10 foot and a 13 foot antenna.

And when you combine a weaker-than-average footprint (e.g., WTBS) and add, as Southern Satellite System is now *planning* to do, several subcarriers to handle five or more separate audio services, the reduction in available footprint power to your antenna can become quite significant indeed.

So while it is small, as measured in terms of dB, there is a price paid when additional (audio) subcarriers are added to the basic video plus one subcarrier format of most video program services. If you have a TVRO receiver which affords you the luxury of tuning for audio (or data) subcarriers, you can build your own relationship "chart" between those transponders that are strong and those that appear somewhat weaker as that observation relates to the presence of *more* than a single (audio) subcarrier.

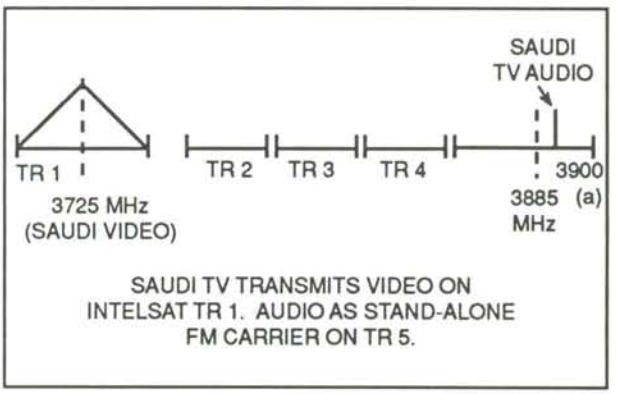
STAYING LOCKED UP

One of the big advantages to the subcarrier system is that the audio carrier is locked to, or referenced to the presence of a video carrier. If your receiver is properly tuned in for the video carrier, the audio will come along on the receiver baseband at the proper 5.8, 6.2, 6.8 (etc.) spot "on the dial." Your receiver has either an automatic frequency control (that keeps it locked on the video carrier), or a manual control which you keep "peaked." *The "video lock" insures an audio lock as well.*

A standard receiver must keep the video portion of the signal within a 30 MHz wide, or so, "passband" at the incoming 4 GHz frequency. As a ratio, that's keeping "one part in 133" for stability and with modern down-conversion oscillators (the oscillator is where the drift occurs), that is not a tough assignment. But, not all of the audio carriers of interest on satellite these days are transmitted in that format, and that is where the problems really begin.

Consider, for example, the transmission of a TV program (or other) audio channel sent separate from the video on a transponder removed from the video. This is a particularly popular system with many of the Middle Eastern countries utilizing Intelsat for relay of internal video programming. It has also become popular recently with several of the new users of Intelsat from South America (e.g., Columbia, Peru). Take Saudi Arabia, as an example (see diagram). The video is transmitted as a full transponder (TR1) from 21.5 degrees west. The antenna system is an eastern hemispheric, which means the service is not seen west of the "bird."

Saudi Video is centered on 3725 MHz (3.725 GHz) and the audio is five transponders higher, near the very top end of transponder 5, roughly 3900 MHz. How, with conventional home system equipment can you recover that audio?



SAUDI TV TRANSMITS VIDEO ON INTELSAT TR 1. AUDIO AS STAND-ALONE FM CARRIER ON TR 5.

Yes, if you want video and audio at the same time (simultaneously), you will need a *pair* of receivers. One for the video and one for the audio. Then what? Simply put the audio receiver on transponder 5, and tune in the audio with a tunable audio system? No, that will not work.

Remember that a baseband tuning audio system functions because the audio is sent along with the video, as a subcarrier to the video. In the Saudi case (and others) there is no video present. Without video, there are no subcarriers.

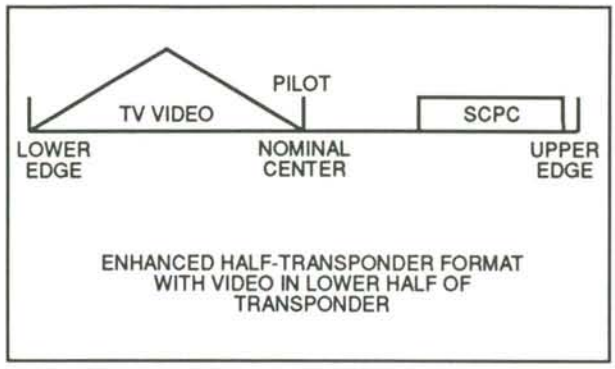
So if the Saudis are transmitting audio *without* a subcarrier, how are they getting the audio on transponder five? By using a technique known as "single-carrier FM." It turns out that the Saudis wanted their video to be as strong and as close to perfection as is possible with the satellite link. They had two transponders leased on Intelsat and decided that if they took the audio *away from* the video transponder they could gain back both some extra "power," plus the use of a full 36 MHz for video only. Transponder 5 (*reads 9-10 on a US receiver dial*) not only has their television program audio, but also a large quantity of Saudi telephone and data traffic transmitting in an SCPC format.

That still does not tell us how to get it back.

Demodulating the audio FM signal is a secondary problem to holding it in one place long enough to be able to tune it in and demodulate it! To explain this, the automatic frequency control (AFC) in a standard TVRO receiver has to keep the receiver's local oscillator within 2 to 4 MHz. The video carrier is the reference on which the AFC locks, typically, and *as long as* there is a video carrier present, the AFC has *something to reference.* Lacking that, the local oscillator in the receiver (it provides the signal to the mixer, which in turn, down converts the 4 GHz signal to ultimately 70 MHz [IF]) has nothing to reference. In the Intelsat installations, a "pilot" or control carrier is transmitted *near* the middle of the transponder (or half transponder) as a reference signal. The receiver has a special detector that locks on to that reference carrier and holds it within stability requirements so that the balance of the narrow audio carriers end up where they should be in the IF system.

This is very expensive requiring phase-locked synthesized oscillators for each of the in-use audio channels. Drift, then, or keeping the 4 GHz signal inside the "passband" of the demodulator, is the number one problem involved. We'll come back to the Saudi system shortly.

A number of countries, such as Niger, Oman, Zaire, Morocco, and Algeria use a system for video transmission called "enhanced half transponder" (*See illustration*). Each of these users places the video in the lower half of the transponder, and the audio is sent in the upper half of the transponder. The audio may also be joined in the upper half by other "domestic" audio channels or communication channels.



ENHANCED HALF-TRANSPONDER FORMAT WITH VIDEO IN LOWER HALF OF TRANSPONDER

Now it is possible, in either a single or double conversion system, for the receiver LO to be so placed that it can be "below" or "above" the signal being converted. For what follows, the receiver LO in a single conversion receiver must be *below* the signal being converted (called "right way up" in the trade). For a double conversion system, the LOs (there are two) must *both* be below, or both be above the signal being converted. "Erect" is the term given to right-side-up conversion and "inverted" is the term applied to reversed LOs.

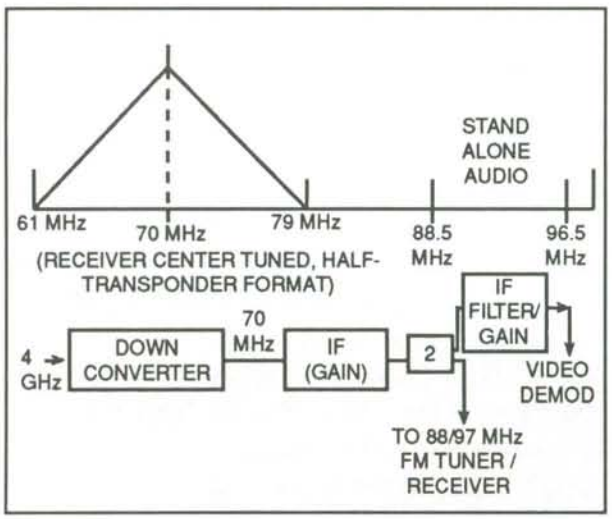
Now if you are tuning in any of the "lower half/half-transponder format" services which transmit the video at the bottom of the transponder and the audio at the top, you tune your half-transponder-format receiver so that the half-transponder wide video signal is centered on 70 MHz. That's the normal tuning procedure. If the video is centered at 70 MHz and the video is really half way down the lower half of the transponder, the upper half of the transponder, which contains the audio carrier, will now be up there between 88 and 100 MHz. That suggests a method of copying the audio because the transmission format is FM, and standard FM broadcast receivers tune from just below 88 MHz to 108 MHz.

To tap into this signal range, you have to be mindful that in a half- transponder-format receiver (such as the AVCOM or ICM) the IF bandwidth is on the order of 15 to 20 MHz, or about half the normal bandwidth. If the IF system if properly designed, that will allow signals within the IF strip from approximately 62.5 (60) MHz up to 77.5 (80 MHz) to pass through to the video detector. Those "way up there" at *88 MHz and above* will be "clipped" or severely attenuated by the IF filter. Yet, you have to get your FM tuner/receiver connected into the "loop" if you are going to tune in these audio FM carriers.

One technique employed with a measure of success is to look carefully at the 70 MHz IF amplifier "string." The filter may fall at the input, in the middle, or at the output. Each design has merits. Most often, however, the filter will end up *in the middle* of the 70 MHz string. This suggests that if you go into the IF board with a tap-off point inside of the IF, *but ahead of the bandpass filter*, you can derive sufficient signal to drive out through a short piece of coaxial cable to the outboard 88-108 MHz tuning receiver/tuner. Some have found that there is sufficient signal at the input to the IF, ahead of the IF amplifier/filter string, and by merely adding a back matched or hybrid two-way signal splitter here (common 75 ohm CATV device), you can drive the IF out of one port and the outboard FM tuner/receiver through the opposite port. The danger here is that you may have a marginal amount of signal coming from the down converter to the IF, and a 3.5 to 4 dB reduction (caused by adding the signal splitter *ahead* of the IF) may reduce the quality of the video picture. It is worth a quick try, however, with two-piece receivers *as long as you check* to be sure the IF line is *not carrying* a tuning or operating voltage for the remote down converter. You don't want to try adding a signal splitter in the line where there is tuning or operating voltage present.

Now, having made the connection, how does it work?

The half-transponder signal is centered on the 70 MHz IF by the fine tuning control on the receiver. The receiver AFC references to that signal and holds it in place to within a couple of MHz if the AFC is good. *But there will be drift.* The 4 GHz range oscillator is simply not stable enough under varying heat and operating conditions to be absolutely stable.



This instability will not be noticed on the video since the "wideband" FM TV signal is fairly tolerant of such changes. When you have spotted Algerian audio at say 95 MHz, and have it tuned in, when the LO moves 2 MHz, the Algerian audio will also move (on your FM tuner/receiver) by 2 MHz. Such a system would possibly not be a suitable method for extracting the strange stand-alone FM audio carriers for a commercial installation, but it does give other terminal users at least access to these otherwise unavailable services. There are other hypothetical ways to accomplish the same thing, but they involve engineering hardware which apparently does not exist at the moment. We'll return to this shortly.

Now that we understand that there are some services which separate the video and audio, and the audio arrives at the downlink site via a method other than subcarrier, what about the unusual technique employed by Saudi Arabia. Well, it turns out that where countries have leases on two or more transponders (or parts of two or more transponders), they may well opt to do this. The recent Columbian video addition to Intelsat apparently is transmitting audio on a transponder 14 away from their video.

One solution is to use two separate receivers, with a splitter from the LNA output feeding the main receiver. One receiver, in the case of Saudi Arabia, would tune in the video on US equivalent TR1 while the second would tune in the audio on the US equivalent of TR9. If the TR9's receiver is one of the half-transponder receivers, by setting the receiver fine tuning so that the lower half of the transponder is centered at 70 MHz, then you will be able to use the previously described FM tuner/receiver play to tune in the audio within the FM band. (In the case of Saudi Arabia, you will also find some radio program channels transmitted in the same "upper half" *of the transponder*, but they will obviously not match the video, and for video-audio reception can be bypassed.)

As noted, the receivers depend upon the presence of a video carrier to lock the AFC to *something.* Without any video on the lower half of the Intelsat TR5, the receiver is going to try to *find* something to which to lock. There *are carriers* on the low end of that transponder (although not video), and the AFC *may* try to latch to one or more of them. When that happens, your carefully tuned-in Saudi audio is going to move away from the spot on your FM dial where you had tuned it in!



Figure 2.15 *In Touch Network. (L) One of over 300 volunteers reading the New York Times. (R) Supervising engineer Michael Bohan (standing left) and engineer Charles Wetmore executing the technical requirements for "In Touch's" 24-hour-a-day broadcast schedule. "In Touch" can be found on Galaxy 3, transponder 8, subcarrier 7.875 MHz and also on Westar 4, transponder 3, SCPC 82.9 MHz.*

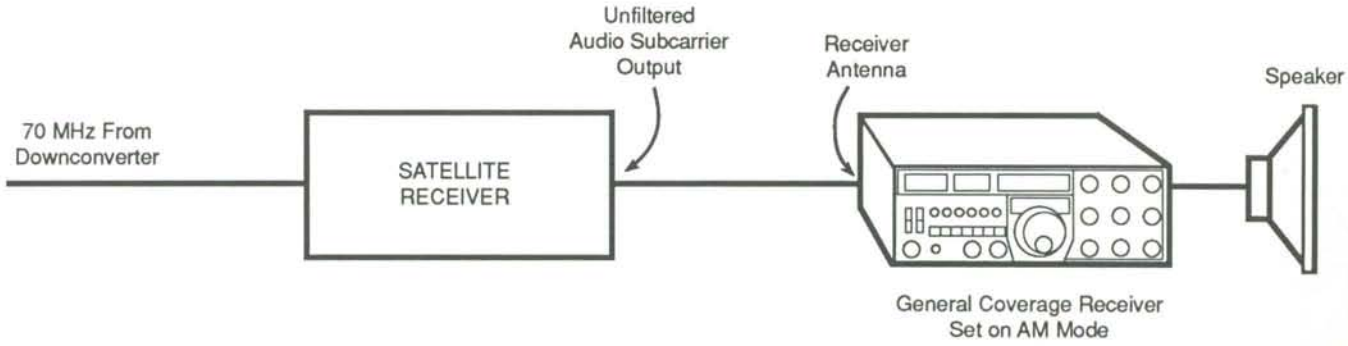
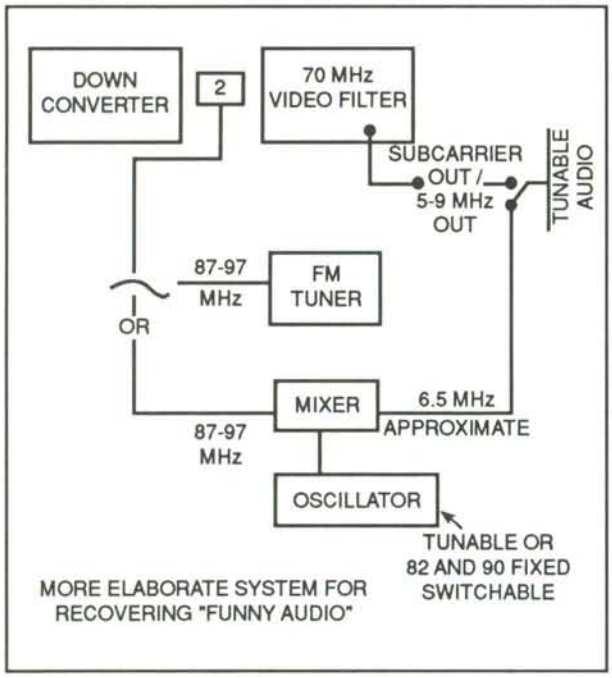


Figure 2.16 *Use of HF general coverage receiver for accurate subcarrier tuning. HF Receiver must have a range of 100 KC to 30 MHz with continuous frequency coverage, all mode reception. Set receiver on AM mode for subcarrier use.*



THE NEXT STEP

There are several techniques being investigated to "clean up" the quick and perhaps dirty approach of tapping into the 70 MHz IF with an FM tuner/receiver. For those who may have some talents in such areas, these proposals are offered:

1) *Convert the audio* directly to a 10.7 MHz IF. Virtually all of the FM tuners/receivers utilize a 10.7 MHz IF. One way to take advantage of their selectivity and still get the package stuffed into a modified TVRO receiver would be to build a tunable VCO which tuned either 78-86 MHz (or 98-108 MHz; this would keep the VCO out of the range normally covered by the TVRO receiver IF), and "mix" the audio carriers directly into a 10.7 MHz IF. This leaves the control that tunes the VCO as a "tuning control" and allows the user to tune, directly at the 70 MHz IF, the strange stand-alone FM carriers.
2) *Convert the audio* directly to the 6.8 MHz position on a fixed tuned TVRO receiver. The approach here is the same as with the 10.7 MHz IF except that the VCO will now tune 80-90 (or *preferably* 94-104) with the mix product being at 6.8 MHz. This means the audio system already built into the TVRO receiver will become a part of the system, and the user will simply "insert" the additional VCO/mixer into the line when he wishes to employ "direct SCPC tuning" for stand-alone, wideband FM carriers.
3) *Convert* the 87-97 MHz region down to 3 to 13 MHz, and modify the tuning range of existing TVRO receiver audio demodulators to tune this range.
4) *Leave the existing* 5 to 9 MHz (nominal) TVRO sub-carrier tuning range alone, but install a fixed oscillator at 90 MHz for most of the popular stand-alone wideband FM signals, or with an optional 82 MHz stand-alone oscillator for the Algerian approach to audio. At these frequencies, a relatively simple translator oscillator and double-balanced (or MOSFET) mixer will handle the chore.

"IN-TOUCH"

"In-Touch" is a new audio service that provides a free reading service for the blind and other sight-impaired people. Everyday, volunteers read text from well-known periodicals such as the Wall Street Journal, Barron's, Sports Illustrated, Good Housekeeping, Vogue, and many other publications. "In-Touch" is transmitted from Westar 4, TR. 3, SCPC 82.9 MHz and Galaxy 3, TR. 8, 7.875 audio subcarrier.

Southern Satellite Systems furnishes this as a free, no-charge service to the cable companies as a good corporate citizen and works with the "In-Touch" group. This group is a non-profit organization run by volunteers; it broadcasts information useful in everyday life. Besides in-depth reports and magazine readings, they offer supermarket sales, stock quotations 24 hours a weekday, and 14 to 15 hours a day on weekends. See **Figure 2.15.**

For best results, a stereo processor should be used; however, a hook-up using a quality general coverage receiver from the unfiltered subcarrier output of the satellite receiver into the antenna jack of the GC receiver will also produce excellent results. Simply tune the receiver to 7.875 MHz. See **Figure 2.16**.

GALACTIC/TEMPO SOUND

Galactic/Tempo Sound is a 24-hours-a-day, seven-days-a-week audio service which features six music formats to cable systems and other users.

The formats are:

- Great American Country Music (5.04/7.74)
- Classical Music Collections (6.3/6.48)
- Light Rock (5.94/6.12)
- Soft Sounds (5.58/5.76)
- New Age of Jazz (7.38/7.56)
- Classic Hits (8.10/8.28)

Plus two other services:

- "In Touch," a reading service for the sight impaired
- BRN, Business Radio Network

The six services are carried on Galaxy 3, Transponder 11, using subcarriers as noted above. All are in discrete stereo, plus there is a demo channel on 5.22/5.4 stereo.

"In Touch," Reading Service for the Blind is carried on Transponder 11, subcarrier 7.87 MHz.

BRN, Business Radio is carried on transponder 8, subcarrier 8.05 MHz.

NOTES

CHAPTER THREE

SATELLITE TELEPHONE SYSTEMS (SSB/FDM)

LOOK BUT DON'T TOUCH

(1) Section 605 of the Communications Act of 1934, as amended, generally warns you that non-broadcast-class communication signals are considered *"private" communications.* The 1934 act was designed to establish guidelines to prevent unauthorized "third parties" (i.e., anyone not associated directly with the "private communications") from setting out to intercept such private communications. Section 605 warns that any person not authorized to intercept such transmissions and who does so, either on purpose or accidentally, shall not divulge to any other party any of the following: (a) that such a transmission exists, (b) the content of the transmission "intercepted." In another section of the FCC rules, the FCC treats all microwave (i.e., satellite) communications in the 3.7 to 4.2 GHz band as "common carrier" transmissions, and thereafter confirms by definition that all common carrier transmissions are considered non-broadcast (as in private) transmissions. These rules were adopted at a time when the primary concern was with "eavesdropping" on private overseas and domestic telephone communications, and in studying the debate of the era, it would appear that the real concern was with employees of the telco/common carrier who might have access in their work routines to these circuits. The Congress clearly was worried primarily about common carrier employees eavesdropping. In the intervening 46 years, the whole nature of communications has changed, including the use of some common carrier transmission frequencies for non-common carrier type signals. The satellite relay of television signals such as Chicago's WGN or radio signals such as Anchorage's KFQD does not fit the meaning nor intent of the 1934 act, as far as "eavesdropping" on a "private" communications channel is concerned. No significant enforcement actions (by the FCC) have ever occurred in the 46-year history of Section 605, and the FCC is currently studying this antiquated section of law with an eye towards revising it to modern standards.

You've seen the signs. They warn you to keep your mitts off of someone else's property. (The sign may also mean the object is delicate or fragile, but we'll overlook that meaning here!). About 99% of what is on the satellites these days could, would, and may in fact carry such a sign. In fact of late, some of the visual services have even begun to insert such warnings into their transmissions!

This is not a discussion of Section 605 (1). Rather, the footnote aside, we are going to ignore for the sake of science and the advancement of technology that there even is such a misunderstood, little-practiced FCC "law" on the books. This is simply going to be a frank and open discussion of what is up there on all of those dozens, indeed hundreds, of 36-MHz-wide transponders.

Satellite capacity is huge. We talk glibly about a transponder being 36 MHz wide, little realizing that that takes in everything from sound waves to well up into the lower portion of the VHF spectrum (i.e., 0 MHz to 36 MHz). Do you have any idea how many 10 kHz wide AM (as in broadcast radio) signals could be shoved into that much spectrum if somebody tried? Well, the answer is 3,600. That would be 3,600 evenly spaced AM broadcast stations, each covering all of North America, each with its own identity, all operating at once. Or, if you think a 10 kHz "channel" is very spectrum wasteful, how about 4 kHz single sideband channels? We could stack 9,000 of these in there all at the same time, and each (again) would have the ability to "talk to" anyplace in North America. These are impressive numbers.

And that's for one transponder. SATCOM and WESTAR have 24 transponders and if one such satellite was utilized for AM radio, we would have 86,400 "clear channel" continent-wide, AM broadcasting channels or 216,000, 4 kHz-wide SSB channels to play with. Dare we suggest that even today there are 8 such satellite spots now being occupied by US birds, and that if all of these birds were turned over to either of our paper models there would be room for (are you ready!):

a) 691,200, 10 kHz-wide AM stations, or,

b) 1,728,000, 4 kHz-wide SSB channels.

These are such big numbers that we can ignore what would happen with another 8 or 9 orbit spots filled, or with the opening of yet a whole new set of transponders in the 11.7 to 12.2 GHz band. Obviously, there is a lot at stake out there in space. Big bucks ride on what happens, who makes it happen, and to whom it happens.

This section of this manual is about some of the things you can find now, today, inside of these magic 36 MHz-wide spectrums. Sure, you know all about TV and the wonderful world of R-rated films, unending sports, non-stop religion, or Ted Turner's attempt to rewrite the news coverage business with dawn-to-dawn reporting. But you probably don't know where to tune in the current Kenai Flight Service Weather Forecasts from Anchorage, or National Public Radio, or several dozen Holidex (Holiday Inns of America) toll free reservation line circuits, or a major computer company's inter-office, 24-hour a day satellite relayed executive "tie-line". . .and on and on and on. **Figure 3.1.**

1) The Perfect Spectrum—If our existing radio spectrum between 0 and 36 MHz was "perfectly used," it would operate like a single 36 MHz-wide transponder on a geostationary/ Clarke Orbit satellite.

How's that? Well, first of all the "satellite 36 MHz spectrum" is perfectly divided up (i.e., allocated) so that at precise (4 kHz) intervals, there is a new carrier signal capable of carrying or transmitting information from point "A" (the uplink) to any other point the satellite can "see." And since each carrier only carries a single set of "intelligence" (i.e., voice, data, etc.) there is never a worry about interference. Unlike the "real" 0-36 MHz spectrum where various groups, nations, users, and so on share and then fight over the "rights" to a particular frequency assignment, in "private" hands the satellite 36 MHz "spectrum" is constantly partitioned into discrete assignments and then those assignments are "protected" full time.

And unlike the "real" 0-36 MHz spectrum, this 0-36 MHz spectrum has all signals within it at essentially the same level of strength. That means that as a receiver is tuned across the spectrum, each carrier is perfectly separated, and there is either no modulation (voice or data, etc.) present because that particular frequency is not in use at that moment, or if there is modulation, it sounds exactly as loud as the carriers adjacent to it on both sides and hundreds of carrier assignments removed as well.

2) The Dedicated Spectrum— Unlike the "real" spectrum where there are constant battles for who uses or controls what particular frequency, the satellite spectrum with a 0-36 MHz transponder is "assigned" carrier-by-carrier to those users who have an immediate need for it at that point in time.

This means that when the assigned user has something to say (transmit), he says it; when he is listening to perhaps the return side of his two-way conversation, his side is essentially quiet. When there is no conversation going on, his assigned frequency is also "quiet." Each user knows that short of equipment failure, the circuit is his when he wants it, for as long as he needs it.

All of this takes a little getting used to, especially if you have had some experience tuning a radio around the real-world shortwave bands, or have ever tried to locate a "listenable AM broadcast station" on the car radio at dusk when you are in the middle of New Mexico.

HOW IT WORKS

There are two types of voice/data/signal channels on satellites these days. The most common type employs something called single sideband (SSB) as a modulation format. The technical name for this format is frequency division multiplex (abbreviated FDM-fm) which simply means that the baseband modulating frequency range (typically to 0 to 8 MHz) is treated like a spectrum of its own before the uplink transmitter gets hold of the modulation. Individual carriers are each modulated with voice or data in the 300 to 3400 Hz (that's hertz!) region. See **Figure 3.1A.** The voice/data information is used to modulate a double balanced modulator where one of the two sidebands is eliminated with a filter. The remaining (sideband) signal is then applied to another carrier typically operating on some precise frequency between 64 and 108 kHz. See **Figure 3.2.** These sideband modulated carriers in the 64-108 kHz region are then multiplexed or mixed together in Groups of 12 to form a larger group of carriers called Supergroups. A Group has 12 carriers, a Supergroup has 60 carriers (consisting of five Groups). The Supergroup can be applied as a package directly to the baseband modulator of the uplink transmitter (which frequency modulates—fm's—the uplink transmitter), and they can, in theory, be placed anyplace from 0.0 MHz up to 10.75 MHz; that's the "spread" of the baseband modulating frequency (index). See **Figure 3.3.**

We'll see how all of this impacts on your receiver terminal shortly; don't panic!

Now because this "spectrum" can, and in fact is, carefully controlled by the uplink terminal operator, he wants to pack as many of these Supergroups into the basic 0.0 MHz (low end of "band") to 10.75 MHz

SATELLITE BUSINESS SYSTEMS

SATELLITE BUSINESS SYSTEMS
SBS SKYLINE
P.O. BOX 96502
CHICAGO IL 60693

BILL DATE NOV 27 ,
AMOUNT DUE $27.48

FOR ALL INQUIRIES
PLEASE CALL 800-368-6900
BETWEEN 9AM AND 9PM WEEKDAYS

SATELLITE BUSINESS SYSTEMS

PAGE 2

DATE	TIME	DESCRIPTION/ CITY CALLED	AREA-NUMBER	QTY/ MIN.	COST	AMOUNT
916	0930P	HOUSTON TX		58.6		7.62
918	0318P	REYNOLDSBGOH		43.3		6.06
918	0455P	REYNOLDSBGOH		2.1		.29
925	0812A	HAVANNA FL		19.2		2.69
925	0801P	CULLOWHEE NC		7.5		1.05
925	1038P	CULLOWHEE NC		1.7		.24
1003	0843P	CULLOWHEE NC		1.0		.18
1008	0923A	HAVANNA FL		33.8		4.73
1010	0633P	CULLOWHEE NC		18.1		3.26
	***	TOTAL CALLS VIA DALLAS				26.12
	***	TOTAL CALLS				26.12
FEDERAL EXCISE TAX OF		.78 ON		26.12		.78

Figure 3.1 *A phone bill showing charges of a satellite telephone system.*

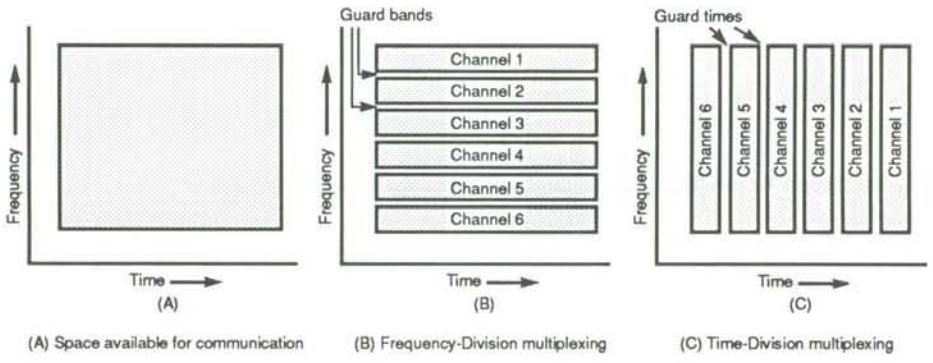


Figure 3.1A *(A) Space available for communication. (B) Frequency-Division Multiplexing. (C) Time Division Multiplexing.*

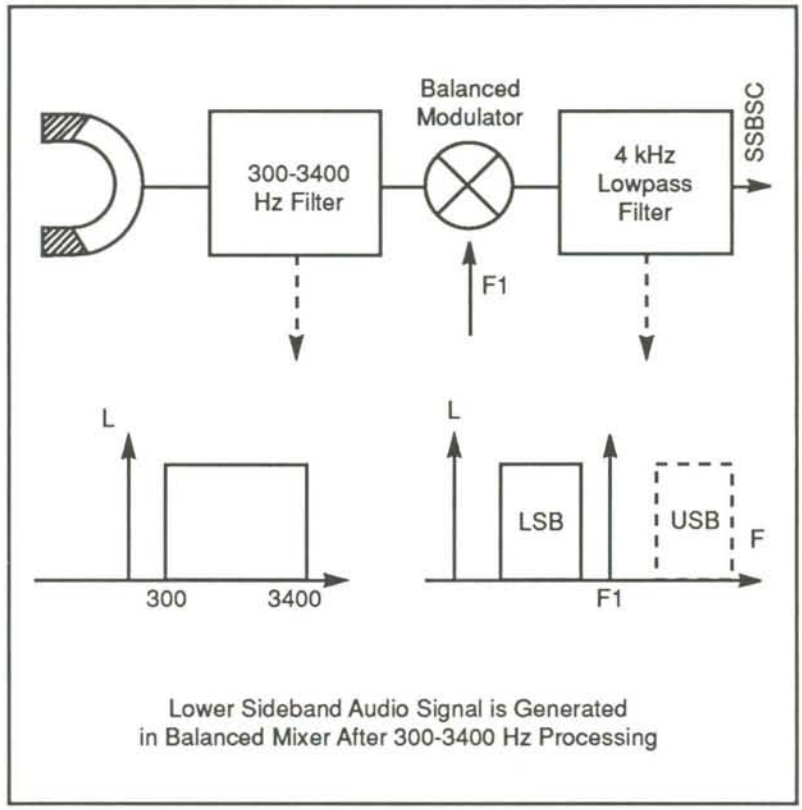


Figure 3.2 *Single side band system with one side band eliminated with filter.*

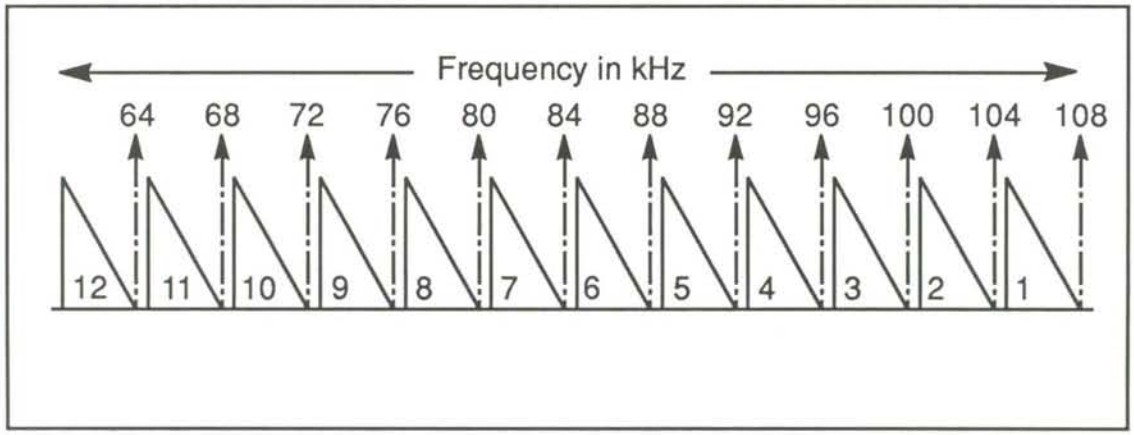


Figure 3.3 *Basic group of 12 "4 kHz" voice grade channels in the 64 kHz to 108 kHz range; each channel modulates the carrier separately. Type B group.*

(high end of "band") frequency range as possible. To do this, and to insure that equipment installed in Nigeria is compatible with equipment installed in Boise, a set of usually-followed "baseband allocations" have been adopted. Now these are not totally universal, but they come close. And when you are dealing with "allocations" within the same bird family, they are identical from transponder to transponder and bird to bird almost all (nothing is 100% in this life!) of the time.

A Supergroup of 60 carriers (each with its own modulation or information) is nice, but that is hardly large enough to accommodate the needs of the fast-growing satellite business. So there is an even larger group called a Mastergroup. This consists of five of the Supergroups, all mixed together at the baseband point before they are applied to the uplink transmitter. Let's see how all of this fits:

a) Group — consists of 12 carriers, each 4 kHz from the nearest carrier in the same Group; each capable of being modulated with audio or data with its own "baseband" frequency range of 300 to 3400 kHz. The basic carriers start off in the 64 (68, 72, etc.) to 108 kHz region where they are "modulated" with single sideband (lower sideband) techniques.

b) Supergroup — consists of five Groups all multiplexed together, plus five "multiplexing carrier frequencies." That means we actually have 13, not 12 carriers, per Group in a Supergroup (see diagram here), and a total of 60 useable (for modulation) carriers in a Supergroup, plus five more that are part of the multiplexing process.

c) Mastergroup — consists of five Supergroups, again all multiplexed together, plus one additional multiplex-mixing carrier per Supergroup. This works out to 60 useable carriers per Supergroup times five, or 300 useable carriers per Mastergroup. See **Figure 3.4.**

Spectrum — A Group occupies 48 kHz of space, a Supergroup occupies 240 kHz of space, while a Mastergroup takes up 1200 kHz of space. Got that? Well, it's not quite true! Actually, a Group does Occupy 48 kHz and a Supergroup does occupy 240 kHz (that's 5 times 48), but a Mastergroup occupies 1232 kHz of space, not 1200. Why? Well, between each Super-group in a Mastergroup, there is an 8 kHz buffer or guardband. We've diagrammed it here.

Now, why do they do all of this monkey business? To provide flexibility to the handling of "batches" of carriers, or Groups/Supergroups as they call these batches. Let's see why this is done.

AT THE UPLINK

At any given uplink site, there is typically more than one customer who is willing to pay the tariff rate for a dedicated (or non-dedicated, meaning less than full time) carrier-channel. In a metropolitan area such as New York City, there may well be several hundred users of the service and system. So at the New York City Toll Operations Center (TOC), all of the local customers come into the facility on either dedicated telco lines or by radio. Each is processed separately at this point of entry, and then the satellite TOC operator "looks at" each user and sees where he is going. If there are 12 users who want to be linked between New York City and Los Angeles, for example, the TOC operator selects each of these and "bundles" them into a Group. Then, he may have 52 that want service between New York City and Chicago; these he bundles into a Supergroup (by utilizing 5 Groups). He now has a set of "bundles," each with the same (metropolitan area) "point of origin" and each bundle is destined to end up at a separate point of delivery.

The various Groups and Supergroups (and perhaps even Mastergroups) are then all multiplexed (added together) at the TOC and sent on to the uplink site. They arrive there in a configuration where they can be applied directly to the FM (frequency modulating) system of the uplink transmitter. For sake of discussion, we'll say that within the uplink modulation baseband of 60 to 108 kHz we have a Group or bundle destined for Los Angeles, while in the 312 to 552 kHz region we have a Mastergroup headed for Chicago. See **Figure 3.5.**

AT THE DOWNLINK

The downlink receiver terminal in Los Angeles will receive everything on the transponder; however, it will (by instruction) pick-off only that (example) Group of signals between 60 and 108 kHz for local delivery. It will do this by demodulating all of the signals on the transponder to the baseband spectrum of 0.0 to 10.75 MHz, and then using block-conversion techniques, extract the 60 to 108 kHz bundle. Since the downlink receive site is typically some distance outside of the metropolitan area itself (Los Angeles is located at a place called South Mountain for RCA), and because the destination

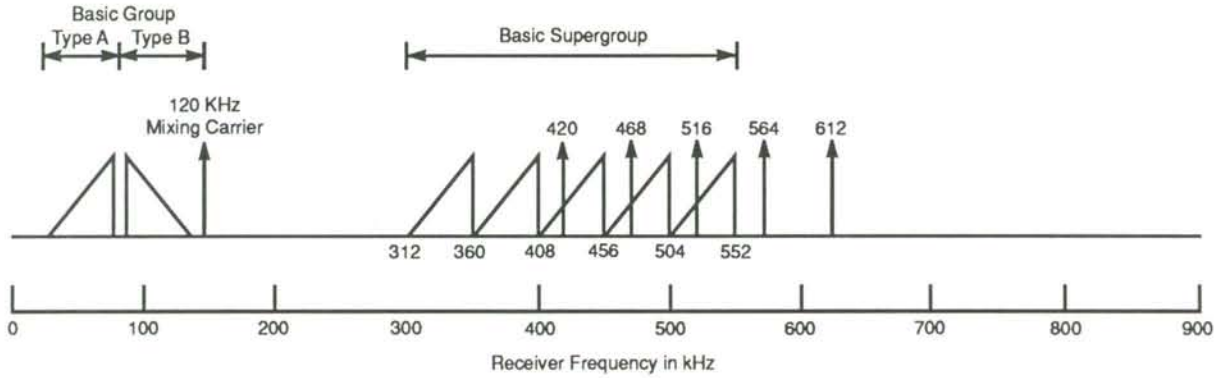


Figure 3.4 *Groups vs Super Groups.*

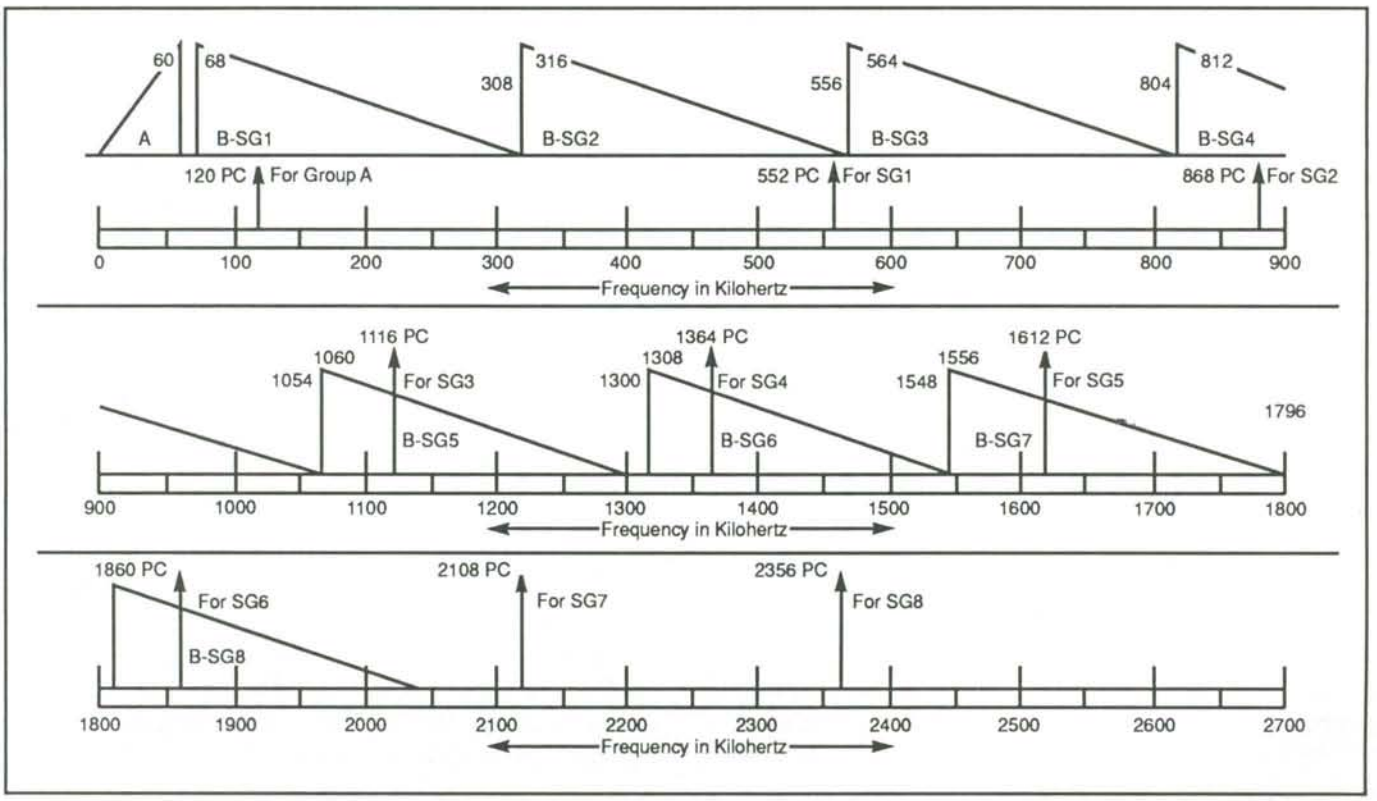


Figure 3.5 *Basic baseband spectrum in single sideband (SSB) frequency division multiplexing (FDM) on a typical satellite.*

customers are likely to be within the city itself, this "bundle" is then transferred to a terrestrial microwave circuit (still as an "intact Group") for delivery to LA proper. Once in LA at the TOC facility, the individual carriers within the Group are independently demodulated using a (lower) single sideband receiver, and the audio/data each contains is then plugged into a leased telco line or radio circuit that carries it to the final destination point.

Now in the case of our Chicago bound Supergroup, perhaps we end up with customers spread throughout the Chicago area. Let's say that by careful planning all of the satellite customers that have been bundled into the Supergroup—Group that is occupying spectrum in the 312 kHz portion of the Supergroup are in the Elmwood Park area of Chicago. At the Chicago receive site (which is out by Lake Geneva, in Wisconsin) it would be possible after demodulating from 4 GHz to baseband on that particular transponder to selectively take that frequency range of baseband (312 to 360 kHz) and send it as a Group on its own terrestrial microwave or radio link to a distribution site serving Elmwood Park. Then at Elmwood Park, the individual (12) carriers are demodulated to true-baseband (audio/data) and plugged into local loop telco leased lines for final delivery. At the same time, other Groups within the Supergroup received at the Lake Geneva receive-terminal can be sent either to individual local distribution centers or into downtown Chicago for redistribution via leased lines.

The beauty of all this is the "bundling" or "packaging" that this approach allows. Rather than having to demodulate down to baseband audio (i.e., take the individual carriers to sound or data impulses) at each point, it only happens once at the final distribution point just before it goes into a telco or radio link to the destination. Otherwise the signal is handled every step of the way at RF (radio frequencies), and these radio frequencies are bundled and batched and (block) converted around to get them into and out of the system as a group.

THE OTHER APPROACH

As noted in the opening paragraphs, there are two approaches to sending less-wide-than video signals via satellite. We have just described the FDM-fm system which is by far the most commonly employed. There is another system as well.

Not every would-be satellite communicator is so located that he has ready access to a TOC or uplink site. For such a user, just "getting into" the system or "receiving from" the system would involve a very healthy expenditure in terrestrial linking. A 100 mile private microwave hop for example could cost the would-be user $100,000, and that just gets him into the system!

As the number of uplink sites grow (and this is one of the fastest growing areas in satellites these days) sooner or later virtually everyone will be within a reasonable-cost terrestrial distance from an uplink. Sooner or later, but maybe several decades. So to handle the interim problem a "remotely located" satellite communicator has to install his own uplink site. He may in truth share it with several others in the same area, but for now assume he is all alone. Now as a stand-alone, single-channel requirement user, he doesn't need all of that fancy multiplexing gear. What he needs is some way to transmit a single channel of voice or data into the bird, and in turn if he is actually engaging in a two-way operation, get a single channel back. This is called the SCPC (for Single Channel Per Carrier) technique and the name says it all. SCPC is not as spectrum effective as the FDM-fm approach; it cuts by around 50% the number of "circuits" that can be carried simultaneously through a single transponder, but it has the flexibility of being a stand-alone system. Using a relatively small uplink dish and relatively low power uplink transmitter (4.5 meter dish, perhaps as little as 30-100 watts of uplink power), the system can be installed quickly and put into operation in a few hours time.

The method of generating the signal (in the SSB format) is essentially the same with SCPC, and with some exceptions the signal will "sound" the same to a listener as an FDM-fm signal. The exceptions are important however:

1) Perhaps the user cannot cram all of his input modulation data into a 300-3400 kHz bandwidth. OK — the SCPC approach can allow wider bandwidths and they may or may not be "recoverable" with a standard SSB receiver.
2) The uplink site may well not have the effective "power per-channel bandwidth" as a full FDM-fm uplink site; this can cause the signal going through the satellite to appear to be considerably weaker than the FDM-fm signals also going through the same transponder.

In practice, the SCPC carriers may well be operating in a portion of the transponder all by themselves, although in theory they can be slotted in right next to the boundary of a Group, or Supergroup, or Mastergroup.

MULTIPLE INPUTS

One of the beauties of the satellite system is that it is not essential that all of the uplink signals going through a single transponder come from the same site. For example, it may be operationally desirable to load up a transponder so that there is a Group frequency band between 60 and 108 kHz originating at Lake Geneva, a Supergroup between 312 and 552 kHz originating at New York (Vernon Valley), a second Supergroup between 812 and 1052 originating at Atlanta, and so on. Each uplink site transmits to the satellite its own bundle and each receives the alternate bundles destined for its area.

In the same way, SCPC transmissions can be fitted in virtually anyplace that they will match the overall allocations scheme. Again, this is a very flexible (and quickly re-configured) system.

HOW TO RECEIVE ALL OF THIS

Now you understand the basics of how the signals are put together and placed onto the bird. Now what happens at a downlink site?

First of all to recover these Groups, Supergroups and Mastergroups, we let our standard TVRO receiver do its thing. It receives the 3.7-4.2 GHz range, downconverts to some IF (such as 70 MHz) and then this IF is demodulated to baseband (i.e., a spectrum from 0 to some upper frequency limit less than 10.75 MHz). Your TVRO receiver may well have a "baseband output" jack, which up until now you never considered using for anything except as a source of video to plug into either a TV monitor or a TV re-modulator.

However, when you tune your TVRO receiver to one of the non-video channels, you are now demodulating (although it can't be seen on the TV screen, since it is not a video modulation format) all of the data that is there. Since you now understand that some or all of the spectrum between 0.0 and a maximum of 12.5 MHz may well have individual carriers (in Groups, etc.) present, naturally you want to know how to make these carriers "talk to you."

Remember that even though we have "demodulated" the 4 GHz signal with our TVRO receiver, the output of our TVRO receiver at this point is really still "modulated." Each of the carriers inside of the cable coming out of the receiver are still on discrete RF (frequencies) and each must be further demodulated from the typically single sideband format.

We do this by running a cable from the "video/demodulated/baseband" output on our receiver to a receiver that can tune the spectrum of interest. That spectrum is from 0.0 MHz up to as much as 12.5 MHz. If you are familiar with Ham or other communications equipment, this is starting to sound like a communications receiver. It is.

The receiver that will perform the final demodulation is a selectable sideband tunable receiver. There are dozens of different makes and models around, many of them on the used equipment market and selling for between $200 and $500. However, there are some warnings here:

1) Most receivers built for this application start off at 500 kHz (their "bottom tuning frequency/range") and tune upwards to 30 MHz. The upper tuning limit is no problem; you aren't going above 8 or 9 MHz most of the time anyhow, but ideally, you would like to tune down to at least 100 kHz.
2) Not all such receivers are SSB adapted; some (in fact many) were built years before SSB came along and they are AM (amplitude modulation) receivers with perhaps a BFO (beat frequency oscillator) thrown in for CW (continuous wave or Morse code) reception. You can use a BFO equipped receiver to tune in SSB or an older AM receiver, but you won't like doing it very much because it is unstable, tricky, and generally not much fun.
3) Some of the more recent receivers only cover the Ham radio bands (i.e., 1.8 to 2.0 MHz, 3.5 to 4.0 MHz, etc.). This will give you a "peak" at a portion of the spectrum, but not all of it.

THE IDEAL SSB RECEIVER

In order to satisfactorily receive the telephone signals on the satellites, your general coverage, single sideband receiver must have the following features and capabilities:

1) The receiver must be stable frequency wise, after a short warm-up period.
2) The receiver must be able to receive both upper and lower sidebands.
3) Tuning must cover from 100 kHz to the 30 MHz range with ample sensitivity and be able to tune 0 to 100 kHz with reduced sensitivity.
4) Receiver should have digital frequency read-out that is accurate.

RECEIVERS USED

Some of the SSB general coverage receivers that have been successfully used are:

- Japan Radio Company's NRD-525 Figure 3.6
- Kenwood R—1000 Figure 3.7
- Kenwood R—2000 Figure 3.8
- ICOM R-71A Figure 3.9

Plus, some of the new amateur transceivers that now carry full coverage receivers, such as the Kenwood TSR-430S, TRS-930S, etc.

PLEASE NOTE:

Many so-called shortwave receivers sold in discount stores and other retail outlets will not perform for this application; your best bet is to secure a receiver from a reliable amateur radio store or shortwave firm that stocks high-quality receivers. The better names are JRC, Kenwood and ICOM.

THE HOOKUP OF EQUIPMENT FOR TELEPHONE RECEPTION

1) *The baseband output of your satellite receiver* is fed to the antenna input of the quality SSB general receiver (.1 to 30 MHz) via a short length of 50 ohm RG-58U coax cable with the proper coax connectors on each end to the satellite receiver. TVRO receiver will no doubt have an "F" type fitting on the baseband output so you can obtain an adaptor from "F" fitting to PL-259 connector for this end of the coax cable, or your 50 ohm RG-58U can be fitted with a standard "F" connector at one end and a standard RF PL-259 fitting for the SSB receiver end. See **Figure 3.10** and **Figure 3.11.**

2) The output of the TVRO receiver must be baseband video that is not filtered. If when tuning the SSB receiver the signals are reduced in level after 4.2 MHz and then disappear, your TVRO receiver contains a filtering circuit that passes only signals in the 4.2 MHz video range. A simple remedy is to add a separate video output fitting that is wired ahead of the TVRO internal fitting. Many of the later TVRO receivers now come standard with this second video output. This is a simple matter for any installing dealer to do.

3) After the correct TVRO to SSB receiver hookup is made, turn to a satellite that is known to be active with telephone traffic and choose a suitable transponder; at this point adjust the communications receiver to receive lower sideband. If you are capable of tuning 100/200 kHz to 30 MHz with your receiver, just start dialing upwards from the "low" end. Every 4 kHz or so, you will hear a carrier. If it is not modulated at the moment, you'll hear an audio note in the 0-2 kHz region as you tune in and out of the carrier. When you run across one that is modulating at the moment, you'll hear a funny Donald Duck sounding voice, which will "clarify" (i.e., sound more normal) as you tune the signal in precisely.

4) Refer to the satellite activity section for satellites that are active with telephone traffic. See **Table 3-A.** After a little practice with tuning SSB, you can try going through the entire range again on the general coverage receiver in the upper sideband side of the signal, where you will find more traffic.

5) On some pure data and telephone transponders (non-video), you may hear something that sounds like a buzz saw, or something that sounds like musical chimes, or you may hear a telephone circuit ringing or a busy signal. On the active telephone channels, you will hear telephone conversations, some radio feeds, communications circuits between the satellite control operators, hotel and motel reservation sections, auto rental companies; at any given moment you could find between 600 to 1200 separate carriers in place! See **Figure 3.12.**

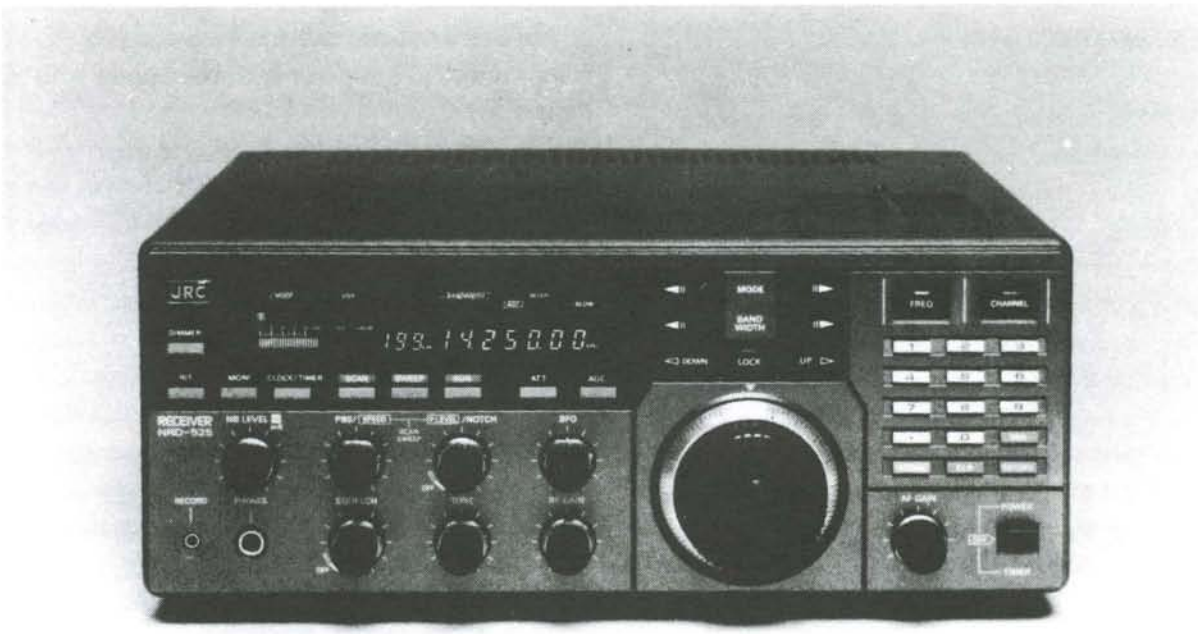


Figure 3.6 *JRC—NRD—525 high-quality SSB general coverage receiver .1 to 30 MHz coverage.*

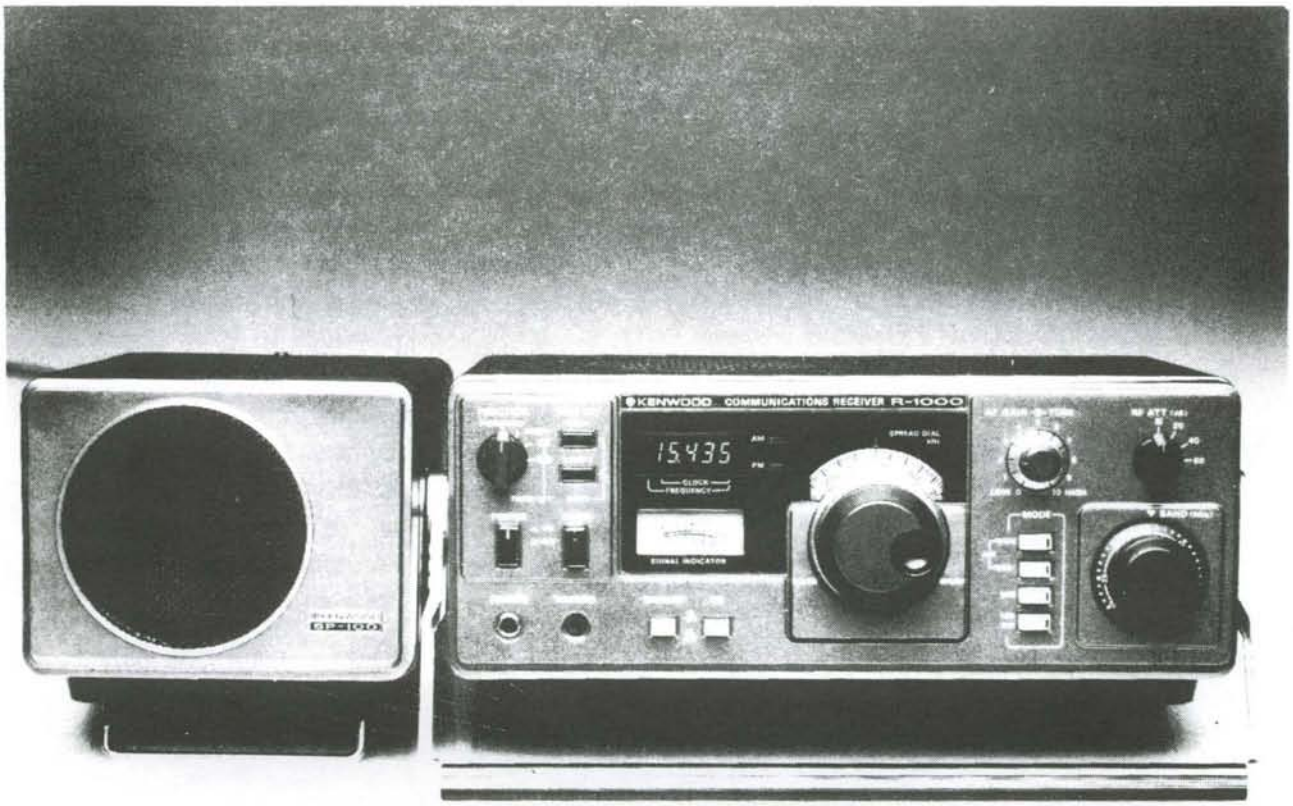


Figure 3.7 *Kenwood R—1000 general coverage SSB receiver.*



Figure 3.8 *Kenwood R-2000 general coverage SSB receiver.*



Figure 3.9 *ICOM R-71A general coverage SSB receiver.*

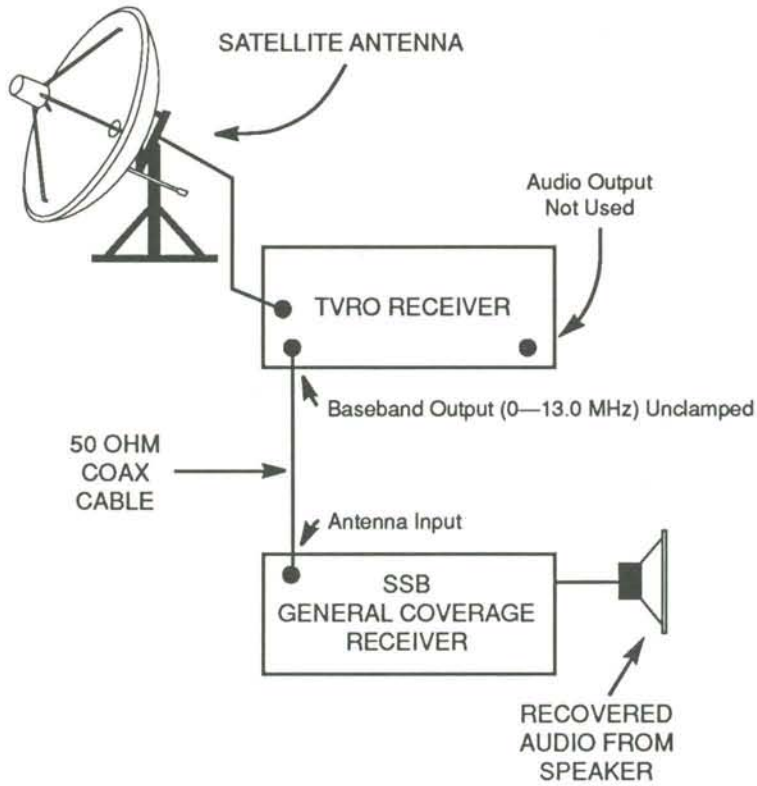


Figure 3.10 *Basic hookup of SSB receiver to TVRO for telephone reception.*

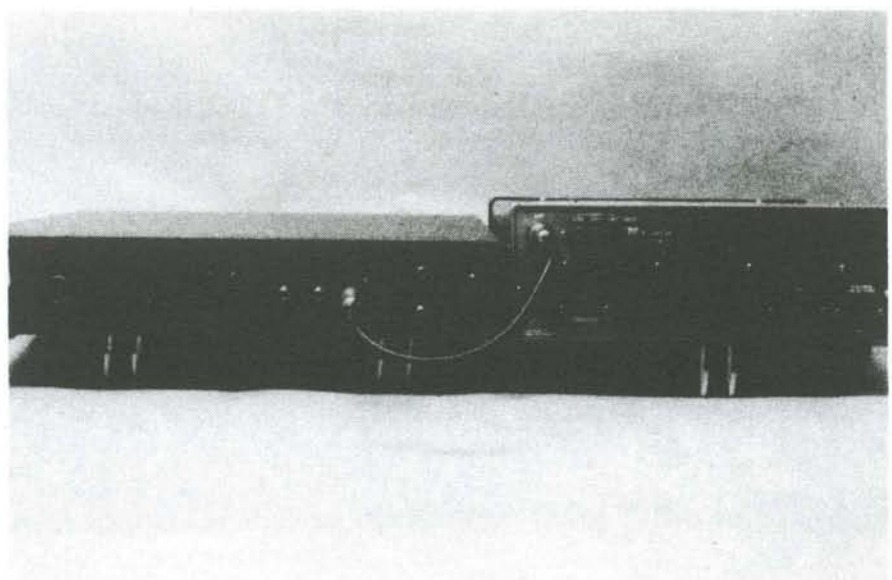


Figure 3.11 *Hookup showing COAX connection from TVRO receiver to SSB general coverage receiver.*

CONNECTION PROBLEMS

Your present TVRO receiver may be so designed that what comes out of the "baseband" output (where you plug in the communications receiver) is severely "filtered" above the normal baseband video frequency range of 0 to 4.2 or so MHz. What does this mean? Well, to keep the normal aural subcarriers associated with a video signal from getting into the video display circuits (i.e., either a monitor or RF video modulator), the receiver designer has built in a filtering circuit that passes only the portion of baseband that is going to contain video information. This cross-over point can occur anyplace from 4.2 to 4.5 MHz. That means that anything above this filtering point is going to get "chopped" out of the baseband output. That also means that any carriers modulated within the transponder above this filtering point are going to be severely attenuated or just eliminated.

What is the solution to this? If you run the system with the filtering in place, you won't copy the data above the cut-off frequency very well, limiting you to the region below approximately 4.2 MHz. The best solution is to look for the point in your receiver at which you can connect an output line to drive the narrow band receiving equipment ahead of the filter. Some commercial receivers already have such an output jack available. After you locate the spot ahead of the filter, simply run a .001 disc ceramic capacitor from that point to a new (added) output jack and plug in the line to your communications receiver in the new jack.

The output of your TVRO receiver may be so strong that you will have to reduce the overall package gain of the communications receiver. The Kenwood R-2000 previously mentioned has a front panel switchable attenuator that lets you switch in 10 dB steps of attenuation. You'll know when there is too much "signal gain" ahead of the communications receiver; if it is equipped with an "S" (signal level) meter, the meter will indicate readings at the S9 mark or over, even when you are tuned between carriers (i.e., no signal being received).

As you tune between 100 kHz and the top end of the band, you may notice that suddenly a whole group of signals can't be tuned in (i.e., clarified). Don't panic—the uplink transmitter has simply multiplexed this Group or Supergroup into the circuit "upside down" and to tune them in, switch the communications receiver from lower sideband to upper sideband. We'll talk more about this shortly.

One of the advantages to receiving narrow-band signals is that they do not require as strong a satellite receiver signal for good quality reception. Why is that? Well, whenever the "bandwidth" (i.e., the amount of spectrum space required to transmit intelligence) is reduced, the whole system picks up additional sensitivity because you can employ a narrower (i.e., sharper) receiver to tune in the signals. For example, with a (big) 20 foot dish equipped with a 120 degree LNA and a standard receiver, these SSB signals typically measure signal-to-noise ratios in the 40 to 50 dB range. If you don't identify with numbers like this, trust us that these are good numbers indicating loud and clear reception. This is another way of saying that when you have a "marginal" TVRO picture (one with noise in it or on the verge of noise), the audio SSB signals will still be loud and clear on a system as described here. In fact, with a 6 foot dish equipped with a 120 degree LNA and the communications receiver system lash-up described here, you can still get "perfect" (i.e., noise free) audio or data reception.

In fact, the signals are so loud that when you are cross polarized (i.e., tuning in a vertically polarized transponder with the feed antenna oriented in a horizontal feed position), the signals are still good (if not perfect) copy on a 15 foot dish.

Receiver stability— An unstable TVRO receiver will be a problem. If your local oscillator stage (VCO) is not pretty stable and if your receiver AFC (automatic frequency control) system is not performing pretty well, you will shortly discover that you are "following" the narrow banded signals all over the dial with the communications receiver. The solution may not be simple, but it should be obvious—stabilize the receiver!

If your receiver has an AGC (automatic gain control) system, disable it before using the communications receiver for what follows:

a) Your TVRO receiver seldom has an accurate signal level meter indicator or one that tells you when you are making small improvements (or degradation) in the aiming of TVRO antenna. The communications receiver will typically have a good quality "S" (signal level) meter on it.

b) Having disabled the TVRO receiver AGC (if there is one), tune in an unmodulated carrier with the communications receiver (using the RF gain control or a switchable front end pad such as the R-2000 employs) so that the carrier you have tuned in reads around "S9,"

typically mid-scale, or lower.

c) Now, as you adjust the TVRO antenna azimuth and elevation, watch the "S" meter on the communications receiver. The rule of thumb is that for each 1 "S" unit you gain or lose on the communications receiver "S meter," you have just picked up or lost 1.5 dB C + N to N (carrier plus noise to noise) at 4 GHz. In other words, since an "S" unit is usually 6 dB ("S meters" are typically calibrated so that all of the "S" marks from 0 to 9 are 6 dB steps, while above "S9" the meter is calibrated in 5 or 10 dB steps), 6 dB improvement in a 2.4 kHz bandwidth works out to around 1.5 dB change in the 4 GHz C + N to N ratio. As long as the carrier you are tuned into stays unmodulated, it will be an excellent "test signal" for fine tweeking on your TVRO dish.

In other words, perhaps the only real "justification" you need to add a communications receiver to your TVRO installation is the fact that you then have a very accurate "metering system" with which to align your antenna to the various satellites!

Now when you are working with very weak signals as when you are getting a system operational or perhaps you are trying to make INTELSAT's feed for Brasil look good, you will find you can tell if things are better or worse much quicker and with much greater accuracy with a communications receiver tuned to an unmodulated carrier on a transponder. I have yet to find any satellite that doesn't have at least one audible (on a communications receiver) carrier on it if it is in the TV relay business. These carriers are there for many purposes including providing telephone intercom links for the people operating the satellites. Since people do not communicate all the time, when they aren't talking, the steady unmodulated carrier is there for you to use in your measurements.

PLEASE NOTE:

You must be sure you are getting pure unfiltered baseband video—that is, the entire spectrum of the video and audio where all hookups call for baseband video and baseband audio, sometimes called unfiltered outputs. To install the proper output see the following section or check with your dealer or service center to have this simple installation done for you. If you do not seem to be getting proper results from any of the outlined hookups, LOOK TO THIS AREA FIRST! Make sure you have the full baseband output on video if you require video connection, or full range unfiltered audio if you require audio connection. Almost every case I know of where lack of reception was a problem, the cause was traced to the output of the TVRO receiver not furnishing true baseband video or audio out.

At this time, there are many TVRO receivers on the market that have the two necessary unfiltered baseband video/audio outputs.

These same baseband requirements will be a requirement for the use of TVRO scrambling decoders, which are used by the major program suppliers, HBO, Cinemax and others.

We expect all of the new generation of TVRO receivers will come equipped with these outputs as standard now that the programmers have progressed into scrambling.

WHAT IS MULTIPLEXING?

As satellite space becomes more and more crowded, new and innovative techniques of optimizing and expanding the amount of information that can be transmitted through a transponder will be required. One effective way of increasing the use of the system is to expand service by means of adding subcarriers and then providing multiple audio channels on the subcarriers.

The term "multiplex" designates a system in which two or more individual signals can be transmitted over a single carrier or other transmission medium. Multiplexing was first used in the early 1900's when the telephone systems were faced with huge expansion of their existing system. Instead of running thousands of miles of additional cable to handle this needed expansion, a new technique was developed to allow more than one channel or voice used per wire which is now called frequency division multiplex (FDM). Since then these companies have refined and improved this technique to many thousands of voice channels over a single wire. Also using FDM up to 2700 voice channels can be transmitted over terrestrial microwave links on a single carrier.

These narrow band signals are now used in many forms on satellite transmission today and will increase many times in the coming years. The telephone voice channels are only one use of multiplexing of many signals on a given carrier. Multiplexing techniques and multiplexing will be dealt with in other chapters in greater detail and combined with other transmission systems. See **Figure 3.1A.**

WHAT WILL WE HEAR?

Many of the telephone circuits you will hear via the TVRO receiver and general coverage single sideband receiver will be one side of the telephone conversation; the other side or other party will be transmitted on another set of carriers. These could be on the next set of signals or they could be on another transponder on the same satellite. We have heard many duplex (i.e., both sides of the telephone circuit) on the same carrier or same signal.

The present plan used by most systems seems to be groups or packages of circuits all going toward one general direction, with another group going the other way. A package or large group of telephone conversations would be from the East Coast of the United States going to the West Coast, with another set or group going one way from Chicago to the West Coast and another set from the West Coast going back to Chicago to form the complete two-sided telephone conversation.

As covered earlier, the telephone circuits use the multiplex system to combine many thousands of telephone-audio channels on a single satellite transponder; this allows the companies to arrange many circuits throughout the entire country.

In conclusion, as with all private transmissions, these should not be used in any way for personal gain. This entire area is dealt with in the Communications Act of 1934, section 605, and are non-broadcast class communications signals considered "private" communications. Review this act on the title page in the front of the book as well as in the general information section in the back of the book.

LOCATION OF SATELLITE TELEPHONE SYSTEMS

The locations of most of the telephone systems seem to have stabilized at this date. Listed on Table 3-B are some of the established locations. As you progress with your receiving equipment, spend some time exploring other satellites and new satellites for telephone and data traffic; we are sure you will be able to find many more as new channels and new satellites appear in the Clarke belt.

Please make sure your polarization is correct for the listed satellite and the listed transponder. Use your signal strength meter on the TVRO receiver as a first step followed by a final peaking using your SSB general coverage receiver's "S" meter.

The SSB receiver makes a great signal strength measuring device as its sensitivity is much higher than the TVRO receiver's signal- strength meter.

TRANSPONDER FREQUENCY/POLARIZATION

FREQUENCY	TRANSPONDER/POLARIZATION SCHEME				
	A	B	C	D	E
3720	1 V	1 H	1 H		1 H
3740	2 H	2 V		1 V	
3760	3 V	3 H	2 H		2H/13V
3780	4 H	4 V		2 V	
3800	5 V	5 H	3 H		3 H
3820	6 H	6 V		3 V	
3840	7 V	7 H	4 H		4H/14V
3860	8 H	8 V		4 V	
3880	9 V	9 H	5 H		5 H
3900	10H	10V		5 V	
3920	11V	11 H	6 H		6H/15V
3940	12H	12V		6 V	
3960	13V	13H	7 H		7 H
3980	14H	14V		7 V	
4000	15V	15H	8 H		8H/16V
4020	16H	16V		8 v	
4040	17V	17H	9 H		9 H
4060	18H	18V		9 V	
4080	19V	19H	10H		10H/17V
4100	20H	20V		10V	
4120	21V	21 H	11 H		11 H
4140	22H	22V		11V	
4160	23V	23H	12H		12H/18V
4180	24H	24V		12V	

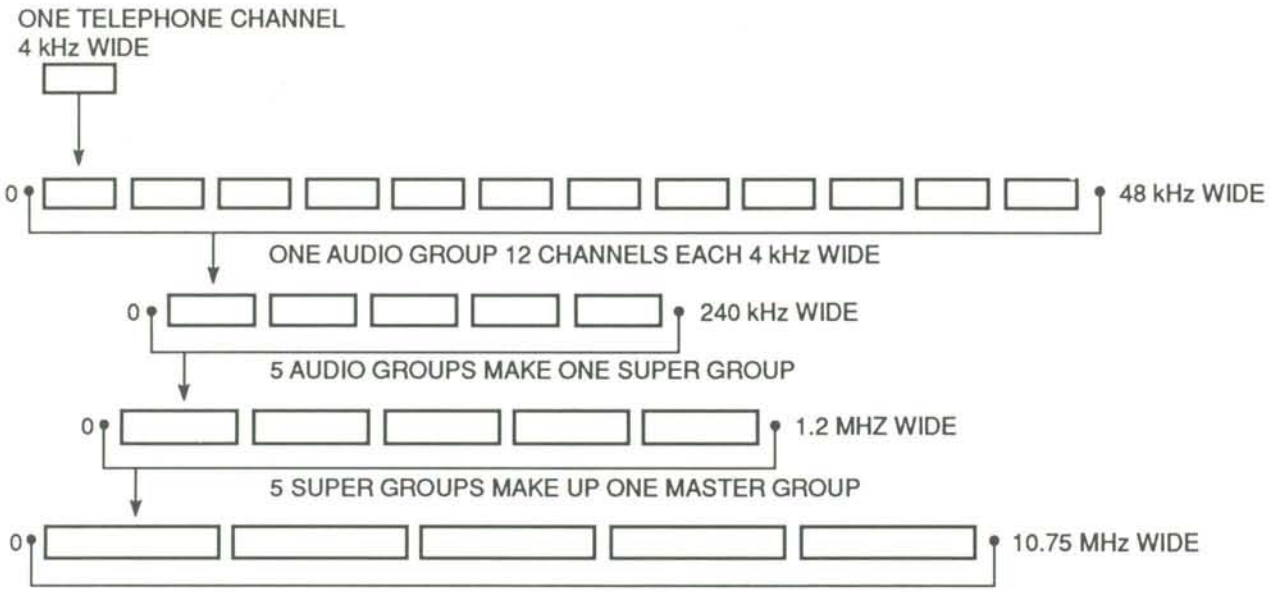


Figure 3.12 *Basic multiplexing telephone system used on many satellite systems. A single side band multiplexing mode.*

IMPORTANT POINTS ON SSB/FDM

(A) On the transponder loading charts in Chapter One, you will see a designation of TBB—this means top baseband frequency of the transponder—A notation of 5260 simply means the baseband ranges from 1 Khz to 5260 Khz. Return to the format explanation and definitions. TBB means the frequency of highest baseband component. Likewise, TSC means the frequency of the highest subcarrier on a transponder. See **Figure 3.13** system for SSB/FDM work.

(B) When using SSB/FDM, (Single sideband) frequency division multiplexing, it is possible to use the unfiltered subcarrier output on your satellite receiver up to about 8200 Khz, which is the frequency point where the subcarrier output cuts off. In other words, this is the subcarrier upper or highest frequency. This is the reason we want to use a *true baseband output* on on the satellite receiver in order to receive all of the contained frequencies. Please note the TBB frequency for many transponders in the chart. This TBB frequency will tell you the possible amount of usable channels carried on a transponder. The higher the frequency, the more channels it is possible to carry on the baseband.

(C) In most cases, a transponder will carry all of the TELCO and DATA channels within this top baseband frequency, (TBB) allocation as stated in the transponder loading charts.

(D) These transponder loading charts are very helpful in your search on more "Hidden Signals" on the satellites. Any transponders listed as TV/FM will be using most of the frequencies for the broadband video signals, plus all of the audio subcarriers needed and used.

(E) When searching for signals, you should turn off your TV set or monitor to cut down on RF that will radiate from your TV set. This RF will appear on the audio as possible false signals and can be confusing.

(F) The commercial channels seem to be carried in groups within a transponder. When you find one, you will usually find another good channel close by. These channels will be grouped within the telephone channels as all are SSB/FDM signals. I have run across many duplex voice channels in the transponders which are listed as FDM channels.

(G) When a series of telephone channels are grouped together, one channel will usually be running in upper sideband and the one next to it will be running in lower sideband mode; therefore, it is necessary to change the sideband control on your general coverage receiver to the proper sideband to receive clear copy on all of these signals.

SATELLITE TELEPHONE SYSTEMS (SSB/FDM)

SATELLITE	LOCATION
SATCOM C-1	139.0
ASC 1	128.0
SPACENET 4	101.0
WESTAR 4	99.0
SPACENET 3	87.0
TELSTAR 302	85.0
COMSTAR D2/D4	76.0

NOTE: *Search all video inactive transponders. Refer to Chapter One's transponder loading report that shows SSB/FDM transmissions.*

Table 3-A

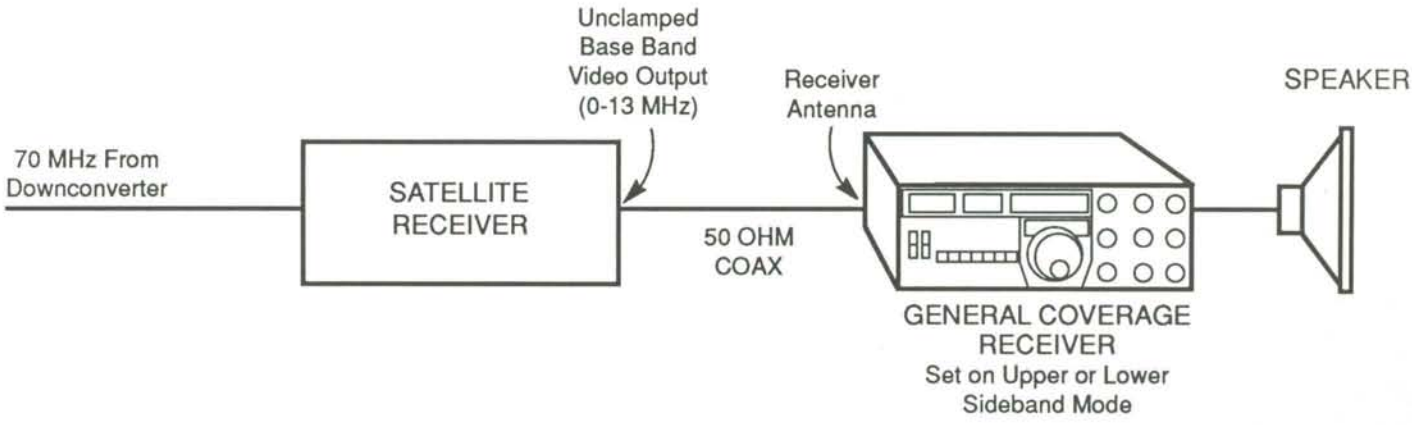


Figure 3.13 *Use of HF general coverage receiver for receiving SSB/FDM satellite signals. General coverage receiver should be set in the upper or lower sideband mode.*



Figure 3.14 *The new generation of satellites will furnish thousands of multiplexed telephone channels for nationwide coverage.*

CHAPTER FOUR

SINGLE CHANNEL PER CARRIER (FM/SCPC) (SSB/SCPC)

FM-SCPC WHAT IS IT?

Many years ago, when satellite TV was new and everyone was learning, there was a flurry of interest in non-video satellite services. In several early TVRO manuals circulated in the 1980/81 era, entire chapters were devoted to the systems required to bring down from the birds network radio services, press services (UPI and AP), Teletype® and a host of other "narrow band" links.

In the intervening years, the intense interest in video has overshadowed what was a growing interest in non-motion, non-video services and information concerning the available services became more and more difficult to obtain. Today very little is known about the current state of those services or the type of hardware required to bring those services into a private location.

There has always been two separate methods of transmitting narrow band material via satellite. In 1980, one of these formats (SSB/SCPC) predominated while another, perhaps technically better and technically more complicated, FM/SCPC, was a newcomer. In the interim years, the FM system has taken hold and most of the high- quality audio and data links in use today, on both domestic and Intelsat satellites, rely on this frequency modulation system.

Let us first define the market for such services, since as system dealers we must always equate what is available to "who we can sell it to" as a business activity. Then we will take a preliminary look at the equipment required and where you go to find that equipment.

RADIO NETWORKING

The development of radio networks in the late 20's and early 30's provided the foundation for the modern-day broadcasting industry we have in North America. And radio networking depended upon the ability to interconnect two or more radio broadcasting stations so that each could release or transmit the same program at the same time. The economics of networking are considerable; networking allows a massive, national or international, audience to participate in the same event or program at the same time. It also attracts national advertisers, who in turn, can build their own product distribution programs around their abilities to reach millions of homes instantaneously.

Radio networking depended for years on the Bell Telephone Company landline network for interconnection. In heavily populated areas, coaxial or other types of cables carried radio network signals from town to town and city to city, dropping off the "feeds" at each community where there was a local broadcast affiliate. The broadcaster, in turn, would dedicate one (or more) audio "lines" on his control console to the directly-connected network service line, and the on-air engineer would, on cue or at an appointed time, simply fade down the audio from the local programming and "bring up" the audio from the network programming. In this way, local news and programs were integrated with national news and programs to make up the full broadcast day.

In more remote areas where the population density did not justify the dedication of full time "wire lines" to radio network program carriage, stations were dependent upon either a microwave interconnection for their network "feeds," or alternately, picking up the over-the-air broadcast from another station affiliated with the same network using an "off-air" receiver. In either case, the end result was the same; the audio from the feed terminated on the control room console and the operator on duty could switch to the network feed as the radio station's schedule dictated.

It is and has been standard practice for the

network operators (Mutual, ABC, et. al.) to pick up the "tab" for the interconnection service. This means that the networks have always been large users of Bell circuits, and their bills to use those circuits have been substantial. Bell likes to plan circuits and systems a decade or more ahead, and when Mutual (for example) went to Bell in 1960 with their network service plans, they were talking not about the network service plans for 1960, but rather for 1970. Getting Bell to move "faster" was not impossible, only expensive. The Bell network, as wonderful and reliable as it is, does not lend itself to inexpensive, *rapid*-change; so when a special event came along that required monstrous rerouting of network services, there were monstrous charges associated with the changes.

Bell also has always been "network-quality line" limited. While it is possible to send human speech ("voice grade") material over a standard telephone line, the standard telephone lines lack several important parameters which are required for *quality* radio networking. Bandwidth is one of those limitations; the standard Bell telephone circuit is typically capable of "passing" audio only in the 50 Hz to 3,000 Hz region with good clarity. Most musical programs contain passages which far exceed this relatively narrow bandwidth; a 15,000 Hz bandwidth is more in keeping with what we normally call "high fidelity" audio. To handle this, Bell circuits have to be specially "equalized" using equipment which is dedicated to broadcast circuit use. Even human speech suffers in a *normal* telephone interconnect; you can hear the difference yourself when a radio announcer is interviewing someone on the telephone and his voice is transmitted to you through his in-studio microphone while the other voice is coupled out of the telephone. The telephone source voice has a "tinny" sound when compared directly to the in-studio microphone voice. Thanks to modern electronic audio processing equipment some of this can be artificially corrected today, but the correction is limited to handling the human voice range and does not extend to the musical instrument range. See **Figure 4.0.**

It was a natural, then, for radio networks to look with favor on the establishment of satellite linked interconnection systems. First of all, the circuits compared very favorably in cost to Bell landline circuit rental if you "amortized" the costs over 5 to 7 years. Second of all, satellite links could be (and were) designed from the ground up to be capable of handling all of the audio range required (20 Hz to 20,000 Hz is not an unusual specification). Next, whereas most radio networks rely primarily on one "circuit" for most of their transmission needs, there are occasions when a second or third circuit would give them the flexibility they need to do a better job. Satellite links can be "stacked" with two or more channels for a minimal increase in cost. This gives the networks an expansion capability, on short notice, which they never had with terrestrial landline circuits. And finally, while landline networking was barely able to handle "high fidelity" monaural audio (with some difficulty) using satellite circuits, the networks could stack a pair of separate "channels" and send stereo service just as easily as they were sending mono over on the landlines.

The Mutual Radio Network was the first of the "big four" radio networks to invest heavily in the satellite linking project. Mutual began in 1978 with a proposal to equip its affiliates with modest-sized dishes (ten feet in diameter). *At the time* of the proposal, the FCC was *not* allowing *anyone* to use 10-foot dishes for anything; you still had to have a satellite-receiving-terminal "license" and the Commission's view of small dishes was that they did not meet their technical requirements. It was at about the same time that cable system operators and the first wave of private terminal owners were trying out dishes in the 10- and 12-foot region, and it took the combined "weight" of all of these factions to convince the FCC that smaller dishes were "OK." Mutual played a substantial role in our "non-license" status we enjoy for home TVROs today simply because they were aggressively pushing the FCC to approve dishes in the ten- foot region.

Since 1982, radio networking has grown up dramatically. Some of the networks supply their affiliates with small "ARO" (Audio/Receive-only) terminals. Others provide the satellite service, but require affiliates to purchase their own terminals. Major suppliers of ARO terminals include Scientific Atlanta, Microdyne/AFC, California Microwave, and others.

The basic ARO terminal consists of an antenna plus LNA, a down converter, and a special "ARO" terminal demodulator. The system, up to the demodulator, looks like and in fact works just like your typical ten-foot region home TVRO. Very few of the ARO terminal systems are equipped with motor drives; however, since the radio stations (and others) using these services don't move around the sky looking for feeds, the feeds are dedicated to specific transponders on specific birds full-time.

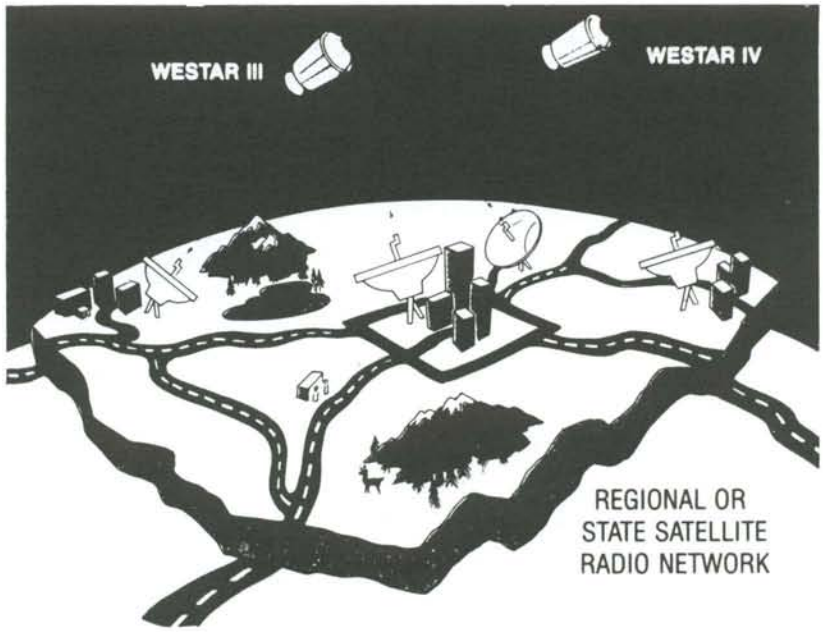


Figure 4.0 *Radio networking via satellite.*
Courtesy Comtech Corp.

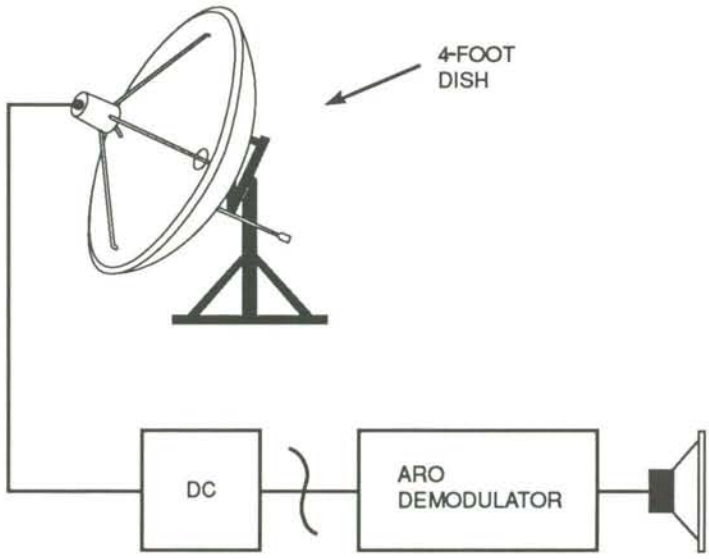


Figure 4.1 *Dedicated 4' ARO dish offers quality FM/SCPC service with small dish.*

The ARO Demodulator is an interesting piece of equipment. See **Figure 4.1.** There are quasi-standards in this field, and the most frequently utilized standards place the individual audio or data signals inside of a transponder 200 kHz apart. The individual "channels" occupy a bandwidth of 60 kHz. How do these numbers relate to TVRO/subcarrier audio? See **Figure 4-2.**

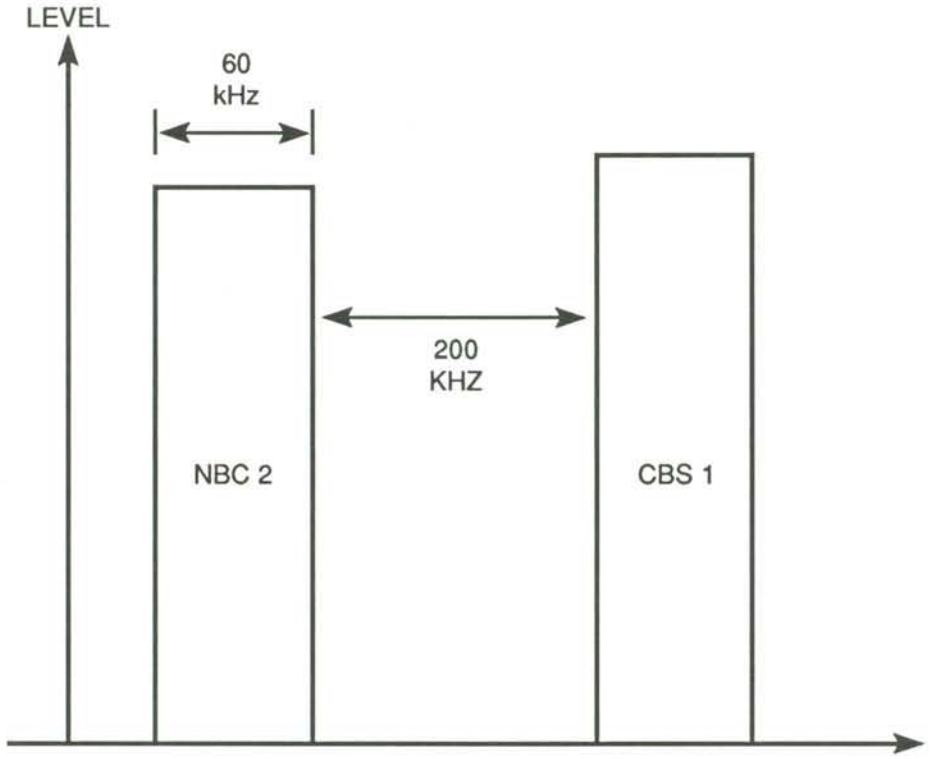


Figure 4.2 *FM/SCPC services typically can be found spaced 200 kHz apart (center to center) with each 60 kHz wide.*

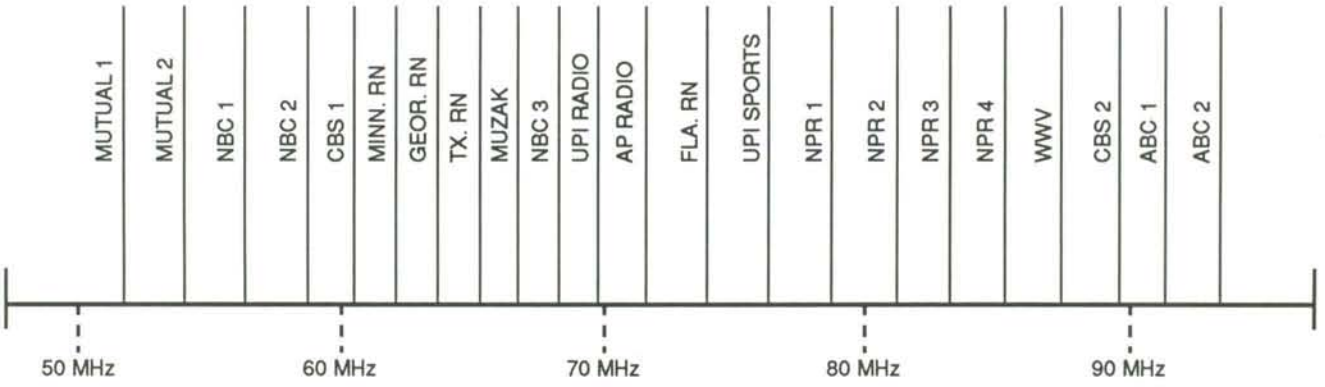


Figure 4.3 *Typical (not actual) FM/SCPC single transponder service assignments.*

First of all, if the transponder has no video, then the entire transponder can be divided up into a subworld all to itself. The satellite operator can look at his 36/40 MHz of transponder space, and he can decide which service he wishes to assign to what frequency within that transponder. In effect, whereas the FCC does the "frequency allocating" for terrestrial broadcast services, the satellite operator becomes "the FCC" for the on-transponder services. The services are assigned space or a specific operating (uplink) frequency. The uplink operator has to be concerned only that he keeps his subcarrier sufficiently spread out so that they do not "cross-talk" to one another; and to insure that as he adds new subcarriers, he does not "rob" too much power away from the video carrier (each audio subcarrier added to a video carrier reduces the effective power of the video carrier).

The FM/SCPC service allows each of the network services operating with a transponder the ability to uplink their own signal. In effect, if you had 20 different radio network signals on a transponder, each independent in content from the other, you could also have 20 separate uplinks *all sending signals* to the satellite. Those uplinks could be all in one geographic region (i.e., New York City), or they could be spread (as they typically are) from coast to coast. So there is a difference. See Figure 4-3. Another difference is that the bandwidth of the FM/SCPC services is far narrower than the subcarrier audio service; rather than being as much as 300 kHz wide (i.e., Disney), the FM/SCPC carriers are pretty much standardized domestically to a 60 kHz bandwidth. This simply means that if you try to use a receiver designed for one service to tune in the other format, you won't recover proper (or any) audio.

However, the major difference between subcarrier techniques and stand-alone SCPC techniques is that, *with subcarrier operation,* first you have to receive (and demodulate) the video carrier. Once you have the video demodulated, you *now* can go to a "second demodulator" and extract the audio from the video signal. In effect, inside your TVRO video receiver you have two separate receivers, one that makes pictures, and having made pictures, another that makes sound. The FM/SCPC format is more akin to your standard FM broadcast service as each individual station "stands alone" and you tune it in with a master tuning dial. In fact, the only significant operational difference between tuning in a dial full of FM broadcast stations on a home tuner and tuning in a transponder full of FM/SCPC signals is that you are tuning the satellite frequency band (indirectly) with the "ARO" receiver rather than the FM broadcast band.

This tells us that what we need to receive "ARO" service is a receiver which operates like a standard FM tuner/receiver, except that it does it in the "satellite TV band," and with the bandwidth system which the typical radio networking link uses. And that brings us back to the typical "ARO" terminal.

THE SYSTEM

There are two major differences between an FM broadcast band tuner/amplifier and an "ARO" receiver/ tuner.

1) The FM broadcast band is 88-108 MHz (in North America); the satellite band is 3,700 to 4,200 MHz.

2) *Some* (but not all) of the satellite FM services (sFMs) employ the same 30 Hz "energy dispersal waveform," or dither, which most of the video services use. This is an FCC requirement (although not all follow it); a system to reduce the likelihood that a satellite signal in the 3.7 to 4.2 GHz frequency range will interfere with a terrestrial (Bell) link in the same frequency range.

The smart approach is to shift the satellite frequency range to a much lower frequency range, just as we do with TVROs. This requires a down converter (after the LNA). There are two possible approaches here just as with TV:

1) *Shift the full band* (3.7 to 4.2 GHz) to a lower "block of bandwidth," say 270 to 770 MHz (i.e., AVCOM, Scientific Atlanta, some of the newer Microdyne receivers). Getting the satellite "band" down to a lower frequency range makes it far easier to "transport" the satellite signals from the antenna/dish (where the down converter is located) "inside" to the demodulator portion.

2) *Shift just one transponder* at a time from its assigned frequency range (say TR3, 3840 to 3880 MHz) to a lower "IF" range such as 50-90 MHz (70 MHz center frequency). See **Figure 4.4.**

Once the signal is shifted in frequency to a lower intermediate frequency (i.e., IF) we can then build a receiver which "tunes" that IF region, say 270 to 770 MHz or 50 to 90 MHz. It turns out that in a block down conversion system (such as 270-770 MHz IF), we are still asking a lot of receiver design engineers to turn that relatively high (UHF) frequency range signal(s) into video or audio. So the BDC is usually an intermediate step. After the 270-770 MHz IF which leaves the antenna mounted down converter, we have a second "conversion" of frequency inside of the demodulator. The 270-770 range then becomes 70 MHz where not the *full* band *but one transponder at a time* is processed. So whether we start out leaving the outdoor down converter at 70 MHz (so-called single conversion system), or we first block convert to 270-770 MHz and then transport the "block" inside, reconvert a second time to 70 MHz, we usually end up at the "standard" 70 MHz IF anyhow. See **Figure 4.5.**

So here we are building an FM "tuner" which will cover the frequency range of 50-90 MHz, nominally. We process the audio-loaded transponder, with perhaps several dozen separate and distinct radio network-type signals, to a standard 70 MHz IF (which is actually an IF that centers on 70 MHz but which typically covers from 50/55 to 90/95 MHz). Then we build our FM tuner, following the specifications adopted for sFMs. This is your basic professional grade FM/SCPC receiver.

This brings us smack up against the first substantial problem with the system: *frequency stability.* Early TVRO receivers had something called "drift." This meant that the user had to touch-up the channel selector tuning control every few minutes, or 30 minutes, to keep the signal "tuned in." A microwave receiver has many demands placed on it; staying tuned on the right signal all of the time is one of those demands. A circuit called "AFC" (automatic frequency control) was the answer. By using the television video signal received by the demodulator as a "reference," the AFC system *constantly monitors* the frequency-centering of the received signal. If the centering moves because some of the circuits in the receiver are not totally "stable," the AFC corrects the tuning, automatically. That ended the constant across-the-dial chasing most of the early home TVRO receivers had. Unfortunately, this technique requires that the receiver have a standard video signal to reference. The typical sFMs transponder has *no video signal present*; therefore, there is no reference.

If chasing a TV signal across the dial was no fun, chasing an audio signal across the dial is "no fun squared." The TV signal is very "wide;" the audio signal is very "narrow." It is far easier to keep your eye on a moving basketball than a moving ping-pong ball. In simple terms, without AFC the ARO receiver constantly moves about and the desired audio signal is bouncing all over the dial. *Not a saleable product.* See **Figure 4.6.**

Clearly, an ARO AFC was required, but how do you do it without driving the costs up very high? One technique is to build your own local reference signal into the receiver. The internal reference signal approach works on the theory that it is not the satellite signal that is drifting or moving about, it is the receiver itself. To be specific, the "local oscillator" is not totally stable with changes in operating temperature nor time. So if you cannot "borrow" the stability of the incoming video carrier signal as a reference, you build your own reference.

The next problem is the "dither" or energy dispersal waveform. This is a form of "scrambling" placed on "all" carriers (says the FCC) to make terrestrial microwave and satellite microwave compatible. They both share the same band, as TVRO installers who have had "TI" (terrestrial interference) problems are aware. The 30 Hz energy dispersal waveform drives the relatively narrow (in bandwidth) audio carriers "crazy" It complicates creating a good stable "AFC" system. It must be eliminated (i.e., clamped) in the receiver or nothing will work properly.

With this we can move on to other equipment areas in SCPC and look at some of the available SCPC receivers being sold today. This equipment will handle the narrow band transmissions. See **Figure 4.7** and **Figure 4.8.**

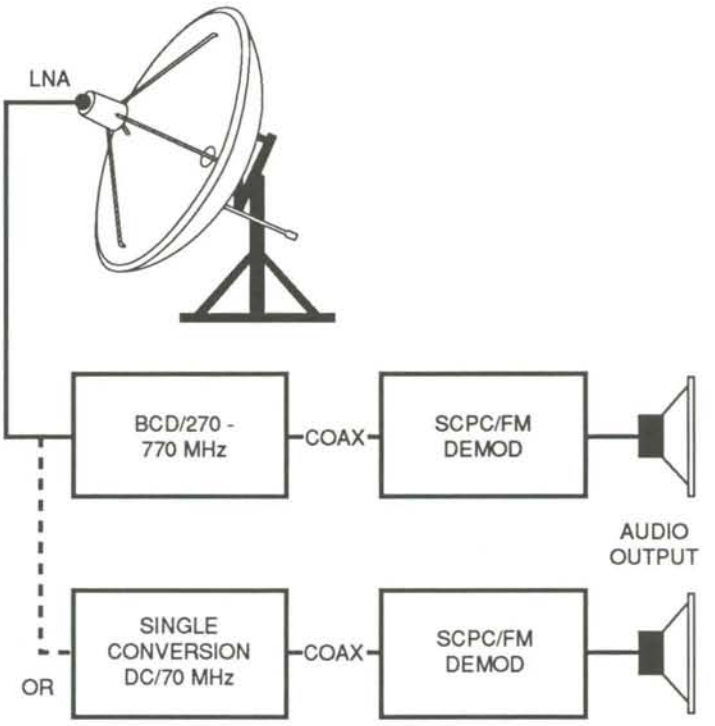


Figure 4.4 *Basic FM/SCPC system operates as an audio-only TVRO.*

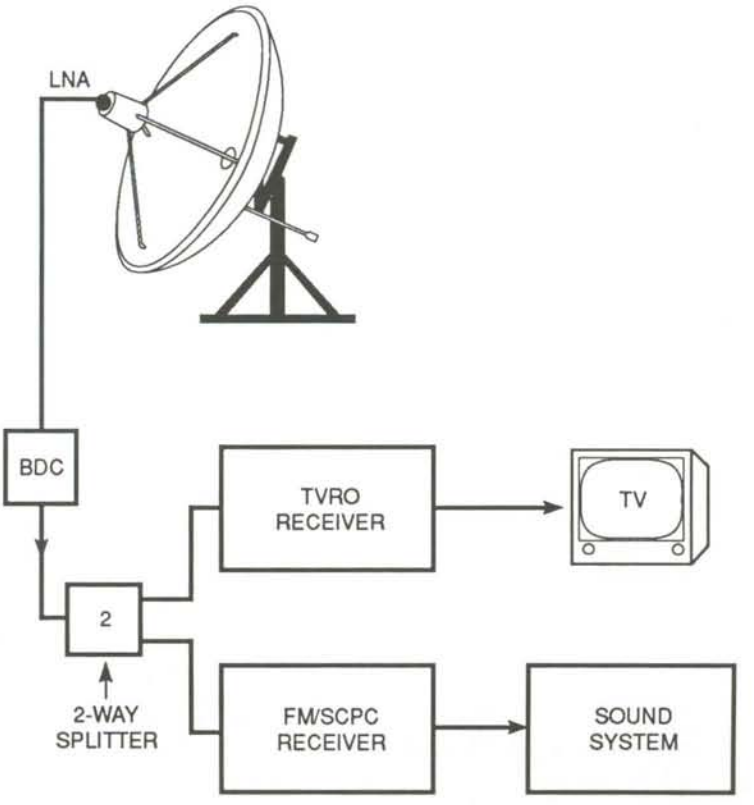


Figure 4.5 *With appropriate block down conversion receivers (AVCOM 66 series) twin receivers can be driven with a single block down converter.*

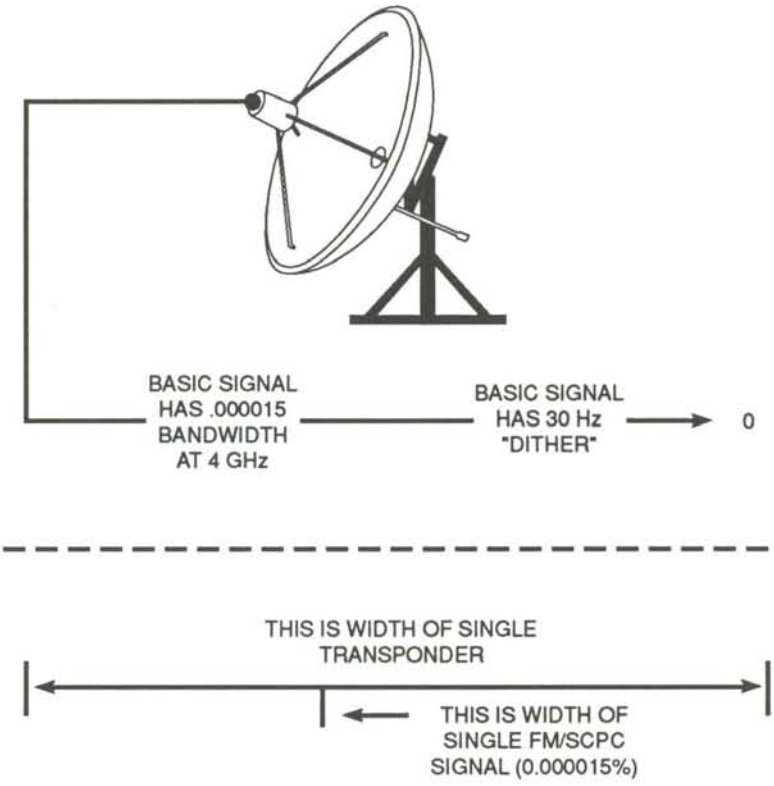


Figure 4.6 *The stability problem.*

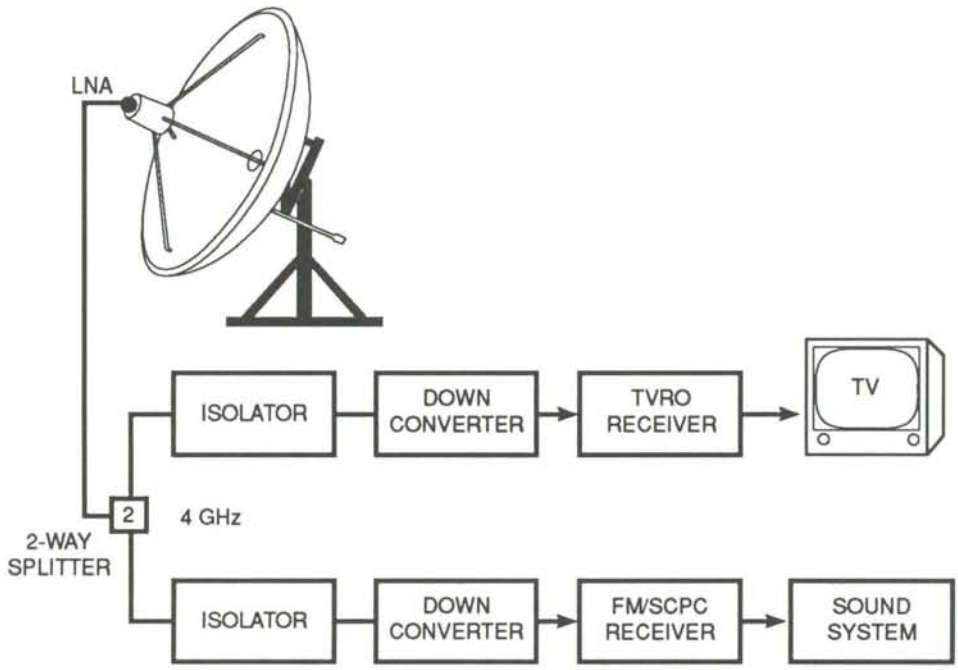


Figure 4.7 *Using single conversion receivers, dual down converters and isolators are required.*

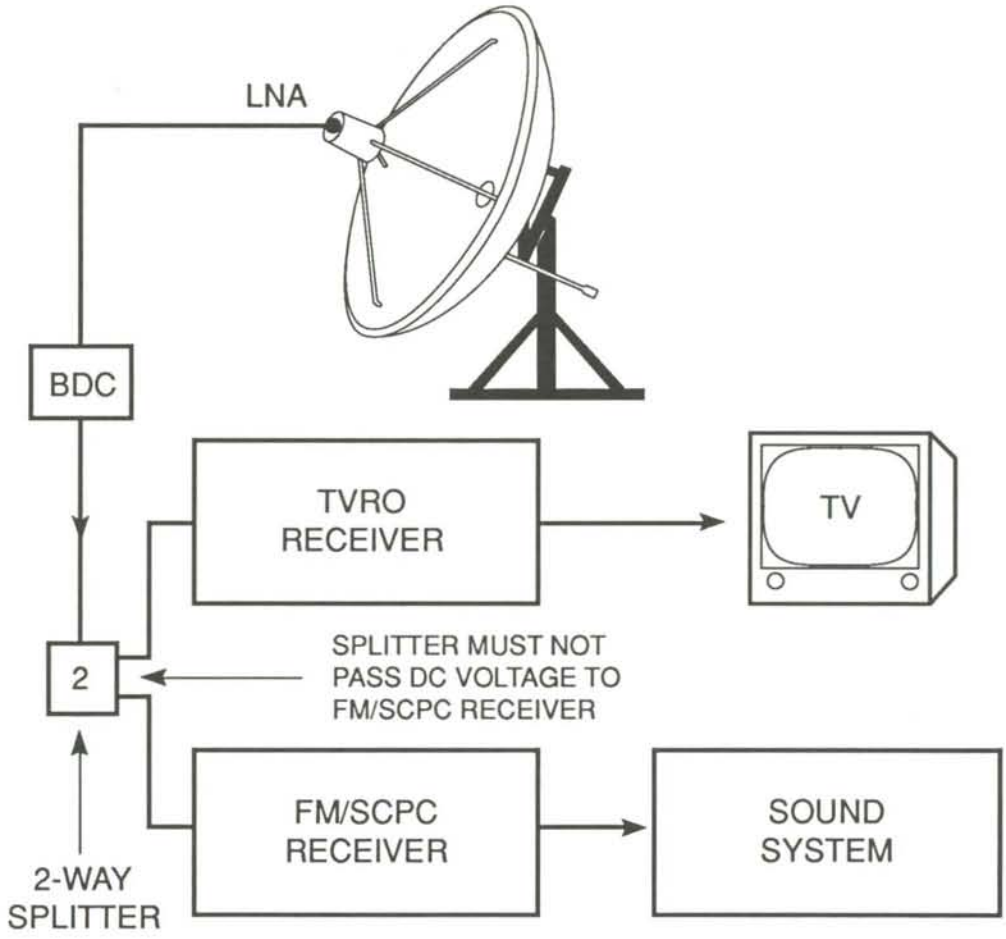


Figure 4.8 *With appropriate block down conversion receivers (AVCOM 66 series) twin receivers can be driven with a single block down converter.*

SCPC/FM EQUIPMENT — GENERAL

Most SCPC equipment has been manufactured for the commercial market by several firms in the satellite data and audio field. These firms manufactured for a very narrow market, for a highly specialized use (actually a single purpose end use); therefore, the equipment was expensive and often difficult to obtain from stock. In the last few years, several manufacturers of audio and data SCPC equipment have set up dealers for their equipment, and it is not uncommon to be able to purchase all types of electronics off the shelf or within several days with notice.

The data field now offers new opportunities for the dealers who have experience in erecting and installing this grade of equipment for the end user.

Some of the leaders in this field are:

- Harris Corporation, Melborne, Florida
- Comtech Data Corporation, Scottsdale, Arizona
- Scientific Atlanta Corporation, Atlanta, Georgia
- Modulation Associates, Mountain View, California
- AVCOM of Virginia, Inc., Richmond, Virginia

HARRIS CORPORATION

Harris Corporation manufactures a wide line of satellite equipment for receive-only stations for news wire teleprinter, news audio, stereo or monaural program audio, photo-facsimile, and digital data.

To an ever-growing extent, news-wire services, radio network programming and other special communications are being distributed nationally by satellite. Newspapers, radio stations, television newsrooms, and stockbroker's offices increasingly receive information and programs via satellite receive-only earth stations.

Harris has developed the series 6015 satellite receive-only terminal to meet the needs of these users of satellite services. This series is field proven; over 1500 terminals have been installed for major news service and state and regional radio networks across the nation. This terminal includes a 3 meter (10 foot) diameter receiving antenna, mount, all electronics, and the interconnecting cable. See **Figure 4.9.**

HARRIS SCPC/FM NETWORKS

For light traffic (primarily telephony) from many stations, Harris Single Channel Per Carrier FM satellite networks provide optimum service. Harris SCPC/FM equipment is being used for national telephony networks in Nigeria, Sudan and Saudi Arabia. An SCPC/FM network is also being built by Harris for the rural telephone system of Argentina. A similar network is planned for communications during construction and operation of the Northwest Alaskan Gas Pipeline.

In a SCPC system, each telephone signal has its own independent channel unit with separate transmit and receive carriers. These carriers are present only when a voice (or wire line modem) signal is being transmitted and drop out during pauses. This allows the limited transmit power of the satellite to be used only for active carriers, increasing the effective signal strength.

Harris builds a Demand Assigned Multiple Access (DAMA) control system for SCPC/FM networks. This system places all channel unit frequencies under control of a central computer. Channel unit frequencies are programmed, as required, to set up calls between any two-channel units in the network. DAMA control increases the traffic capacity of the network and reduces the number of channel units needed at each station.

For special requirements, Harris TDM and SCPC/FM equipment can be combined in a single network. The TDM equipment can be used for heavier traffic links, for digital data signals, or for requirements where voice or data must be encrypted. See **Figure 4.10.**

RECEIVE-ONLY NETWORKS

Satellites can provide economical distribution of programs or information from a single source to many receivers scattered over an extensive territory. Television programs, news wire services, stock and financial data, radio network programs, and similar information programs are being distributed nationwide by U.S. satellites; for example, Harris builds an extensive line of equipment for these receive-only networks including uplinks and receiving stations for television, program audio and news wire. The satellite terminals that United Press International subscribers use to receive their audio and news Teletype are built by Harris. These terminals are low in price and are easily adaptable to the distribution of music, computer data, or other types of information. A 10-foot antenna connected to a small tabletop receiver comprises a complete terminal.

For television, Harris builds complete systems, including antennas, low-noise amplifiers, and video receiving equipment.



Figure 4.9 Harris satellite Receiver-Only terminal, series 610 S.
Courtesy Harris Corp.

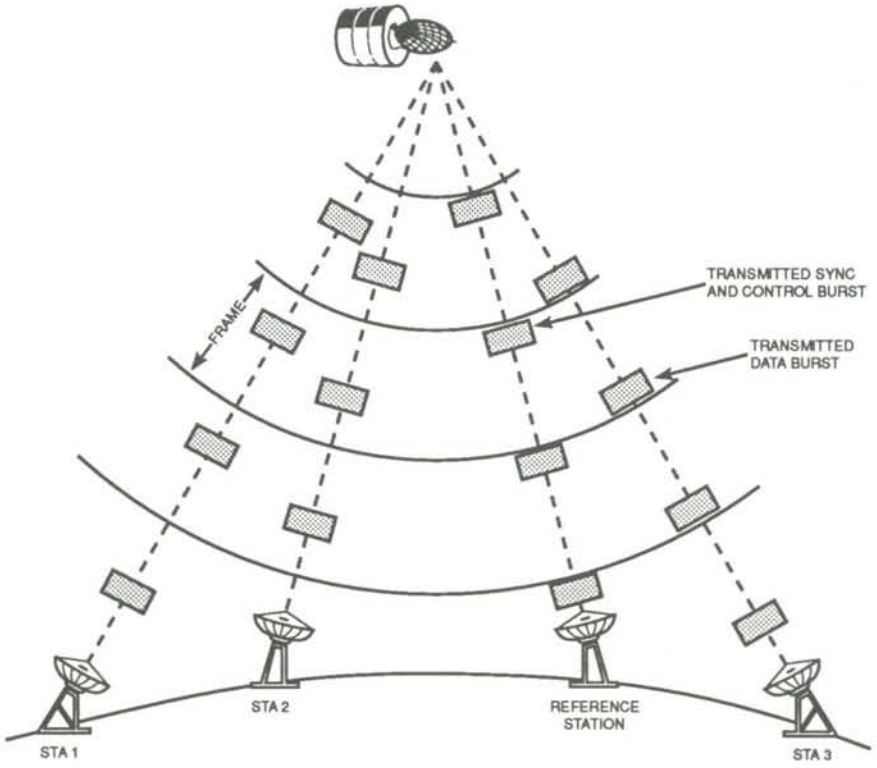


Figure 4.10 Earth stations transmit signals on DAMA SCPC/FM network.
Courtesy Harris Corp.

TDMA IN BRIEF:

TDMA is the most advanced networking method being used to communicate over satellites. TDMA is a digital transmission technique. All signals — voice for telephone calls, computer data, Teletype, facsimile, and television — are converted to digital bit streams. These bits are combined into a single stream for transmission, then separated at the receive station into separate bit streams and decoded to obtain the original message signals.

The most significant difference between TDMA and other techniques, however, is not its digital format, but the rather elegant method used to transmit the signals. In a TDMA network, each station takes its turn in transmitting information through the satellite to all other stations in "round robin" fashion. Each station sends this information in short bursts at extremely high rates — up to sixty million bits per second. The "round robin" switch from station to station occurs rapidly so each station transmits and receives signals many times each second. Because the switching is so rapid, the two-way flow of signals seems to be continuous to those using the network. A telephone call over a TDMA network, for example, sounds no different than any other telephone call.

The major advantage of TDMA is its flexibility. Changing the amount of traffic between stations requires no channel card changes. Instead, software-controlled division of time slots is changed to match the new traffic requirements. If required, this allocation of time slots can be done dynamically by the network master control computer to match time-of-day changes in traffic. Even if additional stations are added to the network, only simple software changes are required at existing sites.

If full transponder traffic (60 Mb/s) is being transmitted by the network, another advantage is the extra output power available from the satellite. Because only one burst at a time is transmitted by the satellite, the transponder can be driven near saturation without creating distortion and interference between signals.

HARRIS TDM NETWORKS

Harris TDM networks for voice, data, and video teleconferencing use digital transmission over multiple carriers. These networks are designed to be cost-effective for light to medium traffic. Continuous carriers are used for transmitting and receiving data at each earth station. Data rates up to T1 (1.544 megabits per second) per carrier are standard; higher rates may also be used for special applications.

Cost analysis of Harrls TDM networks by independent auditors have shown considerable cost reduction compared to standard common carrier services. The networks are designed to provide user organizations with increased control over both traffic and cost for data and telephone signals. See **Figure 4.11**

NEWS SERVICE PRODUCTS

Increasingly, news wire services, radio programming, and other special communications are being distributed nationally by satellite. Newspaper offices, television newsrooms, radio stations, and stockbrokers' offices are receiving news, programs, and internal information on their own satellite receive-only earth stations. In response to the growing demand for multi-point distribution of voice and data via satellite, Harris Satellite Communications Division has developed a receive-only terminal tailored to meet specific news service customer requirements.

The Harris voice/data terminal, called the 6100 Series, comprises a 3-meter Delta Gain receive-only antenna, a voice/data receiver and related electronics. The voice/data receiver is configured with a signal down converter and appropriate plug-in modules to receive news wire, program audio, data, and facsimile in virtually any combination. The system provides superior signal quality and reliability for radio news' Teletype, digital information, stereo audio, and a growing range of other services while eliminating the need for leased telephone land lines.

The Associated Press and United Press International distribute news wire services to subscribers via Series 6100 terminals. In addition, a majority of state radio networks in the United States have chosen the Series 6100 for programming distribution. Over 1500 U.S. locations are current.y receiving news, sports, and information on the Series 6100 system. See **Figure 4.12.**

RECEIVER:

The Model 6550 Receiver is designed for tabletop use or rack mounting. It is about the size of an FM tuner. Model 6550 operates from conventional 115 Vac, 60 Hz power (250 watts minimum). The receiver contains a power supply module, a down converter module, and six slots for channel processor cards. Output connections from the receiver to associated

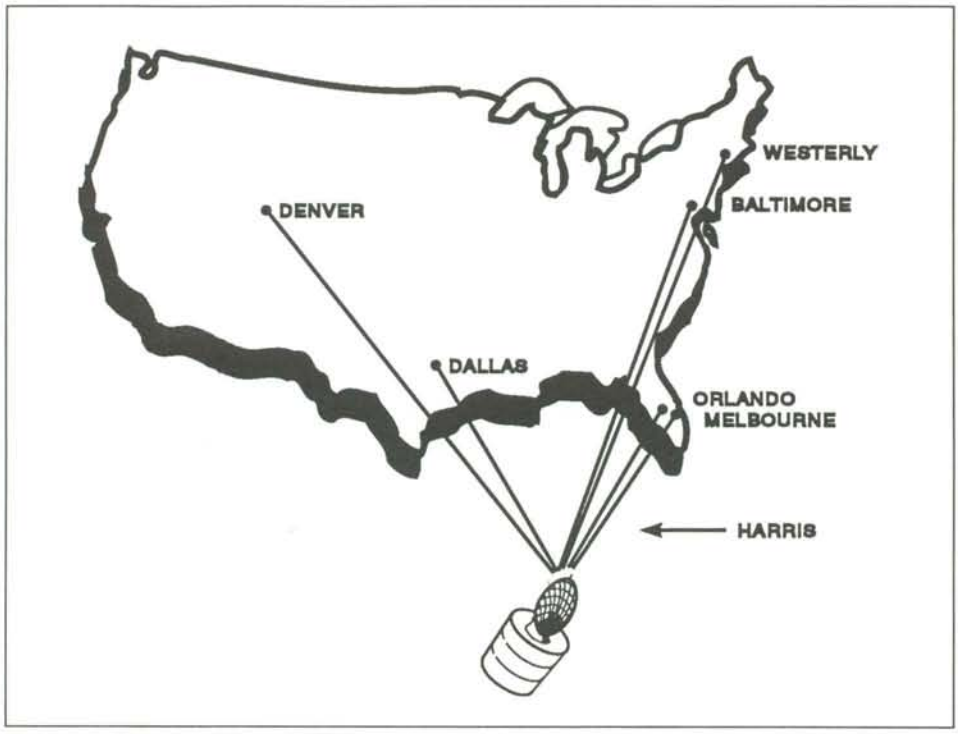


Figure 4.11 *Harris TDMA network.*
Courtesy Harris Corp.

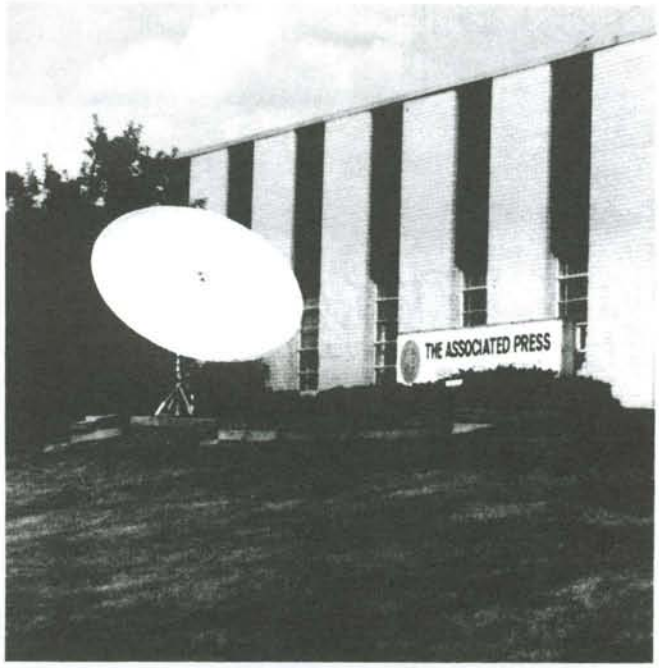


Figure 4.12 *News services distributed via satellite.*
Courtesy Harris Corp.

equipment are made by the twisted pair wire connected to the terminal blocks on the receiver's rear panel.

CHANNEL CARDS:

Several configurations are available depending on network requirements. In many cases, these cards are supplied by the news service or broadcast network to their authorized subscribers. The Model 6550 Receiver is compatible with cards supplied by major U.S. news services and radio networks.

In most U.S. locations, by adding a signal splitter and satellite video receiver, the same earth station can be used to receive TV signals from the same satellite as audio or news wire services. See **Figure 4.13.**

ANTENNA

The Model 5115 Antenna may be mounted either at ground level on a reinforced concrete pad, or on a rooftop. Ground level mounting is generally recommended because of lower cost, less microwave interference, and easier installation. For rooftop mounting, a special steel load frame is installed and bolted or welded to the building framework. Because of wind loading effects on the antenna, this ring and the building structure must be capable of handling loads up to 6400 pounds at each of four attachment points.

The installation area must have a clear line-of-sight toward the satellite. Buildings, guywires, fences and trees will block signals. The entire southern sky in the arc occupied by satellites should be free from obstructions. This will allow future changeover to other satellites if required. See **Figure 4.14.**

PRIVATE/CORPORATE NETWORKS

Technological advances are allowing the development ment of a variety of communications networks that meet specific corporate communications needs. Local area networks connect computers, telephones and information processing equipment within a business complex. Switch and access networks connect several local networks to each other. Wide area networks provide national or even global linkage of the first two types of networks. Increasingly, satellite communications networks are the cost-effective solution to wide area network requirements.

Private satellite networks provide optimum performance for corporations with multiple plant sites, varying traffic patterns, and an assortment of information requirements, such as voice, video, data and facsimile. Common and independent carriers that address the corporate communications market also benefit from the improved performance and reduced costs provided by satellite networks. Harris Satellite Communications Division produces private satellite networks that meet all of these communications needs. Harris Corporation's own private satellite network, for example, provides voice and data communications between three U.S. locations. A Harris-built switching system provides automatic least-cost routing of all long distance telephone calls for twenty Harris divisions in the vicinity of the main sites. See **Figure 4.15.**

TELEVISION BROADCAST NETWORKS

Television network programming is increasingly being distributed by satellite in the United States and worldwide. In the U.S., the National Broadcasting Company (NBC) is converting to satellite communications for distribution of all television network programming to NBC affiliates. Harris Satellite Communications Division was awarded the contract to design and install the ground segment equipment for this network.

The new distribution network will operate at Ku-band to provide reduced terrestrial interference and to allow location of earth stations at urban sites. The equipment designed by Harris features transportable antennas for on-location broadcast of news and sports events, fixed earth stations for transmit as well as receive capabilities, and extensive software design for a satellite network control and monitoring systems.

Earth stations at the NBC affiliates will be fully automated to allow unattended site operation. The stations will be controlled from a master satellite network management system to provide the most cost-effective and accurate operation. The satellite network will also provide high speed data communications between affiliates and NBC headquarters in New York City. See **Figure 4.16.**

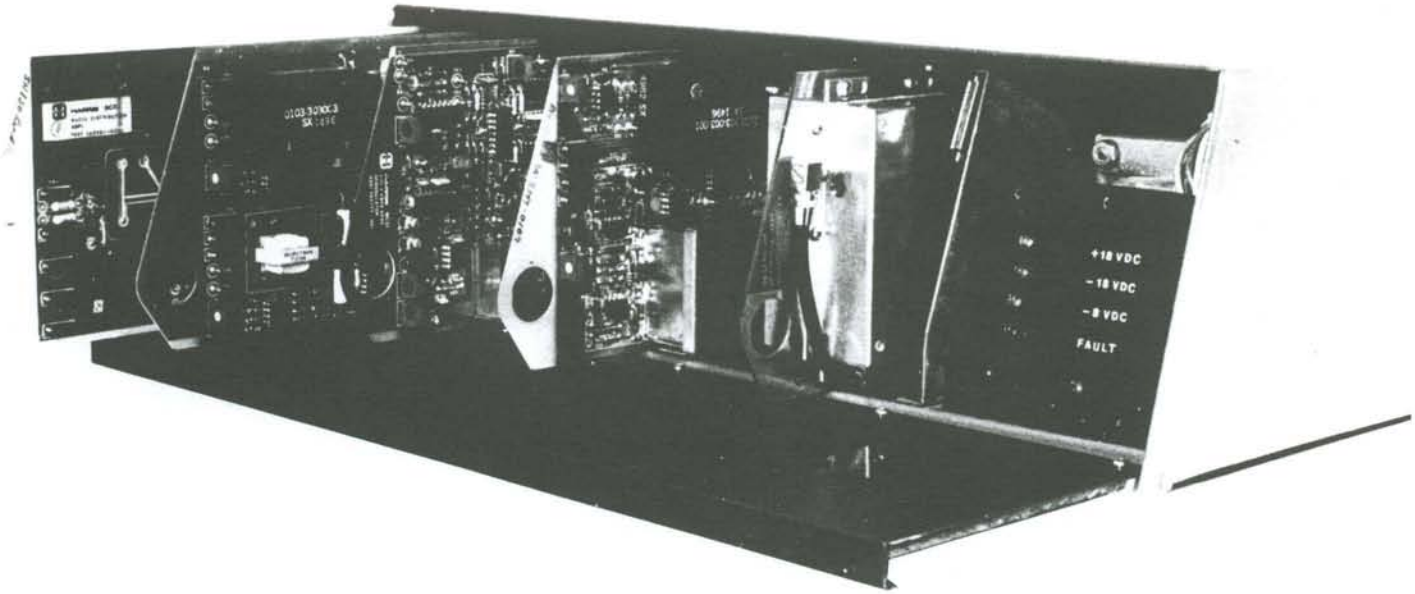


Figure 4.13 *Harris 6550 receiver with channel cards.*
Courtesy Harris Corp.



Figure 4.14 *Three-meter delta gain antenna.*
Courtesy Harris Corp.

DIGITAL EQUIPMENT

Harris products for digital communications include digital BPSK and QPSK modems for data rates from 1200 bits per second to 60 megabits per second, forward error correcting encoder-decoders that significantly improve modem performance, voice digitizing and encrypting equipment, and high speed multiplexer/demultiplexers. Harris Satellite Communications Division digital products are in wide use throughout the world in corporate networks and domestic satellite systems. See **Figure 4.17.**

CONTROL AND MONITOR EQUIPMENT

As satellite communications networks become more complex, the need for sophisticated control systems increases. Harris Satellite Communications Division builds a Communications Management System (CMS) which provides master station monitoring of all network equipment, remote switching and recording of network operations. With CMS, remote stations operate unattended, under control of the master station. The new NBC satellite network uses a specialized Satellite Network Management System. (SNMS). See **Figure 4.18.**

SCPC

For light voice or data traffic (primarily telephony) between many stations, Harris Single Channel Per Carrier or SCPC satellite networks provide optimum service. Harris SCPC/FM equipment is being used for national telephony networks in Argentina, Nigeria, Sudan, and Saudi Arabia. The SCPC system is simple and cost-effective because each voice or data circuit operates independently. Harris builds a complete line of this flexible, low-cost SCPC equipment, including a Demand Assigned Multiple Access (DAMA) control system which places all SCPC channel frequencies under the control of a single computer. DAMA control increases the capacity of each network and reduces the number of channels required at each station. See **Figure 4.19** and **Figure 4.20.**

MICRODYNE CORPORATION'S SINGLE CHANNEL PER CARRIER SYSTEM

Microdyne's 12-Foot Antenna and Single Channel Per Carrier (SCPC) Terminal meets industry demand. This advanced system delivers higher systems' margins to meet the increased activity and demand of the industry's analog and digital subscribers.

Microdyne's 12-foot antenna features a minimum gain of 41 dB at 4 GHz with easy polarization adjustment. The 12-foot antenna is a three-piece molded fiberglass unit with a precision reflector surface. Mounted on a galvanized steel pedestal, the antenna has a full 360- degree azimuth range, with a 10-degree to 65-degree adjustable elevation. Microdyne's 12-foot antenna is designed to withstand winds up to 125 mph. It weighs 500 pounds.

The down converter electronics are provided in two configurations. The SCPC system is supplied as an antenna mounted down converter (as shown), or as an individual component system for indoor, rack mounted equipment.

Features: 3.7 to 4.2 GHz input — 70 MHz output — antenna mounted or rack mounted down converter — crystal controlled conversion — 55 to 85 MHz output bandwidth — prime focus feed. See **Figure 4.21.**

This SCPC system gives the choice of antenna-mounted down converter (DC4-70) which is a rugged fixed unit (**Figure 4.22**), or the 1100 FFC-X1 (RDC) L rack-mounted SCPC down converter for multiple transponder reception. See **Figure 4.23.**

1100-PCDR SCPC DEMODULATOR (FULLY TUNABLE)

Microdyne's 1100 PCDR Single Channel Per Carrier (SCPC) demodulator provides the radio broadcaster with access to a wide range of audio programming services available via satellite. The PCDR demodulates and processes the 70 MHz IF analog signal supplied by a companion 1100 FFC-X1 (RDC) L SCPC Down Converter.

Microdyne's standard 1100 PCDR (3) Demodulator provides front panel switch selection of Narrow Bandwidth (0 deemphasis), Wide Bandwidth (25μ deemphasis), and Wide Bandwidth (no deemphasis). The narrow bandwidth mode is used to process transmissions from low power transponders (typical 10 dBw footprint). The PCDR is designed for

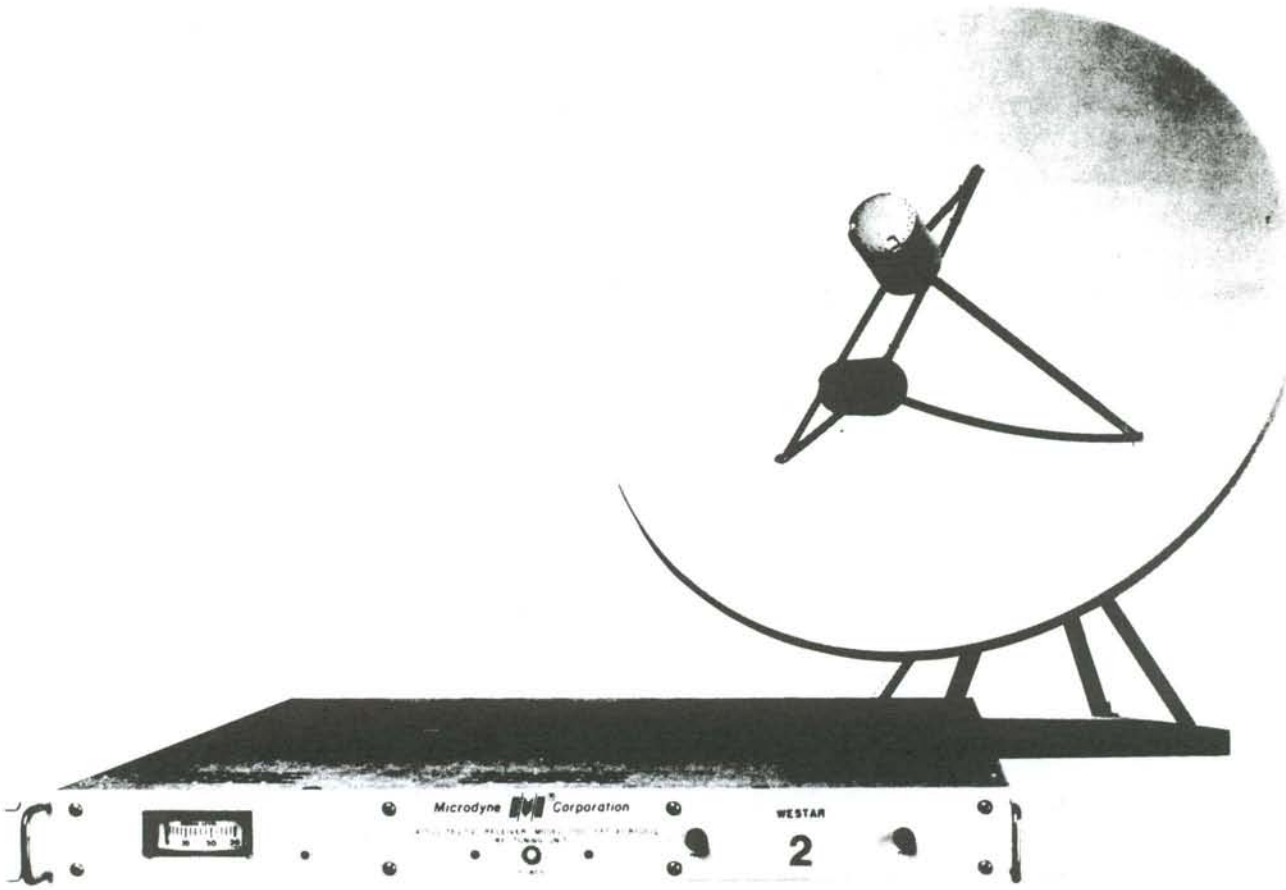


Figure 4.21 *Microdyne single channel per carrier system with 12-foot antenna with rack-mounted down converter. Courtesy Microdyne Corp.*

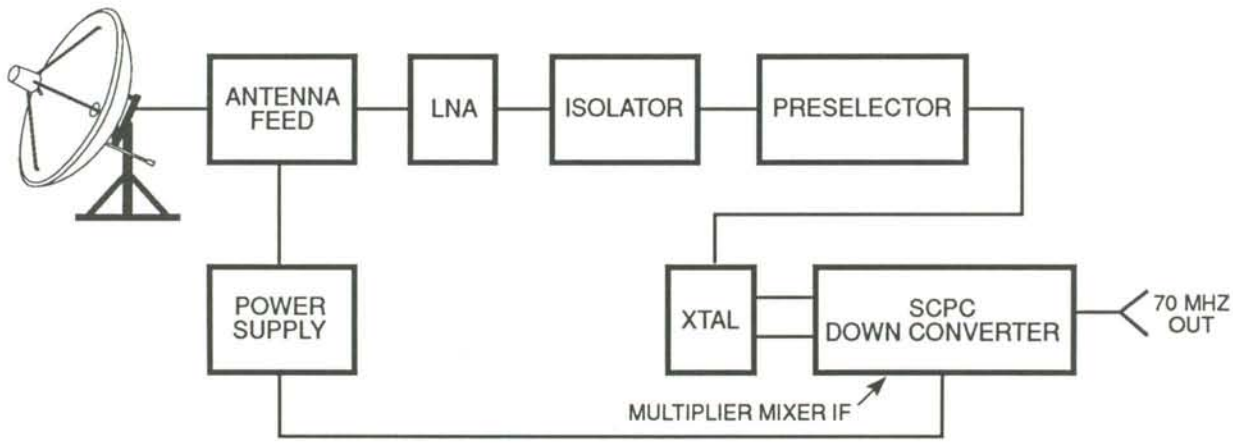


Figure 4.22 *DC4-70 rugged antenna mounted SCPC down converter.*

applications where multiple SCPC networks must be economically accessed. Narrow bandwidth satellite audio transmissions are very cost-effective compared with utilizing phone lines for servicing large numbers of radio stations.

The standard 1100 PCDR single bandwidth demodulator (wide or narrow bandwidth) can be tailored to meet specific requirements including pre and post detection bandwidths, deemphasis and expanding ratios.

Front panel step tuning provides fast and precise selection of SCPC radio channels. The four-position frequency thumbwheel switch is used to select the desired frequency while observing the tuning indicator (AFC loop stress meter), which indicates when the input carrier frequency is centered within the AFC tracking range. When a carrier is not present, the audio output is muted. An input directional coupler provides a rear panel loop through RF output without using splitters or power dividers.

Featuring a standard 1:3 expansion ratio and a selectivity of 40/190 kHz, input levels as low as -65 dBm provide a +18 dBm output.

Other features include: An audio gain adjust, headphone monitor jack, carrier indicator, tuning indicator, and rear panel contact closure output for remote loss of carrier alarm. One 600 ohm balanced audio output is standard with up to three additional buffered and fully isolated outputs optionally available. **Figure 4.24**. Other features are: Synthesized 10 kHz step tuning — 50 Hz to 75 kHz and 15 kHz audio ranges — 600 ohm balanced audio outputs — audio muting — carrier tuning indicators.

COMTECH DATA CORP SERIES 300 RECEIVE-ONLY SCPC FOR NEWSWIRE, AUDIO, AND DATA RECEPTION

The Series 300 Receive-Only Terminal has been designed to meet the needs of the user of satellite services. It allows the reception of Single Carrier Per Channel (SCPC) audio, Multiple Carrier Per Channel (MCPC) audio, digital data, composite video baseband, and subcarrier audio. Up to 6-crystal controlled transponder segments may be selected.

The system G/T performance is rated at 21 dB and allows a low satellite EIRP of 10 dBw for a 7.5 kHz channel. As a result, only 1% of a satellite transponder's bandwidth is required to achieve the same performance provided by other systems requiring up to 10%.

Four components are used in the standard configuration. These consist of a 3.8-meter fiberglass antenna, a 100-degree K low-noise amplifier (LNA), an antenna-mounted down converter, and a Uni-Shelf electronic package. Plug-in modules allow the system to be configured for a mixture of received signal types (SCPC, MCPC, data, etc.). An optional up-link electronics package allows the system to provide both uplink and down-link capabilities. **Figure 4.25**. Complete system packages are available and include the antenna, mount, and all electronics. Applications for this system: Mono and stereo audio, news audio, SCPC/MCPC subcarrier audio, teleprinter wire-services, photo-facsimile, and digital data. See **Figure 4.26**.

The Control Unit features the COMTECH Uni-Shelf concept. This feature allows the user to configure a system that matches his unique requirements. It is designed to mount in a standard 19" rack and requires only 7" of front panel space. See **Figure 4.27**

Several types of channel outputs are available. These include audio SCPC, audio MCPC, digital data, composite video, and audio subcarrier channels.

Audio SCPC: Both voice grade and wide bandwidth capabilities are available. The latter provided essentially flat response from 50 to 15 kHz, with less than a 0.5% distortion.

MCPC: Program audio up to 15 kHz and Cue or Data multiplexed in a 4 kHz band above.

Digital Data: Differentially encoded, QPSK-modulated carriers may be received. Data rates up to 1.5 Mbps are supported and a CCITT V.35 interface is provided.

Composite Video: A baseband composite video output is provided for use with Series 300 subcarrier demodulators or external equipment.

Audio Subcarrier: Demodulation of video subcarrier pairs from 5 to 9 MHz is provided. The outputs are essentially flat from 50 to 15 kHz with less than 0.5% distortion. Companding and stereo matrix decoding is available.

RCV 360 SATELLITE RECEIVER

The RCV 360 Satellite Receiver allows the reception of SCPC, MCPC, and digital program material. Up to six satellite transponder channels may be selected using either a local or remotely located switch.

The down converter is an environmentally sealed unit which mounts at the antenna. It converts the 3.7

to 4.2 GHz output of the LNA (not included) to a 70 MHz IF signal for use by the Uni-Shelf demodulator. The 70 MHz IF is transmitted to the demodulator over low-cost coaxial cable. This same cable is used to provide low-voltage DC power to the down converter.

The Uni-Shelf demodulator is designed for mounting in a 19" rack. It is 7" high and consists of a card shelf, plug-in power supply module, control card, and from one to six demodulator boards. A protective hinged front panel allows easy access when open.

The SCPC demodulator allows a choice of three audio bandwidths and two companding ratios. It also demodulates carrier FM deviation ratios ranging from ±15 kHz to ±75 kHz.

The MCPC demodulator allows operation with a program audio channel of up to 15 kHz and a multiplexed cue or data channel occupying an additional 4 kHz of baseband spectrum.

The data demodulator uses an industry standard CCITT V.35 data interface. It provides demodulation of digital data at rates of up to 1.5 Mbps with a bit error rate of 10^{-7}.

The number and types of demodulators used will depend upon the particular application. However, additional channel capacity may added simply by inserting additional demodulator boards and making rear panel connections. A 6-channel capacity may be provided by a single RCV 360 receiver. See **Figure 4.28.**

AVCOM, INC.
AVCOM SCPC-97, SCPC AGILE RECEIVER

The model SCPC-97 Satellite Receiver is a high performance and fully agile satellite receiver system.

Using block downconversion techniques eliminates the need for bulky and expensive feedline, and since the microwave circuitry in the block downconverter can be shared by several receivers, additional cost savings can be effected.

The SCPC-97 is fully agile, allowing you to select the desired transponder, and then tune all signals between 50 and 90 MHz present on the selected transponder. An LCD readout displays the selected frequency in MHz. The IF bandwidth of the audio demodulator can be switched between "narrow" (normal position) and "wide" (used in many international transmissions). A full range of audio outputs are available to meet most requirements.

The SCPC-97 mounts in a standard 19" equipment rack and occupies three and one-half inches of vertical space.

The feedline connecting the SCPC-97 and the block downconverter can be RG-59 for cable lengths up to 150 feet with up to a four-way power split.

FEATURES

- Compatible with existing 950 to 1450 BDC Systems.
- Both transponder, and frequency agile.
- Switchable IF bandwidth for reception of both domestic and international broadcasts.
- LCD Frequency readout.

See **Figure 4.29**

HOOKING UP THE SCPC-97 RECEIVER

The Avcom SCPC-97 unit is simple to install: A Pico HFS-2 splitter is installed into the RG-6 coax line at the regular satellite receiver. This 950-1450 MHz block is fed into the Avcom unit's input. The SCPC-97 is fully agile, covers all 24 transponders, and tunes each transponder in a converted block from 50 to 90 MHz. See **Figure 4.31**

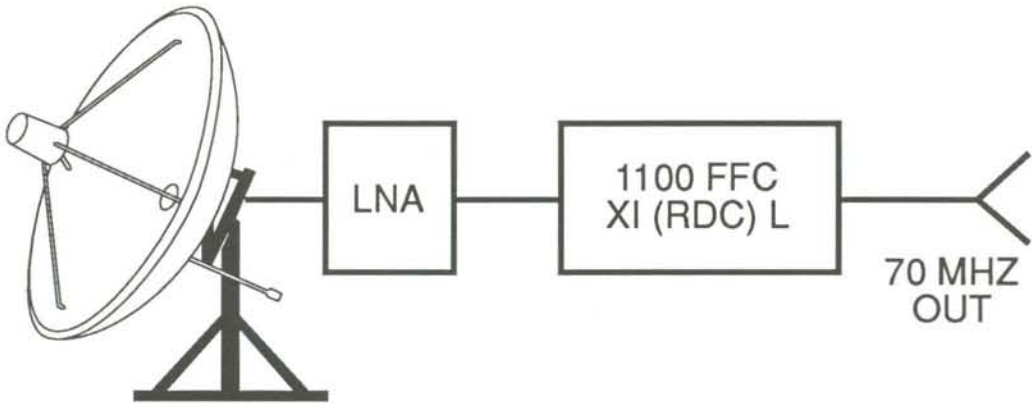


Figure 4.23 *1100FFCX-1 rack mounted SCPC down converter for multiple transponder reception.*

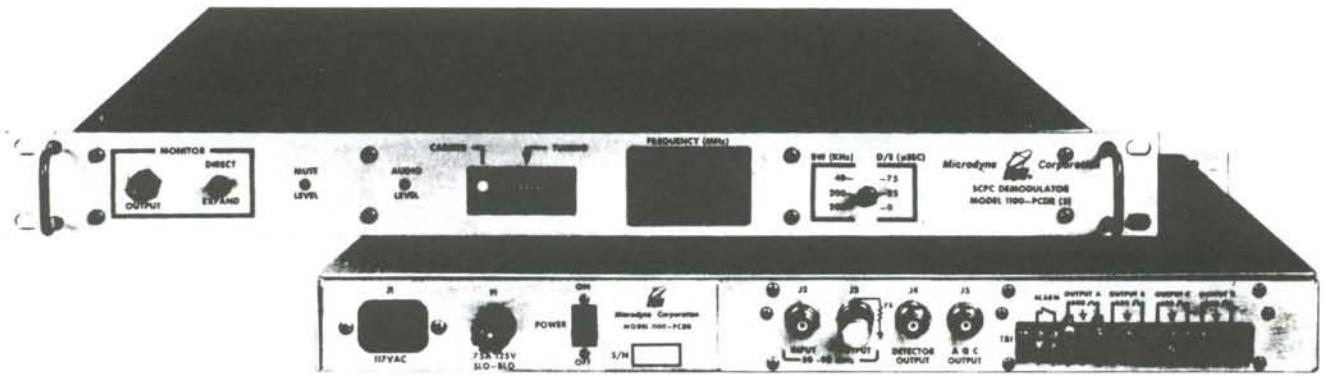


Figure 4.24 *1100-PCDR SCPC tuneable demodulator.*
Courtesy Microdyne Corp.

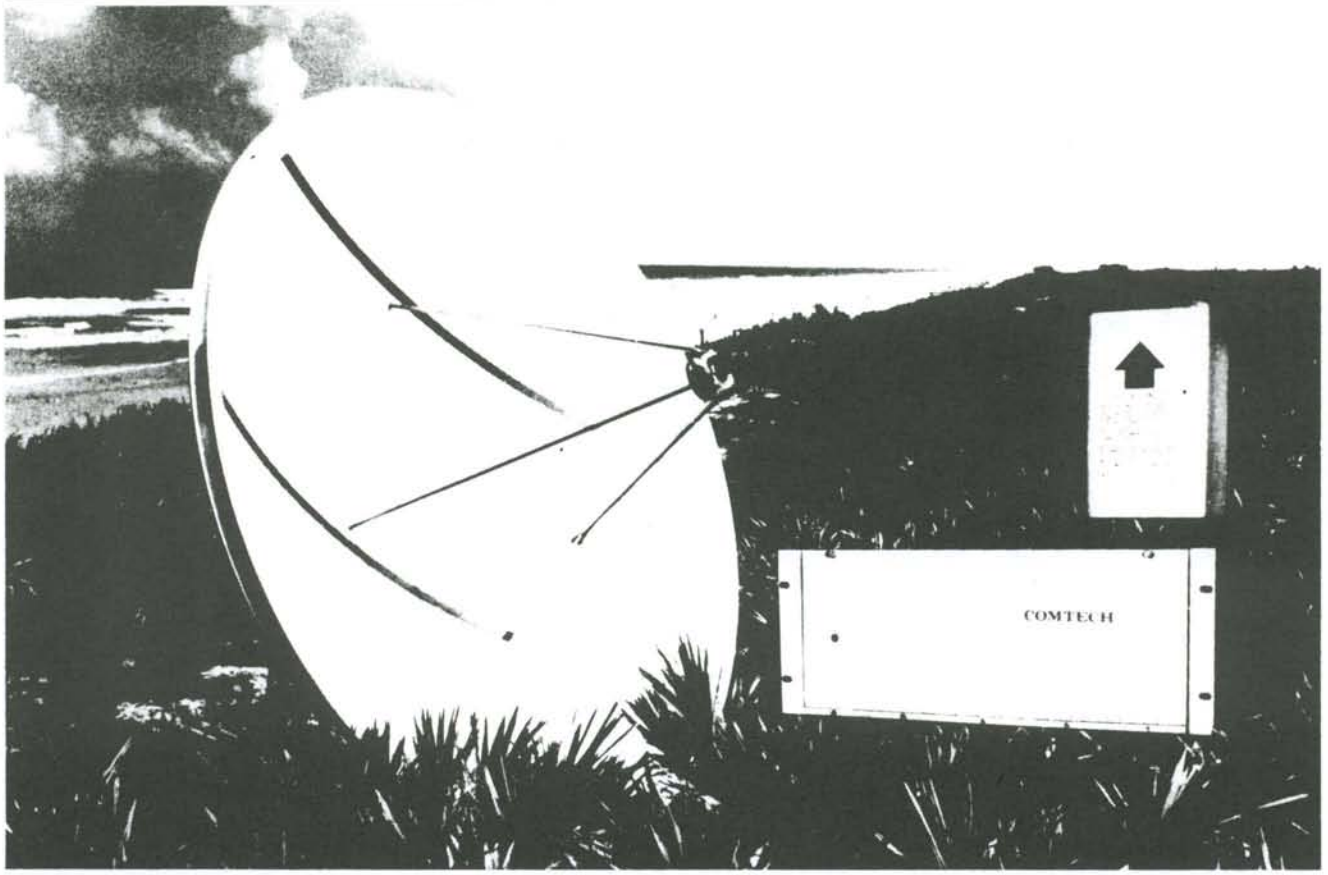


Figure 4.25 *Series 300 receive-only SCPC system for newswire, audio, and data reception.*

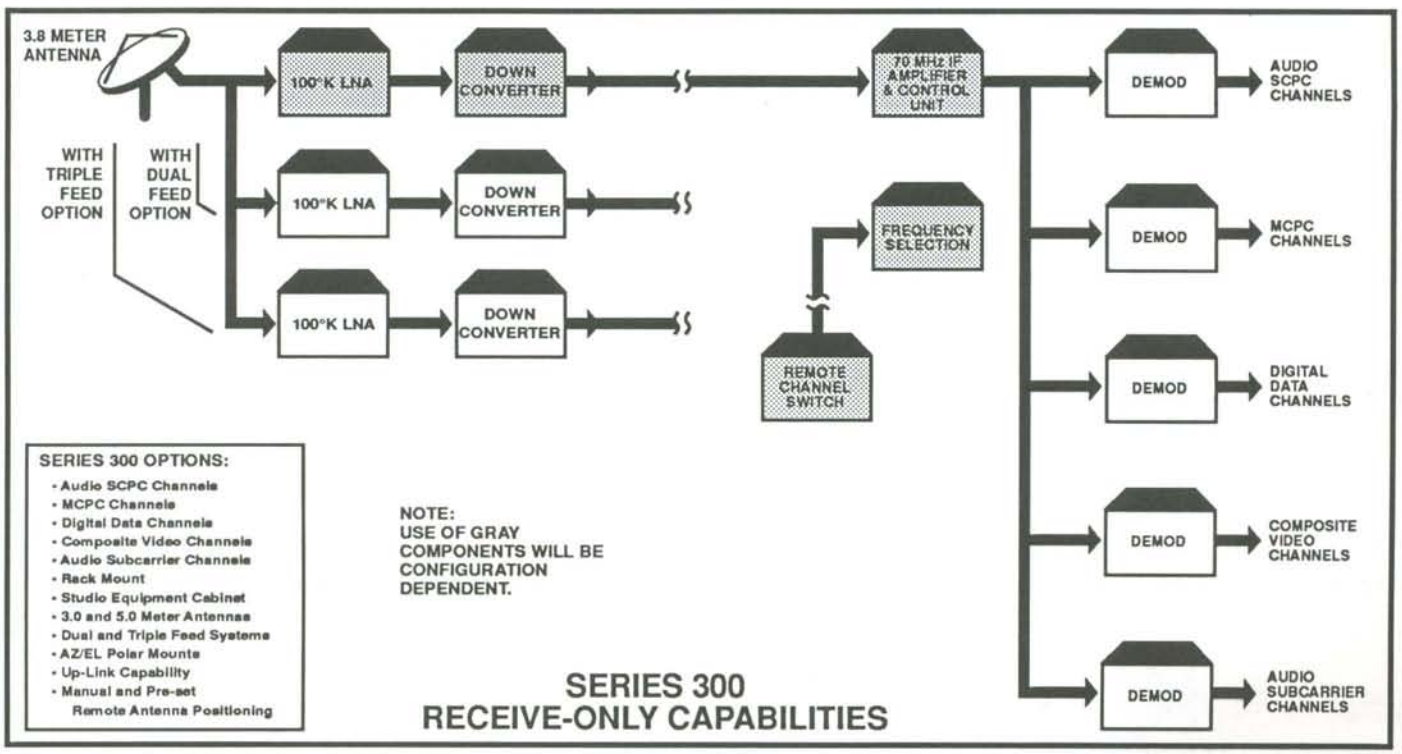


Figure 4.26 *Series 300 system—receive only.*
Courtesy Comtech Corp.

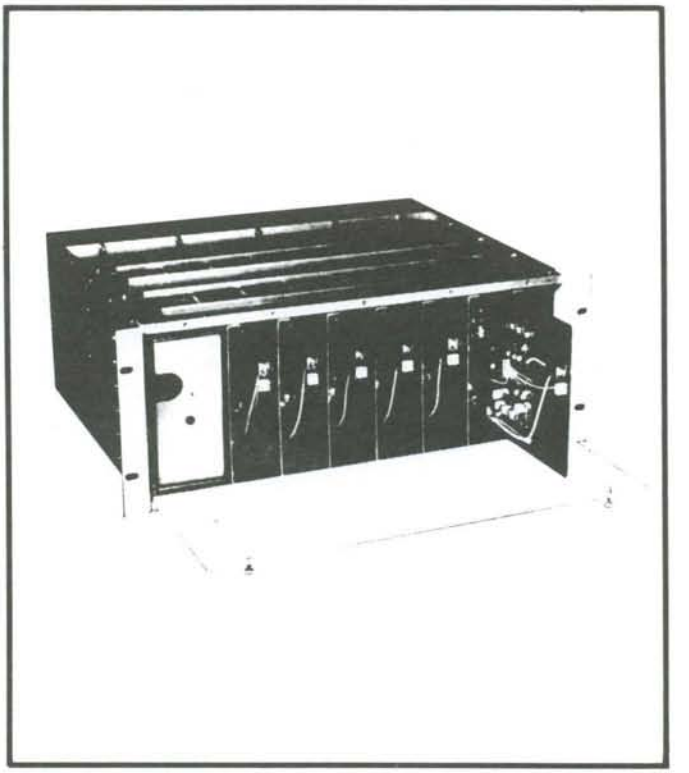


Figure 4.27 *Control unit features the Uni-Shelf® Concept.*
Courtesy Comtech Data Corp.

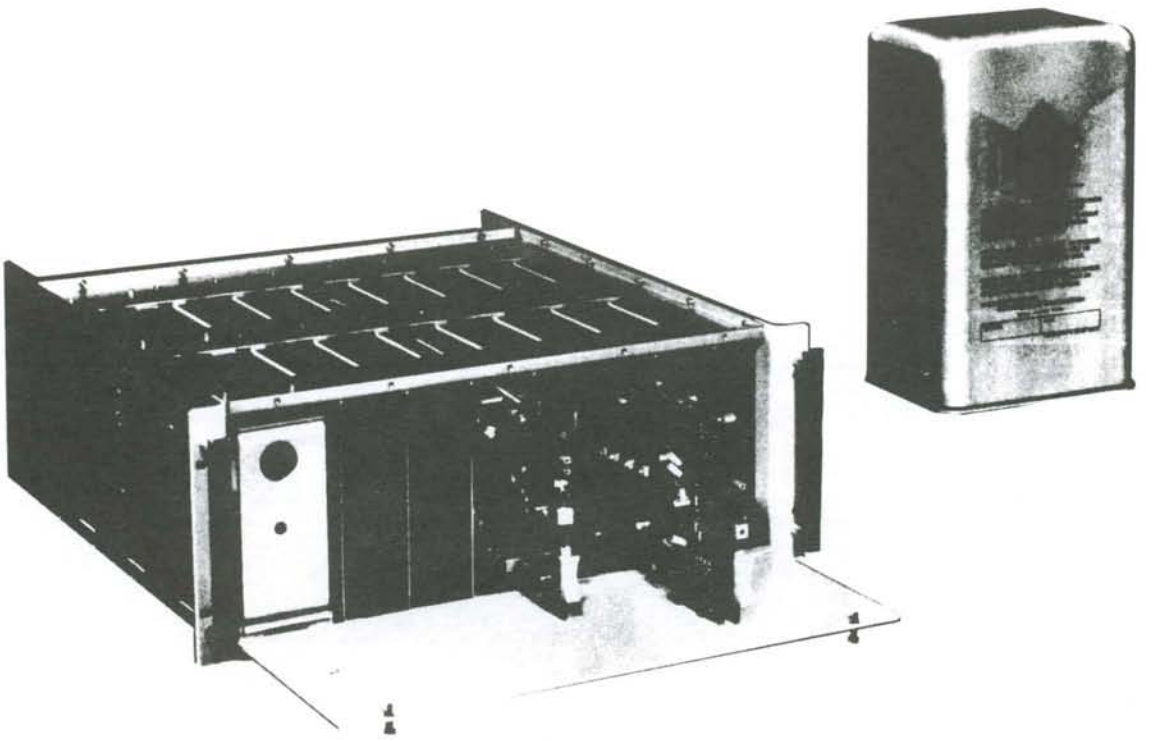


Figure 4.28 *RCV 360 satellite receiver for SCPC, MCPC, and digital data.*
Courtesy Comtech Data Corp.



Figure 4.29 *AVCOM SCPC-97 agile SCPC receiver.*

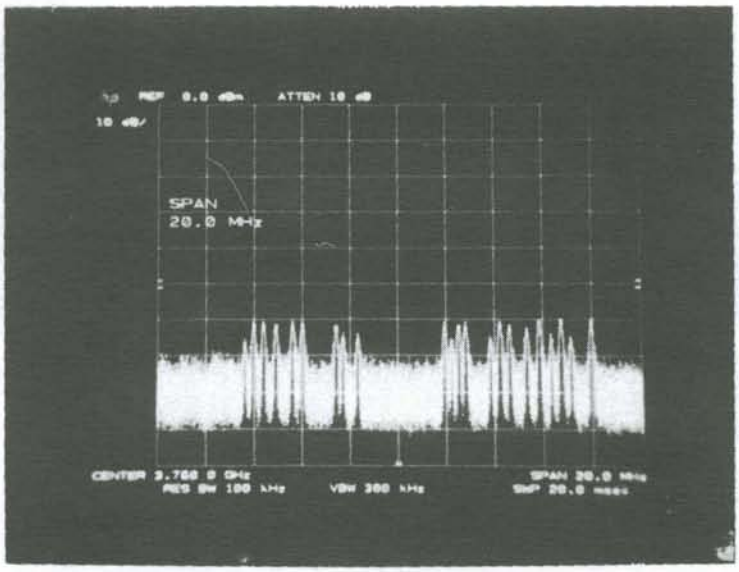


Figure 4.30 *Spectrum Analyzer photo of SCPC signals from Westar 4, transponder 3(2D). Center frequency is 98 MHz and signals 10 MHz on either side of center are shown.*

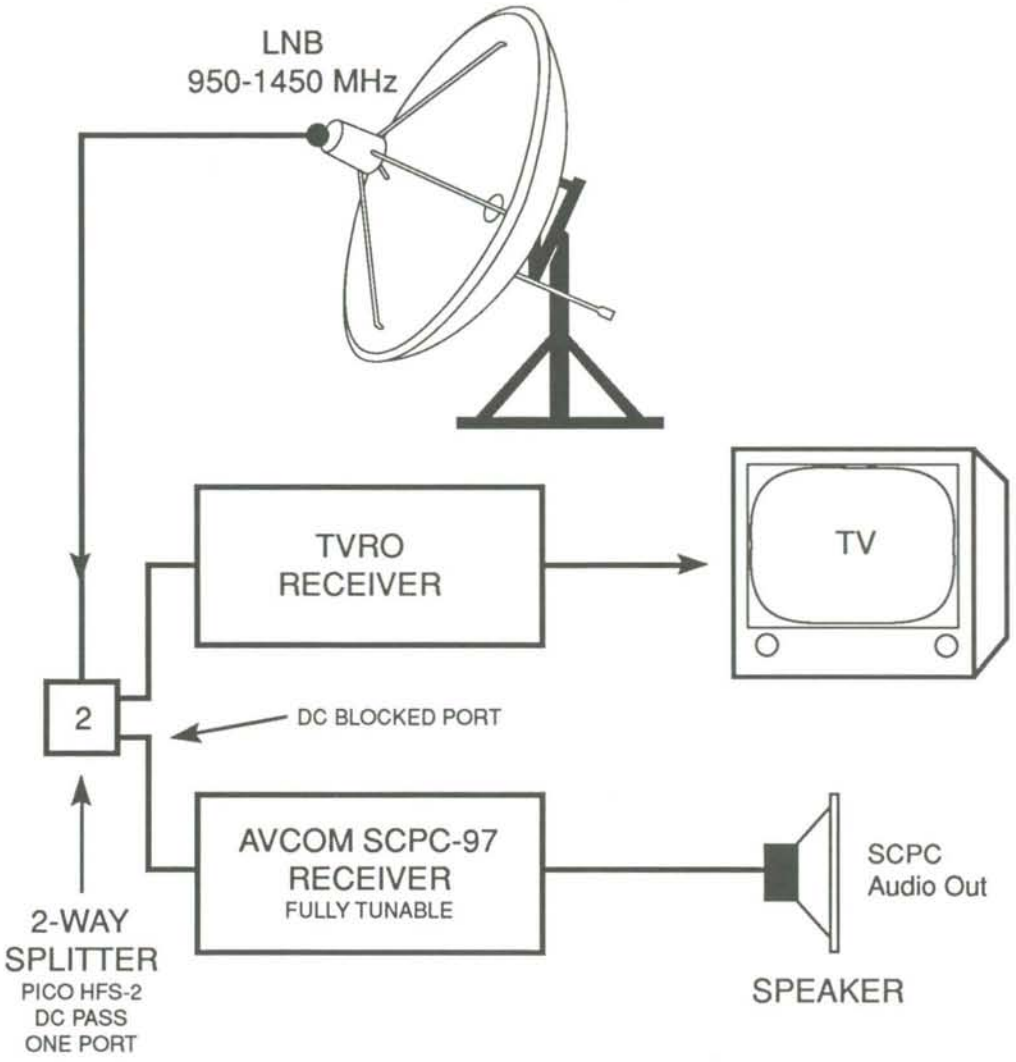


Figure 4.31 *Installation of Avcom SCPC-97 receiver in existing 950-1450 TVRO system.*



Figure 4.36 *Data receiving equipment for SSB/FDM—SCPC format.*



Figure 4.37 *Complete satellite receiving equipment—video, all forms of data, facsimile, all forms of radio.*

Synchronous TDM—In this technique, all time slots on both the transmit and receive side are referenced to a master reference pulse, and a precise time interval from the start of a frame determines the location of the desired channel. (The channel's location is determined by time.)

Asynchronous TDM—This system uses the time slot for a specific channel which can occur randomly and is identified at the start of a specific channel by means of a code or clock burst occurring prior to the transmission of the data stream.

There are several time division multiplexing (TDM) methods used in video work; these are:

(1) Simultaneous transmission and reception of alternating pictures (STRAP). This method and system was developed and patented by CBS, Inc. This system allows transmission of two video signals over a single carrier by transmitting only one field of each of the two video signals and then averaging and reproducing the missing field of each video signal from the two transmitted fields by a digital method.

(2) Data insertion on lines in the vertical blanking interval. This additional TDM system can be synchronous or asynchronous in that the individual channels of information are put on specific video lines. The data is preceded by both a clock run-in burst to synchronize the clock on the receive side and coding to insure that proper data is being transmitted.

HOW TO SET UP TO RECEIVE FM/SCPC/FDM DATA SERVICES

Several of the nation's news services (e.g., UPI) transmit their radio (audio) and regular Baudot teleprinter news service on FM/SCPC/FDM. These services are contained in the many groups of channels that were covered in the sections on multiplexing and frequency division multiplexing in this chapter. These services are using the FM/single channel per carrier/frequency division multiplex system. See **Figure 4.38**.

The system requires a small dish (6 to 8 foot diameter) LNA, down converter from TVRO receiver, a stable FM receiver capable of tuning 65 MHz to 85 MHz, a stable general coverage communications receiver that will tune from 6 kHz to 18 kHz with provisions for upper and lower sideband mode, a radioteletype R demodulator (M-7000 unit) containing video charter generator, plus printer output to drive a printer for hard copy.

Each circuit contains the wire service from many states. The services are sent at 60 and 100 words per minute (45 and 75 baud rate). On the TVRO systems that have a 70 MHz IF, the channels will be found at approximately 75 MHz on the FM receiver. After this 75 MHz FM signal is demodulated to baseband audio, you will have a composite signal of voice or radio feeds that come on, on the hour and half hour, plus several 25-channel frequency division multiplex (FDM) signals. These signals should be found at the center of the voice frequencies of 8.25 kHz and 12.25 kHz plus or minus .10 kHz. This total composite signal, containing voice and data signals, is fed into the antenna input of the communications receiver tuned to 8.25 kHz or 12.25 kHz on the upper sideband setting of the mode switch. See **Figure 4.39**.

The fine tuning of the SCPC data channels must be done with the fine tuning control or RIT control on the communications (SSB) receiver in order to step through the 25 or 50 FDM channels. This set of channels is transmitted at either 45 baud rate (60 wpm) or 75 baud rate (100 wpm) speed.

The M-7000 unit must be set at the proper RTTY shift which is 170 Hz and at the correct baud rate (words per minute) receive speed. The phasing switch is placed in the normal phasing of the signal; if copy does not come up, set the normal/reverse switch to reverse setting.

It is imperative that you become proficient in the use of the M-7000 on HF radio before attempting its use on the satellite data circuits.

Reception of this and other FDM signals requires a satellite receiver with a very stable down converter to tune this 60 kHz section of the total 30 MHz wide down converted spectrum.

WHAT IS TELETYPE® (RTTY)?

The basic narrow band receiver (whether FM or SSB) produces an audio "message" to you via the speaker. That audio message may make sense to you (i.e., be intelligible), or it may sound like gibberish. The gibberish, if it has the sound of "musical bells" or tones, is probably some form of radioteletype. Radioteletype (RTTY is the international teleprinter

system which allows a text message made up of words and numbers to be transmitted from one location to another. A teletype machine may be made by one of several firms and the name Teletype® should always be followed by the notation ® since it connotes a registered trademark of the Teletype Corporation. We will use the word so often here that we'll simply make that notation from time to time to keep the people at the Teletype Corporation happy!

Teletype is a system of codes, either something called the Baudot Code or the ASCII Code. It is akin to (but not similar to) Morse Code. Each letter, number, and punctuation mark has its own code; and when the operator strikes the key for "T" on the machine, that code is transmitted. It has a "musical sound" as do all teletype characters. The code is transmitted and then received by a gadget called a "teletype demodulator." Since these are audio tones, you interconnect your teletype demodulator to your satellite (audio) receiver so the tones you hear are fed into the teletype demodulator. Then the demodulator decodes the coded tones and supplies some type of output which will display the letters and numbers for you.

There are two ways to display this. One is the "soft display," which means that your teletype demodulator has a video output which is compatible with your video monitor or home computer monitor. Text appears on the screen, line by line, and "scrolls" or moves upwards as new lines come in. The current line always appears on the bottom of a full screen (although the screen will begin filling at the top and fill down until full), and then as each new line "comes in," the top line moves off the screen.

Another approach is to connect the output of the teletype demodulator to any popular computer printer which can be found in any computer store. If your teletype unit has a "parallel output" port, it can then be connected directly to your parallel input port on your "hard copy" printer. Now you can copy and keep permanent records of what you receive for as long as your box of paper holds out!

Some of the transmission speeds are moderately fast—100 plus words per minute. Some are even faster, up to a thousand words a minute or so. Speed reading is impossible; you have to "save it" to study it later. Most, however, lumber along in the 100 word per minute and down region, and you can read and stay up with this without much difficulty. If you have a printer, you can save just those portions you wish, such as the stock market quotations or the Anik delivered CBC French Language news to impress your neighbor who speaks French.

Virtually all of the major world news and commodity and commercial money markets use teletype to send data. Most of these use satellite relay, and if you know when and where to look you can find virtually anything happening in the world, first hand, as it happens. We will note that one of the very best, and most reasonably priced, teletype demodulators on the market today is manufactured by DES (Model M-7000. It is available from Universal Electronics, Inc., 4555 Groves Road, Suite 13, Columbus, Ohio 43232.

For a complete study on radioteletype for high frequency radio and satellite data work, you should obtain a copy of a new book devoted to radioteletype, RTTY Today. This new book covers all phases of RTTY and computers in RTTY work. Cost is $8.95 plus $1.75 for shipping and handling from Universal Electronics, Inc., address above.

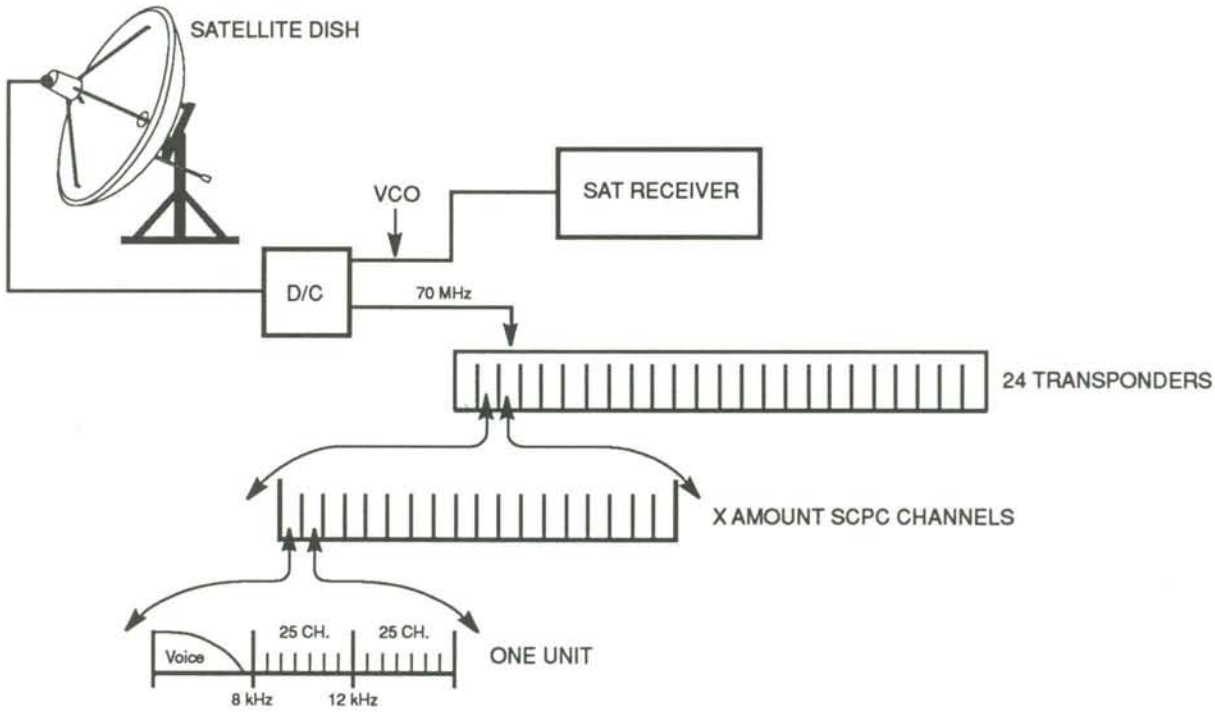


Figure 4.38 *Frequency division multiplex plan.*

A USER-FRIENDLY FM/SCPC RECEIVER—

A typical consumer/home user FM/SCPC receiver should have the following features and uses:

A) The block down conversion approach, employed in the commercial version, is now optionally available with a standard single conversion down converter. This makes the system more compatible with the typical home TVRO installation.

B) The rack-styled receiver is now in a stand-alone, consumer-styled package (which we have not seen as this was written).

C) The professional-grade receiver assumes the operator of the system will be a technically-oriented person. A pair of initial set-up adjustments under the top lid of the receiver have been brought out front. A meter which is used in the professional-grade receiver to properly tune in the individual carriers has been replaced with an easy-to-read and understand LCD (liquid crystal display) four-digit display which serves two functions:

1) It tells the user when he is properly "center tuned" on the individual FM channel, and;

2) It tells the user where in the full transponder "band" he is tuned. More about this shortly.

D) A pair of audio outputs are available—one is a two-watt audio amplifier designed to feed directly into an external speaker (supplied with the unit), and the other is a 600 ohm "balanced" output to allow the user to feed additional peripheral equipment for the "copying" of radioteletype text, news services, and so on.

E) And finally and hardly the least significant, the package has to be in the consumer format so that for $995 (suggested retail), the home user can add an entirely new dimension in high quality news, entertainment and information, "audio programming" to his TVRO or his stand along "ARO."

Now it happens that many of the users of this particular transmission format are getting by very nicely with some extremely small dish systems. Muzak (one of the many available here), for example, goes typically to four-foot (and even smaller) dishes on a commercial basis! That means that with the consumer-style receiver, you could be out there selling and installing high-grade satellite audio reception systems with some very tiny dishes.

OPERATION

As noted, the professional-grade receiver may not be desirable for the average consumer/user; unless this was one of those installations where the dealer was going to put the unit in, tune the receiver to the proper audio or data service channel, and then walk away leaving the receiver in one dial position. The average consumer is going to treat the system just as he treats his AM or FM radio; there is a "dial full" of stations there, some carrying news, some carrying sports, some weather and some music. He is going to want to follow the Minnesota Twins baseball team in the afternoon (using the Minnesota Satellite Radio Network), and attend a concert from Carnegie Hall on NPR radio that evening. The professional-grade receiver requires that the user "remember" where each station is without benefit of an accurate frequency readout dial.

The consumer model has a four-digit meter on the front panel, and as you turn the tuning knob, the liquid crystal displays the number changes. Those numbers relate to the frequency of the signal being tuned in.

Because of the 30 Hz waveform energy that some (all are required; many do not comply with FCC regulations) signals carry, there are two initial set-up adjustments which the dealer must make when installing the receiver (this assumes the dealer will install it; that the consumer will not be asked to do it, although in truth he could). The meter makes these two adjustments painless. Then, after the adjustments have been set, the user finds the meter handy for "center tuning" of the signal—just like you have on some of the TVRO video receivers.

The transmissions from the special satellite feeds are "high fidelity," but not in stereo. Well, let's correct that, Some are in stereo (NPR, for example), but to create the full stereo effect, you would have to install a pair of these receivers so that both the L (left) and R (right) channels could be independently received and fed to a stereo amplifier system. Most of the stereo services (other than NPR) are found on the subcarrier format anyhow, which simply means that existing hardware in the marketplace is available for the stereo fan.

FUN TO OPERATE

Other than a dedicated terminal sold to a Muzak user, or to a local radio station or newspaper, the user of the sFMs package will quickly discover that there is as much "audio fun" on satellite, in the FM/SCPC mode, as there is "video fun." Virtually every major league baseball team now has a satellite connected radio network service; that means that you can be a Montreal fan in Los Angeles or a Los Angeles fan in Florida and never miss a game. Reception is studio quality, and because the listener is "inside" the radio network feed, it is the audio equivalent to tuning in direct back feeds on video of sporting events.

All of the radio networks supply their affiliates with multiple newscasts per hour. Between Mutual, ABC, CBS and NBC, you are never more than a few minutes from a fresh radio newscast. State radio networks abound; you can stay up with Florida news in Maine, or Minnesota news in Texas. Special news feeds for the Caribbean, Central and South America are up there. The Naval Observatory Time (accurate to a few parts in a million) is there. A "talking book" service for the blind is there.

Services are spread across many satellites. Service is scheduled for F2R, and G2. Since the uplink or bird operators tend to bunch multiple users onto a single transponder for ease of switching and maximum transponder efficiency, there is not much of a "fishing expedition" required to locate those that are active.

CONFIGURING A SYSTEM

There are several ways to plan a system such as this; the best design will depend upon the user himself.

If the user is casual, and he is willing to share the FM/SCPC with the TV function of the dish, a single down converter used for the TVRO and ARO system would work; a switch or relay installed in the RG-59/U line coming from the down converter to the TVRO receiver would allow the user to switch off of the TV service and on to the ARO service. The down converter would be powered by either the ARO unit or the TVRO unit; that unit would be left on full-time, regardless of whether the user was watching television or listening to satellite-fed radio.

If the user was interested in joint TV and audio use, a pair of down converters with a 4 GHz two-way splitter at the dish and parallel runs of RG-59/U would be installed.

BUILD A FM/SCPC SYSTEM FOR UNDER $100

The concept of extracting non-video information from the many Clarke orbit satellites pre-dates the use of video, since all of the early experiments were actually "narrow band" or "non-video" based. What is "new" is the tremendous proliferation of non-video material, much of it informational or educational in content, now being fed via satellite worldwide on a routine basis.

Ours has become an intensive "information based" society. We depend upon and often profit from the information which we find relevant to our business activities or life-styles. The transfer of data, or information if you are not quite up to "computer speed" yet, is becoming as important as the creation of data. In some quarters, it has become even more important, and the satellite connection makes it all possible worldwide for exceedingly low cost.

Further proof of this can be found in the latest Intelsat proposals where they are now offering complete 12 GHz receive-only "data terminals" using two-foot dishes for around $2500 (U.S.). They claim that if the terminal is used within the hotter boresight footprint of the latest Intelsat V birds, such a two-foot dish propped up on a table and pointing "through" a glass window will spit out high speed data information relayed via satellite. What all of this has in common is that virtually all data of interest is transmitted using one or another "narrow band" methods.

Our TVRO (video) terminals are all wideband systems; that is, we require between 15 and 30 MHz of "information" to create a television picture on our screens, (and the companion sound). On the other hand, a narrow band system requires only a fraction of this "bandwidth window" (measured in megahertz or MHz) to transmit all of the contents of the message. The message contents may be audio (voice or music or both), or it may be some type of computer data code such as ASCII (pronounced ASK-KEY). Our concern at this time is not so much how you make intelligence out of the various codes, as it is in equipping you to receive the basic transmissions in the narrow band format.

We will show you a couple of ways you can explore the world of FM/SCPC. For well under $100, you can be enjoying FM/SCPC reception this evening. See **Figure 4.44.**

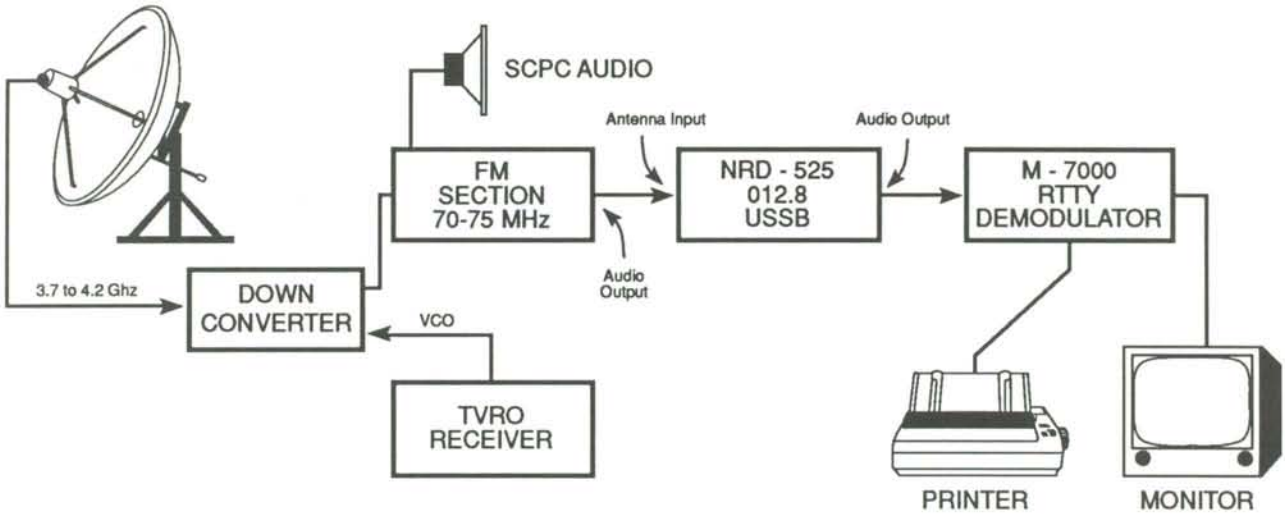
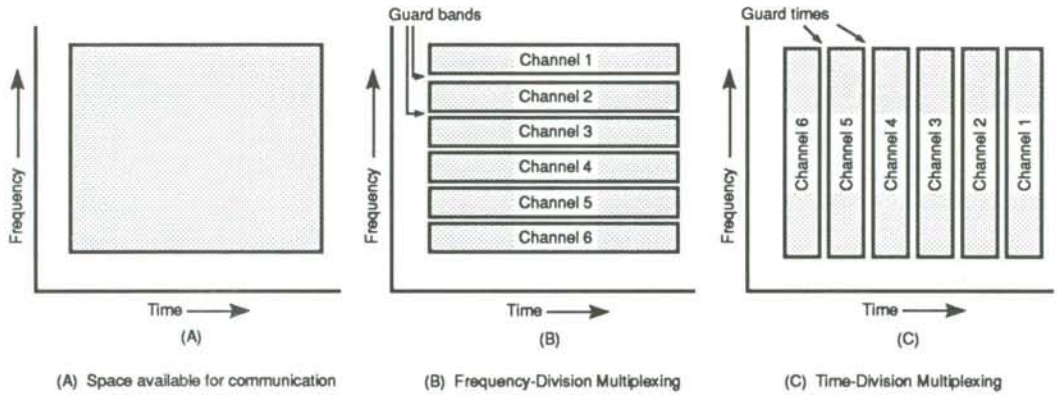


Figure 4.39 *Equipment diagram for receiving FDM/SCPC news services.*



Multiplexing Systems

Naturally there are some trade-offs involved if you are going to "sneak into" FM/SCPC for less than the cost of a first-rate FM narrow band demodulator. The primary trade-offs are as follows:

1) You will have to tune the tuning dial far more carefully, even slowly, to separate the many station services listed here and found on satellite.
2) You will probably have to "touch up" the tuning of the special adapter we will be describing every 15 minutes or so to compensate for the "drift" of the adapter and the balance of the system.
3) You may not be able to "separate" (as in pull apart) all of the services when there are two or more which are located fairly close together within a transponder.

Still, for less than $100 (and as little as $25), you will, in short order, be listening to these wonderful and elusive narrow band audio-type services, and you will be well on the way to an entirely new level of "satellite exploration."

BASICS FIRST

Most of us understand that when a TV signal is transmitted via satellite (relay), the video carrier has a certain frequency and that the video information (detail, color, etc.) is "spread out" from that carrier frequency. This is the primary reason why a video signal utilizes so much of a transponder; there is so much information being transmitted that it cannot all be "crammed into" a tiny or narrow bandwidth. We are also aware that an audio signal, such as a subcarrier, occupies a far smaller "width" in the spectrum because there is far less information present. In fact, many audio subcarriers can be crammed into a relatively tiny portion of the spectrum, as anyone with a subcarrier tuning system can attest by tuning across the subcarrier region. As many as 15 separate audio subcarriers have been found there at one time, all without interfering with one another nor with the video carrier to which they are associated.

Imagine for a moment that you had a transponder filled with just audio subcarriers. If they can have 15 (or more) share the video transponder, how many do you suppose could be there if they took away the video and filled the video area with just audio subcarriers? Hundreds. And that, basically, is what FM/SCPC does. This is not how it works, however, because the audio subcarrier system depends totally upon the presence of the video carrier in the first place. We cannot simply "take away" the video carrier and fill in the space vacated with audio subcarriers because the SUB carriers are "sub" (as in "attached to") to something; that something is the video carrier. The video carrier is the vehicle on which the audio subcarriers ride into space and through the satellite.

So if the system designers want to stack hundreds of "subcarrier-like" audio (or other narrow band) signals into a single transponder without a video carrier present for them to "ride along on," they must use a technique which allows each individual "subcarrier" to stand alone all by itself. This is not such a bad deal since it means that you can transmit one of these narrow band channels from an uplink in Charlotte (N.C.), another from an uplink in Minneapolis, a third from an uplink in Dallas, and so on; each stands alone and each occupies a tiny portion of the spectrum within a transponder.

The bad part, for you, is that your TVRO receiver depends upon the video carrier's presence to "lock onto" a signal and stabilize your receiving system. That transponder you tune in is actually a "signal reference" which the receiver latches to, to insure that your receiver does not "drift away from" the signal. If the video is present, and the TVRO receiver has "locked onto" the video signal and is holding it stable, then the audio subcarriers that ride along with the video carrier will also be stable. It will lock up on the video and then with your built-in audio subcarrier detector, you can tune in any audio subcarrier you wish and it will also stay "locked in."

When you establish a system to tune in an FM/SCPC signal on a transponder where there is no video signal present, your FM/SCPC receiving system has nothing to "lock onto." The FM narrow band signals are very complicated to "lock to," and so far there have been no low-cost techniques developed to overcome this problem. And in fact, that is a significant part of the cost in the dedicated FM/SCPC receiver, the "locking system" that allows you to set the receiver tuning dial to one particular FM/SCPC signal and come back hours later and still find it "tuned in."

The two techniques to be described here are minus this "lock" function. How stable your reception will be will depend largely on the stability of your TVRO receiver's down converter. To the best of our knowledge, no exhaustive comparison testing has

been done between different brands of down converters to determine which of those presently in the marketplace are "stable" and which are not if no video carrier is present to "lock onto." Perhaps as a few hundred people try the system we are about to describe, we will get reader feedback on which down converters seem to function best in this "service."

TUNING THE IF

Your down converter, whether a stand-alone unit at the antenna, or an LNC package will send a 70 MHz (centered) IF signal indoors through the connecting (typically RG-59/U) cable. We will place something at the indoor end of that cable to allow us to feed the 70 MHz (centered) signal into a secondary tuning unit, one which will allow us to tune in the FM/SCPC stuff. We will spend less than $100 to do this.

In **Figure 4.40** we have a typical system with an addition—the antenna plus LNA feeds signals to the antenna mounted down converter. If your system uses an LNC, they would both be together at the feed. The important point is that you have a 70 MHz signal coming indoors on the cable. Note that this diagram shows a system which does not send DC operating voltage for the LNA (LNC) and down converter through the same cable. There are still some receiver systems in use that send the outdoor voltages through a separate line or set of wires.

Indoors, we install a two-way HYBRID splitter. The input faces toward the 70 MHz input side or the antenna. We have two outputs: one of which we connect directly to the TVRO receiver, and the other we connect to the "FM/SCPC Interface Converter."

The "Interface Converter" is nothing more than a $24.95 (last price shown) Radio Shack (Automotive) VHF-TV Sound and Weather Converter ND 12-1354. This is a device that tunes two bands, the VHF (TV) low band and the VHF (TV) high band. The low band tunes from approximately 50 MHz to approximately 90 MHz. This means it tunes through our standard TVRO 70 MHz IF.

Remember that a 70 MHz IF is only centered on 70 MHz; it is actually wider than this, covering from 59 MHz to 81 MHz for a TVRO receiver with a 22-MHz-wide IF and so on up to as much as 40 MHz wide. As the 70 MHz IF signal comes indoors from the down converter, it will be plenty wide enough to cover the entire 50-90 MHz spectrum we have an interest in here. Also remember that a full satellite transponder is 40 MHz wide, and the center of that 40 MHz width falls at 70 MHz while the low end falls at 50 MHz (70-20) and the top falls at 90 MHz (70 + 20). Yes, 20 plus 20 still equals 40. If we have a receiving device that will tune across the 50-90 MHz band, we have an instrument which will allow us to tune in the individual FM/SCPC carriers! We'll return to this shortly.

In **Figure 4.41**, we have a system which also sends the DC operating voltage to the LNA/down converter/LNC via the same coaxial cable. That means we have 70 MHz (centered) signals coming indoors from outside, and we have a DC operating voltage coming outdoors from inside. One good way to blow up everything would be to connect the DC operating voltage intended for the outdoor equipment directly to the Radio Shack (or equivalent) "Interface Converter." So we need a system to keep the DC voltage going to the outdoor equipment, but not to the "Interfacing Converter." The device is called a "directional coupler," and you will find them at the nearest MATV-type store or wholesale house. You want one that is "10 dB down," or in other words, one that attenuates the incoming signal going to the "tap" output side by 10 dB while allowing the main signal to pass through essentially unattenuated to the TVRO receiver proper.

This directional coupler allows the TVRO IF signal from the down converter to pass directly to the TVRO demodulator; it allows the DC operating voltage to trace the reverse path back to the down converter (etc.) outside, and it isolates or prevents any of the DC power from getting into the "Interface Converter." Cost? Under $5.00 (Pico HFS-2).

Now the Radio Shack model 12-1354 is intended for automotive use; it is supposed to allow you to sit in your car and tune in the audio portion of local TV broadcasts. That means it is an "FM receiver" of some sort since your TV audio broadcasts are FM. Here is how it works.

The FM signals, tuned in from the local channel 2, 3, 4, 5 or 6 stations, are down converted inside of the box to an FM-IF. Then the signals are amplified and detected. That is, they are turned into audio. But the object of the 12-1354 is to allow you to tune in the FM-TV audio on an AM radio. So they take the audio and connect it to a low power AM transmitter inside of the box. Yes, that sounds just like a TV modulator built inside a TVRO receiver!

Then they tell you to connect the output of the 12-1354 box to a standard AM radio, any standard

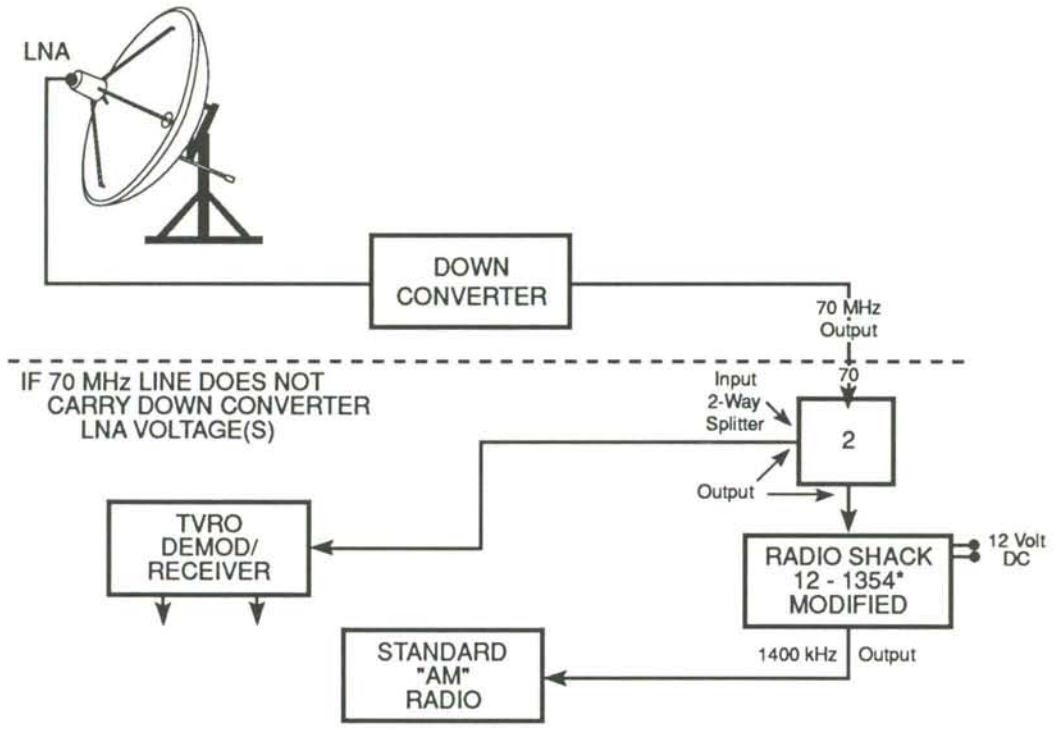


Figure 4.40 *Quick solution to tuning-in FM/SCPC signals off of satellite. Modified units (12-1354) available from Universal Electronics, Inc. Write for details—SASE please.*

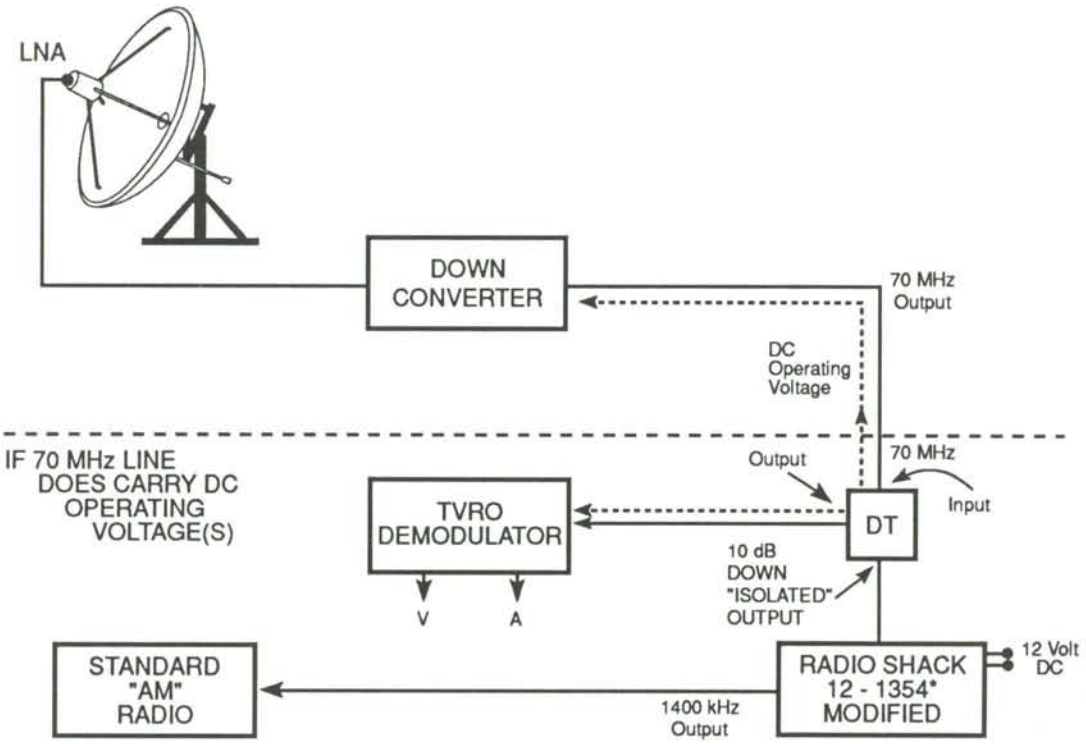


Figure 4.41 *DC power betweeen demod and down converter must be "blocked" so as to not go to FM/SCPC converter-receiver.*

AM radio. Tune the AM radio to around 1400 on the dial (1400 kHz or 1.4 MHz) and there you will find the carrier from the 12-1354 box. If you have a local station near 1400, they give you a slug to tune to move the output AM signal coming from the box away from 1400 so you can find a clear, local spot on your AM radio dial.

To operate the system, you tune the master TV tuning dial on the 12-1354 to the correct operating frequency of your desired FM/SCPC signal. The audio from that signal will appear on your AM radio at or near 1400 kHz. That's it. Not very complicated although since the 12-1354 was intended for automobile use, you will have to find 12 VDC from your TVRO receiver as well (such as the often-provided optional voltage line at the back of your receiver. Caution! Be sure the voltage here does not exceed 13.8 VDC or you could blow up the Interface Converter!). Complete installation instructions for the 12-1354 are included in the box.

There is one other possibility here if you are into the big bucks (such as spending $69.95 or so) and you don't wish to fool with finding 12 VDC for the 12-1354. Go to the same Radio Shack store, or Sears Roebuck or some other "high quality" electronics store and ask to see their "Multi-Band/TV Sound" receiver. Most stores now offer you a portable receiver with built-in power supply, speaker and batteries, which tunes the TV band signals for channels 2-6 directly (that's the band you are interested in) and channels 7-13. One caution here, you will need to purchase a high-quality receiver with a built-in connection for an outdoor antenna. Your "outdoor antenna" will be the piece of RG-59/U that comes from the directional coupler or signal splitter output side, and if you want to be very pure about it, put a small matching transformer on the end of the cable before connecting the coax to the typically 300-ohm antenna terminals on the "multi-band" receiver.

OPERATION

The Radio Shack 12-1354 or the Multi-Band receiver(s) is designed to recover FM signals that are typically around 150/200 kHz wide. The narrow band FM/SCPC signals on the other hand are closer to 60 kHz "wide." That means you will be getting lots of extra fidelity, but you also may be getting extra noise with this system. And if you are tuning in an FM/SCPC signal which is close in frequency to others on the same transponder, you may experience some problems separating the two (or three) signals. But then again, the price is right.

Shown here is a diagram which perhaps will assist you in determining how my listings correlate to where you should tune in your receiver dial to find the same signals I am reporting. The top line is the (as marked on the unit) Radio Shack 12-1354 tuning dial. The next line down is your 70 MHz IF which, as we know really, is a 50-90 MHz IF as the signal comes indoors from the down converter or LNC. See **Figure 4.42**. The third line down is my own "dial," the digital frequency tuning system we use with our receiver system. If you see a listing of some service you want to tune in from our tables, and the listing says 25, that means you would tune your 1354 tuner to the region just below where the 1354 has Channel 2 marked. (Note: The dial calibration on the 1354 units we have tried is not great, so you may experience some variation here.)

The bottom line is the reference for you, a typical transponder at its original "GHz" frequency, as that would compare with the above three reference lines. (Note: A multi-band receiver, tuning in low band TV audio, would have the same dial calibration as the top line since the 12-1354 and the TV audio tuner/receiver are essentially the same type of gadget. The TV audio receiver is simply more complete, and ultimately perhaps, a tad higher in quality.)

There are alternate methods to accomplishing this "trick." Some people have taken high-quality FM tuners (tuning 88-108 MHz) and they have modified the oscillator so that the tuner now tunes 60-80 MHz (that's part of the "band" anyhow). You also must modify the input RF stages of the tuner as well when you do this since they were designed to tune 88-108 MHz, not 60-80 MHz. Overall, the quickest cheapest way to get into FM/SCPC is as outlined here. You will discover, as we have, that there are considerable performance variations between different down converters in this service.

If the Radio Shack converter number 12-1354 can not be purchased in your area, this unit can be supplied at a reasonable price, along with modification instructions from Universal Electronics Inc., 4555 Groves Road, Suite 13, Columbus, Ohio 43232. Send SASE for details.

The following listings show you where you can find the (typically) 60-kHz wide FM/SCPC services with a narrow band FM receiving system or the "experimental" systems described previously.

Many transponders have one or more unmodulated carriers present; these carriers are always (or nearly always) "up," but no audio or data has ever been noted. Most services that are not full-time will keep their carriers operational between the actual "broadcasts." When you tune across an unmodulated carrier, you simply find the receiver "quieting" (i.e., the static noise disappears and the sound from the speaker becomes "quiet"), then it will abruptly turn into programming at the scheduled time. An example of the latter would be Mutual Radio News which may send news at 00, 15, 30 and 45 minutes (past the hour) and if the newscast lasts five minutes, then that particular audio channel SCPC service would be active from 00 to 05, 15 to 20, 30 to 35, and 45 to 50 minutes.

WHERE TO FIND SCPC SERVICES

Many of the SCPC channels change every few months, some stay in one place for several years.

The most up-to-date listing of SCPC channels and audio subcarriers is the WESTSAT Satellite Channel Chart published six times a year by WESTSAT Communications, P.O. Box 434, Pleasanton, CA 94566, Phone: 415-846-7380, Dept. HS. This is the best source of locations I know of. See Figure 2.2B.

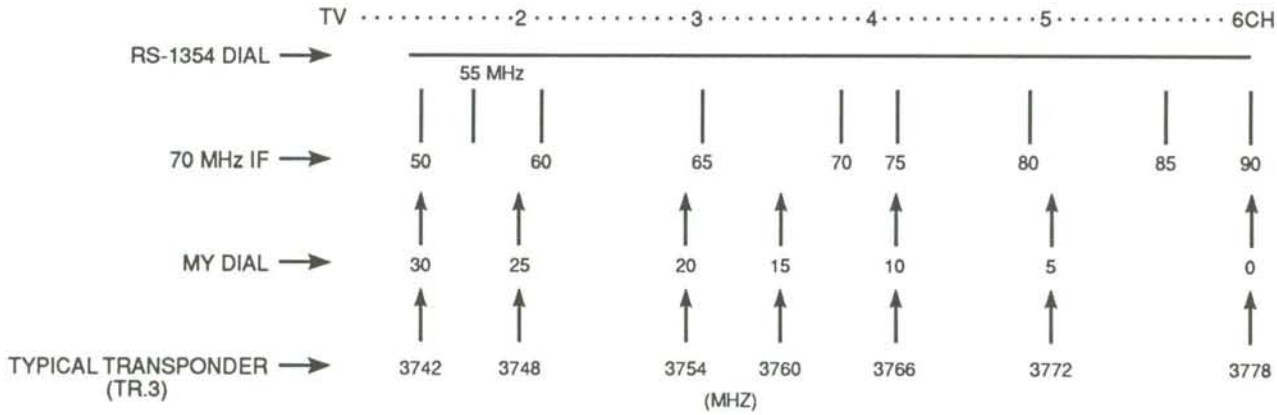


Figure 4.42 *How to relate your tuning to the receiver system you are using. RS-12-1354 dial must be set precisely for each individual signal (top line). TV audio receiver tunes directly on "70 MHz IF" or second line. SCPC receiver tunes to line three. Line four shows typical 40-MHz-wide transponder and relation of frequency to top three scales. On the Radio Shack V-100 Stereo Tuner, you would tune from TV channel 2 to channel 6 (50 to 90 MHz) in the mono mode. Please note: This unit must be modified for SCPC use.*

A SUMMARY OF SCPC

A brief summary is needed to clear up any misunderstanding regarding the SCPC signal. We know it is not a carrier by itself, not modulated onto the main carrier, and consequently not available at the output of the receiver's discriminator — so what is it? We first must understand a subcarrier. A subcarrier might better be called an *"attached carrier"* because it cannot stand by itself. The only pure carrier in a satellite TVRO system is the video carrier; It is generated by itself, modulated with the video information, and it contains all of the elements required to get from "here" (the uplink site) to "there" (the down link site). Even the program audio (the sound that is the audio for the picture) is sent on a "subcarrier" (or attached carrier). A subcarrier cannot travel from "here" to "there" on its own. It is introduced into the uplink part of the system by attaching it to the video carrier. If you take away the video carrier, you lose the subcarrier as well. Multiple subcarriers, the type you can tune in with a Drake SA-24, Arunta SSP-318, and so on, or with a TVRO receiver with subcarrier tuning built in, are all *"attached carriers."* Take away the video and they all go away, even if their audio material seems to be totally unrelated to the "content" of the picture carrier. Programwise, they are separate; technically, they are impossible without the video carrier.

When we speak of a *"36 MHz bandwidth,"* we are talking about the full, usable bandwidth at the RF carrier frequency of the up or down link. Transponder 1, for example, extends from (typically) 3702 to 3738 MHz. Less accurate charts show it to be 3700 to 3720 or 3.7 to 3.72 GHz. That 36 MHz bandwidth persists or stays with us from the uplink transmitter, through the satellite, to your down converter and through your receiver IF. A 70 MHz IF? It has a 70 MHz "center channel frequency" but it actually is quite wide: from 52 MHz to 88 MHz if it is capable of passing and processing the full channel or transponder width.

This "70 MHz signal" is processed through the "IF" stages to the demodulator (same as discriminator). There it is turned from a modulated carrier wave signal that is 36 MHz wide to a "baseband" signal that is, at the very-very most, around 10.7 MHz wide. That 10.7 MHz wide "signal" can be thought of as the "final" or "last conversion stage" in the receiver. The information that falls between 0 MHz and 10.7 MHz, coming out of the discriminator/demodulator, is where we find our video (picture) information. Attach that 0- to 10.7-MHz-wide signal to a video picture tube (i.e., monitor) and you will have television pictures displayed!

So what was 36-MHz-wide is now "no more than 10.7 MHz" wide after passing through the discriminator—a form of "bandwidth compression" or frequency crunching. However, the actual video picture information will occupy no more than 4.2 to 4.5 MHz *(from 0 MHz to 4.2/4.5 MHz)* of that "as wide as" 10.7 MHz signal. That leaves a considerable amount of frequency space to tack on "attached signals." The subcarriers attach in this region, usually no lower than 5.0 MHz and no higher than 8.1 MHz. (In the *real world*, the original transponder is usually not used to its full 36 MHz width—30 MHz is normal—so if we lose part of the overall "width" we will also lose part of the 0-10.7 MHz width as well.)

When you tune in a transponder that does not have a TV signal on it, they may be using it for other forms of communication (TV being but one form). One of these forms is called SCPC (Single *channel* per carrier, or single *carrier* per channel, depending upon your school of thought!). SCPC can be tuned in, as suggested, by connecting the baseband, or normally, video output from your TVRO receiver to a communications receiver that tunes the frequency range from 0 to 8 MHz. If there is *no video* there, and *there is SCPC* use of that transponder, you will tune in these SCPC signals on the communications receiver.

We call these SSB/SCPC because they are transmitted using a modulation format known as single sideband (SSB for short). There is another type of SCPC as well which uses a frequency modulation rather than a single sideband modulation format. All of the services we have written about here are *FM/SCPC signals*. Because they are FM, and not SSB, to tune them in requires an FM receiver that is capable of tuning NOT the 0 to 8 MHz frequency range but rather the original 70 MHz receiver range prior to the discriminator/demodulator.

Why is this?

The demodulator/discriminator is a wideband device. These are *"narrow band"* FM carriers. They are not 36 MHz wide (or 30 MHz wide) each; they are but a tiny fraction of that wide (typically 60 to 100 kilohertz or kHz). If a wideband discriminator demodulates them, they are lost, gone. If a single transponder has two or 200 of them, they all get demodulated as a "lump," all together. You get no

"audio" or intelligence out of that, only noise. Thus the requirement for the special FM demodulator receivers that tune through the 50-90 MHz (IF) region is to catch these signals *while they are still* "RF carriers" and before they get messed up in the wideband demodulator in our TVRO receiver.

WHAT IT TAKES To Tune It In:

1) Video: Wideband receiver, capable of 14 to 36 MHz bandwidth.
2) SSB/SCPC: Wideband down converter going to a wideband demodulator (30 MHz or better with an 8 MHz or better baseband output bandwidth) in turn going to a selectable sideband (SSB) upper/lower sideband communications receiver tuning 0 (.1) MHz to 8 MHz (+).
3) FM/SCPC: Wideband down converter with a 70 MHz (centered) IF connected to a 60/100 kHz bandwidth FM audio receiver that can be tuned between 50 and 90 MHz.
4) Subcarriers: Wideband (video) receiver capable of processing video in an IF from 14 to 46 MHz wide, a wideband video discriminator/demodulator capable of passing 0 to 8.0 MHz, feeding a 100/200/400/800 kHz wide FM detector that tunes from 5.0 to 8.1 MHz.

COMPANDING

A system of compressing the satellite signal at the transmission (uplink) side of the satellite system and transmitting this compressed signal, usually 2:1 or 3:1 compressed state, over the system. At the receive (downlink) side, this signal is received and run through a device to re-expand the signal to its original dynamic range or expanded state. The basic system consists of a series of compressors and expanders which allow the information to be condensed to one-half or one-third its original range.

Companding is used to increase the number of channels and traffic a 36 MHz transponder can handle. In use, a typical transponder's message handling can be raised from approximately 1,000 channels to over 2,000 channels using 2:1 companding, or from 1,000 channels to almost 3,000 channels using 3:1 companding. This method was first used by the military and was considered a top military secret for many years.

In addition, to increase traffic handling capabilities, companding can also improve the overall signal-to-noise ratios as much as 16 dB with 2:1 companding, and as much as 26 dB with 3:1 companding. Almost all forms of data and voice transmission can benefit from this system.

FDM/FM systems use the companding very successfully, along with many of the radio networks who use satellite distribution systems. **Figure 4.43**

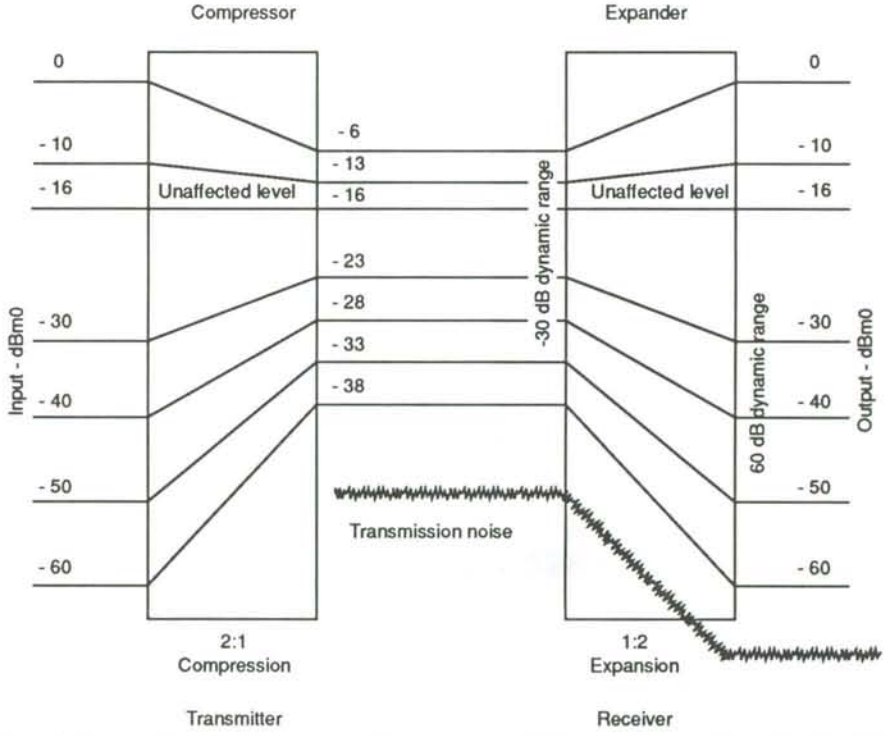


Figure 4.43 *"Companding" showing 2:1 and levels of compression and re-expansion to original levels.*
Courtesy Communication Consultants, Inc.

FREQUENCY LOCATIONS OF SCPC SERVICES

Listed below are satellite transponder locations of many SCPC services. The second column lists the SCPC/FM frequency of the service based on the 70 MHz center frequency block (50 to 90 MHz). Up-to-date SCPC listings can be found in the Westsat Satellite Channel Chart. See Figure 2.2.

This listing of SCPC channels is only a representative sample of services on the satellites. The owners of these channels make changes on an ongoing basis according to the needs for SCPC channels and other factors. The frequencies will shift from time-to-time, plus the frequencies may read different from listed frequencies because of a plus or minus LNB drift in your equipment.

There are many SCPC channels that only transmit a carrier (i.e., a full quieting effect), yet will not have audio on a regular or full-time basis. Some of these SCPC channels will be transmitting data and other data signals.

SATCOM C-1

Transponder 23

Frequency	Service	
50.0	KCRW-FM	National Public Radio
50.8	KPFK-FM	L.A. News - Music
51.7	KUSC-FM	Classical Music
52.5	KKBT-FM	Rock Music
53.2	KODJ-FM	Music

MORELOS 1

Transponder 4

Frequency	Service	
59.6	Radiosat	
66.5	Mexicano Radio	
67.7/68.1	XIV-FM	Radio
68.3/68.5	XEJP-FM	Radio
71.6	XEQR-AM	Radio
72.1	XEOY-AM	Radio
72.5/82.4	XEAW-AM	Radio
73.0	XERED	Radio
81.0	XEL-AM	Radio

ANIK D2

Transponder 10

Frequency	Service
52.9	French News Feeds
55.5/57.0/58.1	English News
56.3/56.4/56.7	Radio, French
57.2/57.3/57.4	Radio Canada International
57.6	BBC World Service

ANIK D1

Transponder 3

Frequency	Service	
70.1	CBC Radio	

Transponder 7

54.1	CBC Radio	

Transponder 11

54.0	Radio Canada	
54.5	CBC Radio	

Transponder 15

52.8	CBC Radio	

Transponder 17

54.0	CBC Radio	
54.4	CBC Radio	

Transponder 19

54.0	CBC English Network	
54.5	CBC Radio	

Transponder 21

54.0	CKRW-AM	Music
54.5	CHON-FM	Music

Transponder 23

54.0	VOCM-AM	Music
54.5	CKNM-FM	Music

G STAR 1

Transponder 13

Frequency	Service	
76.2/76.4	KILA-FM	Music
77.5/77.7	SMN	Music Network
78.0/78.2	SMN	Music Network

WESTAR 4

Transponder 1

Frequency	Service
52.3	Family Radio
53.2	Voice of China
54.1/54.3	Family Radio
56.2	Unidentified
56.6	Chinese Music
62.0/62.5	Religious
66.0/66.3	KCBI-FM

Transponder 2

Frequency	Service	
75.2	Farm Bureau, Illinois	
77.4/78.0	News Network, W.V.	
80.0/81.0	News Network	
81.2	Farmers Network	
82.0/82.4	Associated News Service	
82.6	WWWE-AM, Cleveland	
82.8	Texas Network	
83.3	Information Network	
83.8	KMOX-AM, St. Louis	
84.3	KC Royals	
85.6	WIBR-AM	Music/Talk

Transponder 3

53.6	KPRC-AM Baseball	
54.7/57.5	NPR	Classical Music
55.4/58.1	Music Radio	
56.2	WNTL-AM	
56.5	Religious Programming	
57.0/82.2	Public Radio	
57.2	Religious	
57.9	KNOW-AM	
61.7	NPR	
62.5	Talking Book Radio	
62.6	BBC World Service	
62.9	KPRC-AM	
63.2	Tenn. Radio	
63.6	News, Georgia	
64.0	Greek Network	
64.1	Music	
64.5	KLON-FM, Long Beach, CA	
64.8	Florida Radio Network	
65.2	Kentucky Radio Network	
66.0	NPR	
66.4	Kentucky Radio Network	
67.6/68.2	NPR, Music	
68.0	Spanish Radio	
71.9	Florida Radio Network	
72.2	NPR	
72.5	NPR	
72.8/74.2	NPR	
73.1	Motor Racing Network	
73.8	Talknet (NBC)	
74.6	U.S. Naval Master Clock	
75.3	NPR, News Feeds	
76.0	KCFR-FM (NPR)	
76.3	Occasional Programming	
76.9	Texas News Network	

WESTAR 4 (Cont.)

Transponder 3

Frequency	Service	
77.0	Occasional Programming	
74.4	U.S. Armed Forces Service	
82.0	Occasional Programming	
82.9	In Touch	Reading Service for the Blind
83.2	WKSJ-FM	Music
83.5	WHO-AM	News/Talk
84.0	Reader Network	Reading for the Blind
84.2	Music	

Transponder 4

52.4	WCCO-AM	News/Talk
52.6	WPTF-AM	News/Talk
52.9	Agriculture Network	
53.8	Iowa Network	
54.0	WWL-AM	News/Talk
54.4	Louisiana Radio Network	
55.2	Mississippi Radio	
56.0	Occasional Music	
56.5	Occasional Music	
57.0	Occasional Music	

WESTAR 4

Transponder 4

Frequency	Service	
57.4	Virginia News	
61.4	Arkansas Radio	
62.5	WPLZ-FM	Music

Transponder 6

53.1	WCRP-FM	Religious

SPACENET 3

Transponder 13

Frequency	Service
52.1	Religious Programming
52.4	Religious Programming
52.9	Religious Programming
53.5	Music Network
54.0	Music Network
54.4	Music Network
57.1/57.3	Music Network
57.4/57.6	Rock Music

Transponder 13

Frequency	Service
57.8/58.0	Oldies Music
58.2/58.4	Modern Rock Music
58.7/58.9	Rock Music

TELSTAR 302

Transponder 3

Frequency	Service
55.0 to 62.0	Various SCPC Channels - Data

Transponder 4

56.0 to 61.0	Various SCPC Channels - Data

Transponder 5

55.0 to 63.0	Commercial SCPC and Data

Transponder 12

55.0 to 61.0	SCPC Channels and Data

GALAXY 2

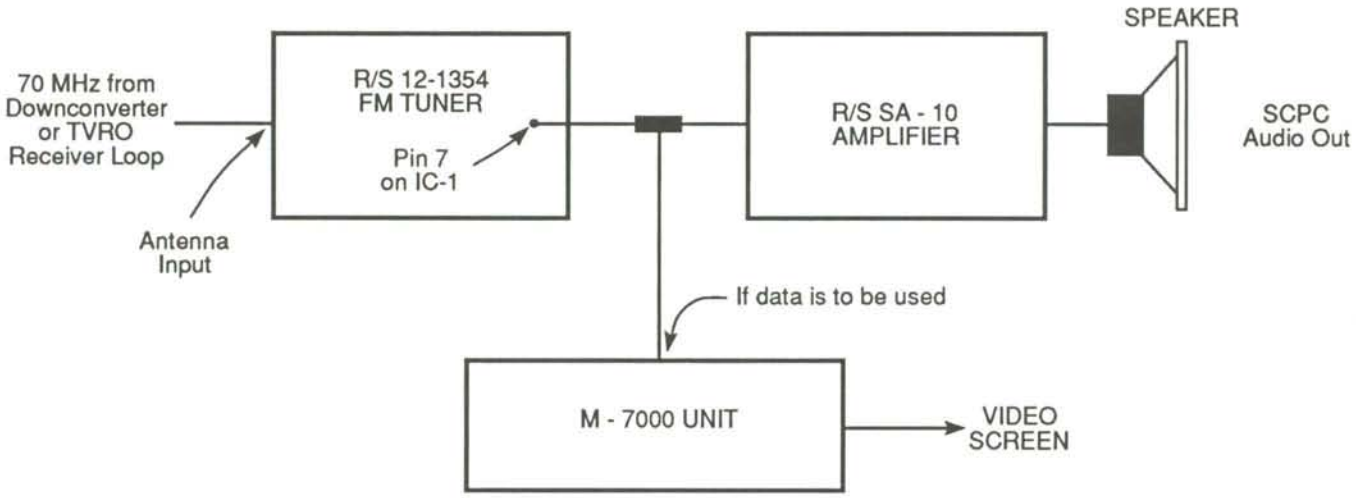
Transponder 3

Frequency	Service	
54.3	KIRO-AM	News/Talk
54.6	News Service	
55.4	Carrier	
55.6	WLW-AM	Radio/News/Talk
55.8 to 56.5	Carriers (some audio)	
56.8	Motor Racing Network	
57.0 to 58.2	Carriers, Data, Occasional Audio	
58.6	WGR-AM	Talk Radio
59.1	WBAL-AM	News/Talk
59.4	KMOX-AM, St. Louis	News/Talk
62.2	Carrier	
62.8	WTMJ-AM	Baseball/News
65.3	Sun Radio Network	Talk
66.4	Agri-News Network, Florida	
66.6	WGN-AM, Chicago	Talk/Baseball
67.3	WGN-AM, Chicago	Talk Radio
68.4	XPRS-AM	Spanish Radio
69.1	Texas Network	
69.4	Dodgers Network	
69.6	Dodgers Network, Spanish	
71.1	Florida Network	
71.3	Florida Network	

Transponder 3

Frequency	Service	
71.5 to 72.6	Carriers, Data, Occasional Audio	
72.9/73.5	WJR-AM, Detroit	News/Talk/Sports
73.3	WJIM-AM	Talk
74.4	WBT-AM, Charlotte	News/Talk
74.9	Talk Radio	
75.8	KMPC-AM	Music/Sports
76.2	KJR-AM	Music
76.6	KSFO-AM	Music/Sports
76.8	KDKA-AM, Pittsburgh	Talk/Sports
77.4	Spanish Network	
82.4	KUSC-FM	Classical Music
82.6 to 85.6	Occasional Audio, News, Music	
85.9	KEX-AM	News/Music
87.0	KMXI-FM	Music

Please Note:
Check all satellites for possible SCPC and data channels because new services are being added monthly.



CONNECT UNIT AS FOLLOWS:

1. Using a "T" adaptor, connect the 70 MHz output from down converter to antenna jack of FM tuner.
2. Using a shielded audio cable, connect the detector output from the FM tuner (pin 7 on IC-1) to the input on audio amplifier. Connect good regulated 12 volt DC tuner as instructions. If data system is to be used, tap off audio cable to M-7000 unit at this point.
3. Do not use the FM-tuner radio output cable.
4. Set TV/WX selector switch to TV1 (center) position. Complete required connections if you are using M-7000 for data work.
5. The R/S 12-1354 is no longer being supplied by R/S; however, Universal has an ample supply of these units in stock.

Figure 4.44 *FM tuner hookup for SCPC audio and SCPC data (FM/SCPC).*

SCPC SCANNER RECEIVING SYSTEM

The interesting SCPC Channels found on many of the domestic satellites can easily be received by using a readily-available special blocked downconverter that covers a block of transponder frequencies 500 MHz wide. This actual range is 50 MHz to 550 MHz as a single block. In other words, the 3.7 to 4.2 GHz satellite band is reduced to a single 500 MHz block that is then tuned by using one of the new VHF/UHF scanner receivers.

The special blocked downconverter is an Avcom standard BDC-60 unit that normally has a range of 270 MHz to 770 MHz block. This BDC-60 is factory tuned to our required frequency block of 50 MHz to 550 MHz that our scanner can tune. Our special BDC-60 downconverter can be ordered from Avcom of Virginia, 2500 Southlake Blvd., Richmond, VA, 23236, Phone 1-804-794-2500. Avcom also manufactures a leading, high-quality line of TVRO receivers and satellite test equipment. You must ask for the special BDC-60 tuned to 50 MHz to 550 MHz range. It is recommended that the BDC-60 be mounted indoors because the downconverter uses a dielectric resonant oscillator which gives a high level of stability. However, this material combined with the metal used in the oscillator cavity will change when subjected to extreme temperature changes causing frequency drift.

The next component in this system will be one of the two VHF/UHF scanners that has continuous frequency coverage from 50 MHz through 550 MHz. We are using the Regency M-5000 unit manufactured by Regency Electronics. Used M-5000 units are available from various dealers.

The other scanner is the ICOM R-7000 which tunes from 25 MHz through 2000 MHz. The R-7000 receiver would be used on a system with an LNB with an output of 950 MHz to 1450 MHz. The unit will also cover 50 to 500 MHz. (See **Figure 4.45**).

The scanner hookup is simple. The BDC-60 (specially tuned) is connected to your LNA using a power splitter that will handle the 4 GHz range. Avcom has these microwave splitters with DC blocking (if needed) and isolators which would be used when the system is used along with your regular TVRO system (See **Figure 4.46**). Several items needed would be as follows: Either a two-way power divider, with or without DC Block (PD-2), or an isolated power divider with DC block would fill all requirements, power divider, isolation and DC blocking. This one unit (IPD-65) will take the place of three separate units and would be the best to use costwise. The use of the Avcom IPD-65 will also eliminate the use of several RG-213 coax cables in the system. The BDC-60 does not have DC voltage present at the IF output. However, if your present system is using the coax to run the LNA power, you will need DC blocking, plus isolation with the two-way power divider. **Figure 4.47**

The ferrite isolator gives 60 dB of isolation and effectively prevents interaction between two single conversion receivers.

CONNECTING THE SCANNER TO THE TVRO RECEIVER

The hookup consists of coax cabling the 4 GHz signal from the LNA to the input of the Avcom BDC-60 downconverter, the output of the BDC-60 is run to the antenna jack or fitting of the Regency M-5000 scanner or the R-7000 scanner via a 75 OHM coax cable (RG-59 or RG-6). This completes the hookup. **Figure 4.48**

FINDING THE SCPC SERVICES

The scanners have a search mode which can be used to find the unknown SCPC services. You simply set the scanner program in search and move through the block of frequencies from 50 MHz to 550 MHz in set steps of 5 KC, 12.5 KC, or 25 KC. The scanners squelch control is adjusted until all background noise disappears and the scanner starts its search mode. It will scan the frequency range set into its memory and stop at each SCPC frequency that is in use. This allows you to monitor the channel in use and then move on to other channels by pressing the scan mode.

Many times the scanner will stop and lock on to a buzzing signal. This is a SCPC channel that is quiet at the moment. Some of these channels will come alive at set times to carry radio station or other information.

When an active SCPC channel is located, its frequency is taken down from the scanners LCD digital readout. These frequencies (channels) can then be programmed into the memory for quick recall by using the keyboard.

Each transponder showing SCPC channels from



Regency M-5000 scanner for use with 70 MHz block of frequencies (50 to 90 MHz). Tunes 25 to 550 MHz.



ICOM R-7000 receiver for use with BDC-950 to 1450 MHz. Receiver tunes 25 MHz to 2 GHz — standard LNB output is 950 to 1450 MHz.

Figure 4.45 *Two popular VHF/UHF scanners for use with the SCPC blocked down converter system.*

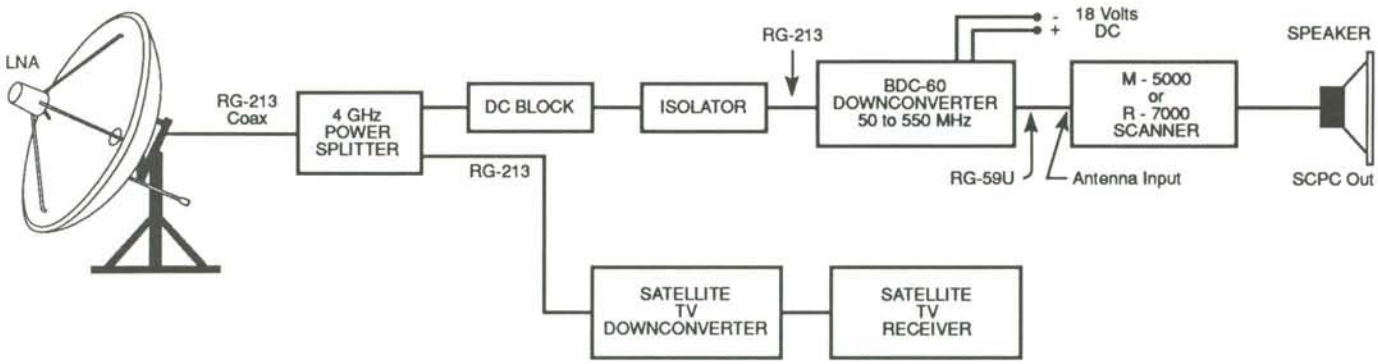


Figure 4.46 *SCPC SYSTEM USING SCANNER. This hookup is used where blocking is needed and is shown as DC blocked on BDC-60 downconverter side of power splitter.*



Figure 4.47 *Avcom IPD-65, Isolated Power Divider. An economical solution to the problem of using two satellite systems with one LNA and one dish. Automatic feedline power switching and DC block circuits are included to simplify downconverter hookup.*

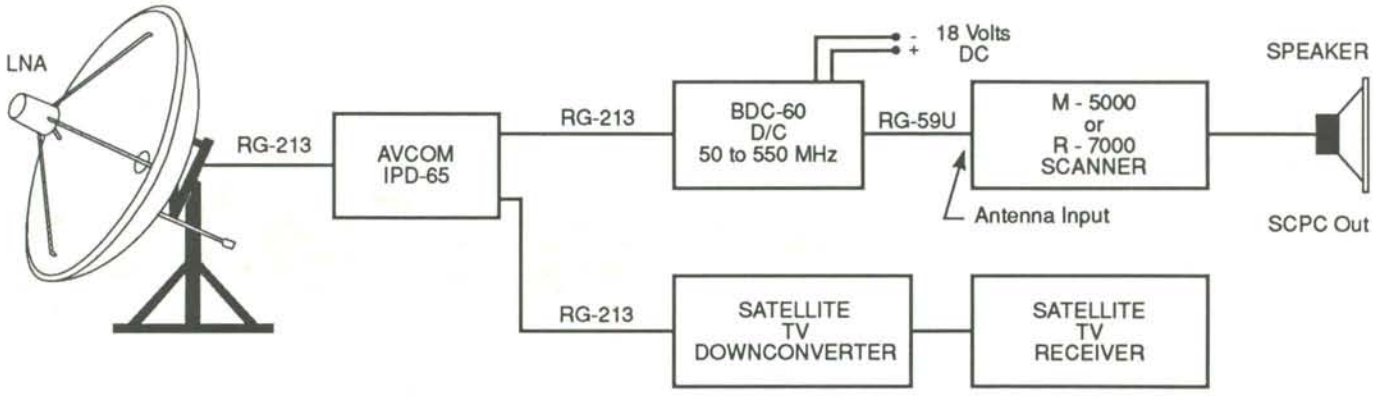


Figure 4.48 *SCPC SYSTEM USING SCANNER. This hookup is used where isolation and DC blocking are required. The Avcom IPD-65 is a self-contained power splitter, ferrite isolator, and DC block in a single unit. This system cuts down on cable runs and gives full isolation and saftey blocking.*

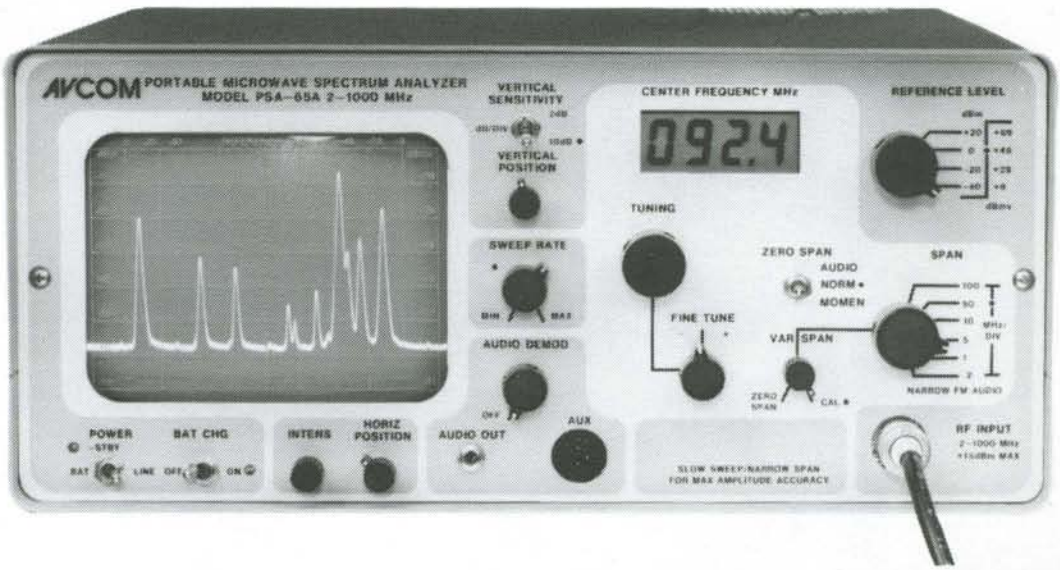
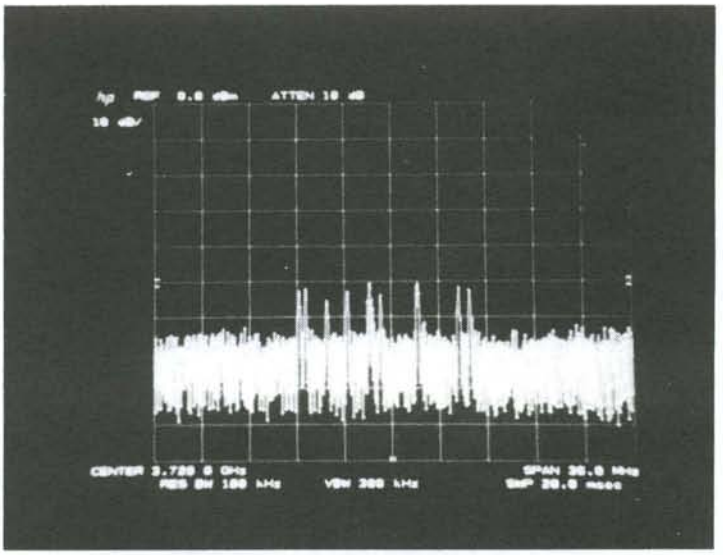


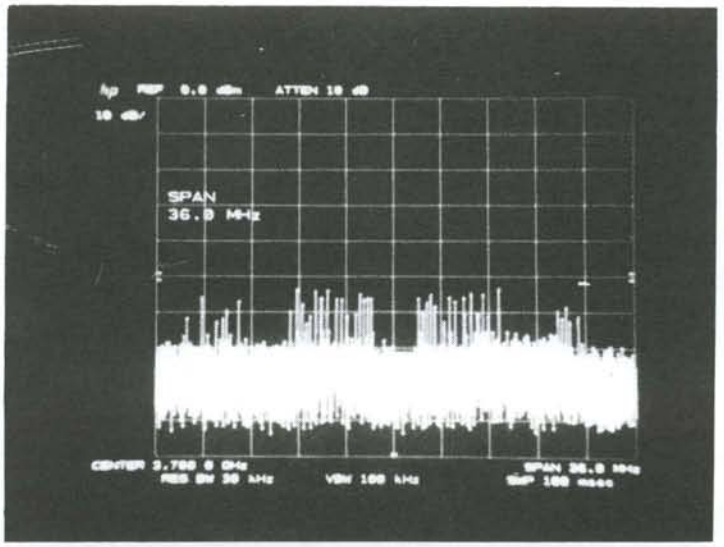
Figure 4.49 *The AVCOM PSA-65A Spectrum Analyzer covers 2 to 1000 MHz with digital frequency display and audio demodulator for audio output of signal.*

the SCPC lists should be scanned several times and an accurate log the scanner's frequencies kept for each satellite's transponder for future reference and rapid tuning to a favorite SCPC channel.

Avcom of Virginia has produced a great satellite tool, the PSA-65A portable spectrum analyzer. This excellent new instrument is a must for any serious "satellite nut". The unit offers continuous frequency coverage of 2 to 1000 MHz for checking signal strength, inband attenuations, terrestrial interference, filter alignment, faulty connectors, LNA, feedhorn isolation, plus rapid identification of all signals on a transponder. You can tell a TV/FM signal from a FDM/FM signal, and most of all, the SCPC signal is easy to identify and count. This is a portable and self-powered quality unit. We could fill pages with the many uses for the PSA-65A spectrum analyzer. (**Figure 4.49** and **Figure 4.50**)



SCPC signals shown on spectrum analyzer,
Westar 4, transponder 1, 36 MHz span.



SCPC signals shown on spectrum analyzer,
Westar 4, transponder 2, 36 MHz span.

Figure 4.50 *SCPC signals on Spectrum Analyzer.*

HEIL SC-ONE SCPC RECEIVER

This SCPC audio receiver is a stand-alone unit for consumer use and small radio stations. The SC-ONE is stable when used with a high-quality commercial LNB. The audio output is sufficient to drive a small external speaker or the line input of an audio amplifier.

The front panel includes a ten-turn master tuning control with a three digit log readout which allows the return to a known station or channel. Because this unit is completely frequency agile, it can tune the 900 MHz through 1500 MHz range of SCPC signals or channels.

The log tuner does not give a frequency readout of the SCPC signal as do most commercial units. (See Figure 4.51)

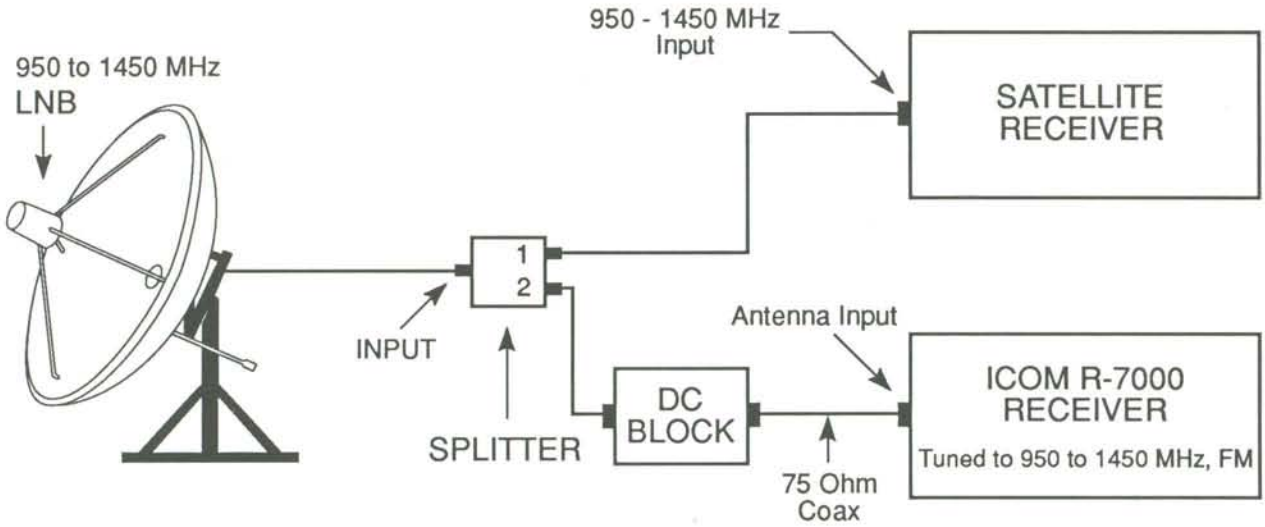
The SC-ONE works very well and is easy to hook up to any modern TVRO system using a 950 to 1450 MHz splitter out of the LNB. The splitter must pass the DC voltage on one port only because the Heil SC-ONE would be damaged if 15 to 18 volts of DC current were injected into the unit. This special splitter is furnished with each SC-ONE receiver. (See Figure 4.52)

The SC-ONE is contained in a black steel chassis which measures 9.5" by 7.5" by 3". The back panel has a standard "F" connector for the input from the LNB splitter and an RCA line level audio jack. The unit is complete with cables and splitter and is simple to hook up. The SC-ONE sells for $450. For full information, contact Heil Sound, Ltd., 2 Heil Drive, Department HS, Marissa, IL 62257, phone 618-295-3000.



Figure 4.51 Heil SC-ONE SCPC receiver.

THE SCPC SYSTEM



SPLITTER — R/S 15-1141 75 ohm
DC BLOCK — R/S 15-1259 75 ohm

1. CAUTION - Do not input DC voltage to R-7000. DC voltage into R-7000 will damage receiver.

2. Tune R-7000 receiver to 950 to 1450 MHz. In FM mode, try narrow or wide FM for best reception.

3. Try both horizontal and vertical polarization. Tune entire block of frequencies in both horizontal and vertical polarization modes for complete coverage of SCPC channels.

SATELLITES WITH SCPC CHANNELS

- SATCOM C-1*
- MORELOS 1*
- ANIK D-2
- ANIK D-1*
- GSTAR 1
- WESTAR 4*
- SPACENET 3*
- GALAXY 2*
- SATCOM F2R
- SPACENET 2

(*Satellites which carry many SCPC channels.)

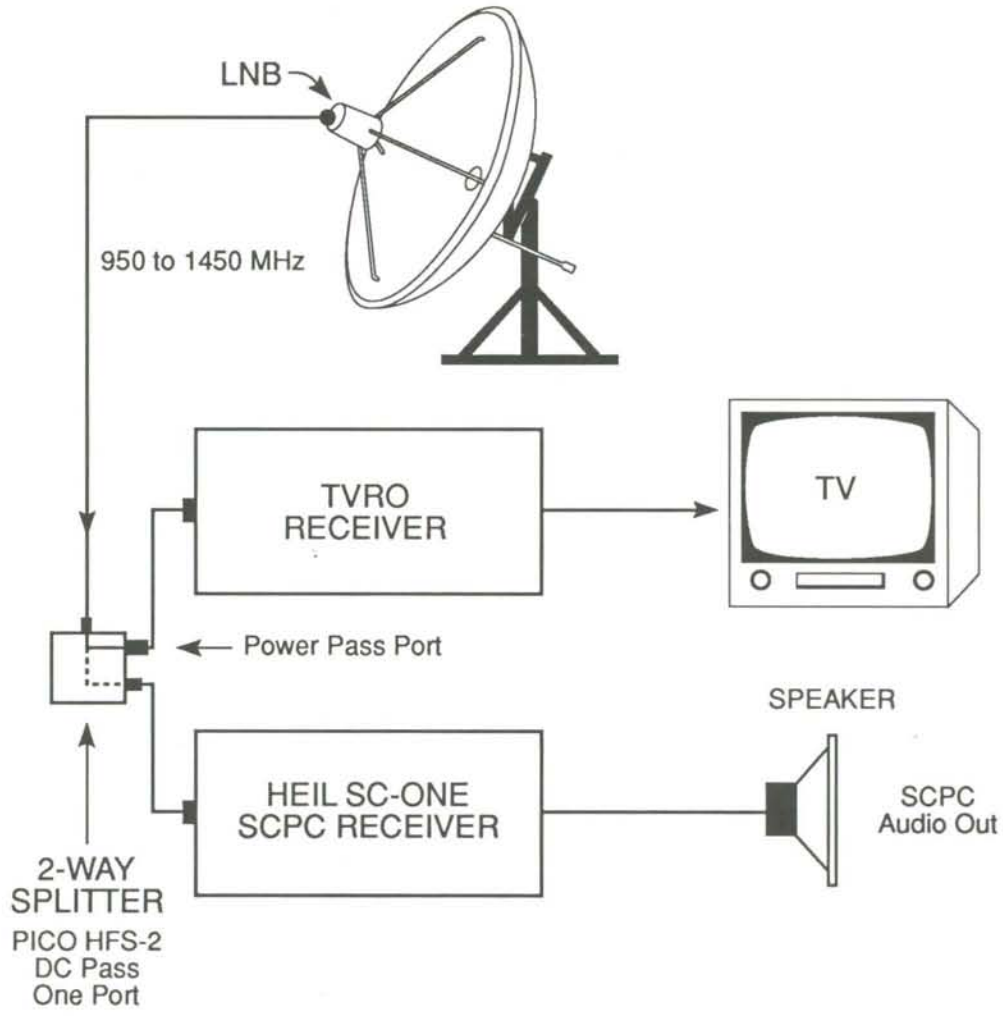
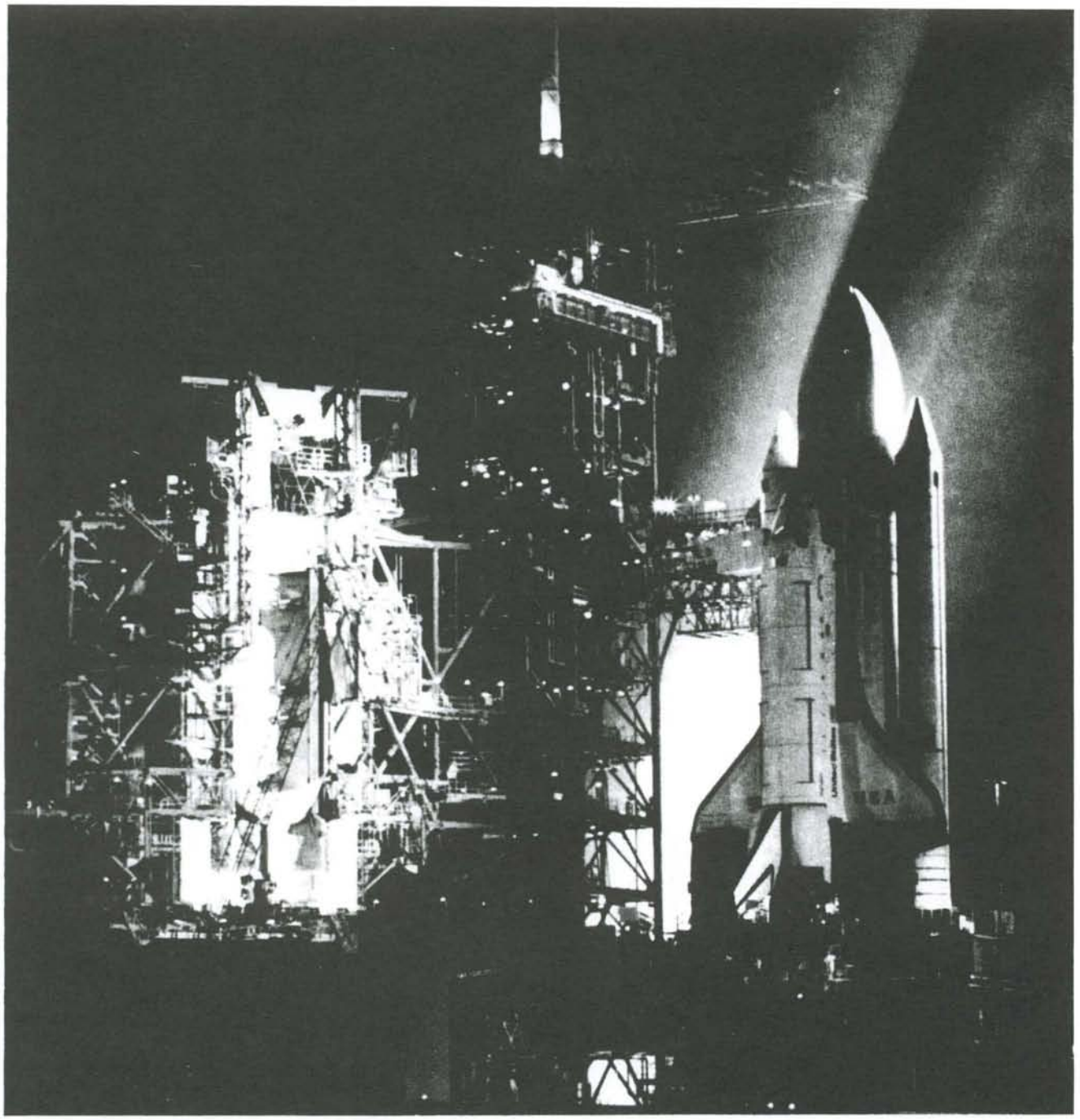


Figure 4.52 *Hookup of Heil SC-ONE SCPC receiver.*



SPACE SHUTTLE SATELLITE DELIVERY SYSTEM

The advent of space shuttle operations has opened a new era of access to space, expanding the range in size and weight of satellites that can be delivered into geostationary orbit.

This new generation of high powered communications satellites will lower the overall cost of communications by reducing down link costs and reducing earth station size and costs. The space shuttle will also allow the servicing of satellites in space, saving millions of communications dollars by extending the satellites useful life by many years, plus the possible reuse of present and future satellites.

CHAPTER FIVE

SATELLITE NETWORKS

HISTORY OF DATA COMMUNICATIONS

The term data communications is used to describe an environment in which data is produced by a terminal or computer and is transported using communications facilities, such as phone lines, microwave, optical fibers, and satellites.

The means of long distance communications has been in existence for over 100 years. The telegraph was conceived in the early 1800's, followed by the telephone in the 1870's.

In the early 1940's' the military attempted to place into use an inventory control system using a combination of data processing and communications. Later, around 1952, American Airlines developed the first commercial data communications system to handle airline reservations. In today's business world, many data communications systems are used by airlines, banks, stockbrokers, insurance companies, and by many other businesses, large and small.

The new means of communication is the Satellite System. With each new development, the cost of satellite communications has dropped and its use increased.

Many of the common systems of data handling are now being transmitted via satellite at moderate cost. These are the same systems that several years ago were transmitted by telephone line, microwave communications, high frequency radio links, and transoceanic cable systems.

All data communications have common characteristics and employ the following:

(A) *ON LINE TERMINALS* that receive or transmit information and are said to be "on line." These terminals are connected and send data directly to a computer (processor) of another terminal without being stored on disk or tape. If the data is stored on a system before direct transmission, the terminal is considered "off line."

(B) *REAL-TIME PROCESSING* requires that the data be acted on immediately after receipt by the other terminal. A computer reduces the number of units in inventory immediately upon the data receipt, showing the number of units sold or delivered. Most data communications systems are used on-line and are real-time processing. Banks send data on cleared checks on an account and subtract the amount of the check at the time of receipt of the data.

(C) *FAST RESPONSE TIME*—Most data communications systems provide an immediate response to inquiries. This time is measured from the time the data is entered (enter key activated) until a reply is received. One to two seconds is considered fast, two to ten seconds is an average response; more than ten seconds is considered slow response time.

(D) *MULTIPLE SIMULTANEOUS USERS*—Most data communications systems serve many users at the same time: United Press International, Reuters Services, Dow-Jones and Airlines Reservations Services. All of these services would not be economically feasible if only one person could access and use the service at one time. These systems must be able to handle many users at the same time. **Figure 5.1.**

TELECONFERENCING VIA SATELLITE

Videostar Connections is a satellite communications company which provides complete communication services for satellite teleconferencing to first-class hotel meeting rooms throughout the U.S. and also to college and university sites through an agreement with the National University Teleconference Network (NUTN). The company takes total

responsibility for transmission of domestic or international events, including all the necessary satellite communications facilities and the voice return circuits for two-way audio if desired. Videostar's services include booking satellite time, arranging satellite facilities from the conference origination point, providing satellite receiving stations at the various meeting locations, and providing large screen video displays in the meeting rooms. **Figure 5.2.**

Using a combination of fixed and transportable satellite earth stations, Videostar's Tele-Meeting Network now serves all major cities around the country. Additional cities are being added continually, and through agreements with overseas affiliates, Videostar can route a teleconference signal to or from anywhere in the world. **Figure 5.3, Figure 5.4.**

Besides hotels, teleconferences can be delivered to some convention centers, civic auditoriums, and even directly to the client's offices. All of the facilities are staffed with experienced satellite field engineers and include the capability to receive from any domestic satellite so that televised events have acceptable signal security, high reliability, and complete scheduling flexibility. Videostar Connections, Inc., 3390 Peachtree Rd., Atlanta, GA 30326.

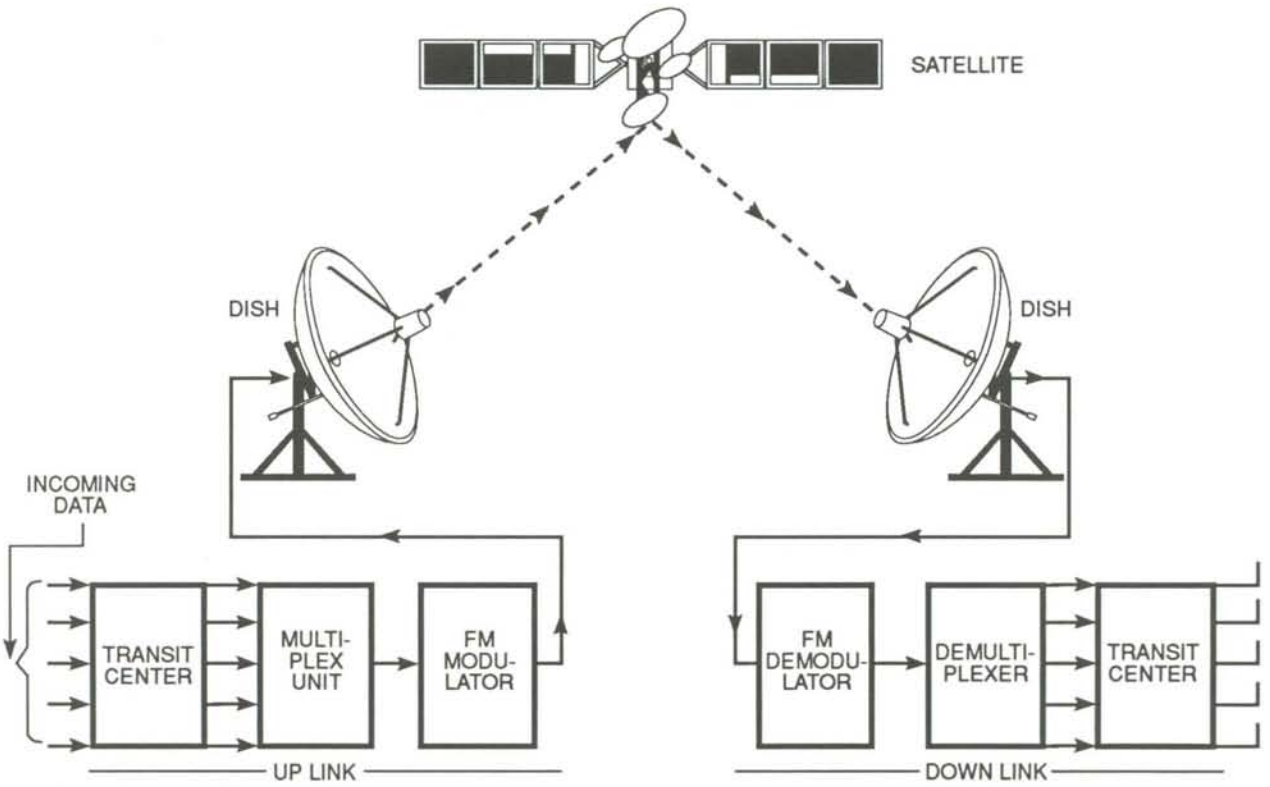


Figure 5.1 *Satellite data system using FDM/FM.*

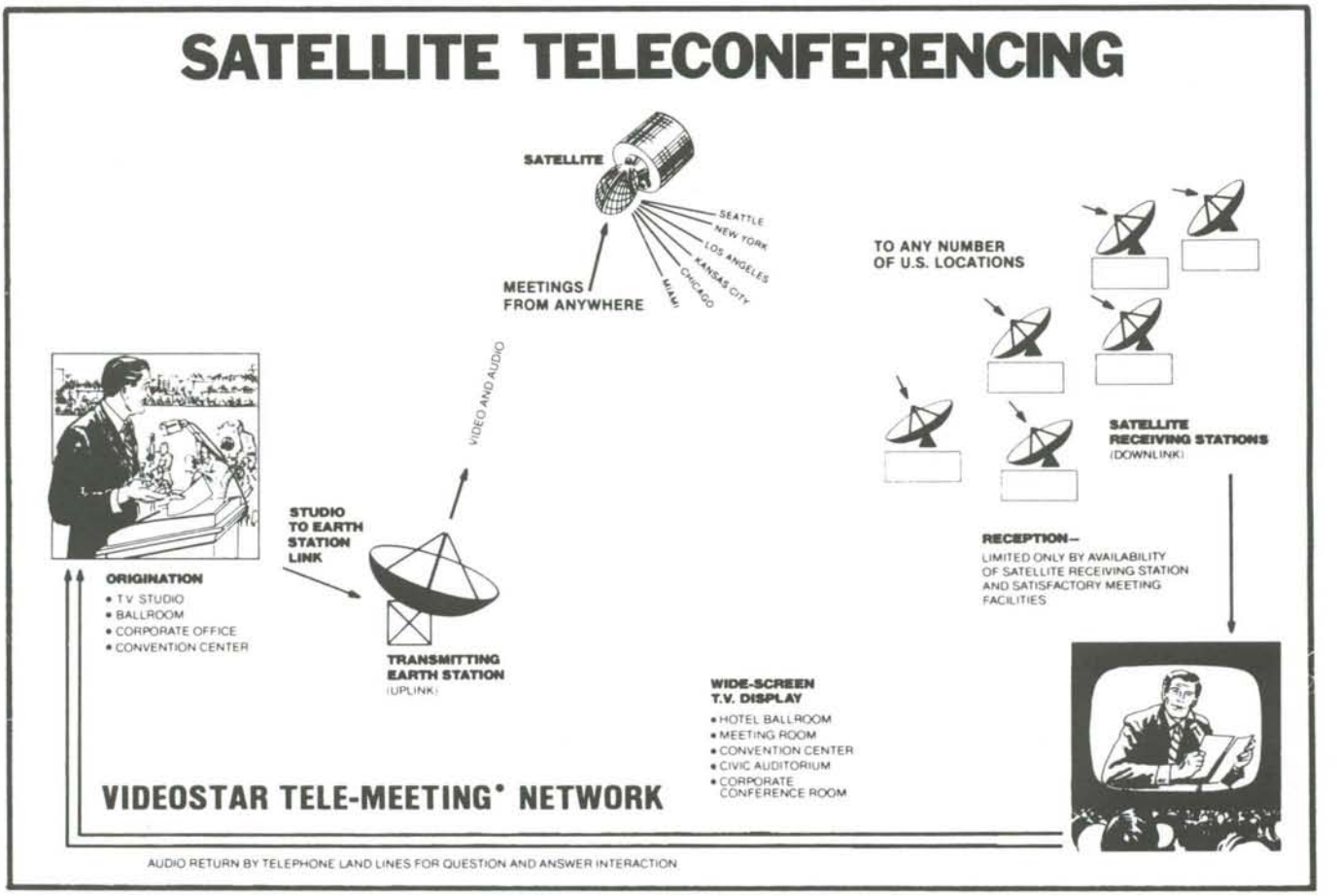


Figure 5.2 *Videostar tele-meeting® network.*
Courtesy Videostar, Inc.

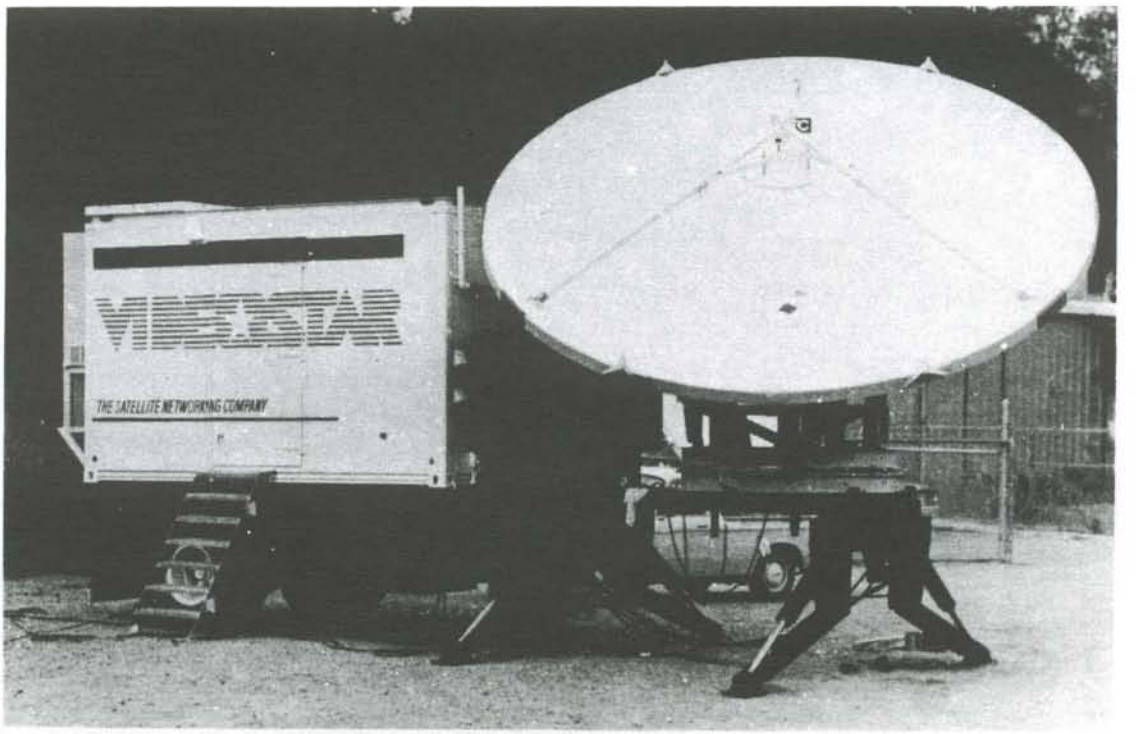


Figure 5.3 *Fully transportable uplink.*
Courtesy Videostar, Inc.

DIGITAL RADIO NETWORKS VIA SATELLITE

Today all of the major radio networks are either now using satellite to distribute their programming to their affiliates, or are in an active transition program into satellite delivery. This switch from landlines to satellite has been prompted by several factors: The increasing costs of landlines and the line quality variance between different locations. The break-up of AT&T brought on a degree of uncertainty to the networks which had the problem of serving many sections of the country. This break-up now meant that the networks were forced to deal with many distributors instead of one. A further incentive was the decreasing costs of satellite space units and decreasing costs of earth stations (downlink).

The overall trend in radio networking stressed improvement of overall quality of transmission and more flexibility for the affiliates in the future with the possibility of supplying other types of services for added revenue for the network and the affiliate. Several large networks now plan on utilizing their satellite distribution systems to open the door to nationwide paging systems.

Other added use of these systems would be:

- Internal communications between the networks and its affiliates.
- Printout of internal data and communication from the network.
- Selective or global message service, the ability to communicate selectively to affiliates in any combination required via addressing the category of stations on a regular basis or by need.
- The future use of the affiliates rebroadcasted subcarrier groups (SCA) for date distribution and other uses.

The Audio Digital Distribution Service (ADDS) has been in use now for radio networking since 1983 with good success. This same service (ADDS) is referred to by another system name: Digital Audio Earth Station (DAES) which is one-half of the total system. The Audio Digital Distribution Service (ADDS) is the transmitting or distribution end of the total network system. The receive end or downlink side is known as Digital Audio Earth Station (DAES). **Figure 5.5.**

The ADDS system makes use of a number of

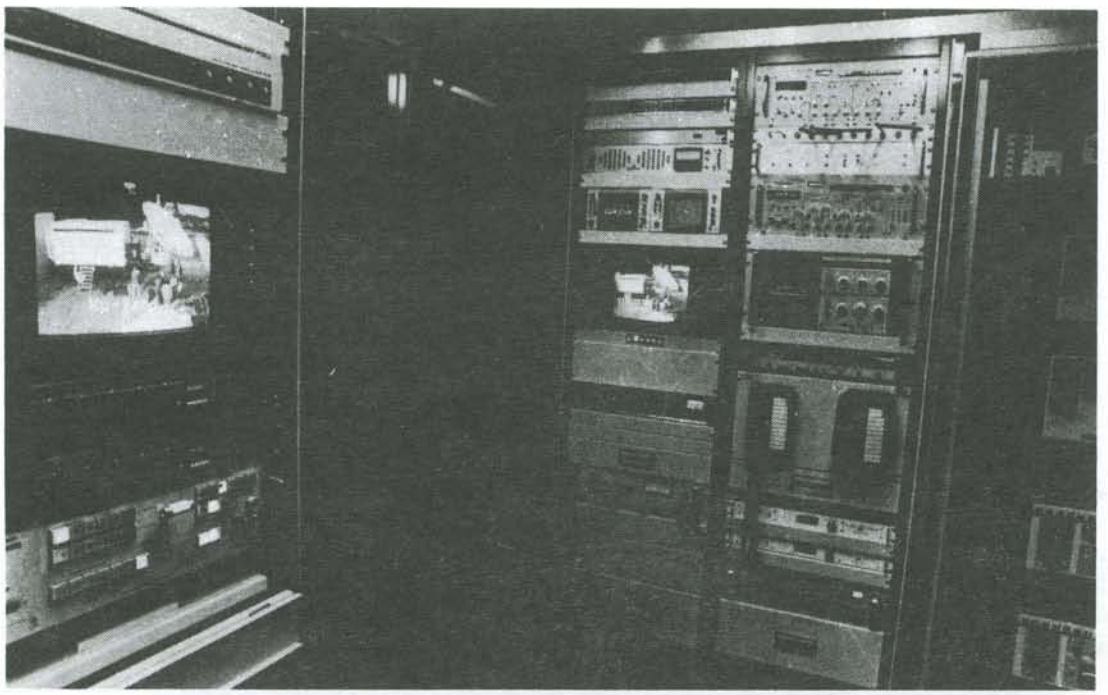


Figure 5.4 *Interior view of transportable uplink van.*
Courtesy Videostar, Inc.

techniques: end-to-end digital, bit-rate companding, time division, multiplex, pulse code modulation techniques, Forward Error Correction (FEC), plus other methods.

After several years of study, it was decided to use a combination of these advanced techniques for transmitting the needed high-quality radio network audio. At this point, the Scientific-Atlanta Company started a program to develop specific equipment for this use.

The networks, ABC, CBS, NBC, and others are recommending the direct purchase of the needed ADDS equipment from Scientific-Atlanta Company. The network furnishes and pays for the satellite time, and the affiliates purchase their needed downlink (receive) equipment.

In the case of the RKO radio network, the network will pay for and install the needed equipment for its stations located in the 150 largest markets.

The equipment that the stations buy and install will be the basic S/A equipment with a few options available depending on what each affiliate station's needs are and largely depending on its programming plans.

DIGITAL SATELLITE NETWORK EQUIPMENT (ADDS)

The Scientific-Atlanta Company describes its equipment package for ADDS reception as a digital audio earth station (DAES).

This configuration consists of S/A series 9000 antenna, 2.8 meter; a series 300-1, 120-degree Kelvin low-noise amplifier (LNA); 200 feet of ½ inch, foam-filled coax cable; the model 7300 wideband BPSK receiver; and the model 7325 digital processing unit (DPU). This unit will house up to 7 cards of any combination for the desired services. A full description of the S/A DAT-32 digital audio terminal follows.

The Scientific-Atlanta DAT-32 Digital Audio Terminal is designed for reception of media information broadcast via satellite using digital data techniques. With this terminal, it is possible to receive various types of data services including:

- Digital Program Audio Channels (15 kHz or 7.5 kHz)
- Voice Cue Channel (32 kb/s)
- Data Channels (32 kb/s)

The DAT-32 is designed to receive a single biphase, shift keying (PBSK) carrier modulated by a high-speed Time Division Multiplex (TDM) digital data. It demodulates and demultiplexes the data into

RCA Americom—Digital Audio Transmission Service (DATS)

All DATS services are located on Satcom C-1

SERVICE	TRANSPONDER
Westwood One	3
Transtar Radio	3
IDB Communications	3
ABC Radio, LA to NY	3
ABC Talk Radio, LA to NY	3
CBS Radio Network	15
CBS News	15
CBS Special News	15
Westwood One	15
NBC Radio	15
NBC News	15
NBC Special News	15
NBC Talk Radio	15
United Stations Network	15
Dow Jones Network	15
ABC Special News	23
ABC News, All regions	23
ABC Network, Music, Stereo	23
ABC Talk Radio	23

the audio and data channels. The system achieves a bit error rate (BER) of less than 10^{-7} with over 1.5 dB of margin for most locations throughout the continental United States.

The data is distributed using a BPSK modulation at 8.78 Mb/s rate. This rate and modulation format were selected especially to provide sufficient spread of transmitted energy to be cleared by the FCC for transmission, yet narrow enough to fit snugly between two terrestrial TD-2 potential interfering signals located at ±10 MHz from the transponder center frequency. TDM signal carrier digital transmission allows saturated transponder operation, so all available power is used to provide minimum network annual cost for point-to-multipoint, one-way distribution into 2.8 meter terminals with a large variety of data services. The satellite transponder has the capacity to provide 20 channels, each 15 kHz (or 40 each 7.5 kHz), and each can be divided into 12 subchannels for voice cue and data uses.

The standard DAT-32 receive-only earth terminal includes the Series 9000, 2.8 meter parabolic reflector; a Model 300-1, 120 degree Kelvin low-noise amplifier (LNA); 200 feet of 0.5 inch foam-filled coaxial RF cable; the Model 7300 wideband BPSK receiver; and the Model 7325 digital processing unit (DPU) which houses any combination of up to seven program audio, voice cue, and data channel cards for the desired services.

Both the 7.5 kHz and the 15 kHz program audio modules are dual channel cards. A separate card is required for voice cue. Each data card provides for three output channels of asynchronous information. The LNA is mounted at the antenna's focal point while the two 10.5 inch electronics chassis are installed into a standard 19.5 inch equipment rack in the host facility. An extension chassis is also available when additional channel units are required. DC power to the LNA is provided through the coaxial cable from the receiver.

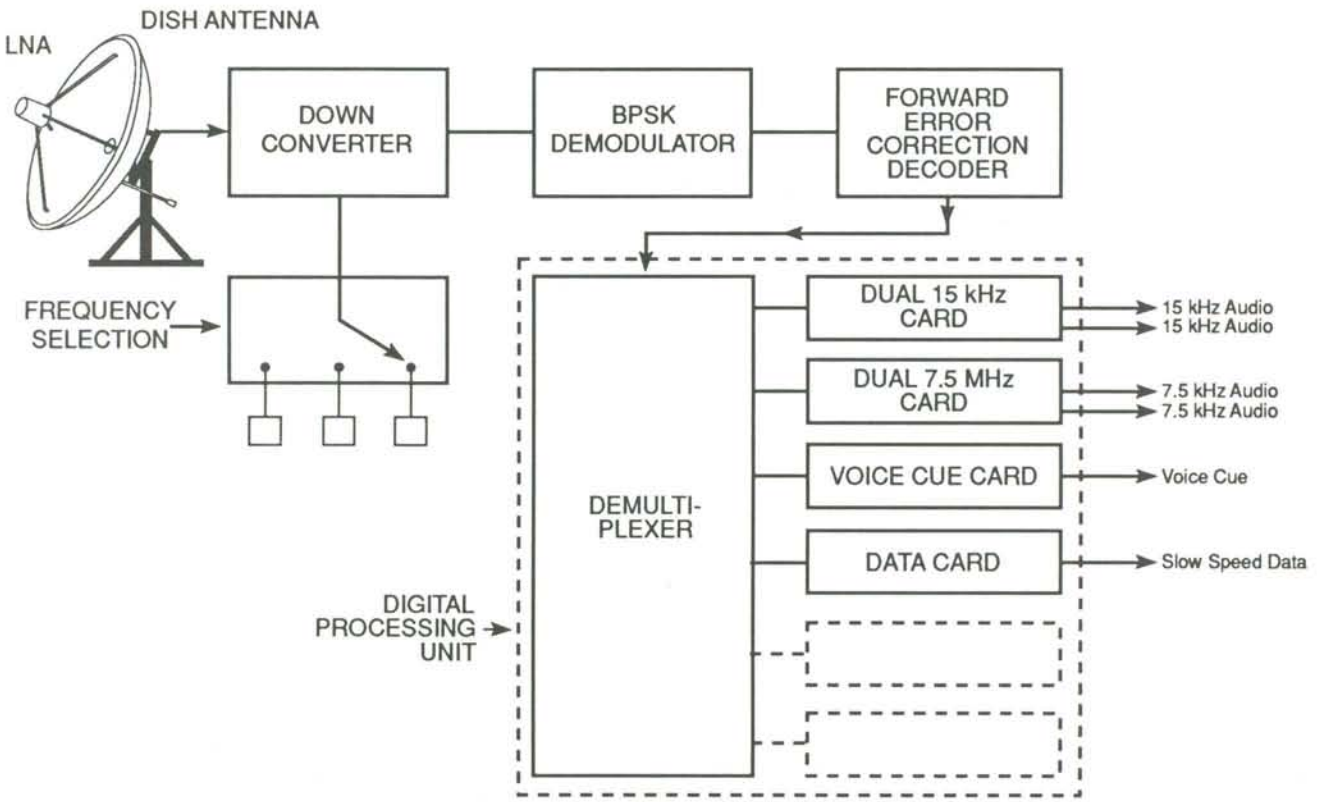


Figure 5.5 *Digital audio earth station setup (radio station).*

The downlink signal is received by the antenna. The RF energy is reflected to the LNA which is mounted at the antenna's focal point. This device provides the first stage of amplification so adequate signal is input to the receiver through the coaxial cable. The BPSK receiver-decoder downconverts the 4 GHz signal to a 70 MHz intermediate frequency, demodulates the wideband IF BPSK signal, and provides Forward Error Correction Coding at a 7/8 rate. The resultant 7.68 Mb/s data stream is passed to the DPU chassis. Frame sync and descrambling occur in the demultiplexer card provided in this unit. The individual data streams are routed to the channel cards where reconstruction of the analog signal takes place. This signal is then amplified for interconnection to the appropriate radio station equipment.

The 15 kHz program signal is sampled at a 32 kHz rate (16 kHz for a 7.5 kHz signal) and digitized into a 15-bit word. Digital companding techniques are used to instantaneously compress the 15-bit word into an 11-bit word to reduce the transponder bandwidth required. A parity bit is included resulting in a word length of 12 bits.

The parity bit is used in an additional error concealment encoding that allows the bit-error rate to degrade to 10-5 before errors are "just perceptible" in the 15 kHz program audio output. Each program audio card contains two separate 15 kHz (or 75 kHz) channels which may be used independently or as a stereo pair. The balanced output level is 24 dBm maximum into a 600 chm load. This allows for 16 dBm of headroom when a 8 dBm average program level (APL) is used. Maximum deviation from a flat frequency response is 1.0 dB over the 40 Hz to 15 kHz (or 75 kHz) band. The unit provides in excess of 80 dB peak signal-to-idle noise ratio and a peak signal-to-quantization noise ratio of 56 dB.

The voice cue channel is used for network closed circuit broadcasts and event coordination. A continuous variable slope delta-mod (CVSD) encoding scheme is employed for voice quality service at a 32 kb/s rate.

The data decoder will simultaneously process three asynchronous RS-232 data streams using a single 32 kb/s subchannel. This unit is fully addressable from the originating studio. The data channel can be used for electronic mail and other distribution of one-way data. **Figure 5.6** and **Figure 5.7.**

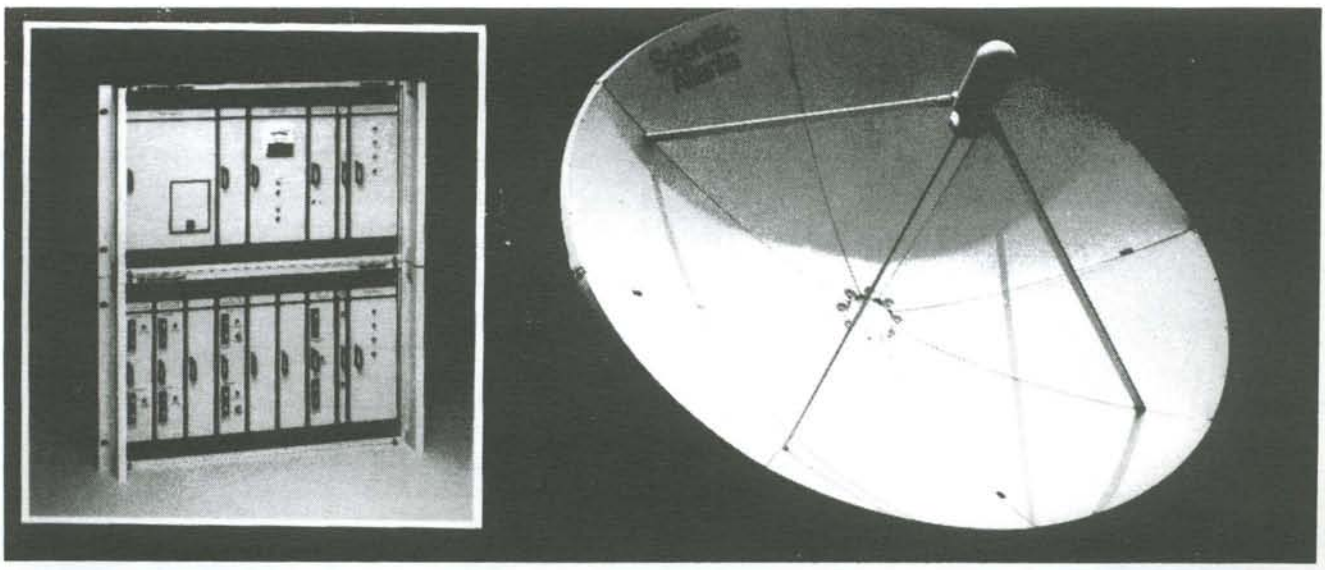


Figure 5.6 *Scientific-Atlanta's DAT-32 digital audio terminal.*
Courtesy Scientific-Atlanta, Inc.

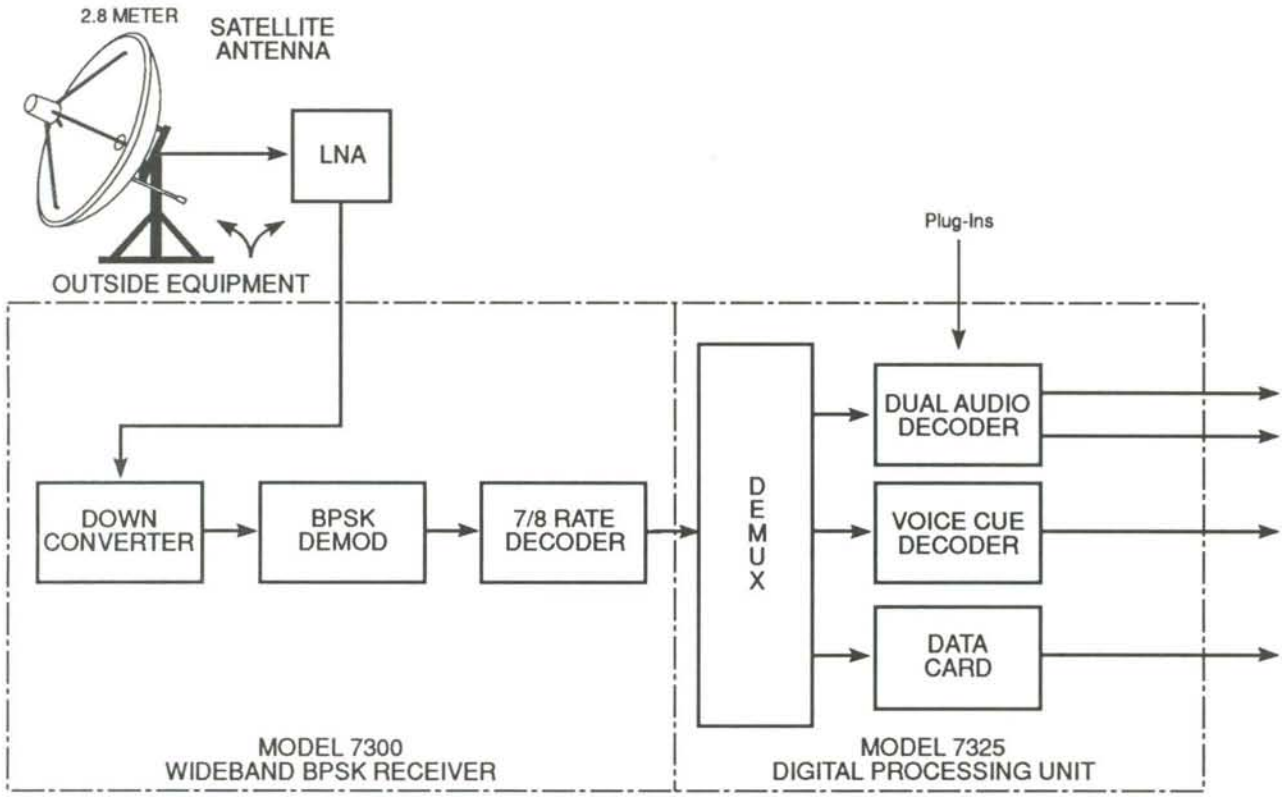


Figure 5.7 *Scientific-Atlanta DAT-32 system block diagram.*

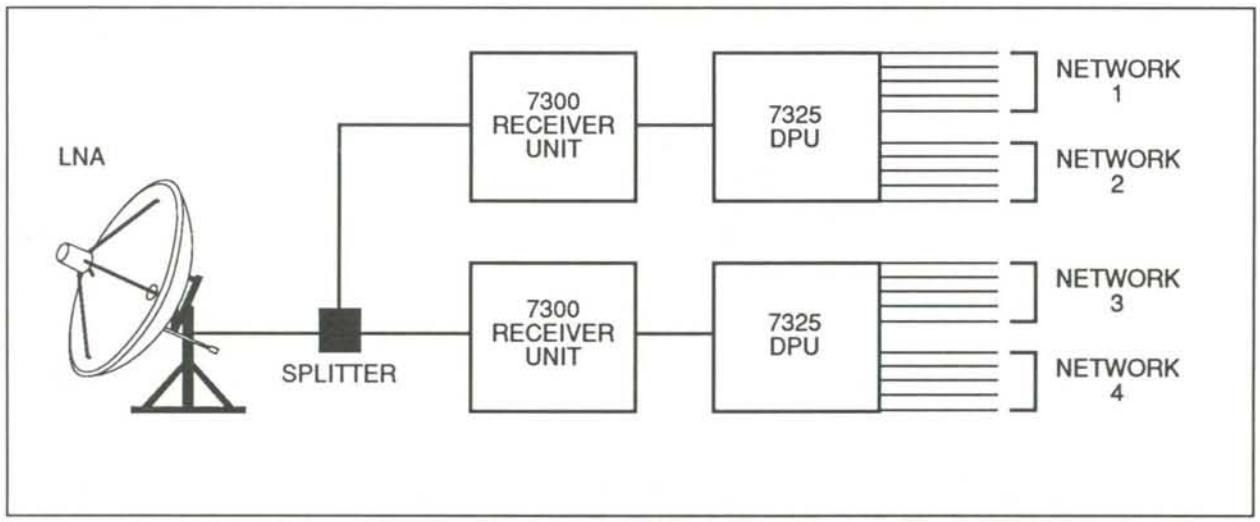


Figure 5.8 *Dual electronic system.*

A redundant DAT-32 system can be had by adding another 7300 receiver to the system with its own digital processing unit, as shown in **Figure 5.8.** Here two 7300 receivers are fed in parallel from the LNA, and in turn, each receiver feeding its own DPU. This makes a very flexible system. For example, if one receiver is dedicated to transponder 23 reception and the other receiver dedicated to transponder 19 reception, it is then possible to bring up all of the 20 audio outputs at one time for whatever use desirable. Of course, this system would have to be placed on say ABC's networks and the others would have to be RKO, CBS, or NBC. **Figure 5.9.**

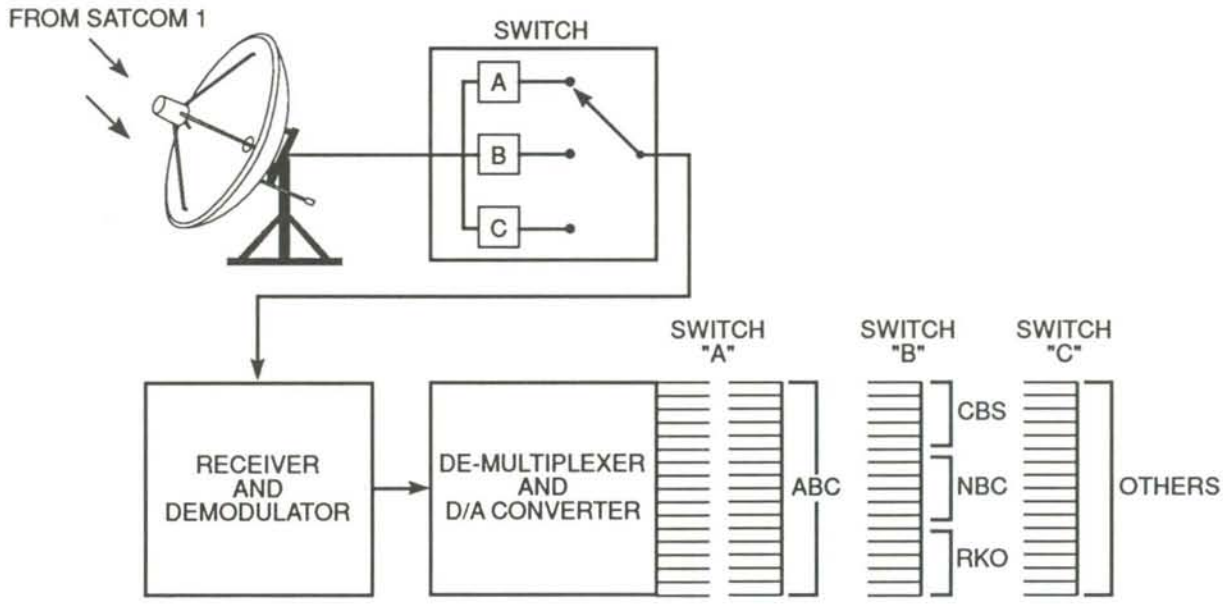


Figure 5.9 *DAES with optional transponder switch to receive all the channels of all four networks.*

MODULATION ASSOCIATES CORPORATE DATA NETWORK

The SU-10 SOLID STATE UPLINK is specifically designed for corporate data networks, regional radio networks, remote broadcasting, and data collection, as well as for telephone and compressed video transmission. For data networks the uplink allows full duplex or point-to-multipoint high-speed transmission of data information. In radio networks, the SU-10 is ideal for two independent SCPC uplink channels or for stereo transmission.

The SU-10 design incorporates 10-Watt solid-state, high power amplifiers. The amplifier outputs are combined into a single waveguide output for application to the uplink antenna. In its complete configuration the SU-10 is available with audio or data processors, frequency agile modulators, dual channel upconverter, and dual HPA's. The entire uplink is housed in a 5-foot rack for easy shelter mounting right at the antenna.

The low phase noise and high frequency stability of the upconverter LO source allows transmission of SCPC program or data channels over satellite links without the need for pilot channels at the downlink. Image reject mixers and output filtering keep spurious and unwanted signals well below allowable FCC limits.

Optional features include redundancy and dial-up remote control from your personal computer using the MODULATION ASSOCIATES UC-10 Remote Controller. Up to 16 agile modulators can be switched off and on and moved to new frequency assignments. Alarm limits for RF power, voltage, temperature, audio level, and loss of data can be set and cause the UC-10 to dial in alarms to the master control. A 4-to-1 remote control audio switch is available for unmanned remote broadcast uplinks. The user can interface other types of baseband equipment at the IF input of the converter.

A truly portable version of the SU-10 is available for remote broadcasts, compressed color video teleconferences, data collection, and temporary telephone service. This SU-10 portable is housed in a 4-foot by 2-foot by 2-foot roll-around, carrying case which is accepted as luggage or cargo by most airlines. **Figure 5.10.**

The M/A Satellite Data Receiver was designed specifically for use in corporate data, electronic mail, and reservations networks — the MODULATION ASSOCIATES DATA-SAT provides convenient, low-cost, and reliable satellite reception of high-volume, point-to-multipoint 56 kbs data information, permitting universal high quality service to any geographic location within a satellite coverage area at a rate five to eight times faster than the average landline rate and with fewer errors. The DATA-SAT is designed for applications where a large number of highly reliable data downlinks are required.

The DATA-SAT takes in a satellite signal at 4 GHz, downconverts it to 70 MHz, and demodulates the data stream. It uses commonly available components and is designed to operate for years without on-site maintenance support. A front panel, LED display indicates whether the data is good, marginal, or unusable. A sophisticated AFC tracks out any frequency errors in transmission.

Because the DATA-SAT is a stand-alone, complete receiver, data capability can be added to a user's already existing earth terminal at any time without complex and expensive common equipment. **Figure 5.11.**

With the M/A SU-10 Uplink and DR-56 units, any number of downlink systems can be in place to serve most corporate needs large and small. This system could serve companies nationwide which have many branch offices and warehouses. **Figure 5.12.** These network experts will provide a company with a complete satellite package, including space segment, FCC licensing, hardware and installation of the complete system which provides low-cost, reliable data reception to multiple users.

SPREAD-SPECTRUM TECHNOLOGY

The cost and size of earth stations have, in the past, prohibited small users from taking advantage of satellite communications. As recently as 10 years ago, an earth station 32 feet in diameter was considered "small." Currently, the term "small earth station" generally means one approximately 16 feet in diameter. However, the latest size reduction produced a disk measuring two feet in diameter and weighing 15 pounds, facilitating installation and maintenance.

The low-cost receiving earth station, located at the user's home or office, eliminates the need for both local and long-distance telephone charges. Selective data filtering by the earth station permits relevant portions of larger databases to be retained for local searching and display. The use of microcomputer intelligence at the user site reduces large-computer time-sharing complexities and permits

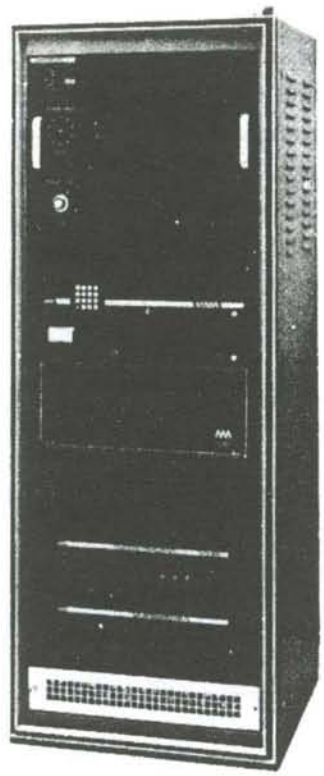


Figure 5.10 *Modulation Associates SU-10 solid-state uplink unit.*
Courtesy Modulation Associates, Inc.

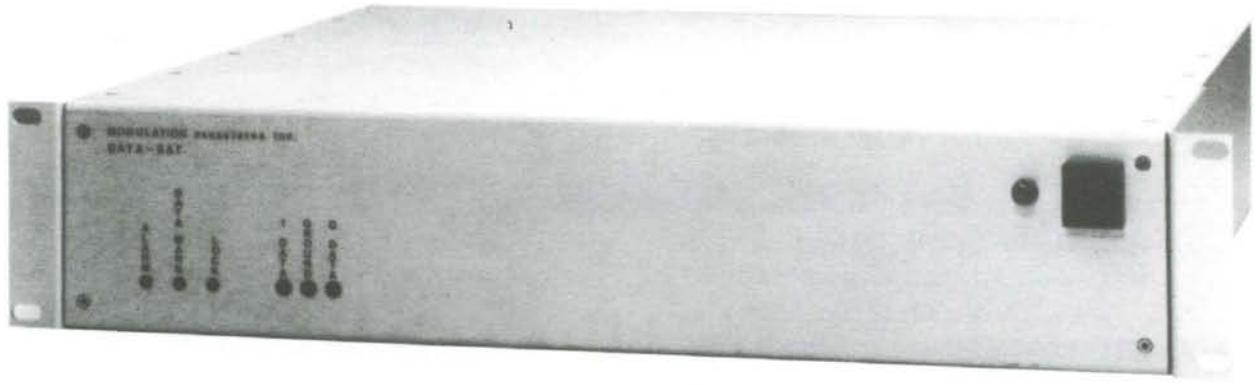


Figure 5.11 *Modulation Associates data SAT receiver.*
Courtesy Modulation Associates, Inc.

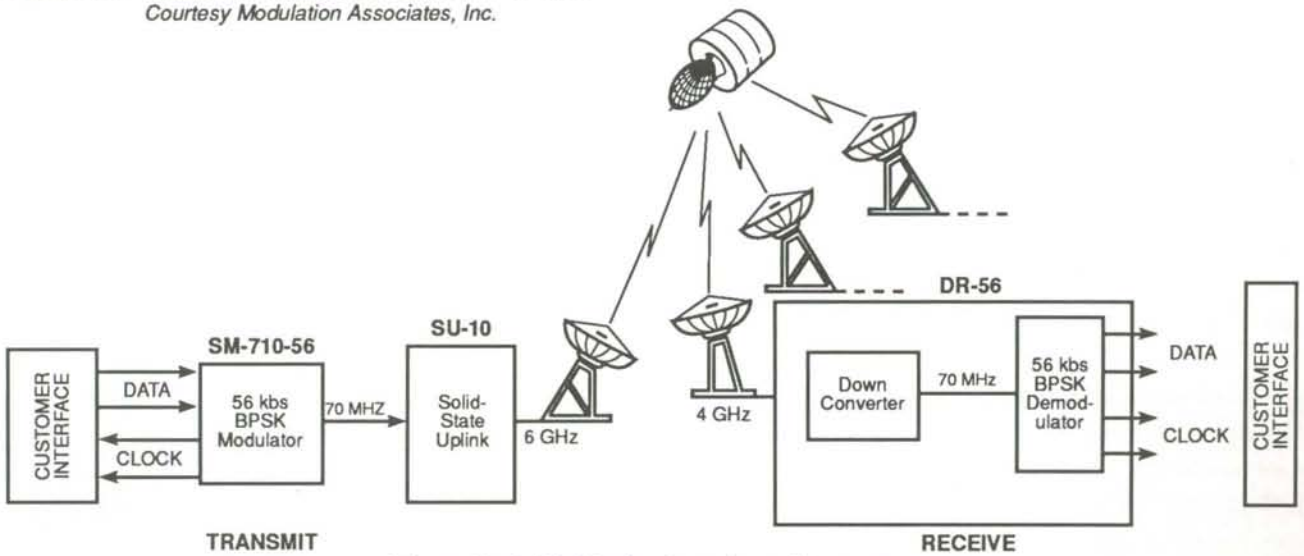


Figure 5.12 *Modulation Associates data system.*
Courtesy Modulation Associates, Inc.

immediate nationwide local access to centrally updated data files without shared-computer response-time delays.

Packet-switching point-to-multipoint satellite networks are available to distribute databases to microcomputers (or minicomputers) at a large number of widely-dispersed remote sites while retaining central database control.

Spread spectrum is a transmission modulation technique that has long been used in radio astronomy, research, and military communications applications. The technique has been in regular use in commercial data communications networks only since 1981.

Spread spectrum is particularly suitable for communications via satellite to small earth stations because it permits reliable data transmission despite the presence of strong interfering signals. This technique has been used in military applications to transmit unobtrusive signals that ensure reliable transmission despite "jamming" signals deliberately transmitted to create interference. Radio astronomy and other space research applications of spread spectrum have permitted reliable communications over interplanetary distances with very weak signals that would otherwise have been overwhelmed by random noise.

As the name implies, more frequency bandwidth is required for spread-spectrum signals than for conventional narrowband signals transmitting comparable data rates. Consequently, the technique has not been extensively used in commercial terrestrial communications applications where conservation of bandwidth is an important network criterion. In satellite communications involving small earth satellite stations, networks are limited by the availability of satellite power, rather than by availability of bandwidth. Therefore, no additional costs result from spreading the signal over a greater bandwidth that would otherwise go unused.

In spread-spectrum data transmission, each bit is subdivided into a number of pieces called "chips." Each chip is transmitted through a conventional modulation technique as if it were a bit. For example, each phase of a binary-phase, shift-keyed signal would represent a chip in spread-spectrum transmission, whereas it would represent a bit in conventional narrow band transmission. The resulting higher occurrence of chips (and corresponding phase shifts) per bit of information spreads the signal over a wider frequency bandwidth.

The chips of a spread-spectrum transmission are ordered in a unique code sequence called a pseudo-random noise (PN) sequence. Each spread-spectrum receiver includes a "match filter" (matched to the transmitting PN sequence). The result is that even when a large number of chips are garbled in transmission, the receiver can still perform the pattern recognition analysis to reliably recognize the bits.

The spread-spectrum technique makes possible data reception at very small earth-stations. The smaller the diameter of the receiving antenna, the wider the angle of view of that earth station. Larger earth stations, like larger telescopes, permit a narrower focus. A two-foot diameter earth station at satellite radio frequencies of 4 GHz has a half-power beam width of 9 degrees when pointed at the equatorial orbital arc where the satellites are located.

Therefore, with satellites spaced 4 degrees apart as they currently are, or 2 degrees apart as the FCC has recently proposed, each small earth station is susceptible to interference from multiple satellites as well as from terrestrial microwaves. The interference rejection property of spread-spectrum transmission permits small earth stations to coexist with terrestrial microwaves in urban environments and permits them to operate not only with the current satellite spacing but also with proposed narrower satellite spacings.

INTERACTIVE DATA COMMUNICATIONS NETWORK SERVICES BY EQUATORIAL COMMUNICATIONS COMPANY

Equatorial Communications Company markets satellite network products and services for terminal-to-computer, terminal-to-terminal, and distributed database applications. These networks can provide end-to-end communications without the need for terrestrial circuits. The company manufactures interactive Micro Earth Stations for installation at user-terminal locations as part of its satellite networks. Customer data communication services are available through EQUATORIAL's satellite transponders and value-added, packet-switched satellite network. EQUATORIAL also provides turn-key private satellite data communication networks with technology licensing for large corporate customers.

EQUATORIAL's satellite networks offer independence from local and long distance telephone companies by providing a cost-effective alternative to the use of terrestrial circuits for data communications. Communication requirements of data collec-

tion, inquiry/response and database distribution applications can be effectively supported. A typical EQUATORIAL network consists of:

Transmit/receive Micro Earth Stations featuring very small antennas and low-power requirements for use with remote user data terminals.

A satellite and Master Earth Station communication link which relays the data between the user's terminal and host computer.

A conventional high-speed terrestrial or satellite communication link connecting the Master Earth Station to the host computer.

The satellite network operates at the same speed and with improved performance characteristics for data communications typically carried over voice-grade telephone lines. EQUATORIAL offers variable inbound and outbound transponder capacity for its interactive communications service allowing the customer to optimize the performance of his system without the need to pay for excess capacity in either direction.

Network advantages include lower cost, low data error rate, insensitivity to distance, network flexibility, simple Micro Earth Station installation, and improved network reliability. Satellite communication networks for single remote data terminals are practical. In addition, EQUATORIAL's satellite network offers extensive system diagnostics, ease of network cut-over, and network performance prediction and control.

EQUATORIAL has been providing real-time continuous transmission services for news, financial, and commodity information providers since mid-1981. Over four thousand C-100 receive-only Micro Earth Stations operating in the network demonstrate EQUATORIAL's ability to provide high-quality communication services with consistent performance and availability. This prior network and earth station experience has resulted in product and service reliability enhancements that can only come after extensive field experience. EQUATORIAL has maintained availability of better than 99.9% on its common carrier spread-spectrum network since the start of operational services. EQUATORIAL'S satellite network offers:

- Priority access (7 days/week, 24 hours/day) available for networks in capacity increments of 1200 bps up to 150 Kbps.
- Maximum aggregate data rate to customer interface up to 19.2 Kbps.
- Maximum aggregate data rate from customer interface up to 1200 bps.
- Bit error rate of better than 1×10^{-7}.
- Fully redundant Master Earth Station transmitter and receiver electronics and an uninterruptible power source.
- Continuous network monitoring and diagnostic analysis contributing to high network reliability.
- Proprietary spread-spectrum transmission techniques maximizing noise rejection.
- Time-shared packet data communications permitting efficient satellite channel utilization.
- Multiple data channels of differing data speeds which may be multiplexed within each customer network.
- Host computer-to-Master Earth Station high-speed conventional data communication links.

EQUATORIAL's extremely high data integrity packet-switched networks utilize efficient, variable-length packets. Each data packet may have either an individual or group address. Forward error correction coding is included within each packet. Sequential packet numbering, combined with store-and-forward packet techniques, permit re-transmission of any locally uncorrectable packets.

Satellite data communications networks are available in various configurations including:

Terminal-to-host computer networks with the host computer connected to the Master Earth Station by conventional high-speed satellite data link.

Terminal-to-host computer networks with the host computer connected to the Master Earth Station by conventional high-speed terrestrial link.

Terminal-to-terminal interactive data communications through the Master Earth Station.

Figure 5.13 shows a terminal-to-host computer network with the host computer connected to the Master Earth Station by conventional high-speed satellite link and then to the C-200 Micro Earth Stations and associated data terminals by a spread-spectrum signal from the Master Earth Station.

Figure 5.14 shows a terminal-to-host computer network with the host computer connected to the Master Earth Station by a terrestrial line. Network operation is identical to that shown in Figure 5-10 except that the high-speed satellite link is replaced by the terrestrial line.

Figure 5.15 shows a terminal-to-terminal satellite network link between two C-200 Micro Earth

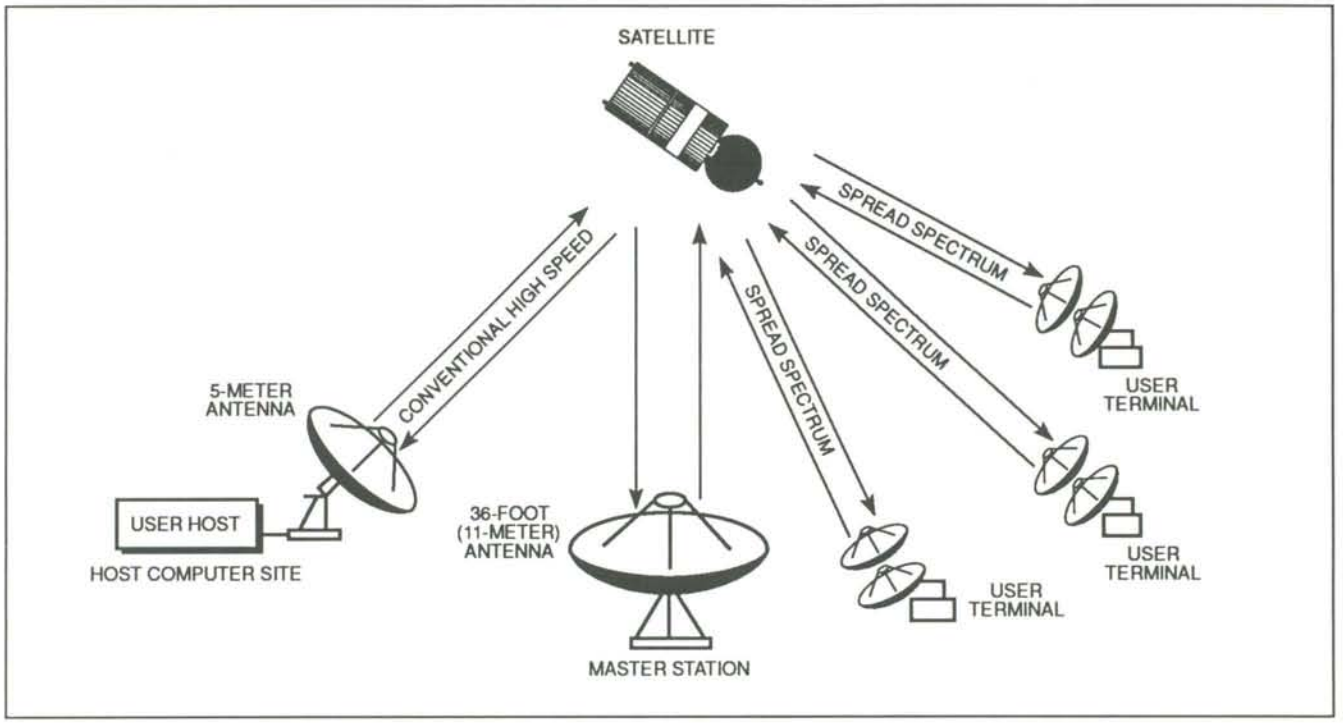


Figure 5.13 *Terminal-to-Host computer data communication network using spread-spectrum and conventional satellite links. Courtesy Equatorial Communications Co.*

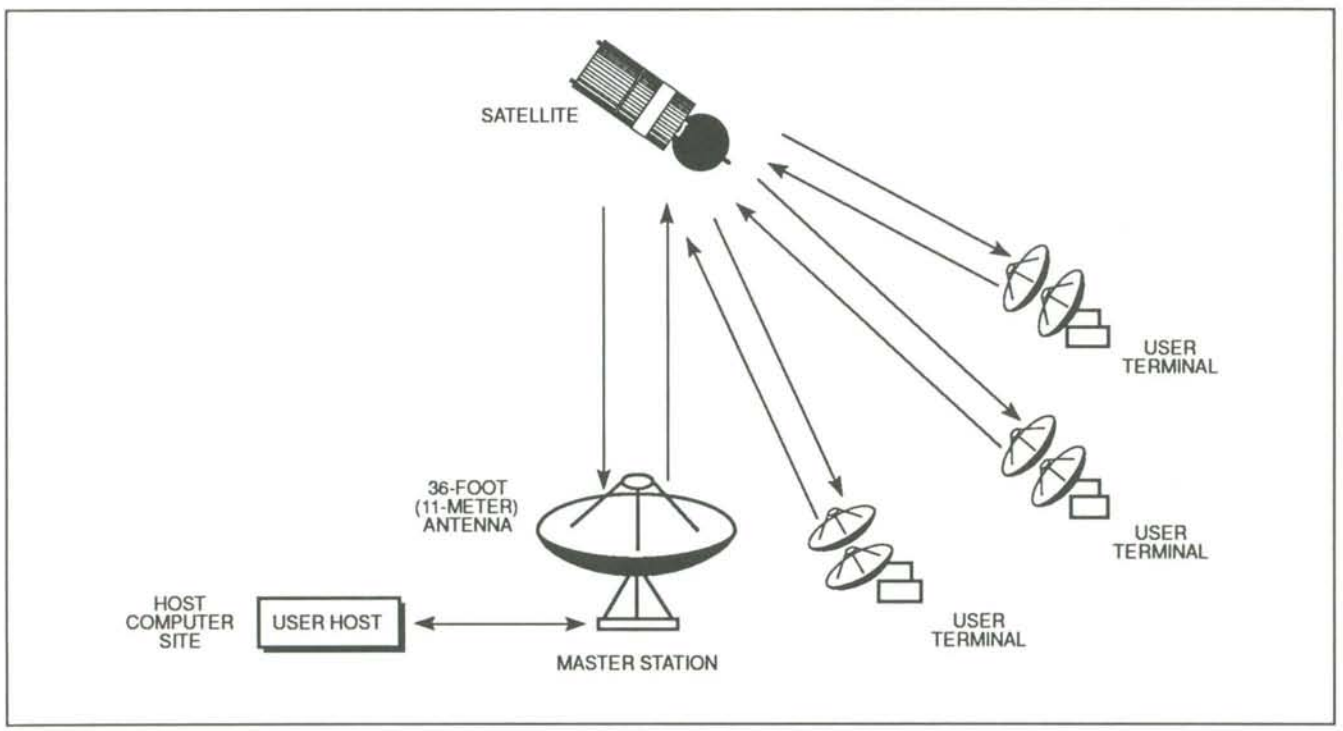


Figure 5.14 *Terminal-to-Host computer data communication network using spread-spectrum and satellite link and local terrestrial line. Courtesy Equatorial Communications Co.*

Stations utilizing the Master Earth Station as an intermediate signal amplifier. The low-power signal from the first Micro Earth Station is transmitted to the large Master Earth Station where it is amplified and transmitted back to the satellite. This strong signal is again amplified by the satellite transponder and transmitted to the receiving Micro Earth Station with enough power to be detected by the 4-foot (1.2-meter) antenna. **Figure 5.16**— EQUATORIAL offers satellite data communication services through its Master Earth Station in Mountain View, California using transponders on the WESTAR IV satellite. This Master Earth Station, owned and operated by EQUATORIAL as part of its satellite network operations, consists of a 36-foot (11-meter) antenna, transmitting electronics, and modular arrays of switching and multiplexing electronics as shown in **Figure 5.17** and **Figure 5.18.**

Refer to the WESTAR IV footprint map (Figure 5.19) for contours that represent the boundaries within which the EQUATORIAL Earth Stations will operate within an error rate of 1×10^5 or better with a 3 dB nominal margin to guard against mispointing, rain attenuation, sun noise, or equipment degradation. Outside these boundaries, the earth station may receive the satellite signal and appear to operate well but the error rate will be higher. The contours have been generated from spacecraft antenna gain contours supplied by Western Union for 3840 MHz. Westar IV is nearing the end of its useful life and will be replaced.

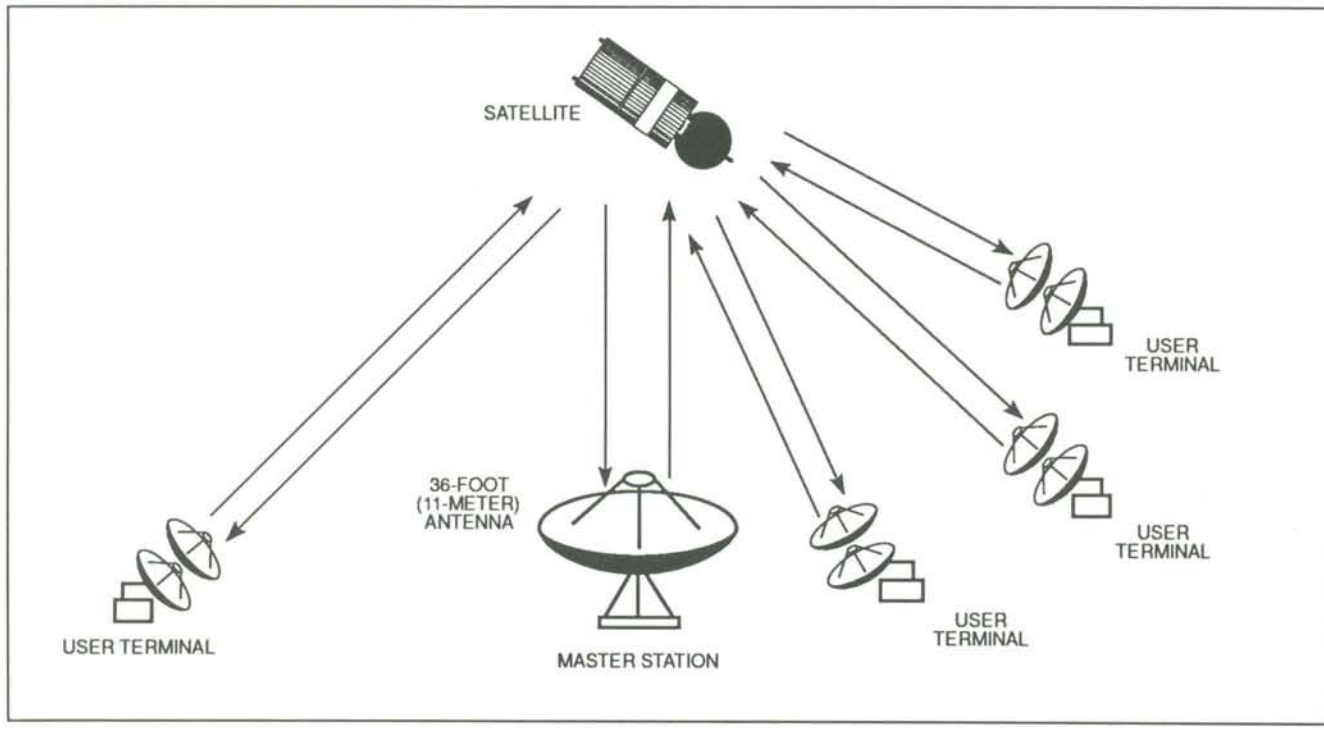


Figure 5.15 *Terminal-to-Terminal data communication network. Courtesy Equatorial Communications Co.*

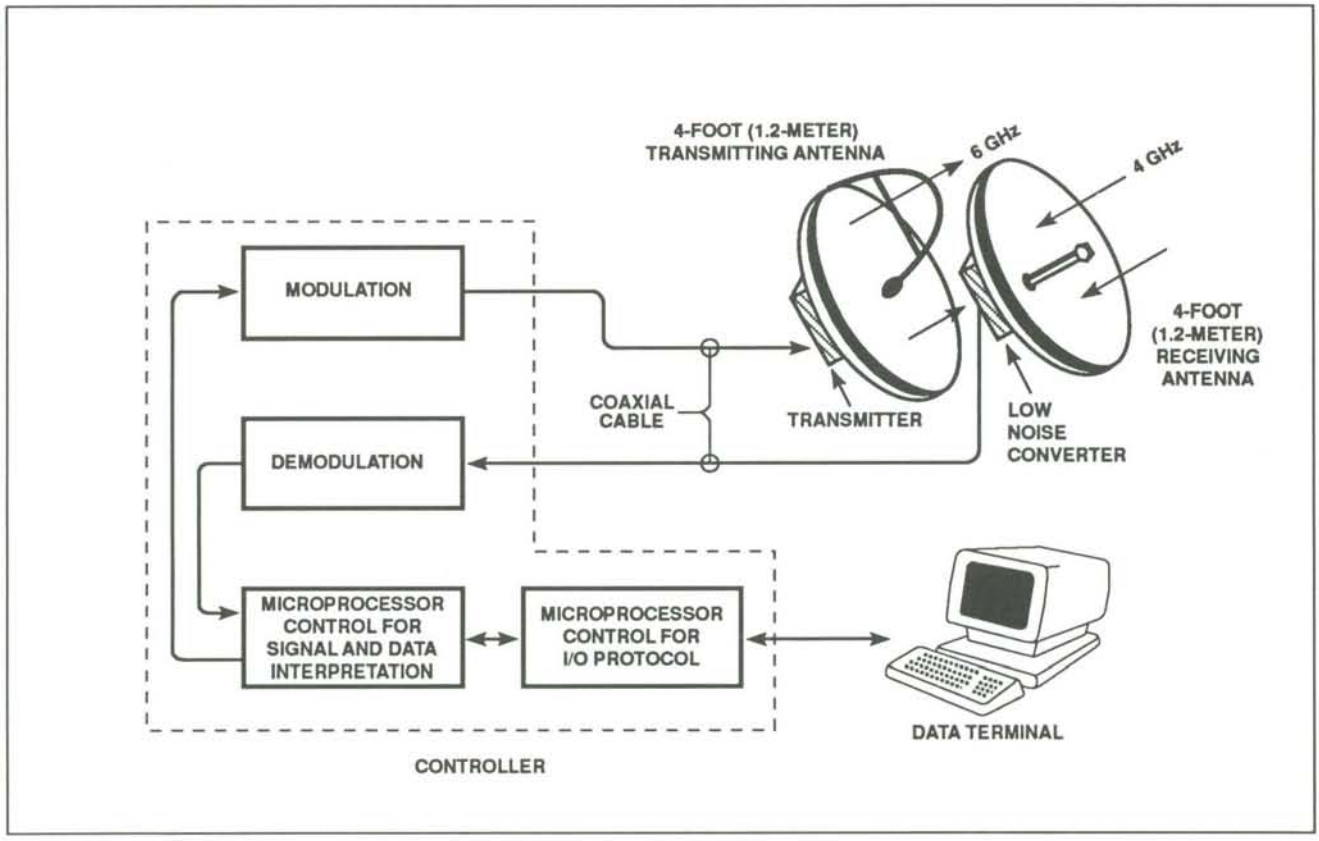


Figure 5.16 *Micro earth station block diagram.*
Courtesy Equatorial Communications Co.

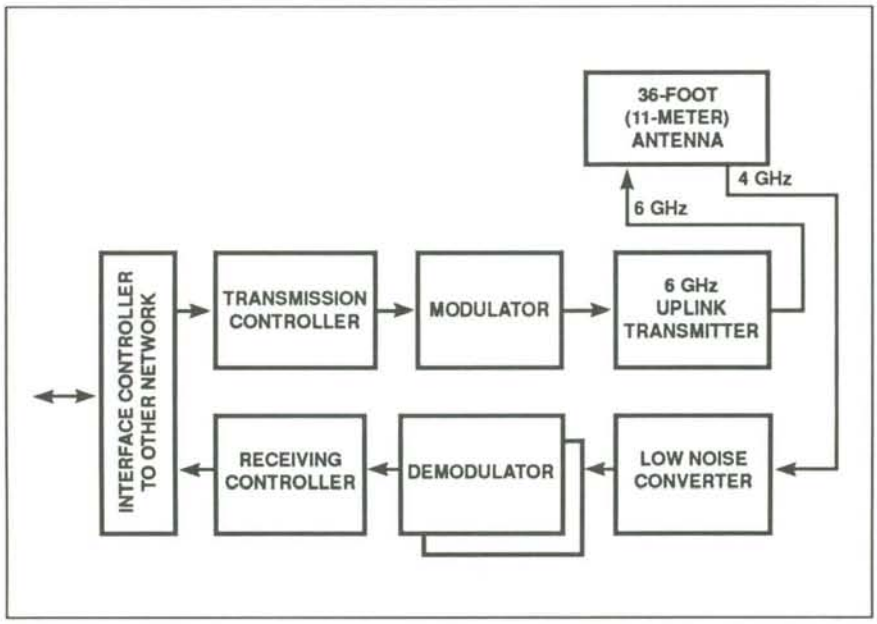


Figure 5.17 *Master station block diagram.*
Courtesy Equatorial Communications Co.

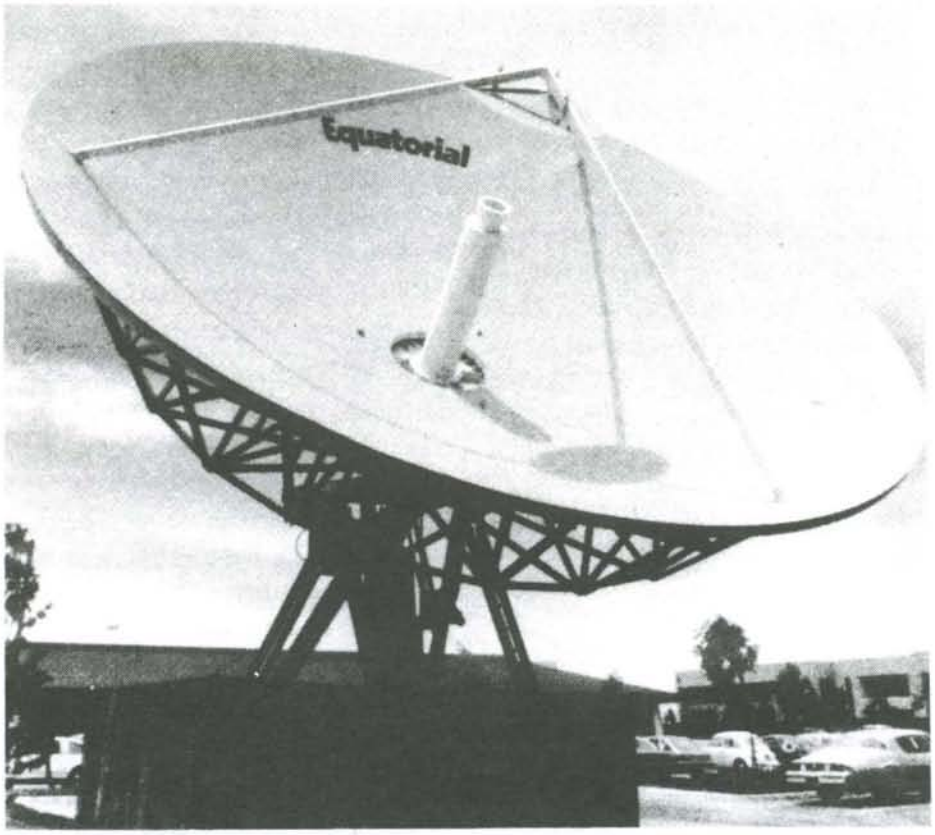


Figure 5.18 *36-foot master earth station antenna.*
Courtesy Equatorial Communications Co.

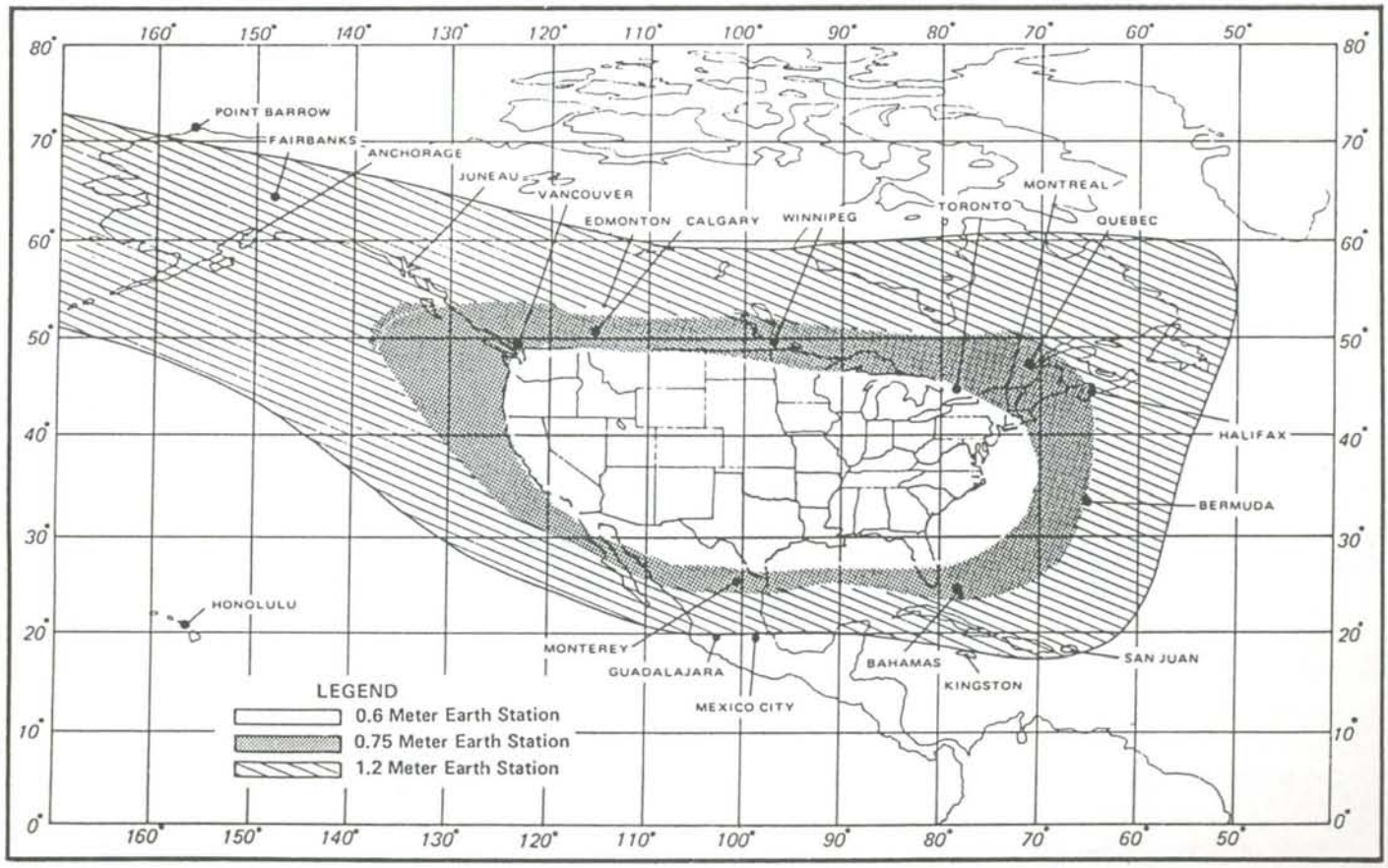


Figure 5.19 *Westar IV Footprint. NOTE: Westar IV will soon be replaced.*
Courtesy Equatorial Communications Co.

EQUATORIAL's point-to-multipoint communications networks are available in various configurations including:

Point-to-multipoint networks with the data source connected to the Master Station by conventional satellite data link.

Point-to-multipoint networks with the data source connected to the Master Station by conventional terrestrial link. **Figure 5.20** shows a network with a data source connected to the Master Station by conventional terrestrial line or satellite link.

The Micro Earth Stations (**Figure 5.13**) and associated terminals receive this data by a spread-spectrum signal from the Master Station.

The Micro Earth Station features include:

Two-foot (0.6-meter) diameter antenna.

Lightweight.

Bit error rate better than 1×10^{-7}.

Data rates from 45 to 19,200 bits per second.

Multiport receiver capability.

Built-in intelligence/diagnostics.

Small antenna size, low power requirements, and interference-resistant receiver for simple installation at urban user sites.

Reliability for continuous unattended service on end-user premises.

A microprocessor provides the data handling and protocol functions necessary to adapt the Micro Earth Station to many different application requirements.

A block diagram of the C—100 Micro Earth Station is shown in **Figure 5.21**. The 2-foot (0.6-meter) antenna collects the 4 GHz signals received from the satellite. Microwave electronics in the antenna module accomplish the amplification and frequency conversion functions for the incoming signals. The separate Micro Earth Station controller module contains circuits for signal demodulation, a microprocessor based signal and data interpretation function, and 1/0 control facilities.

EQUATORIAL's high data integrity packet-switched networks utilize efficient, variable-length packets. Each data packet may have either an individual or group address. Forward error correction coding is included within each packet.

Each Micro Earth Station is identified with a unique subscriber code permitting the unit to be preprogrammed to capture selected portions of a data stream. The unit's data access authorization is maintained in non-volatile memory. Since the data authorization comes from the network manager and is transmitted over the satellite link to the Micro Earth Station receiver, the integrity of the authorization is assured. Users at the Micro Earth Station end of the system do not have access to the authorization codes.

This unique addressing capability of the Micro Earth Station provides for a flexible network control scheme. Data publishers using the EQUATORIAL satellite network may determine which Micro Earth Stations are eligible for reception of different data segments. Micro Earth Station eligibility for data reception can be changed in real-time by the network manager. Using these subscriber codes, database publishers can deliver subsets of the data base to authorized subscribers since each site will receive only the subsets ordered. Additional levels of coding can customize reception of individualized data or specific pages of information.

EQUATORIAL's C-200 Micro Earth Stations make satellite communication networks for single, remotely located data terminals practical for the first time. These products offer significant communications costs savings in data collection, inquiry/response, and data base distribution systems. Typical applications include:

- Financial Transactions
- Order Entry
- Point-of-Sale
- Process Control/Monitoring
- Reservation and Other Transportation Related Systems

EQUATORIAL's C-100 Series Micro Earth Stations make satellite communication networks for single, remotely located data terminals practical for the first time. These products offer significant communication cost savings in data distribution systems. Typical applications include:

- Financial information distribution
- Commodity news and financial information distribution
- General news delivery
- Database distribution and updating
- Electronic mail
- Digital facsimile transmission

EQUATORIAL is presently delivering Micro Earth Stations to several customers including Reuters, Commodity News Services, Inc., Market Information, Inc., and Trans-Lux Corporation. Both Commodity News Services and Market Information transmit commodity news and prices to newspapers, brokers, and farmers. **Figure 5.21.**

FSK DATA ON SUBCARRIERS (SbC)

Frequency shift keying (FSK) is the system used in slow-speed (low baud rates) teleprinter data networks. Some call these services radioteletype or teletype® (RTTY).

Another type of keying system is audio frequency shift keying or AFSK. AFSK uses the audio frequency shift to denote the "on" or "off" situation in the signal that carries the full data code. The data codes can be the common Baudot, or more modern ASCII systems, based on "0" or "1" expressions representing binary states or conditions.

In data language, the zero or one is referred to as a bit. Bit is a contraction of the word binary which means something that is composed of or has two parts. Binary uses components such as transistors and flip-flops to read the binary information which is composed of series of bits arranged as a set code to produce the 26 characters of the alphabet. Each character has a combination of zeros and ones.

A five-bit binary code is known as Baudot Code. In Baudot, the on state or bit is known as the "mark" and the zero or the "off" state is known as the "space." Most Baudot teleprinters use 60 words per minute, 66 words per minute, or 100 words per minute—or expressed in baud rate would be: 45 Baud Rate = 60 W.P.M., 50 Baud Rate = 66 W.P.M., and 75 Baud Rate = 100 W.P.M.

Another common standard code is the American Standard Code For Information Interchange (ASCII). The ASCII Code uses 7 bits of information to provide 128 possibilities, plus an eighth bit for parity checking. ASCII is in common use for most data transmission and data processing.

It is a very simple matter to run inexpensive teleprinter circuits and systems on satellite subcarriers with little loss in transponder output power.

FSK DATA EQUIPMENT (SbC)

Wegener series 2000 FSK subcarrier equipment is used to transmit data from 9.6 to 56 KB/S in the baseband spectrum above the video in satellite systems. The data interfaces are either RS-232C (for 9.6 and 19.2 KB/S) or CCITT V.35 (for 56 KB/S). Data transmission is transparent with no checking of protocols or error correction or detection.

Where full-duplex operation is used, the data out of a demodulator can be switched to its mating modulator remotely. Data channels can be placed anywhere from 4.5 MHz to 10.0 MHz. Up to eight modulators can be summed in with the video by a high impedance loop-through in a single mainframe. Using more than eight modulators requires the use of an external 8-way splitter/amplifier. This allows up to 72 channels to be placed on one baseband. On the receive end, up to 72 demodulators can be driven from a single 75 ohm source. **Figure 5.22.**

The Wegener Model 1606 Subcarrier receiver is designed to demodulate FM/FM/FDM multiplexed program, voice and data channels transmitted as subcarriers over video. The receiver is packaged in a standard Wegener series 1600 mainframe and is capable of feeding all series 1600 channel demodulators and accessories. The receiver consists of a downconverter to receive the incoming 4 GHz signal and convert it to a 70 MHz IF, a wideband IF amplifier/filter/demodulator to demodulate the video and subcarrier signals to composite baseband, and appropriate channel unit plug-ins. **Figure 5.23.**

The Model 1606 receiver features single conversion downconverter, wideband demodulator with thumbwheel transponder selection, precision AFC circuits for accurate IF passband centering, and the receiver interfaces with all series 1600 audio and series 2000 data demodulation equipment.

Turner Broadcasting System transmits a data channel with both CNN and CNN Headline News (CNN/2) satellite feeds. The Wegener Series 2000 system provides up to eight independent 300 Baud ASCII information channels on a single low-level data subcarrier. The data receiver/printer is designed to accept composite baseband video as an input and provide hard copy printout of messages associated with the Turner Broadcasting System feed. The data receiver is available in either the Model 2003-12 or Model 2004-12 configuration. The Model 2003-12 allows expansion capability while the

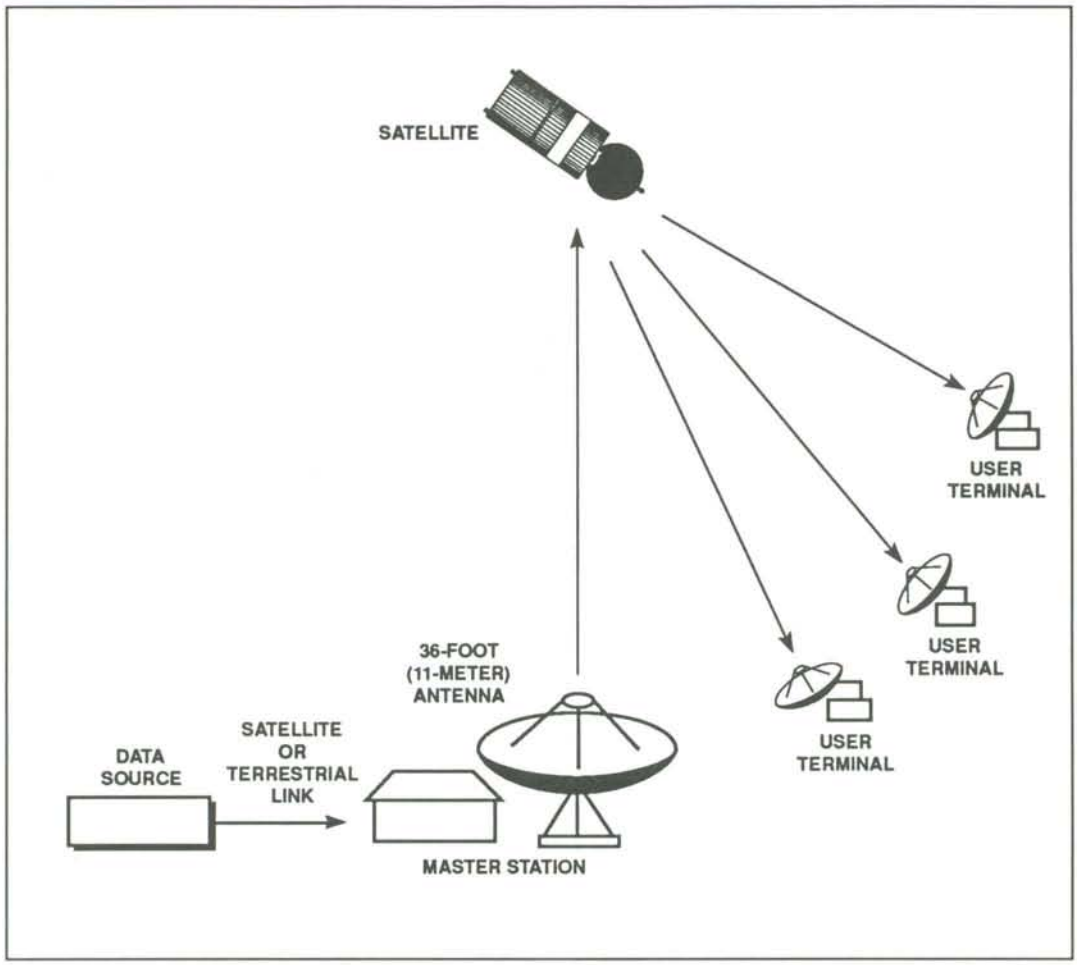


Figure 5.20 *Point-to-Multipoint data communication network using spread-spectrum satellite link.*
Courtesy Equatorial Communications Co.

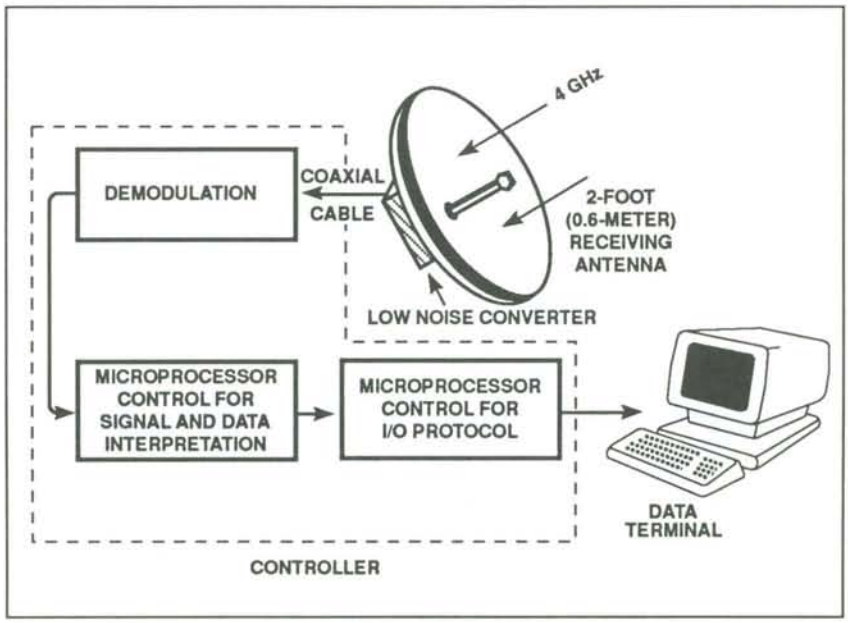


Figure 5.21 *Downlink. The satellite signal is transmitted at 4 GHz to the subscriber's two-foot antenna, amplified, and converted to an intermediate frequency for transmission by coaxial cable to the controller. The signal is then demodulated and sent as a standard digital signal under microprocessor control to user terminals.*
Courtesy Equatorial Communications Co.

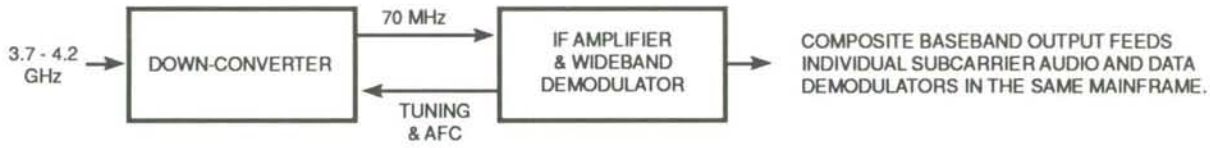


Figure 5.22 *Typical model 1606 application.*

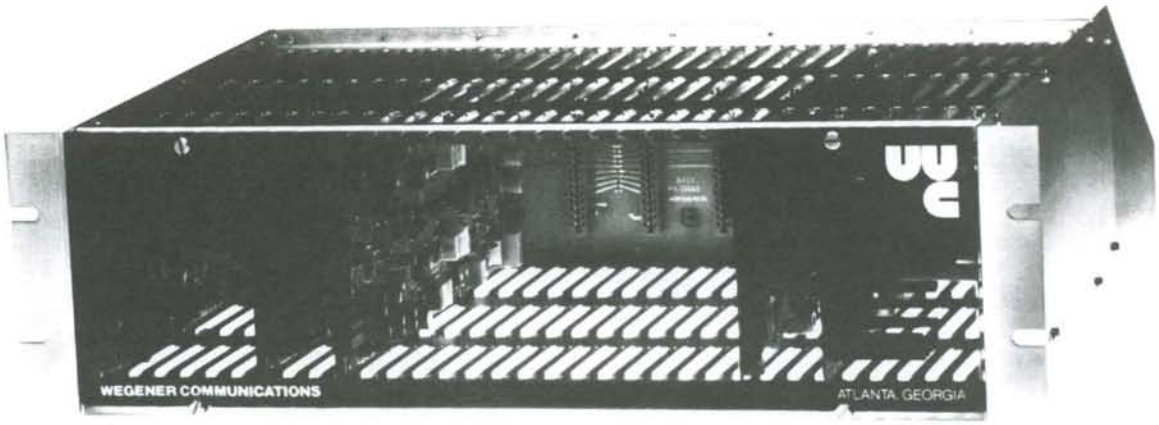


Figure 5.23 *Wegener model 1606 subcarrier demodulator-receiver for FM/FDM-FM/DATA-FSK.*
Courtesy Wegener Communications

Model 2004-12 has limited flexibility. The printer is an MX-80 by Epson. **Figure 5.24.**

Equipment features:

Precision low-level subcarrier demodulator optimized to the Wegener Data uplink in use by Turner Broadcasting System, 3000 baud data system, at least 4 independent 300 baud printer channels are available on all models, expansion cards available for up to four more printer channels, and the unit will use an Epson MX-80 printer.

Model 2012-01 Data Demodulator/ Demuitiplexer—The Model 2012-01 is a plug-in card that accepts composite unfiltered baseband video as an input and provides subcarrier demodulation of the 3000 baud data stream. In addition, the 2012-01 will demultiplex four independent 300 baud (ASCII) data streams providing RS-232C outputs for printers. The four 300 baud data streams are switch selectable on the card. (Any four of the eight available data streams can be selected.)

Model 2032-01 Data Demultiplex Expansion Card—The Model 2032-01 is a companion plug-in card to the Model 2012-01 above. This card accepts the demodulated 3000 baud data stream and demultiplexes up to four additional 300 baud multiplexed data channels. RS 232C outputs are provided, also switch selection of the data streams is provided on the card. These data channels are carried on both CNN transponders.

"SUN OUTAGE"—THE SATELLITE DATA NETWORKS' PROBLEM

All good things seem to have a drawback and satellite networks are no exception. The drawback is the phenomenon of "sun outages" which occur twice a year. These outages cause a severe degradation of the satellite signal for a period of time and are due to the satellite's position in relation to the sun. These two occurrences can be predicted very accurately as to the time of day, duration, and the degree of signal degradation that can be expected.

The primary concern is the period of maximum signal degradation which lasts only a few minutes. Other times during this period, signal degradation may not present a real problem to an efficient system. Most satellite networks have provisions for this brief period twice a year: Some go to telephone lines for proper program feeds; others simply shut the system down during the brief outage.

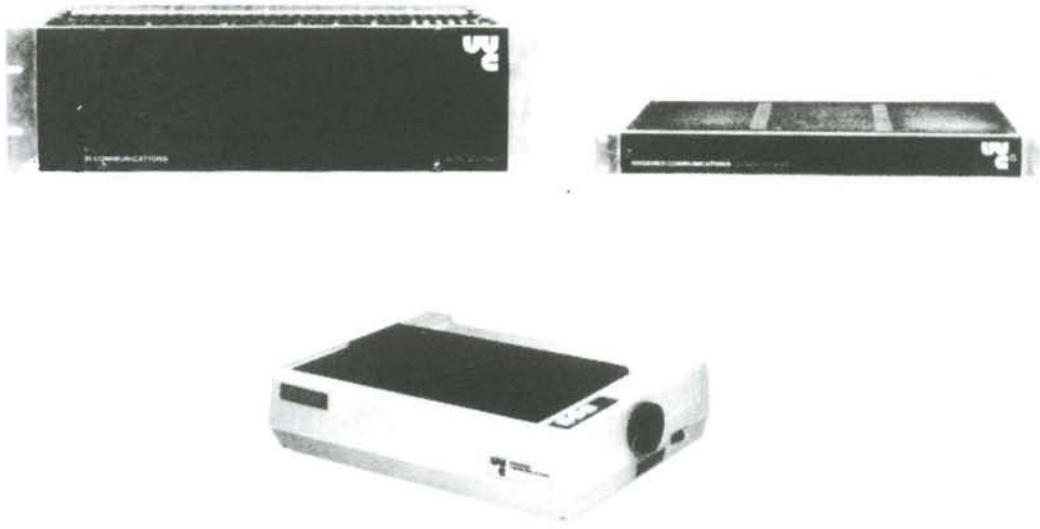


Figure 5.24 *Turner Broadcasting Company's data system used on both CNN transponders. Data transmitted on low-level subcarriers of CNN and CNN/2.*
Courtesy Wegener Communications Co.

FM SQUARED TECHNOLOGY
FM/FM — FM²®

FM Squared Technology was developed by Space Com Systems in 1985 and was introduced to the market in 1986. Space Com Systems is a United Video Company. United Video is the largest commercial user of subcarrier technology. UV also owns and operates the Chicago International Teleport which provides transmission services for Space Com.

The FM/FM subcarrier system is a very cost-effective method for transmission of data and audio services on C and KU-Band satellites.

In the FM/FM subcarrier system, many frequency modulated subcarriers are frequency modulated on the main carrier. In the normal satellite communications network, the signal to be broadcast is back-hauled to the broadcast site via single-channel per carrier (SCPC); at the final broadcast site, this signal is converted to the required frequency and then rebroadcast on the FM Squared subcarrier network. Any mix of audio and data subcarriers can be transmitted in the voice (audio) and data frequencies. On the data channels a wide range of data rates can be handled without a problem. Direct FM Squared fax, plus other data modes, can be broadcast. This modified subcarrier technology provides the space segment price advantage and flexibility of SCPC transmission along with affordability to the user. **Figure 5.25.**

This technology uses video subcarrier methods without the power-robbing video signal which allows the entire energy to be placed into the subcarrier signals. The audio and data can be back-hauled to the uplink on the same transponder which carries the entire range of subcarriers with no additional cost.

FM/FM technology allows the use of very small antennas because the entire power is being used for the subcarriers. At KU-Band frequencies, antennas as small as 30 inches work very well; in case of C-Band frequencies, six-foot antennas yield acceptable reception of signals. **Figure 5.26.**

The downlink or user's equipment costs are very low using this method of modified subcarriers. An average cost of user's receive equipment, including antenna, would be $700 for KU-Band, and $1200 for C-Band. All in all, it is easy to see why FM/FM systems have been quick to catch on — affordable equipment costs, affordable satellite costs for large users, and small antenna size with KU-Band.

FM/FM services are found on KU-Band GSTAR 1, transponder 13. A few of these services are: Data Transmission Network, Stockmate Financial, Zephyr Weather Services, Skytel, Talking Yellow Pages, Bonneville Telecommunications, Brite Voice Systems, Orion Network, Tradestar, Agri-Data, plus other audio and data services.

FM/FM C-Band users and services are: CUE National Paging Service, Moody Broadcasting, Satellite Music Network, Pop Radio, USA Radio Network, Zephyr Weather Services, United Press International, Christian Radio Network, New Wave Music Network, News/Information Network, plus many others. C-Band signals are carried on Spacenet 3, transponder 13 and 17. Other C-Band satellites are slated for FM/FM in the future. Wegener Communications, Inc. uses Satcom F1R for its FM²® services.

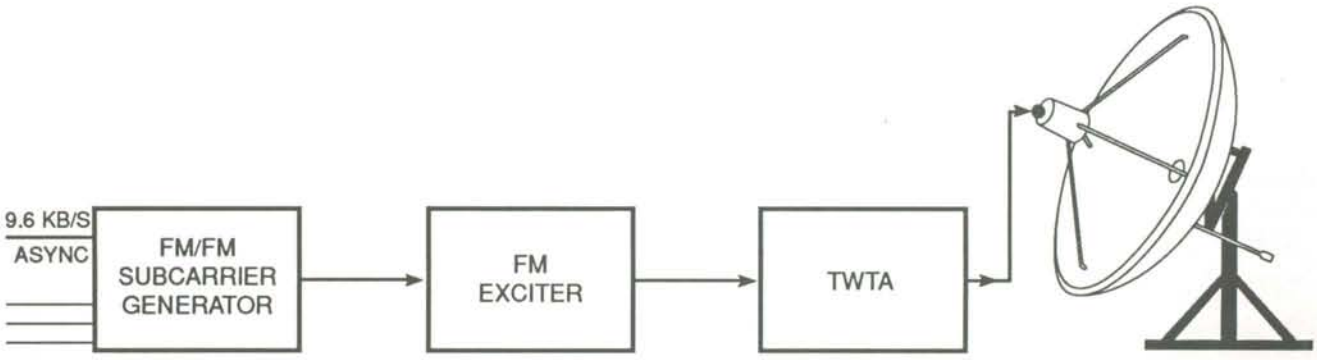


Figure 5.25 *Block diagram of FM/FM head-end system master station.*

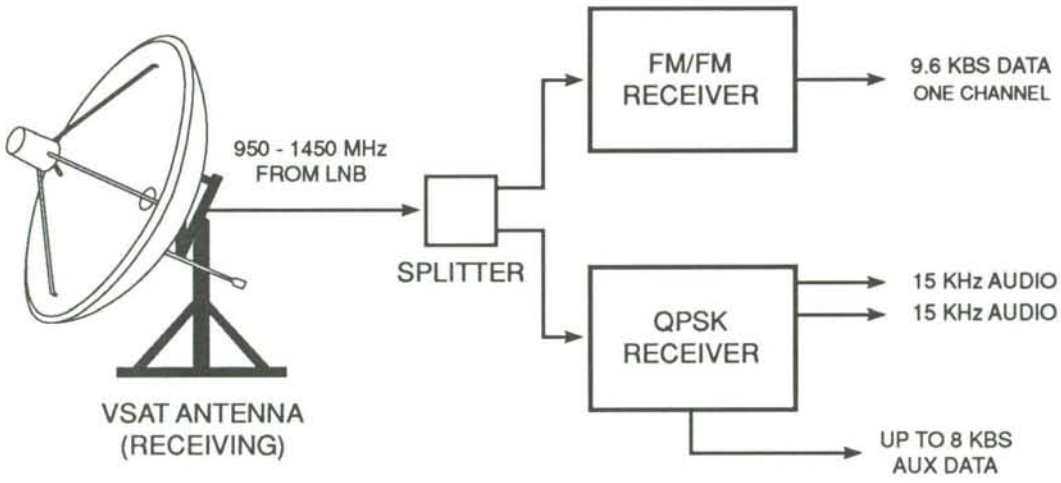


Figure 5.26 *User's equipment for FM/FM system.*

NEW FM³ (FM CUBED) BROADCAST SERVICE

Shortly after the introduction of the FM/FM systems, Space Com Systems announced its new FM³ (FM Cubed) system which will go into service in the very near future. Space Com's press releases report that the FM Cubed technology will transmit over a high-powered KU-Band transponder yet unnamed at this date.

FM/FM uses FDM (Frequency Division Multiplexing) which is a pure analog system that fills the FM baseband with multiple narrow band subcarriers, each carrying different audio or data information and each subcarrier sharing the power of the transponder.

FM³ (FM Cubed) uses Time Division Multiplexing (TDM) which is a basic digital system and uses the entire baseband to transmit a small segment of each channel in a time sequence rotation at a high rate of speed. The high rate of speed makes each channel seem to broadcast simultaneously, when in fact, each channel is being transmitted in very small time-frame segments. This method allows each channel to be transmitted at full transponder power.

The new FM³ system will be carried on new KU-Band satellites which carry high-power transponders.

Please note that the trade mark of FM² (FM Squared) has been granted to the Wegener Communications Company, Inc. of Duluth, GA. **See Figure 5.27.**

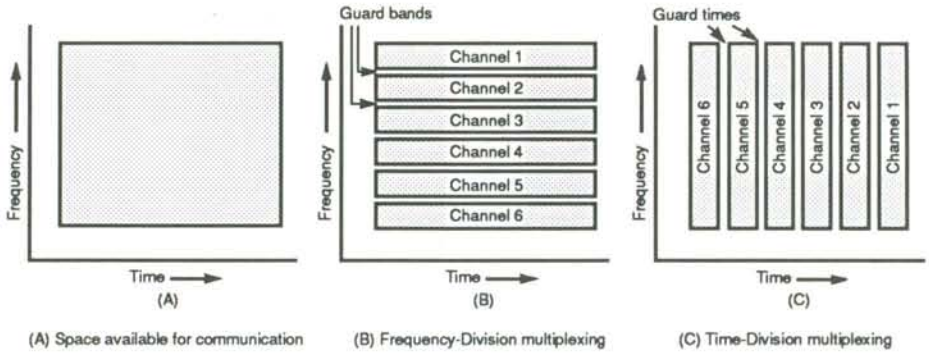


Figure 5.27 *(A) Space available for communications. (B) Frequency division multiplexing (FDM). (C) Time division multiplexing (TDM).*

DATA TRANSMISSION NETWORK (DTN)

Data Transmission Network Corporation has used various satellite systems, including FM radio sideband, to distribute it farm and agriculture market information and quotes in addition to the company's new DTN Wall Street Financial Information.

The DTN company now uses FM/FM (FM Squared) technology as the main means of transmitting its agricultural and financial services to its many thousands of customers.

DTN's service attest to FM² low cost and trouble-free transmission technology. The DTN Agricultural Market Information and Quotes service costs the user $29.95 a month after a $295 setup fee. The Agri-Service furnishes over 75 different pages of vital market information 24 hours a day. The Agri-Service screens provide commodity futures and option quotes, local cash grain and livestock prices, selected regional and world weather reports and forecasts, USDA reports, grain export data, livestock auction information, and a variety of daily analysis and commentary on news and information which affect grain and livestock prices.

DTN Wall Street Service provides subscribers with over 61 pages of financial information. The DTN Wall Street Service includes: Delayed quotes on stocks and bonds from the New York Stock Exchange, American Stock Exchange, and NASDAQ; quotes or price information on selected foreign currencies, precious metals, mutual funds and money market funds (presented along with time-sensitive business and economic news important to the financial markets). Stock and bond indexes, various interest rate quotes, and commentary and analysis on the financial markets are also part of DTN Wall Street Service.

DTNergy Service is utilized by petroleum refiners to send terminal prices, terminal alerts, electronic funds transfer notifications, electronic invoices and sales and marketing announcements to their wholesalers or jobbers. Energy futures and options quotations and financial news is also provided.

DTN's services require a 34-inch KU-Band satellite dish, DTN receiver and satellite receiver, and a 12-inch video monitor to place it in service. The entire equipment system is customer-installed and simple to use. The $295 start-up fee and $29.95 per month cannot be beat. Small, hard-copy printers are available at a reasonable cost.

For full information, contact Universal Electronics, Inc. at (614) 866-4605. Ask for DTN Agri-Service or DTN Wall Street Service information. **Figure 5.28.**



Figure 5.28 *DTN Wall Street Service showing bond information. Service also shows all exchange stock quotes, world and business news. Over 75 pages of full financial information.*

CHAPTER SIX

TELETEXT BASICS (TxT/VBI)

VIDEOTEXT: A PRIMER

VIDEOTEX—Generic term for systems that transmit text and graphics for display on a television screen.
VIDEOTEXT (VIEWDATA)—Interactive, two-way videotext service delivered via cable or telephone lines allowing information retrieval and transactions.
TELETEXT—One-way videotext system that transmits text and graphics as part of the television signal over the air or via cable.
CEEFAX—British teletext system operated by the British Broadcasting Company. **Figure 6.0.**
ORACLE—British commercial teletext system.
PRESTEL—British viewdata system operated by government postal and telephone service.
TELIDON—Canadian teletext system.
ANTIOPE—French teletext system.
WORLD SYSTEM TELETEXT (WST)—A teletext format, based on the British standard, that is used in the United States and in more than 90 percent of all teletext systems in the world.
NORTH AMERICAN BASIC TELETEXT SPECIFICATION (NABTS)—A teletext format derived primarily from Canadian Telidon; currently in use in the United States.
CAPTIONS FOR THE DEAF (CFD)—The most widely used teletext format in the United States offering text to accompany television programming for the hearing-impaired.
VERTICAL BLANKING INTERVAL (VBI)—A generally unused portion of a television signal over which teletext and captioning can be broadcast.
FULL-FIELD—Use of a full television channel to broadcast text and graphic information. **Figure 6.1.**

TELEVISION AND VBI

Two portions of the television baseband have been used for various applications such as the vertical blanking interval (VBI) and the audio subcarrier. There are 21 VBI lines in each of the odd and even fields comprising the television picture. Thus, of the 525 lines used to create television pictures (262.5 in each of the odd and even fields), 42 are used in the vertical blanking interval. Often the 21 lines in the odd field are just duplicated in the even field, so that in essence, only 21 lines are used.

Television pictures are formed by means of interlaced scanning whereby an electron beam trace is directed from the top left to the bottom right portion of a cathode ray tube (i.e., television screen). The VBI occurs when the signal is retraced from the bottom right to the top left to start tracing the next field. First, the odd lines (i.e., 1, 3, 5, etc.) are traced, then the even lines are traced—thus the term "interlaced scanning." During the VBI, no picture information is transmitted although several lines have been reserved for control applications.

The FCC has reserved several VBI lines for specific applications. For example, line 21 is reserved for closed-captioning. Lines 14-18 and 20 have been made available for teletext applications, with lines 10-13 to be available on a phased-in basis over the next several years. For technical reasons, television stations may not be able to pass all 21 VBI lines.

There are a number of ways to use VBI lines and some engineers may be concerned that some uses may interfere with other VBI uses or perhaps the main television channel.

Beyond teletext, there are a number of other possible applications for the VBI lines which are available to television stations. At this time, several networks are broadcasting teletext signals plus other services. And some group stations and local broadcasters are piggybacking teletext signals on top of other video programming.

These applications are: remote transmitter control, data return from transmitter, cueing, utility load management, and several other uses.

ARE YOU READY FOR TELETEXT?

A number of television networks and satellite-delivered services are providing teletext services 24 hours a day, 7 days a week, but very few of us have decoded the contents. This chapter will tell you what they are, and most important, how to receive them.

The FCC defines teletext to be ". . . a new form of communication that involves the transmission of textual and graphic data on the Vertical Blanking Interval (VBI)—of the video portion of the TV signal."

If you are unfamiliar with these encoded transmissions, have a quick look. Tune in WTBS G-1, T18. Adjust the vertical hold control on the TV set until the picture starts to roll. See the white dots moving between the frames? *That is teletext.*

At this point, some additional terminology may be important. You may be familiar with the term "videotex." Videotex means all graphic and textual materials which can be displayed on a TV screen or monitor. Your kid's VIC 20 or VIC 64 probably can function as a videotex terminal when connected to a phone line and with the proper passwords. The VIC can access data services such as the *Source or Compuserve*, or a couple of dozen other services, so your home PC (personal computer) can act as a videotex terminal.

There are a couple of ways of getting that videotex onto your screen. One way is to hook your VIC or IBM, or whatever, to a telephone modem. The "modem" modulates or demodulates computer data which is transmitted by the phone line. Videotex usually connotes a two-way system; the user's computer terminal transmits commands to the "host" computer. The host then retrieves the information and transmits it back down the phone line. **Figure 6.2.**

Teletext is simply a type of videotex. Think of it this way: the "tele" in teletext is descriptive of the mode of transmission by tele(vision) or tele(communications). One other thing to remember: teletext, like television itself, or like a TVRO is basically a one-way affair. Information is received, but the user cannot transmit.

When most people talk about teletext, they refer to signals transmitted on the VBI of the TV signal, but this is not quite accurate. Text and data can be transmitted by any aural or visual medium. Therefore, you can transmit "teletext" by means of subcarriers or digital audio encoding.

It might help to understand how teletext works. It is important to remember that all teletext is computer data. You probably already knew that computers operate on the basis of a coding system of zeros and ones. When the 0's and 1's are deciphered by the

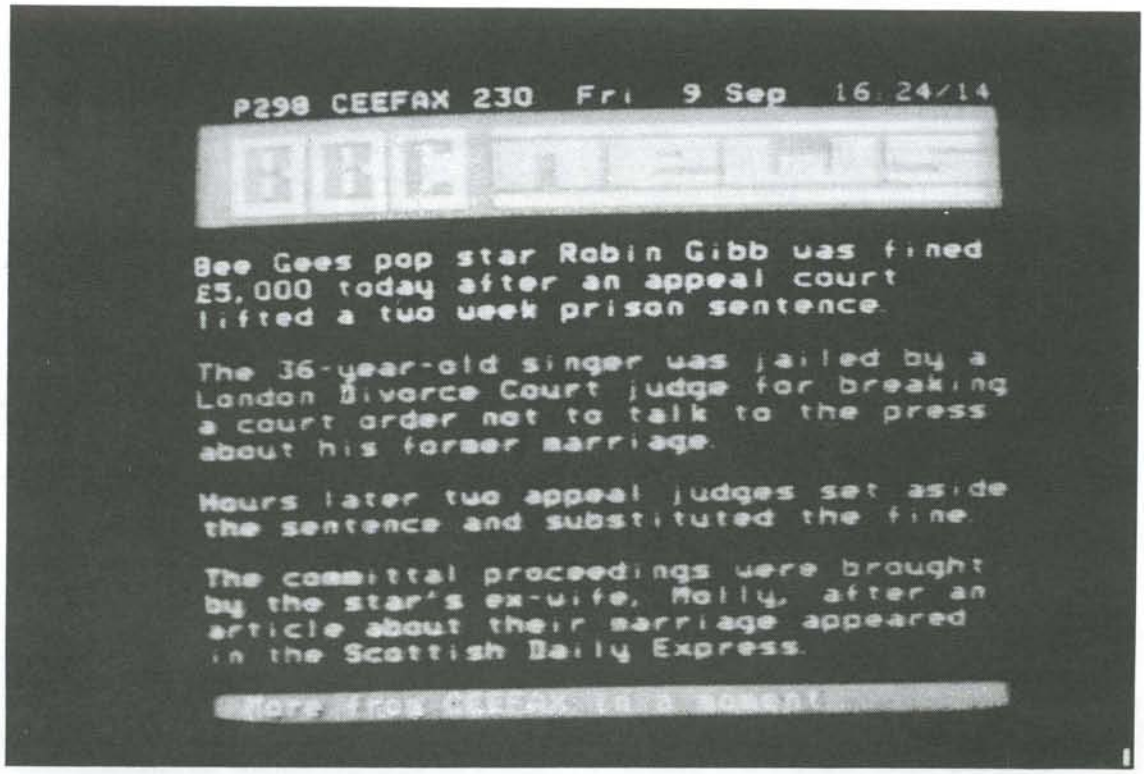


Figure 6.0 *CEEFAX, British Teletext System operated by BBC.*

electronic circuits, the computer can form numbers, letters, words, and most importantly, colors and pictures.

If you have dabbled in the world of personal computers, you will also know that while Apples, IBMs, and Ataris can all do word processing (with the proper software), you can't shove an IBM diskette into an Apple and get the Apple to function with that IBM software disk.

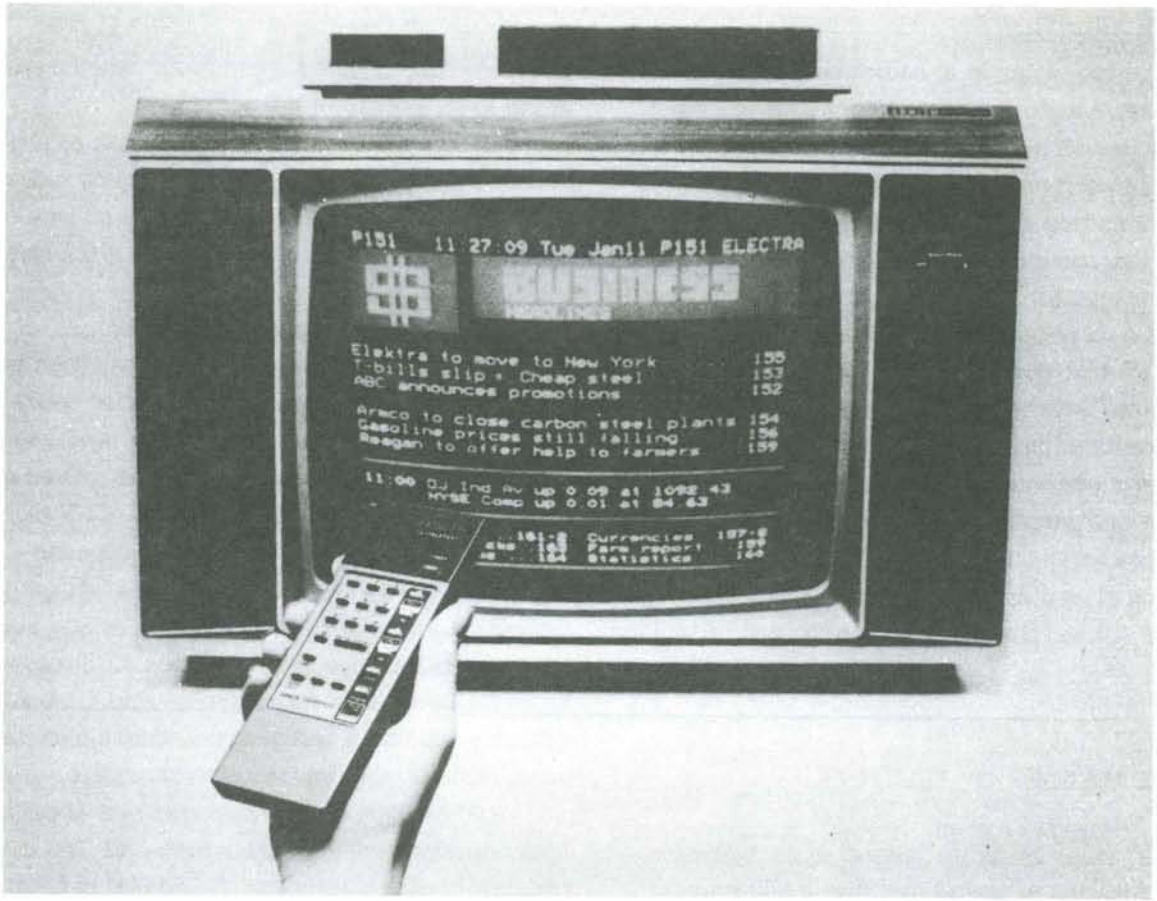


Figure 6.1 *Zenith Teletext Decoder and Color Television Receiver will receive and display Teletext information.*

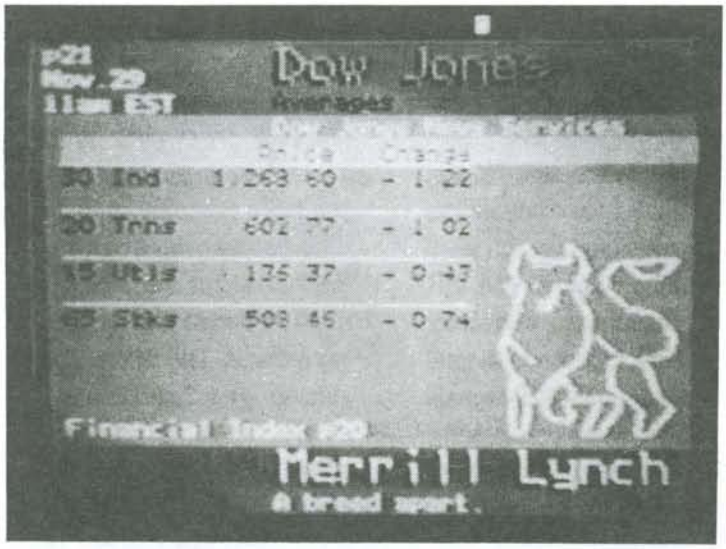


Figure 6.2 *Many services are transmitted via Teletex service (Dow Jones).*

Without engaging in too much technological discussion, let's just say that while personal computers are all based upon the same premise, they use different microprocessors, or different operating systems to achieve basically the same results. So it is with teletext. There are a number of systems now in the marketplace, and like personal computers, they have significant differences.

But before we jump ahead of ourselves with a history lesson, there are a few other things you must know. *All teletext decoders are personal computers.* They might not look like an Apple or Atari, but they contain integrated circuitry and, in fact, they usually contain *more memory and circuitry* than the average personal computer. The software is usually inscribed right on the IC chips (RAM and ROM) so when you turn the teletext decoder on, it knows what to do; because the "software" is built-in, you don't have to insert a cartridge or floppy disk. Think of a teletext decoder as a personal computer designed for one purpose and one purpose only: to receive information "pages" via transmitted signals. When we talk about the pricing of teletext decoders later in this chapter, you should recall that you are getting a sophisticated personal computer.

A SHORT HISTORY OF TELETEXT

More than a dozen years ago, television engineers started to realize that they could cram all sorts of *digital* information into the vertical blanking interval (usually lines 13-21) without physically interfering with the TV picture. At first, the BVI was used for special monitoring signals which allowed engineers to perform quality control checks on the TV signal as it passed from the network studio to microwave links and ultimately to broadcast transmitters. The public got involved with the VBI signals in the late 1970's when several TV set manufacturers took advantage of VIR (Vertical Interval Reference) signals which were transmitted on the VBI's of various stations. The VIR signals were used for quality assurance and color fidelity. Several TV receiver makers, including General Electric, reasoned that a set locked into the VIR signals would produce better color pictures more consistently on more channels. VIR signals, it was thought were not as prone to multipath interference as the traditional color control signals. **Figure 6.3.**

Also in the 1970's the Public Broadcasting Service in conjunction with the National Captioning Institute (NCI) and Texas Instruments, developed a system for closed-captioning of TV programs for the hearing-impaired. This was a very crude system of teletext. Signals were transmitted on line 21 of the VBI. The viewer purchased a decoder (sold by Sears) or a receiver equipped with a built-in decoder. The decoded captions were superimposed over the picture in the lower portion of the screen.

Closed captioning was a crude form of teletext because the graphics capability was quite rudimentary. The captioning was usually displayed as a one-line message scrolled along the bottom of the screen similar to a computer printout. The captioning materials usually paraphrased the dialogue of the television program. Word-for-word translations were impractical because the average reader could not comprehend the one-line caption at a rapid rate.

Three networks opted to broadcast closed-captioned programs, PBS, ABC, and NBC. CBS did not initially opt to use the NCI system because CBS engineers believed that this system was inefficient and it used up a significant portion of the Vertical Blanking Interval for *low-resolution* graphics. CBS reasoned that if NCI closed-captioning proliferated, it would be difficult to introduce a *high-speed* data transmission using high-capacity transmission standards.

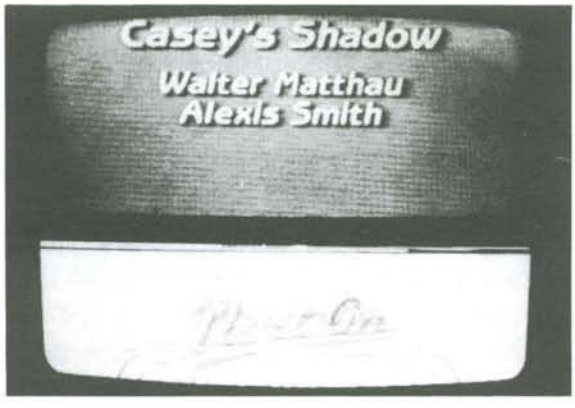
By 1978 there were a number of teletext systems under development throughout the world. The British had developed a system (called *CEEFAX*, or *ORACLE*, or *PRESTEL*) which was based upon alpha-mosaics. The Canadians had invented a system (called Telidon) based upon alpha-*geometrics*. What's the difference? The British system created shapes in much the same manner that you might create a drawing on a computer. On your computer terminal, you can create graphics by typing in the right combination of characters and dots. If you have a computer terminal, you have probably seen the program which will draw a woman by means of X's and O's. That's a very crude form of alpha mosaics. The Canadian system was more dependent on the computer to assist in drawing pictures. The difference in the two systems is rather striking. The Canadian system could create circles, arcs, and all other geometric shapes. This meant that artists could convert realistic drawings into teletext pictures. The best the British could do was create pictures based upon squares, boxes, and jagged lines.

The French developed a system called Antiope/ DIDON which shared attributes of both the British and Canadian systems. The British, French and Canadian governments poured a lot of money into their respective systems, so an international standards battle broke out. *Each country* wanted *its system* to be adopted as a *"world standard."* Each country knew that the real victory would occur in the United States where there exists a market of more than 86 million television homes in an information-hungry nation. No one wanted to repeat the standards battles of the 1940's and the 1950's which resulted in a lot of different television transmission standards.

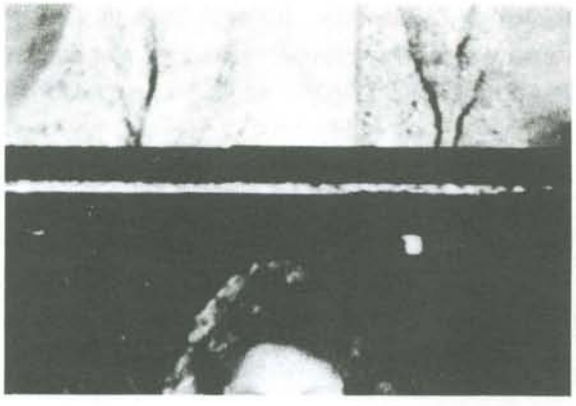
The French and Canadians found some common ground, but the British were unable to agree on anything *except that they wanted everyone to adopt their standard.* In 1980, several manufacturers with support of their respective governments supplied a number of American broadcasters with prototype equipment to conduct field trials. WETA, Washington, D.C., used Canadian-made equipment, KMOX used some French equipment, and WKRC TV, Cincinnati, Ohio, (no relation to the radio station in the sitcom TV show) used British equipment. NBC used French equipment at KNBC. There was a lot of lobbying in Washington as each faction tried to get the FCC to move toward *one teletext standard* (Reminiscent of the Quadrophonic and AM Stereo battle, isn't it?).

You have probably noticed that we haven't mentioned an "American system" of teletext or a "Japanese system." There was a Japanese system developed called CAPTAIN, but it seemed to fizzle out in the face of other international competition. Most American and Japanese companies sat back and watched the other governments and their engineers fight. They figured that eventually they would be involved in the final outcome, and they were right. Committees were formed and a number of American companies including the giant AT&T, and CBS and NBC set out to determine a "protocol" for transmission of Videotex and Teletext. Over a period of two years, a transmission system was developed which incorporated a lot of the original Canadian Telidon system, along with elements of the French Antiope & DIDON systems, and a lot of new twists thrown in for good measure. This meant that much of the equipment used on those original field trials had to be scrapped as the standards evolved.

The new protocol, known as NABTS (North American Broadcast Teletext Specifications) sets a basic blueprint for teletext transmission, although individual manufacturers or broadcasters have made some minor changes of their own. Meanwhile, during the time that AT&T, CBS, NBC, Time, Inc. (the parent of HBO, and Cinemax), and others were sitting around the bargaining table, the British started to make inroads in the U.S. with individual broadcasters.



NO DATA HERE—Standard frame bar has "softer," less "busy" appearance.



TELETEXT—Roll up (or down) your vertical hold and "freeze" the sync bar near the middle of the display screen. Along the bottom edge of the bar you will see "dancing" dots of data containing the Teletext message material (CBS on D3, WTBS on F3R, etc.).

Figure 6.3 *VBI on TV set.*

Many teletext observers wanted the FCC to declare that there would be only one technical standard for TV transmission, but the FCC decided to authorize teletext under the "open market" approach. Like AM-Stereo, the FCC decided that the only restriction should be *non-interference* with the regular broadcast service of the originating station.

THE SATELLITE-DELIVERED SERVICES:

At this time only the Electra Service is on the air. Electra is a Taft Service found on G-1, Tran-18. Time Teletext *has ben found* on F4, TR18, and F2R TR23 up until December 31 ,1983. Time, Inc. has wound up its experimental service; however, don't be surprised if you see the Time Teletext signal up and running on various satellites from time to time. Many people thought that the signal on F4, TR18 was a form of scrambling for HBO because digital data which did not really resemble the Reuters transmission system occupied the entire transponder on F4. **Figure 6.4.**

More teletext can be found on Anik B and Anik D on the CBC channels. The English language channels have a service originating from Toronto, while the French language channels have a teletext service originating from Montreal, although on Anik D, we have sometimes found French language test slides running on the CBC English language transponder, which originates from Montreal. TV Ontario on Anik C3 can be found from 8:30 am EST to 11:30 pm EST with a news and information service. The hours are sporadic on weekends. **Figure 6.5.**

MAJOR TELETEXT SERVICES

What is the content of the major services? Let's have a look. *KEYFAX was the first commercially available service.* It was transmitted on F3, TR6 on the Vertical Blanking Interval of WTBS. The KEYFAX system used British "CEEFAX" technology, referred to in the advertising literature as World Standard Teletext (W.S.T.). However, as we mentioned, there is *no* "world standard" (the British is *one type of teletext*, not a standard). It is an alpha-mosaic system. **Figure 6.1.**

The content of the service includes world and national news, sports scores, and business news. There is also weather news and a news flash feature which allows you to have bulletins displayed on your TV set even while you watch WTBS. Keyfax also includes leisure and entertainment features and will probably contain commodity information later.

The KEYFAX decoder (see **Figure 6.6**) is made by Ayr Electronics of Great Britain. There is an infrared keypad to call up individual pages. When the decoder is turned on, a menu page is displayed. On the menu page there are numbers which refer to features; NEWS might be found on pages 001 to 019. To receive the news, you would "key in" 001.

When I contacted KEYFAX, their marketing strategy had just been modified. Originally, they were only looking at marketing through cable companies; however, now it is possible to purchase a decoder. The pricing of the decoders is around $300. The suggested retail price for the service via cable is $19.90 a month, with half of the fee for content, and half for the leasing of the decoder. Eventually, there will be sponsorship of pages in the service.

PLEASE NOTE:

The KEYFAX Service is no longer on the air, it ceased broadcasting early in 1985. There are rumors in the industry that the service will resume broadcasting. This section is for information only.

EXTRAVISION

CBS has made a significant commitment to teletext. Their service is known as EXTRAVISION and consists of about 50 pages. Unlike KEYFAX, CBS uses the North American Broadcast Teletext Specification (NABTS). That means that the KEYFAX decoder will not work on CBS. The CBS service has generally the same content as KEYFAX with a couple of differences. CBS has some fascinating pages related to the communications and entertainment industry. It also has a few pages for the hearing-impaired and a listing of programs for the four major networks. On the menu pages, there are always two news headlines which "blink." Almost every page on the CBS service contains advertising, and despite the lack of decoders in TV-land, there does not seem to be a shortage of advertisers on Extravision. Advertisers include Coke, Ford, and Phillips 66. I happen

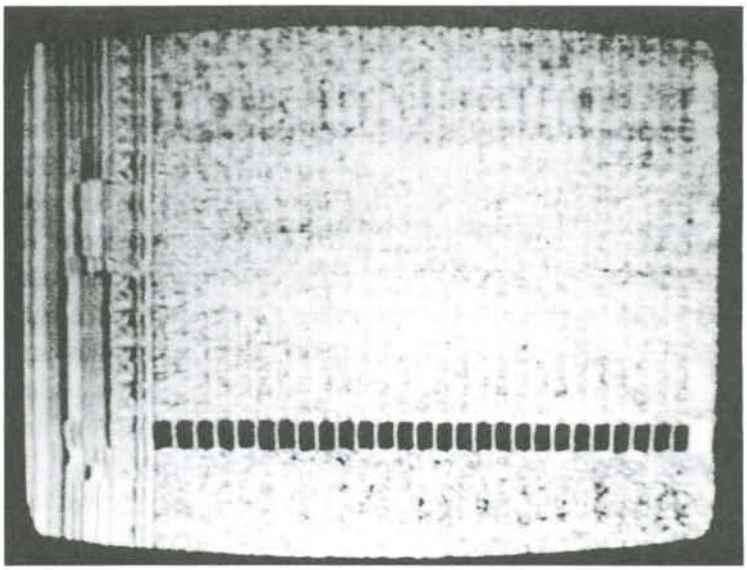


Figure 6.4 *Many people thought this Time, Inc. service on F4, TR18 was scrambled television.*

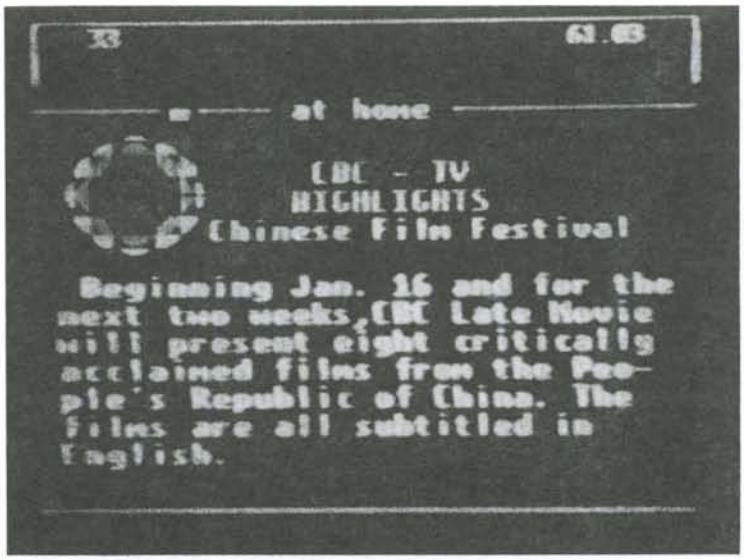


Figure 6.5 *CBC Service makes excellent use of background colors (ANIK B and D) and creates easy-to-read format even on a small screen display.*

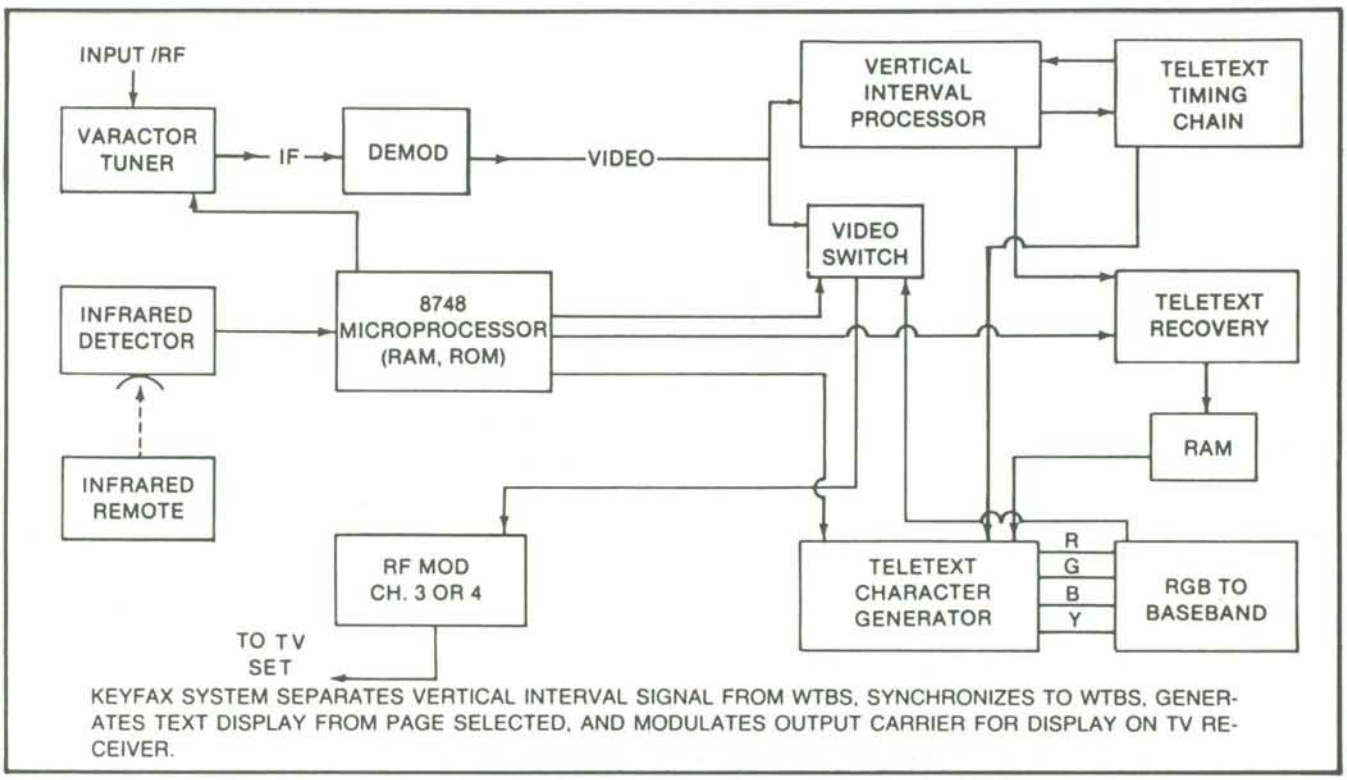
to like the CBS service, primarily because the pages flash up on the screen quickly (more about the speed of the service later). The other nice thing about CBS is that the service is free of charge. **Figure 6.7.**

The NBC service has been up and running on D3, TR1. It is reputedly in the NABTS format, but there seems to be some problems with the method of encoding. Our Norpak decoder could not lock onto NBC. One engineer theorized that NBC was using some French software, and that the NBC database was structured differently than most NABTS databases. This meant that when the decoder was turned on and automatically searched for the "menu pages," it in fact searched for page numbers on NBC which simply were not in their databank. Consequently, the decoder would not "lock on" to the NBC service. We are trying to get more information from NBC concerning the problem.

Time Inc. (parent company of HBO and Cinemax) conducted the most expensive and extensive test of teletext. Their service occupied a full transponder (not just the Vertical Blanking Interval), and they had the capability to transmit up to *5,000 pages* simultaneously(!). When the service was good, it was very good. It was primarily delivered via F4, TR18 and F2, TR23 to cable head-ends in Orlando and a couple of other cities. There, test homes were equipped with decoders which had the added feature of "down-line loading." That meant that the software for video games could be loaded into the decoders.

The Time service also had TV listings, horoscopes, travel information, sophisticated weather data, even an astronomy section. The potential was there, but Time, stunned from its multi-million dollar losses in a weekly cable-TV listings magazine, pulled the plug.

The Canadian Broadcasting Corporation has multiple teletext feeds on Anik B & D. The French language channels have French teletext originating in Montreal, while the English language channels originate in Toronto in English. The news, sports, and weather service is pretty good. The CBC is way ahead of CBS in their use of graphics. For example, with the CBS service, you'll strain your eyes if your TV set isn't a monitor. The CBC uses a combination of background colors and type fonts to overcome the problem of print on the electronic screen. Recently some advertising has crept into the CBC service. One of my favorite pages was an ad for Baskin Robbins Ice Cream. One of the other CBC features



KEYFAX SYSTEM SEPARATES VERTICAL INTERVAL SIGNAL FROM WTBS, SYNCHRONIZES TO WTBS, GENERATES TEXT DISPLAY FROM PAGE SELECTED, AND MODULATES OUTPUT CARRIER FOR DISPLAY ON TV RECEIVER.

Figure 6.6 *Keyfax system separates vertical signal from WTBS, synchronizes to WTBS, generates text display from page selected, and modulates output carrier for display on TV receiver. Keyfax is no longer on the air; it was replaced with Electra Service and Cable Text.*

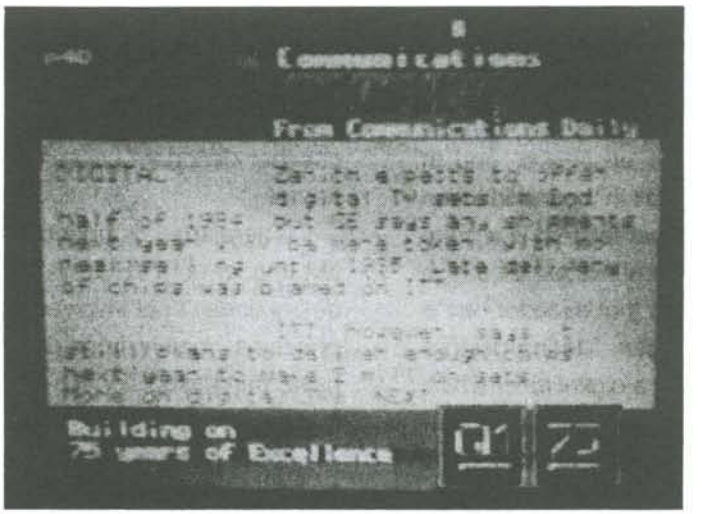


Figure 6.7 *CBS Extravision is excellent service covering basic essential data.*

AVAILABILITY OF DECODERS

First, the availability of decoders. As mentioned previously, the service telecast on WTBS is available only with a WST-type decoder.

The Dick Smith Electronics Company of California now has a low-cost teletext decoder kit available. The unit has an easy-to-build circuit board with screened overlay for proper component placement. The unit is housed in an attractive case.

Control of this teletext unit is accomplished with a 21-button hand- held remote control unit. The kit will be no problem for anyone with intermediate building experience. This VBI teletext unit is based on the world standard teletext system so it will be compatible with other future teletext services. The unit works very well with Taft Broadcasting's Electra Service.

ASTRO-TEXT 90-TM TELETEXT DECODER

The Astro-Text 90-TM teletext decoder incorporates an infra-red transmitter/receiver, video processor and micro-processor (8 bit). This model has a screwdriver-adjustable tuner for any VHF channel 2 through 6 (it is factory tuned to 3), with a RF modulator set to TV channel 3 (channel 4 is also available). This decoder will pass standard signal when off and convert the teletext data that is transmitted during the vertical blanking interval into a display when on.

Hooking up and using the Astro-Text 90-TM teletext decoder is simple. **See Figure 6.8.** Tune the TV receiver to station TBS (G1-18 or cable). Switch from the regular TV to Teletext by pressing the TEXT button on the remote control. The red LED on the Astro-Text unit indicates that a telecast is on. Select the desired page numbers by slowly entering single digits on the remote control key pad. Requested page numbers appear in the upper left hand corner of the TV screen; searching page numbers are shown in the top right hand corner. Press the HOLD button to hold the page; press it again to release the page. Press the HALF button to double the size of the text (a half page is visible), and press it again to enlarge the other half of the page. Press the FULL button to reveal the whole page. Press the REVEAL button to reveal the answer to the puzzle shown on page 117.

The Astro-Text 90-TM teletext decoder unit price is $319. It is available from Astro Products Co., 340 Ranchers Drive, San Marcos, CA 92069. Phone: (619) 471-9930.

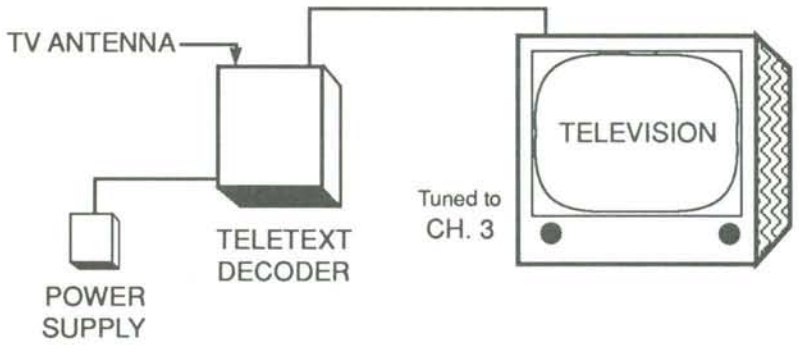


Figure 6.8 *Hookup for the Astro-Text 90-TM Teletext Decoder.*

The decoders for North American Broadcast Teletext Standard (NABTS) which is transmitted by CBS, NBC, Time Inc., CBC, TV Ontario and Learn Alaska are, at the present time, expensive and in relatively short supply. You'll recall in the introduction to this chapter we mentioned that teletext is a computer system. The NABTS system of teletext uses high resolution graphics. Therefore, in that decoder box is: the front end of a TV receiver plus filtering devices to differentiate the VBI lines, *a digital tuner* which will tune VHF and UHF and mid-band and superband Cable channels, a computer to decode the data, an infrared remote system, RGB circuitry for display on a high-resolution monitor, and a modulator. *All of that adds up to a lot of money.*

I am using a decoder made by Norpak Corporation of Kanata, Ontario (an Ottawa suburb). The decoder retails for about $3000. As you can imagine, that price is enough to cool anyone off quite quickly. But the truth is, quantities of teletext decoders have not been large to date. Also, the two-year negotiated battle over transmission and display standards meant that R&D was continuous, and terminals which should have been production models became prototypes. Because there was something of a metamorphosis of the technology, a lot of extra circuitry had to be built into the boxes. Likewise, these were never really meant to be consumer models; most have been designated for "field trials." In summary, the situation concerning NABTS teletext decoders is somewhat analogous to TVROs in 1979; limited production runs, sometimes unreliable, a variety of different circuits, and high consumer prices. *But don't count NABTS teletext out yet.*

Several things are about to happen: First, a number of major manufacturers are working on VLSI. That stands for *Very Large Scale Integration of circuitry.* Most major functions will be integrated on a chip set. That means there will be a major price breakthrough. Since one chip, or a couple of chips, will perform the function of many circuits, reliability should be improved. Rockwell International has joined with Norpak of Canada to design VLSI. The Japanese companies led by Mitsui are also interested, as are AT&T, RCA/NBC, and a number of other major players. It is rumored that Texas Instruments has a chip set nearly ready which can be built right into a microcomputer. Manufacturers are also getting ready to integrate teletext into TV sets. If the trend which I noted in England last summer carries over to North America, Sony and the other component TV makers will offer "component" teletext. In other words, the market for teletext is about to explode. By early 1987 cheaper decoders using VLSI could be moving into homes.

There are a number of technical problems which will impact on TVRO systems, and if the TVRO industry doesn't get involved, and quickly, there will be problems, mainly from disgruntled consumers who have purchased TVRO systems in good faith for teletext use.

HERE ARE THE PROBLEMS

The VBI information, which appears as a bunch of "flashing dots" in the vertical frame-bar, are a *precise coding system.* The teletext decoder recovers computer data from those "flashing dots." Then the data is processed; the data instructs the teletext unit where to draw lines, how to color the pictures, and how to display text.

Earlier in this chapter we made reference to waiting times. Try to visualize teletext as a large magazine which is transmitted page-by-page, over and over again. If you turn your decoder on and want to see page 62, you have to wait until that point in the transmission cycle when page 62 is transmitted before it can be displayed. In theory, a teletext magazine on the VBI could contain hundreds, or thousands of pages of information. However, if there were hundreds of pages in the service, *you would have to wait a long time* before the page you requested would be transmitted in the cycle. In other words, because VBI teletext only occupies a small part of the video bandwidth, you compromise the size of the data base in favor of cycle time. Most VBI teletext services contain less than 200 pages. To keep the waiting time for viewers down to a minimum, key pages (such as the menu page) are included more often in the transmission cycle so there is a faster response time. This is why the CBS service contains approximately 50 pages and CBC contains about 100 pages. Time Inc., used a *full video channel* with 525 lines devoted to teletext. As you might have guessed, they had hundreds of times more capacity to transmit pages to their viewers, and the transmission cycle was much faster than VBI teletext. **Figure 6.9.**

We also mentioned that there were problems with satellite transmission of teletext. To better comprehend the problem, remember that teletext is a computer transmission system. Instead of using phone lines or wires, teletext is transmitted on TV pictures. Most computer systems perform quality control functions to ensure that the data received from a remote location is accurate. Teletext is no exception. *"Error rates"* have been established. This is an important aspect of the NABTS teletext transmission system (and all other data systems for that matter). That means the decoder performs certain verification tasks. If there are too many anomalies, the decoder or computer won't display the data. In other words, the machine virtually shuts down if there are significant errors. You may recall earlier concerns about the Reuter's system. They had stringent standards concerning signal quality and had reservations concerning allowing TVRO owners to access their system for fear of greater than acceptable error rates. We have the same problem with teletext.

1) *Sparklies.* This is simply the number one problem facing teletext. The sparklies are displayed in the video signal almost identically to the digital data in the VBI. While the decoder can differentiate the VBI data in lines 13-21 of the picture from the other video information, the sparklies appear in all lines of the picture. *That means if you have sparklies in the picture, you have erroneous information in the VBI.* While you and I know that the sparklies aren't supposed to be there, and we might ignore the sparklies, the decoder thinks that they are data and instructions for displaying pictures. With sparklies, you get errors in the data, and that can cause the decoder to reject all of the data, and hence, no teletext picture.

This phenomenon concerning sparklies is not limited to teletext. Recently, I had a look at the Scientific Atlanta receiver for the new NBC (and other networks) *digital radio* transmission system. There was a very strong wind buffeting the dish which was on the roof of a radio station. The LNA was moving. When sparklies (noise) were introduced into the signal, the audio did not get noisy, *it simply got cut off!* With digital transmission the general rule is, if the data gets through, the reproduction should be perfect; if the error rates are exceeded, *you get nothing!*

Unfortunately, one of the trends in the TVRO installer business seems to be that of misleading people. Recently a friend of mine was shopping for a TVRO system for his home. A majority of the sales people (some who had been in the TV business for a lot of years and sell on the basis of their fine reputations) tried to sell undersized antennas with LNAs that weren't fit for the job. They tried to con him that sparklies on F3 were a normal fact of life; something that came with TVROs, something you lived with. Unfortunately, a few sparklies will virtually kill chances of decoding teletext, now and forever.

If your clients are potential users of teletext (and I would think that most TVRO owners will want TxT, then the dealer/installer has a moral responsibility to make sure that customers purchase and receive sparklie-free signals.

When we tried to decode signals with even moderate sparklies, we either got pages with garbled data or nothing at all — the machine would not display pages properly when sparklies were present.

2) *Saturation.* I would rank this problem second to the sparklies problem. Despite blistering signals from Anik D and Anik B, we had a lot of trouble. The saturated reds display as a form of sparklies. Although the saturated colors are in lines of the video signal other than 13-21 of the video signal (where teletext is transmitted), for some reason the decoder was "fooled" and we either got garbled data or no data at all. *Game shows on CBS were the greatest problem.* The Price is Right (for example) uses a lot of saturated colors, a lot of chroma key, and a lot of blinking lights around displays. I literally had to wait until commercial breaks to get the teletext decoder to display CBS pages. One small consolation is that during prime-time there aren't as many shows with saturated colors so you don't run into this problem as often. *But on Magnum P.I., they seem to wear a lot of Hawaiian shirts with saturated reds!*

I understand that a lot of companies are abandoning the 564 circuit, and now are addressing the saturation problem. The industry rule should be: *If there are no sparklies, there should be no saturation.*

3) *Modulators.* This did not seem to be a severe problem with the receiver, but it is a potential problem for teletext. The receiver modulator must not only pass the lines in the picture portion of the video, but *it must also pass lines 13-21* without distortion. Unfortunately some manufacturers skimp in this area. If you are a manufacturer and use a brand-name VCR modulator, you should not assume that the modulator was designed to pass the VBI. *Some don't.* You can also be easily fooled. While you might think you see VBI signals coming out of the modulator, enough distortion may have been introduced at the time of modulation to create significant errors. As noted, the Panasonic modulator passed through the VBI data, but the videotape machine could not properly record and reproduce those VBI signals. Ironically, while we found that the Panasonic VHS machine seemed to record signals containing VBI data, and on playback, all of the pulses seemed to be in the VBI, we could not recover the data. The reason? *½-inch videotape machines do not record or play back all of the lines.* While the picture may appear to be 525-line NTSC, it is in reality a degraded signal with a loss of resolution. That resolution comes in the form of lines which are displayed.

The engineers at Norpak indicated that they even had some problems recording VBI data on 3/4-inch U-Matic machines which comply with broadcast standards.

4) *Video processing.* As we mentioned, we were not able to evaluate raw video going right into the teletext decoder simply because the Norpak unit did not have an input port. But in the future, *TxT units may have video inputs.* Obviously, the less you process a signal containing VBI teletext, the better the odds that you will not introduce noise or other aberrants into the signal. The problem would seem to be a generous interpretation by manufacturers of "standards" for video output on their receivers. Although we did not run the output through a scope, we were able to recover all audio subcarriers from 5.3 to 8.1 MHz when the video output was run through an audio demodulator. That meant that a lot of what was reputedly filtered got through. Also, video amplification is achieved through 2N2222 transistors. We had some problems with the processed video. Eventually one of the videoamps had to be replaced. We put in 2N2222A transistors which are a little faster in switching. There was a significant improvement. *Somewhere along the line, receiver manufacturers had better awaken to the fact that consumers will eventually plug computers, teletext decoders, monitors, and yes, "legal" descramblers into their satellite receivers.* Manufacturers had better build in proper video ports and RS232 connectors. There should be a filtered port and a port for raw unfiltered video. Likewise, more care and attention should be devoted to the actual levels which come pouring out of receivers. In my experience, too many TVRO systems compromise video performance, and consequently, what comes out of a receiver bears little resemblance to NTSC or any other "standard." In short, *if data of any kind* is transmitted via satellite, be it in subcarrier form or encoded video, *the consumer should be able to recover that data without distortion.*

One other point: Sometimes consumers or manufacturers use RF amps to amplify and then split the modulated signal coming out of the receiver to feed multiple TV sets. One must also be careful with the RF amps. In our experience, while you might get acceptable pictures out of the amp which seems to

be noise-free, you might also distort the VBI with RF amp "noise."

5) *Audio quality.* Some teletext is transmitted by means of encoded tones (e.g., Genesis Story Time). Many receiver manufacturers have adopted audio sections in their receivers which make most audio engineers cringe. Until recently, I think most receiver designers have placed audio processing at the bottom of the list of priorities. I have personally seen many receivers which have questionable audio frequency response.

Very few receivers can accurately reproduce audio above 10 kHz. Many receivers have audio response which may contain some top- end or bottom-end frequencies, but are far from linear in response. The irony is if an LNA manufacturer put out a product which deviated 10 dB here, 15 dB there, or had high levels of noise, the receiver makers and distributors would yell and scream. Unfortunately there is a double standard in the receiver industry because the audio sections of receivers often deviate many dB and are just plain noisy; yet little has been done and there has been little public discussion of the problem. There are some receivers which distort badly on narrow band signals. Others advertise subcarrier tuning but cannot tune the subcarriers on WGN or CBN or WTBS. The audio section was designed for MTV and the Movie Channel stereo, and 6.2 and 6.8 main channel audio, but just won't work properly on other subcarriers. The truth is, *many receivers can't tune in subcarriers properly.* In our complaint about video processing, we noted that many receivers have filtered video outputs, so even if you wanted to add an audio processor, you would have to cut right into the circuits of the receiver. The real answer is to provide a wide-band output, and more care and attention must be paid to audio processing with proper equalization and flat-frequency response. One other point: Many modulators also skimp on frequency response and that is another reason for providing audio outputs.

If you are a manufacturer of TVROs, you are probably wondering how can you obtain a NABTS teletext decoder to ensure that your receivers will perform properly. At present, Norpak Corporation of Kanata, Ontario makes a teletext video decoder which is a rack mount unit. *It sells for $4,360!* They also make a dual-mode videotex and teletext decoder which is somewhat more versatile. It sells for approximately $3,000. Apparently, the dual mode decoder does not have FCC-type approval, so you might have some difficulty getting one across the border legally.

To sum up, in the next five years teletext will become a multi-million dollar industry. Electronic publishing has the potential to cater to every taste. Since the cost to transmit VBI signals and create pages is under $100,000 (the cost of 2 TV minicameras), you can almost be certain that there will be dozens of services up and running shortly. There will be some fascinating partnerships formed between traditional "broadcasters" and print publishers. CBS and NBC are poised to supplement their revenues with teletext. Obviously, people who demand the latest entertainment technology will be likely candidates for teletext. *People living in remote areas, unable to obtain print material easily will also demand access to teletext.* As digital audio, computer software transmitted by satellite, and data services are introduced into the home, consumers will demand sparklie-free and saturation-free signals. Now is the time for the industry to take action.

KEYFAX AND OTHER TELETEXT SERVICES

In 1984, Satellite Syndicated Systems, Inc. and Keycom dissolved their two-year-old joint venture, Keyfax. SSS is now testing a new but similar teletext service, and Keycom is introducing an all new videotex service for the Chicago market area.

The original joint venture was formed to produce and market a 100-page teletext magazine for the cable industry and direct satellite delivery to the home TVRO market. The signal was delivered on the vertical blanking interval on WTBS's satellite signal which SSS distributes to the cable industry.

SSS determined that Keyfax was not a chargeable service, and there was not enough interest in the service to get subscribers to pay for it. SSS further stated that they had not given up on teletext type of service.

The present Keyfax subscribers were issued the Zenith or Ayr decoders. Suggested retail for the service was $19.95 per month.

TAFT BROADCASTING COMPANY

Satellite Syndicated Systems, Inc. and the Taft Broadcasting Company are now operating a test that may lead to a national offering of Taft's Electra Teletext Service.

The Taft Broadcasting Company has been of-

fering the Electra Service in Cincinnati, Ohio on a Taft Broadcasting Company station for some time. SSS has substituted the Electra Teletext Service for Keyfax on WTBS's vertical blanking interval, and present Keyfax users can now receive the Electra Service free of charge. Taft and SSS have announced that the Taft Electra Teletext Service will be on a national basis. Meanwhile, the Keycom group began offering its Keyfax Interactive Information Service in the Chicago area.

This is a two-way interactive videotex system which offers banking and shopping, among other features, via telephone to users with either a dedicated terminal or a personal computer.

INFOTEXT

A new teletext service geared to the farm and agri-business communities was recently launched at Madison, Wisconsin by television station WHO-TV. The Infotex Teletext Service contains many information services, commodity, and full market information which is updated several times an hour. This group also has a satellite delivered service called Agri-Sat which is a farm information service. Service on Galaxy 1, Transponder 22.

NBC TELETEXT SERVICE

NBC launched its Teletext Service in May, 1983. It used the North American Teletext Standard. This 50-page teletext service was transmitted by KNBC, an NBC owned station in Los Angeles, providing coverage of the Summer Olympics. The service is not being broadcast at this time.

CBS TELETEXT SERVICE

Over the past five years, both CBS and NBC have spent in excess of 15 million dollars to develop and operate experimental 24-hour teletext services.

At this time, CBS says they have no plans to pull back from their 100-page national service as a result of NBC's withdrawl from Teletext. CBS launched its North American Standard System in April, 1983. The system is based in Los Angeles and is carried by a number of its affiliated TV stations.

Four CBS affiliates: WBTV-TV in Charlotte, NC., WIVB-TV in Buffalo, NY, KIRO-TV in Seattle, and KSL-TV, Salt Lake City, Utah carry the CBS Teletext System.

CBS also uses this Teletext System to insert closed-captioned programs for hearing-impaired viewers. It is estimated that less than 2,000 homes in the United States have any form of teletext decoders or television sets with special adaptors enabling them to receive any teletext service.

ZENITH TELETEXT SERVICE

Zenith began research and development in teletext in 1978, becoming one of the first American electronics manufacturers to actively pursue the new communications medium.

Here is a brief synopsis of Zenith's research and development efforts in teletext: **Figure 6.10.**

1978. Early broadcasts of teletext were originated at KSL-TV in Salt Lake City, Utah, and KMOX-TV in St. Louis, Mo., where Zenith color TV receivers were equipped with teletext decoders based on the proven British standards.

1979. To investigate the many possibilities of videotex, Zenith engineers built a special computer-controlled display generator that has been widely used as a part of the industry development work at Zenith.

Zenith was approached by Satellite Syndicated Systems, Inc., (SSS) in its search for teletext decoders suitable for use with a satellite-delivered newswire service, now called CableText in the United States. Company researchers built a breadboard decoder using about 100 integrated circuits for full capability (40 characters by 20 rows) British teletext.

1980. Interest in reducing decoder complexity, together with equipment orders from SSS, led to the introduction of the Virtext teletext decoder. As new integrated circuitry became available, the decoder was reduced to some 35 silicon chips—a practical decoder design.

As an extension to the Virtext decoder later that year, Zenith developed the Virdata system which allowed the SSS satellite-delivered services to feed additional cable TV systems.

1981. A separate Videotext Engineering Department was organized at Zenith as part of the Cable TV Products Division in January 1981. In its first year, the videotext research and development operation posted several significant developments:

- Design of a 25-inch, color TV sets with built-in teletext decoders.
- Development of prototype 13-inch viewdata terminals.
- Design of a special encoder for Telidon (the Canadian Standard) graphics.
- Preliminary research and development of a decoding system for full-field teletext based on the standard now known as North American Basic Teletext Specification (NABTS).

Decoder-equipped, 25-inch diagonal, color TV sets developed using British teletext technology were used in a teletext field trial by Field Electronic Publishing (now KEYCOM Electronic Publishing).

The Chicago-KEYCOM venture was the first commercial broadcast teletext experiment authorized by the FCC. Teletext receiving equipment was supplied to Taft Broadcasting Co., another teletext pioneer, for a similar teletext operation in Cincinnati.

The videotex engineering staff also designed a versatile teletext module that could be incorporated in either set-top or built-in teletext applications. This module included a remote control interface, allowing smooth integration into existing systems, and advanced display characteristics: 40 characters by 24 rows with 15 colors.

At the Western Cable Show in November 1981, Zenith introduced a special teletext decoder called Z-TEXT using this same module. Z-TEXT was developed for use with Zenith's tiered, addressable cable television system, Z-TAC.

Also in 1981, several customers expressed interest in 13-inch viewdata terminals. Prototype terminals, designed and built to Prestel specifications, offered full-color display and a detachable keyboard. Memory stored the user ID and terminal configuration characteristics. Several of these units were on display at Videotex '82 in New York.

1982. With the growing numbers of experimental teletext operations in 1982, Zenith supplied specially designed decoders to Time, Inc., for the field trials in San Diego, Calif., and Orlando, Fla. (Time ended its San Diego field trials in early 1984.)

The Time, Inc. operations offered full-field North American Basic Teletext Specification (NABTS) teletext. The special Zenith-designed decoders consisted of a Z-TAC cable TV decoder and a second module that includes a sophisticated teletext decoder system.

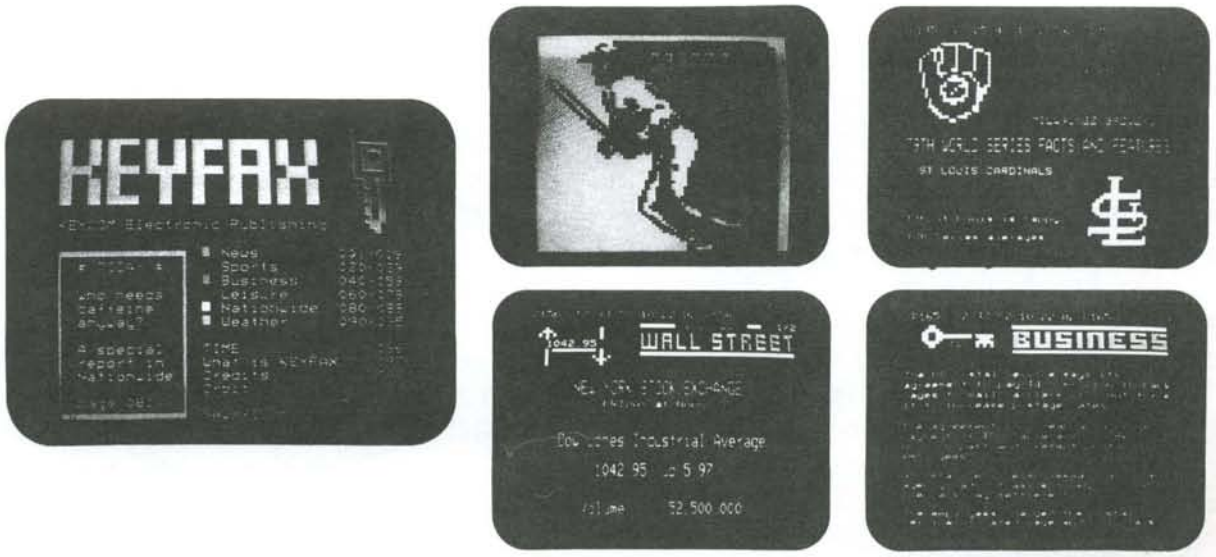


Figure 6.9 *Several of the indexes that were offered by the Keyfax System.*

In June, Zenith introduced its new full-field Teletext Decoder. Full-field teletext uses a full cable channel providing access to up to 5,000 pages of world, national and local news, weather, sports, financial, and other fast-breaking information as well as special features and services such as computerized banking and shopping.

1984. Zenith teletext equipment made an appearance at the 1984 Summer Olympics. Visitors to the Los Angeles area received up-to-date news and information on the games through the company's teletext decoders and color television receivers placed at the Olympic sites, hotels, airports, and other high-traffic areas.

Field trials of the Zenith full-field WST system will begin this year. Current work at Zenith focuses on enhancements to existing products including full-channel teletext.

Zenith is also bringing videotext, the communications technology of the future, into the present with a new personal computer (PC) and personal information terminal. The Z-150 PC, an IBM compatible personal computer introduced by Zenith Data Systems Corporation (ZDS), and the low-cost ZTX-11 computer terminal already are being used by small businesses to retrieve videotext.

More significant are the broad videotext applications for these products in the future. Personal information terminals and personal computers have laid the groundwork for the burgeoning videotext industry. Thousands of Americans use videotext today—services such as Dow Jones News Service, the Source, and AgriData.

The computer and the terminal both have the capability of accessing these established videotext services to receive the latest news, sports, weather and stock prices. With the appropriate software, either could be used for banking and shopping from home; in fact, almost anything in printed form eventually could be accessed: airline schedules, theater times, restaurant hours, even telephone listings.

The ZTX-11 has exciting videotext applications for the future because of its built-in modem and automatic dialer that can access not only computer information networks, but also business and educational mainframe computers; and unlike many terminals available today, with the ZTX-11, users can access data bases with just one key stroke.

Likewise, the Z-150 is promising because its full-color graphics capability will allow it to display more sophisticated forms of videotext once the software becomes available.

Zenith's broad experience in high-quality displays, teletext and computers provides a solid foundation for growth in the emerging videotext market. The Z-150 and the ZTX-11 are part of the ZDS line of desktop and microcomputer systems, video monitors, terminals, and software. See **Figure 6.11.**

The recent announcement by the Taft Broadcasting Company of Cincinnati, Ohio prompted a quick trip to the area to pick up a new Zenith decoder from the Tracey-Wells Company, the local Zenith distributor. After picking up my decoder, I visited several local Zenith dealers to get the full story and see this system in operation with Taft's WKRC-TV station. All in all, I was impressed with Taft's new "Electra" service; the programming was good, the news, business, and other offerings seemed worthwhile.

One final stop to a dealer on the way home was indeed an eye opener! This dealer was in the process of doing what I was to do in a few hours; he had a satellite set up and was attempting to pick up a teletext signal direct from the satellite's transponder. After a few minutes, he lead me to the service department to show me how he did the job.

The Zenith decoder was designed for use with the new Zenith Smart Component TV Systems now on the market. While I liked the new Zenith system, I had no plans to purchase this system just to do the teletext bit because I had just purchased a complete Sony system.

A quick look at the back of the decoder showed an input with "F" connector and an 8-pin DIN plug as an output to the TV set up. A 15-minute study of the schematics on the decoder, and the input of the Zenith system showed the output from the DIN plug to the TV (or monitor), to be the standard red, green, and blue signal input. Another 15 minutes were spent making a few sketches of both units, plus the Sony input, which solved my upcoming problem—connecting the Zenith decoder to my Sony monitor. At this point, I went back to the dealer's setup in the service department to learn the following:

(A) The Zenith decoder works great as long as you have a clean sparklie-free transponder (WTBS) signal. After this point, I found it necessary to fine tune the (WTBS) signal to

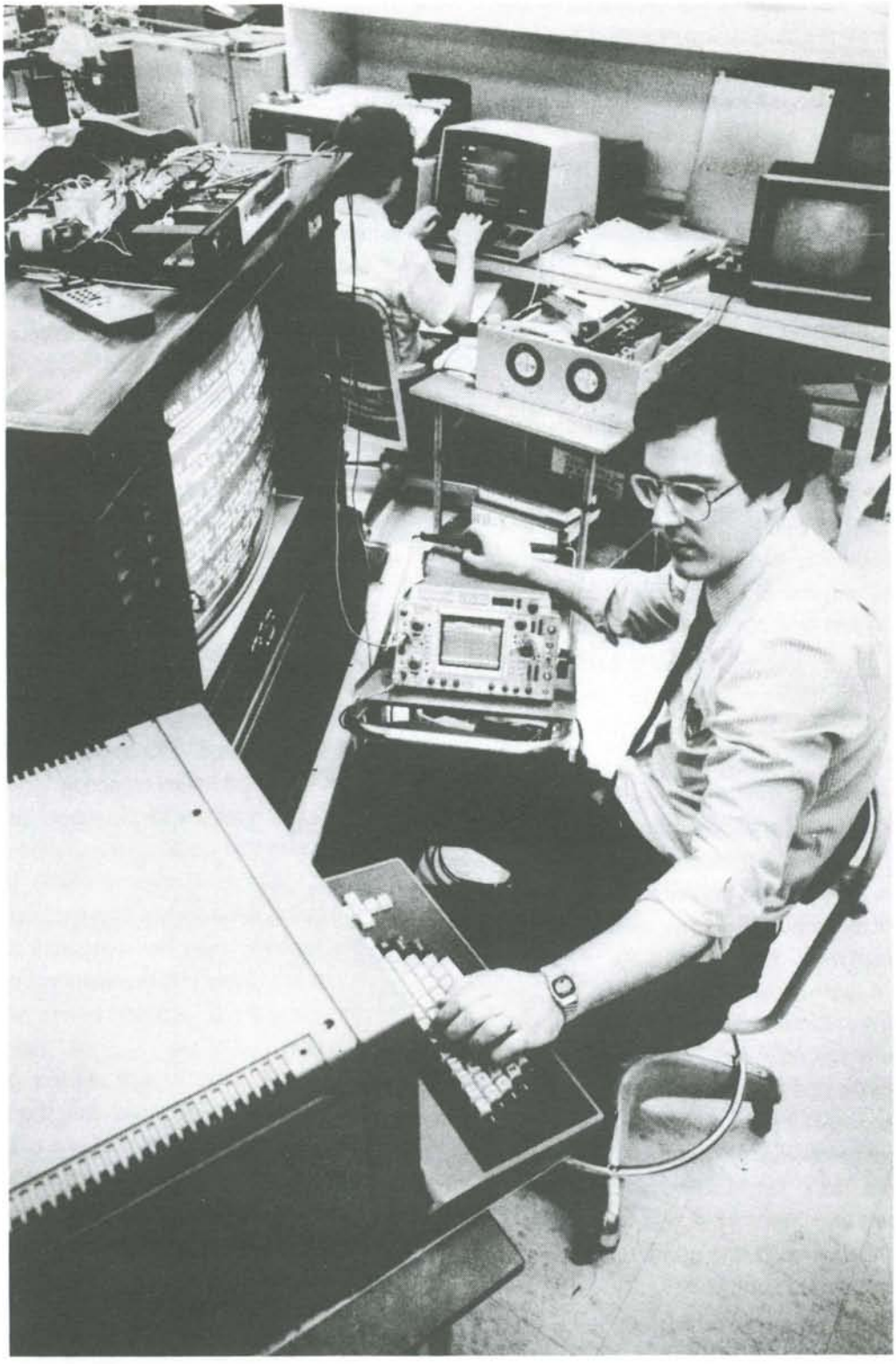


Figure 6.10 *Zenith Researchers have been actively pursuing research and development in videotex and teletext technology since 1978. Above, Gregory Woodsum, manager of videotext engineering, tests a World System Teletext decoding system at the company's Technical Center in Glenview, Ill.*

get error-free reception of the teletext service. With transponder 18 the weakest signal on G-1, some TVRO setups might have a problem with teletext reception.

(B) A 10-foot quality antenna would be the minimum size that would give error-free copy. The TVRO receiver should be stable. If not, you are going to be jumping up and down to tune the receiver every few minutes. I don't think some of the low-end receivers will do the job; therefore, try a decoder before you buy if possible.

(C) The Zenith decoder puts out red, green, and blue signals to the video unit; therefore, you must use a new monitor or one of the newer generation component TV systems to use this unit. It is possible to bring out the red, green, and blue inputs on some TV's; your service dealer should be able to do this at a reasonable cost.

(D) Don't look for any audio on the teletext service, there isn't any. If you desire audio you could tune one of the many music programs found on the audio subcarriers of (WTBS) with a stereo processor.

The cost of the Zenith unit is under $300, and you should be able to purchase a unit from any Zenith dealer or distributor in the area that is now in service (e.g., Zenith Radio Corp., 1000 Milwaukee Avenue, Glenview, Illinois 60025, phone 412-391-8181).

ANOTHER OVERVIEW OF TELETEXT

Teletext is digital data that is sent as a part of the regular TV signal, be it on direct satellite, cable, or regular broadcast TV. There are 21 scanlines that are not used to carry the regular TV picture data. These form the vertical blanking interval, or VBI. This VBI section can be seen as a black bar between the top and bottom of the TV picture when the TV set's vertical hold adjustment is tuned to show a slight roll-down of the TV picture. The VBI area will run across the top of the picture.

When the VBI area is carrying data, this bar will appear to have a wide band of sparkles running in it. These light and dark bits seem to move around or dance in this VBI area; these are the data sections that are carried within these 21 unused lines.

To Dx or find hidden teletext, simply detune the vertical hold adjustment until the TV picture takes on a slow roll; then tune through the satellites and cover all transponders to find the transponder that is carrying VBI data plus other data.

Teletext is made up of individual screens or pages containing text and graphics. These pages are composed at the programmer's and then sent via computer as an endless loop of data. At the uplink site, the digital data is inserted into the vertical blanking interval of the outgoing video signal and is broadcast along with the regular video signal.

All that is required to receive teletext is a reasonably good noise-free video image and a teletext decoder. Some decoders have a built-in TV tuner that covers all of the VHF and UHF TV channels; others have no tuners and require a pretuned composite video signal from a satellite receiver, VCR, or component TV tuner.

The data for the teletext pages is transmitted serially as the pages on the teletext. The data for page 1 is sent first, then the data for page 2, and so on to the last page in the system; then page one is sent again as an endless loop. Several of the services use about 100 pages of text and graphics.

The average data rate is approximately 13,000 bits per second per VBI lines used.

To access any page in a teletext magazine, you simply enter the desired page number into the decoder unit via a hand-held keypad. When the called page runs by, the teletext decoder extracts the data that makes up that page and displays it on the TV screen. The greater the number of pages a service contains, the longer it will take to display the desired page; therefore, most services carry from 25 to 200 pages which gives a workable system.

TELETEXT FORMATS

As we have discussed in other sections, there are several popular (VBI) teletext formats. One is the old British Standard now known as the World System Teletext (WST) which is the most widely used in Great Britain, Australia, much of Europe, and the United States. The World System system has had more years of use and is relatively inexpensive to use.

The other teletext format used in the USA is the North American Broadcast Teletext Standard (NABTS). The NABTS does have a slight edge on the graphics and has been used and supported in the United States by the major networks such as CBS, NBC, plus AT&T and IBM. The NABTS has a number



Figure 6.11 *Zenith's terminal, Model ZTX-11, can be used to access established videotext services. This terminal will also access other data services.*
Courtesty Zenith Corp.

of drawbacks and is more costly to use; and as a result, it is not now in wide use and it is unlikely to be in the future.

TELETEXT SERVICES USING WST FORMAT

At this time, the WST Format Teletext is being used by several major services being distributed via satellite to cable operators in the U.S. The widest distribution is in the form of three magazines: First is the Electra Service by Taft Broadcasting Company which carries a 10-page general interest magazine covering the latest news, sports, statistics, business information such as Dow Jones' money rates, weather, etc. Electra is broadcast on Galaxy I, transponder 18 (WTBS) and on Satcom 3R, transponder 6. **Figure 6.12.** Second is the Cabletext Service which is carried along with the Electra Service. Electra is carried on pages 100 to 199 and Cabletext on pages 200 to 212. The Cabletext pages carry stock prices on the New York Stock Exchange and over-the-counter stock prices. **Figure 6.13.** The third is Infotext which is carried on Galaxy 1, transponder 22. The Infotext Service is produced by the University of Wisconsin and carries a range of agricultural bulletins and other items of interest to farmers and gardeners. The service also carries AP news, detailed weather information, and other features of interest to non-agricultural users. **Figure 6.14.** There are other VBI services which are easy to find by using the method outlined in this section. You may not be able to receive all of these other services as they could be using other teletext formats.

NEW DICK SMITH ELECTRONICS TELETEXT DECODER KIT K-6315

This new and simple teletext decoder kit sells for under $200 and is the most simple and best performing (WST) teletext decoder that I have found to date. The unit should not be difficult for anyone who has average soldering skills and has intermediate kit building experience.

The heart of the Dick Smith Electronics Teletext Kit (DSE) is the preassembled and aligned Mullard VM6780/2 decoder module. This module was designed for future incorporation into television sets. The module is mounted on top of the main board which the owner must assemble. This board assembly is straightforward and only requires proper parts placement and proper soldering of these parts.

The Assembly Manual is easy to follow as each step is called out with proper instructions and photos. After assembly, the unit is put through a simple text and alignment procedure followed by the decoder hookup to your satellite receiver.

The DSE K-6315 decoder is controlled by a hand-held keyboard which is simple to understand and use. The Dick Smith group has a "Sorry Dick it doesn't work" return coupon for the unit which guarantees, for a small fee, that the decoder will be put in working order. **Figure 6.15.**

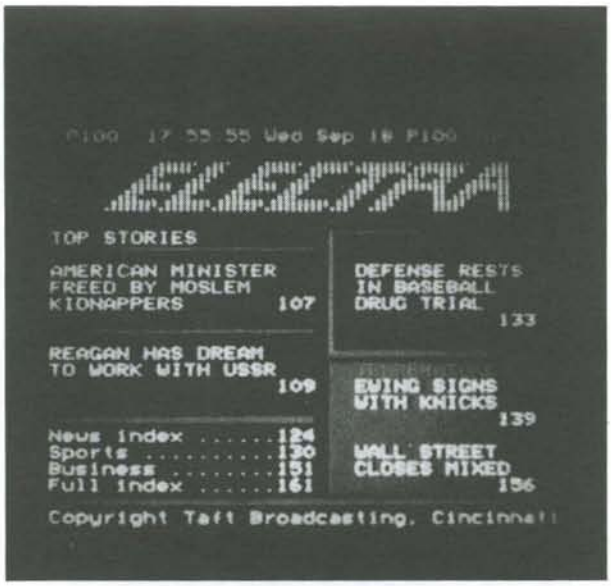




Figure 6.12 *Taft Electra Service, front menu and one sports headline page.*

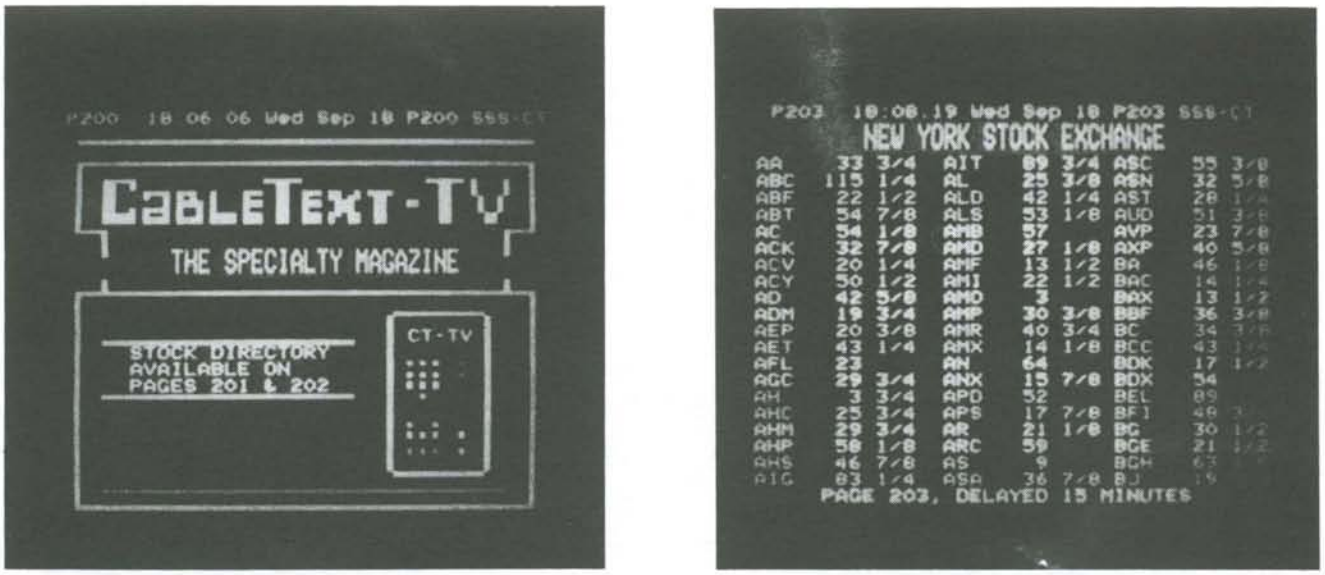


Figure 6.13 *Cabletext Service, featured page and one page of NYSE Service.*

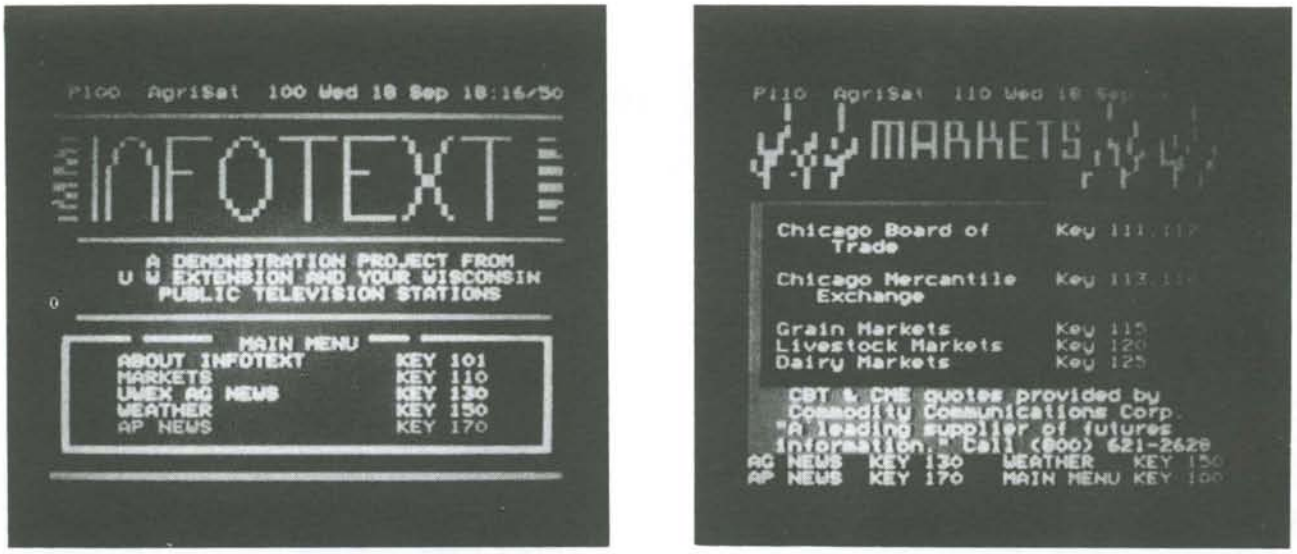


Figure 6.14 *Infotext Service showing main menu and market data.*

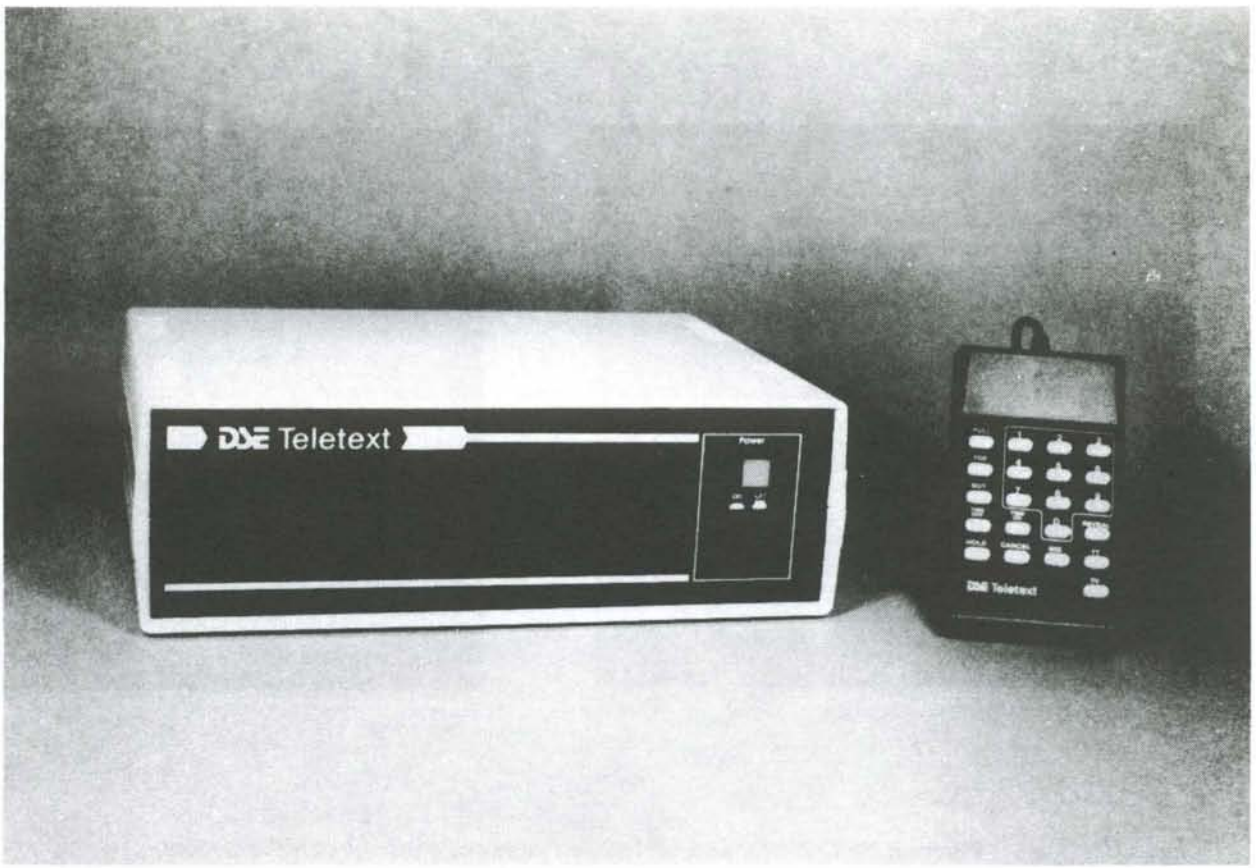


Figure 6.15 *Dick Smith Electronics teletext decoder with hand-held controller.*

STOCK MARKET

Overseas Report, plus Pre-Opening "Outlook," capsulated versions of columns "Heard on the Street" and "Abreast of the Market." After the market closes — 10 Most Active Composite Trades on NYSE and AMEX — Hourly Most Active Stocks on NYSE and AMEX — Closing Prices 300 Most Active — NASDAQ Closing — Market Diaries — NYSE, AMEX and NASDAQ — Consumer Interest Rates — Lipper Municipal Bond Fund Index — Complete NYSE Exchange Prices — Capital Markets — Commodity Reports and Future Markets — Gold and Silver Markets — Dollar Market — Business News — plus an extensive weekend report with many features from the Wall Street Journal and Barron's columns and features on a selected basis.

ASSOCIATED PRESS NEWSCABLE

AP Cable News, on the SSS VBI section on Galaxy 1, transponder 18, features 24 hours per day, seven days a week of national and international news, sports, and business reports from the Associated Press Bureaus worldwide.

This service is text in nature, is a cable pay service, requires a special VBI Decoder Unit not now available to the individual subscriber. **Figure 7.2.**

"UNIQUE" SATELLITE SERVICES GENESIS

In the unique category, is a service known as Genesis Stoytime. This service is transmitted on F3R TR 3 (CBN). It is not transmitted in the VBI, but instead, by means of the subcarrier. A modulated tone is transmitted. To decode the signal, one uses what is essentially a "videotex" terminal. Instead of hooking the videotex terminal to the telephone lines, it is hooked up to the audio output of the subcarrier demodulator. The operating system is *NAPLPS*, which is the videotex version of NABTS. In layman's terms, they are using the North American videotex system rather than the French or British system. There is a significant cost savings involved, and the terminal equipment is more widely available from such sources as AT&T, Electrohome of Canada, Norpak of Canada, AEL Microtel of Canada (a GT&E subsidiary) and soon, *Sony*. Terminals cost roughly $1,000 for the Genesis Storytime system. It *might* be possible to get pictures on an IBM PC using some special software. Genesis transmits children's stories with graphics and texts. Cable operators are picking up the text using Wegener audio demodulators, and they take the decoded videotex pictures and remodulate them on a full channel of their cable systems. SSS is handling the marketing of the service in the U.S. Thus, using a narrow bandwidth and high resolution, TV graphics are transmitted. **Figure 7.4.**

STOCK MARKET TELETEXT SERVICE

Satellite Syndicated Systems has begun offering a current stock information service. They are transmitting information on over 500 companies that trade on AMEX, NASDAQ, OTC, and The New York Stock Exchange.

The trading information is continuously downloaded for consumption of the viewer. All stocks are listed in alphabetical order. The standard unorganized ticker service is transformed into a simple format that is easy to use.

Teletext decoders are necessary for receiving the service. The cost to cable systems is $4.95 per month rental or $299 for outright sale of decoder. At this time, the service is free to cable companies and arrangements are being made to furnish this stock service to the home TVRO market. The signal is transmitted on WTBS,s VBI.

SSS is also planning to introduce several other cabletext-TV consumer services in the near future. These are: a sports ticker service and a personal computer service containing stock and commodities information in real time. These new services will be introduced in the near future.

BEETS DATA SYSTEMS

Located on Galaxy 1, transponder 18 Vertical Blanking Interval is the BEETS Data System which is a basic commodity trading service that provides real-time commodity quotes and financial information for down-loading into a home computer setup. It furnishes charting for 20 commodity classes, lists 100 contracts on 10 pages of text. This system is menu-driven and a subscriber can choose materials from listings.

An Apple Computer is the basic hardware with the software furnished by the BEETS organization. An additional decoder box is required along with a serial board, if required, to drive your serial printer.

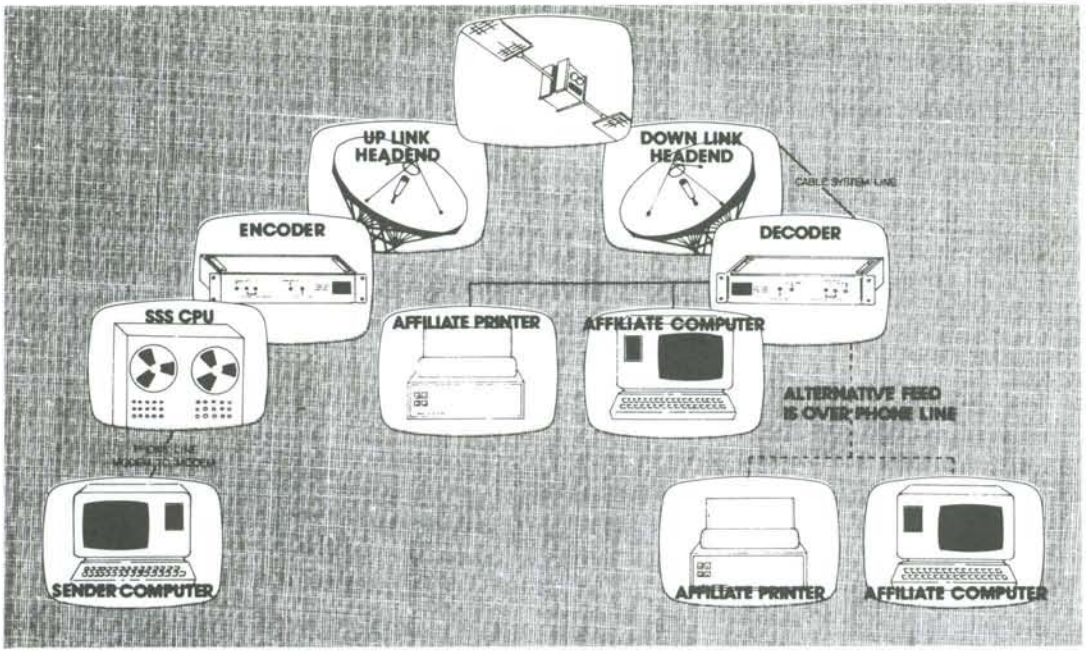


Figure 7.0 *The Program Information Network (PIN) system.*
Courtesy Satellite Syndicated Systems, Inc.

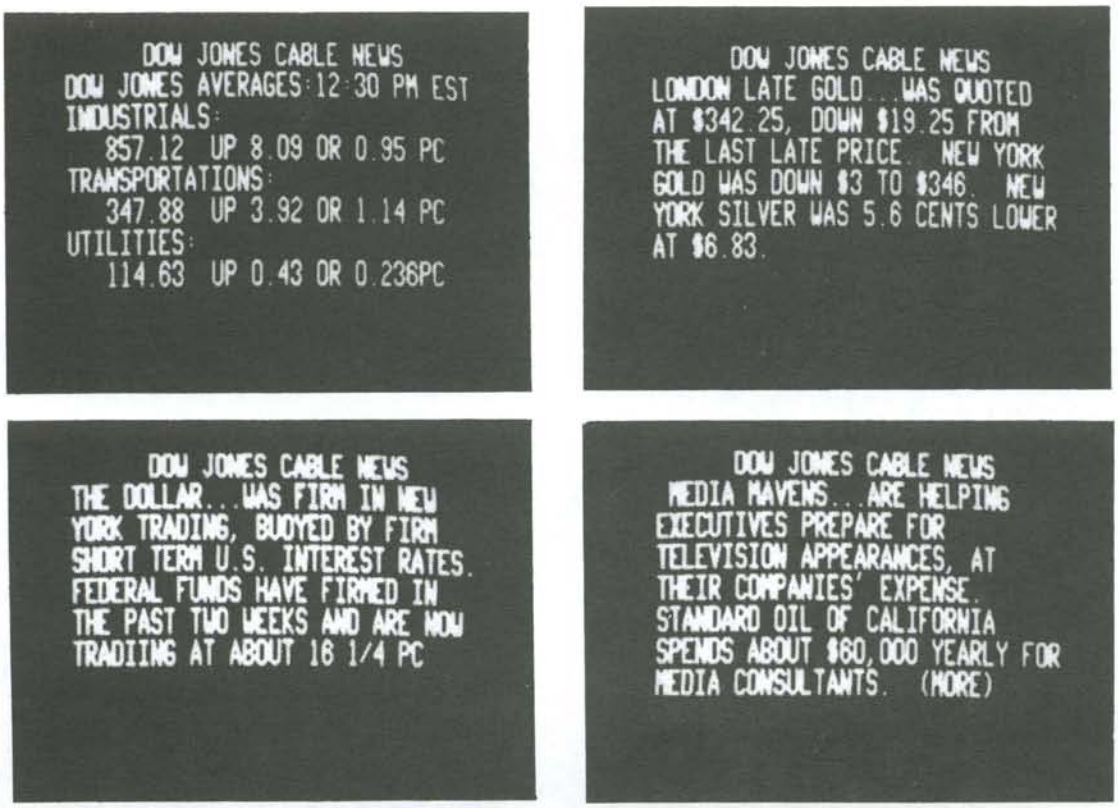


Figure 7.1 *The Dow-Jones service carries many types of business information and news.*
Courtesy Dow-Jones

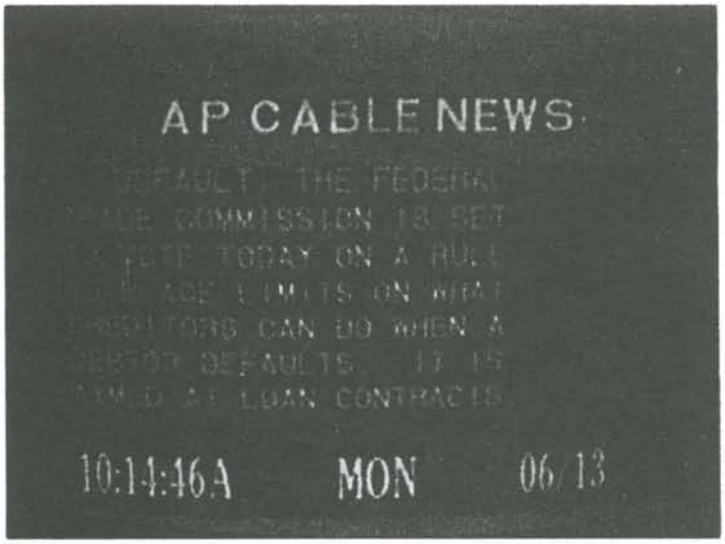


Figure 7.2 *Sample of screen of AP Cable News Service.*

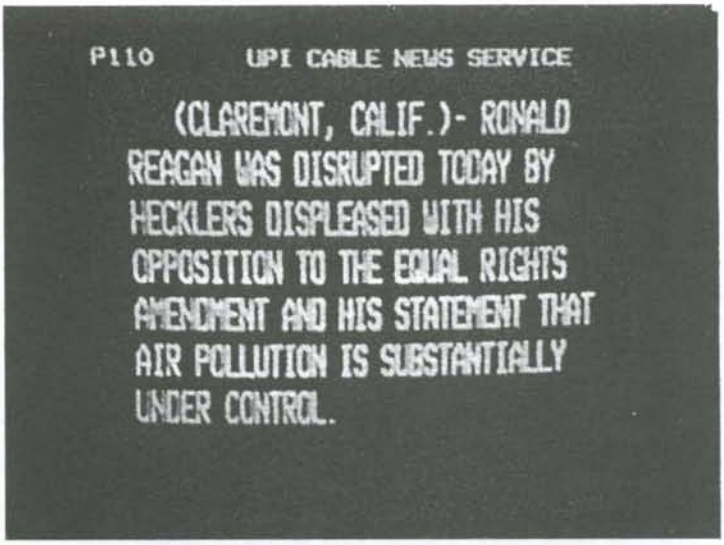


Figure 7.3 *Screen sample of the UPI Cable News Service.*

This is a basic 300-baud rate service furnished through the CableText services for decoding of the commodity information at the subscriber's home or office in conjunction with a computer and/or printer.

BONNEVILLE DATA SYSTEM

A new and very novel means of data transmission and complete commodities coverage is offered by the Bonneville Telecommunications Data Systems Division. This system is known as Market Monitor® and uses Bonneville's satellite and FM station networks to relay the data to the subscribers.

This series relay starts with an uplink of the commodities data to the satellite, downlinked to a local FM radio station in the subscriber's area. The subscriber has a decoding box which attaches to an FM radio to decode data on the subcarrier in the FM signal. This network utilizes many FM radio stations by using the capability of their audio subcarrier. After receipt, the data is then routed through an IBM personal computer. Naturally, the IBM PC requires the use of their proprietary software in order to select and read the desired data.

The Bonneville System gives complete commodities coverage and provides true tic-by-tic coverage of the following markets: Precious Metals, Financial Instruments, Agricultural Commodities, Cash Markets, and Petroleum.

The software package known as OCTOOL allows you to track the time of every tic, make graphs, set stops on over 80 commodities, and create a total history for each of these commodities. This service is widely used by many businesses and individuals who trade daily in the commodities market. This is not a VBI service.

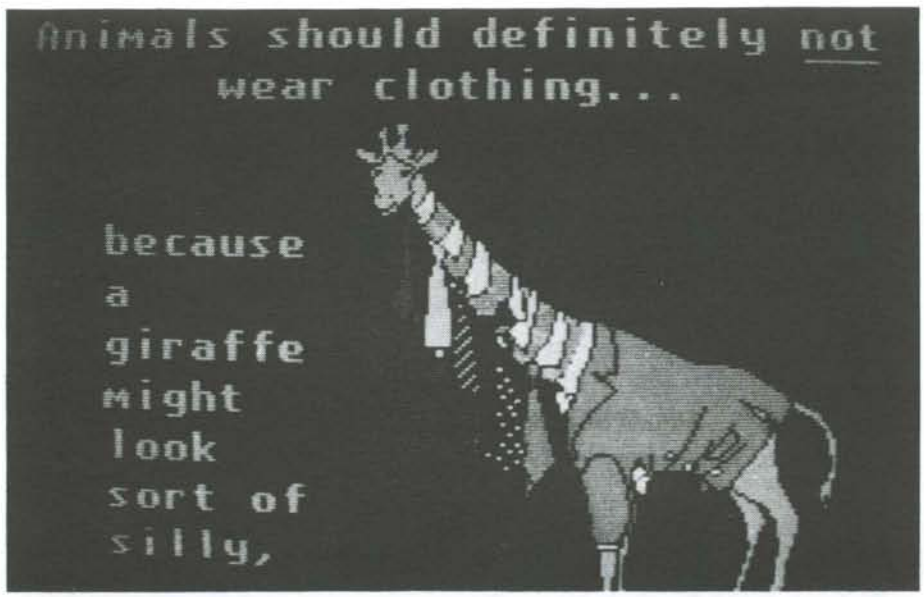


Figure 7.4 *Computer-generated children's storybook channel which displays full-color pictures and words on the screen page-by-page.*

CHAPTER EIGHT

MISCELLANEOUS SATELLITE SERVICES

REUTERS SERVICES

Reuters News services spans a time frame of over 125 years of continuous service to the public and business world. This highly respected name in the news-gathering world is also one of the pioneer users of the satellite systems and other state-of-the-art techniques in the modern communications world.

Reuters originally set up their monitor service for Wall Street brokers and financial houses. After years of successful service, the Reuters Monitor Service was offered to the general business world via satellite.

The service is transmitted off Satcom F3R, transponder 18 during the business day. Many think this signal and data is a scrambled video picture. It is not; it is a system of high speed data transmission developed by IDR, Inc., of Farmingdale, New York, a wholly-owned subsidiary company of Reuters.

This system uses a row-grabbing technique which converts the data and/or test into packets, from this point to a digital stream, and to a standard television format for broadcast to the subscriber's terminals. The subscriber's terminals can be hooked up to a cable system or to an over-the-air satellite receive-only system. The Reuters Service requires a special terminal with the proper software in order to receive the data and display the data on the terminal's CRT or on hard copy with the use of a dot matrix printer. The unit's terminals are addressable and can be activated only by the proper signals which are sent along with the data stream to turn on and turn off service to a defined terminal.

The Reuters System carries many forms of commodity, stock price quotations, money market prices, foreign exchange, plus a wide range of general interest and business news. The nature of the data carried requires the Reuters System to be accurate and free of errors. Because of this high quality, the system is constantly checked for low-error rates.

The Reuters signal can be transmitted as an FM double sideband signal or at video baseband. Reuters terminals will display up to 64 characters on 18 lines and are capable of carrying up to 1,000 pages in the system. **Figure 8.1.**

The Reuters Monitor Service covers the following information groups with many pages of information:

Money/Financial Futures
Grain/Livestock
Metals
Soft Commodities
Coins
Energy
Securities
News/Business
International News
Contributed Information
Plus other information

Private individuals may lease the Reuters terminals and use their present TVRO systems to receive the data off the air. Contact Reuters, 2 Wall Street, New York, New York, 10005, 212-732-7800.

REUTERS SMALL DISH SERVICE (SDS)

The Reuter Monitor Small Dish Service (SDS) combines proprietary state-of-the-art computer technology and advanced communications systems with Reuters renowned news and information-gathering superiority.

Utilizing the most advanced direct satellite transmission techniques, the REUTERS SDS SERVICE offers a highly affordable professional terminal that can be tailored to individual needs.

The SDS SERVICE offers up-to-the-second price quotations on almost all U.S. commodities and many foreign contracts as well. In addition, recipients will have access to the latest news and information affecting the markets as well as trading summaries and commentaries.

Detailed coverage of U.S. money markets and rates, foreign exchange quotations and reports, stock market reports, and Federal Reserve Bank activity is also available on the service.

At the heart of the system is a series of unique "personal pages," which allow the user to custom design screen displays to instantly provide the most desired information from the entire spectrum of available news and data.

The SDS SYSTEM utilizes a new generation REUTER-developed microprocessor and software designed to exploit the field of broadband satellite communications.

Broadband transmission makes it possible to access the Reuters satellite signal with a small receiving dish, which in the case of the SDS service, is a two-foot dish that can be easily mounted in any convenient location.

The small dish receiver allows the user to obtain the REUTERS signal 24 hours a day anywhere within the satellite service area (subject to line of sight). **Figure 8.2.**

Reuters small dish service covers the following information areas: Grains, Weather, Livestock, Business/Market, Foreign Exchange, Money, Metals, Energy, Sports, Gold, News, Stocks, plus others. The service carries many pages of information in each of the above categories.

A teleprinter service gives access to the highly-regarded report areas of information. These are: The Reuter Money Report, The Reuter Metals Report, The Reuter Commodity Report, The Reuter Grain and Livestock Report, and The Reuter Financial Report. This small dish service is an excellent service, it is desirable by the individual user because of the small dish size (24 inches), yet it provides all of the needed services.

This SDS Service is very complex in nature and is totally addressable by the company (turn "on" or turn "off"). The signal is contained in the same transponder as the main Reuters Monitor (text retrieval) Service. The service is available to individual users on a reasonable monthly rate.

REUTERS NEWS-VIEW SERVICE

Yet another information and news service from Reuters is their News-View Alphanumeric Text Service. This service has been in constant use for over 10 years and was originally a service for CATV operators.

News-View has been delivered by several methods: telephone lines and by Vertical Blanking Interval (VBI) on Galaxy 1, Transponder 18.

The service requires special VBI equipment to decode the signal, and it is not available to individuals on a monthly basis because the service is mainly a cable system news channel.

The service carries two types of information and programming. During the day its content is business and financial in nature with some news content; in the evening hours, the service goes to a sport and sports scores reporting programming.

News-View carries a 10- to 12-minute cycle of contents, so it is possible to gather an up-to-date news summary in a short time. A feature of the financial channel of News-View gives the real-time stock prices of the most active stocks on the New York Stock Exchange as well as key stock indices, company news, and key commodity news and prices.

COMMODITY COMMUNICATIONS NETWORK

On Satcom 3R, transponder 16, you can tune the audio subcarrier to 6.2 MHz and hear the digital audio signal of the Commodity Communications Corporation Network. This signal sounds much like buzzing bees or insects.

The CCC system utilizes several of the personal computers (e.g., Apple and IBM PC). The PC hardware and software service is called FutureSource™. The features of each computer system are shown in **Table I.**

(See Next Page)

The CCC system also has three other levels of services for users: these are the VQP-3000 system, the VQP-5000 system, VQP World News, and Compuquote.

THE VQP-3000 SYSTEM—As the most economical quote system, the VQP-3000 brings real-time prices, point and figure charts, and commodity news. The keyboard is user friendly; the function keys are marked for quick access to needed information. The monthly fee includes the appropriate mode of transmission for fast and efficient data delivery anywhere in the U.S.A. and Canada. These include the Associated Press Satnet System which was

FutureSource

FEATURES	IBM PC	APPLE
Charts	23 Rescaleable Bar Charts	16 Rescaleable Bar Charts
Programmable Pages	10 Programmable Pages. Each Page Tracks 14 Contracts	10 Programmable Pages Each Page Tracks 14 Contracts
Market MinderTM	Sets High & Low Price Limits on 14 Contracts	Sets High & Low Price Limits on 32 Contracts
News	Scrolling Video News with	Interface to World News
Last 5 Trades	Display Last 5 Trades of Preselected Contract, Time of Day—Last Trade	
Split Screen	View 4 Features at Same Time	
Spreads	Display 4 Contract Spreads at Same Time	
Group Format Displays	Displays Last Price, Net Change for Seven Contracts for Grain, Meats Stocks, Etc.	
Equipment Requirements	For IBM PC 128K, Also IBM Compatible Computers	Available for Apple II, IIe 48K or 64K — RAM

TABLE I

designed for the futures trader. **Figure 8.3.**

One of the features of this simple-to-use system is its single strike key system which brings up the requested information at once. The complete system covers: Seven Fixed Format Quote Pages on Grain, Meat, Metal, Money, Food Items, Financial 1 and 2, plus Petroleum.

Three additional programmable pages allow for formatting 58 contracts with all changes, trend indicators, high/low, and bid/offer on any programmed contracts.

An all-options page is furnished for every commodity showing last change, high/low, and bid/offer for all option months. Some of the other extras are two point and figure charts, which allow you to set scale, midpoint, and reversal for the commodities of your choice. These charts are updated automatically.

The five-page commodity news pages keep you abreast of current fundamental information affecting commodity prices. **Figure 8.4.**

THE VQP 5000 SYSTEM—This system is a complete quote system for the professional trader who needs technical and fundamental information in addition to real-time quotes. This quote processor was designed to assist in monitoring the market with efficient quote displays, rescaleable bar and point and figure charts, and a price alert system. Programmable pages let the user tailor the system to meet his individual trading requirements. The program can be interfaced with computers.

The VQP-5000 carries the following services and features: 12 Fixed Format Quote Pages, 10 Programmable Pages, All-Options Page, 10 Rescaleable Chart Pages, Market Minder™, Spread Page, and five Commodity News Pages. **Figure 8.5.**

For a small charge, VQP users can subscribe to a comprehensive news service, Commodity World News Service (CWN), which covers events pertinent to the futures markets more extensively than what is covered on the regular VQR System. Many editors, experienced in handling commodity information, gather and report the news as it happens. CWN sends in-depth reports on government and private sectors affecting the markets, weather, grain and



Figure 8.1 *Reuters Professional Data Terminal*
Courtesy Reuters

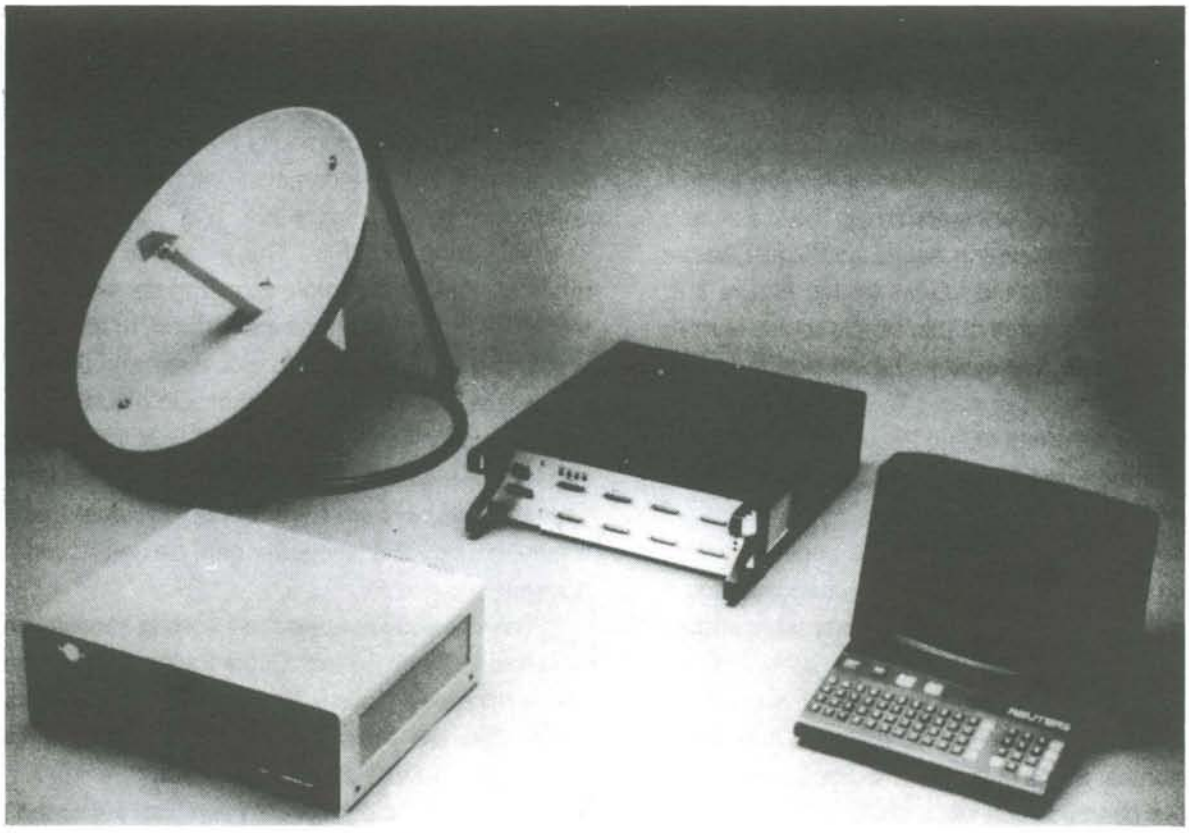


Figure 8.2 *Reuters complete small dish service equipment package with two-foot antenna and mount.*
Courtesy Reuters

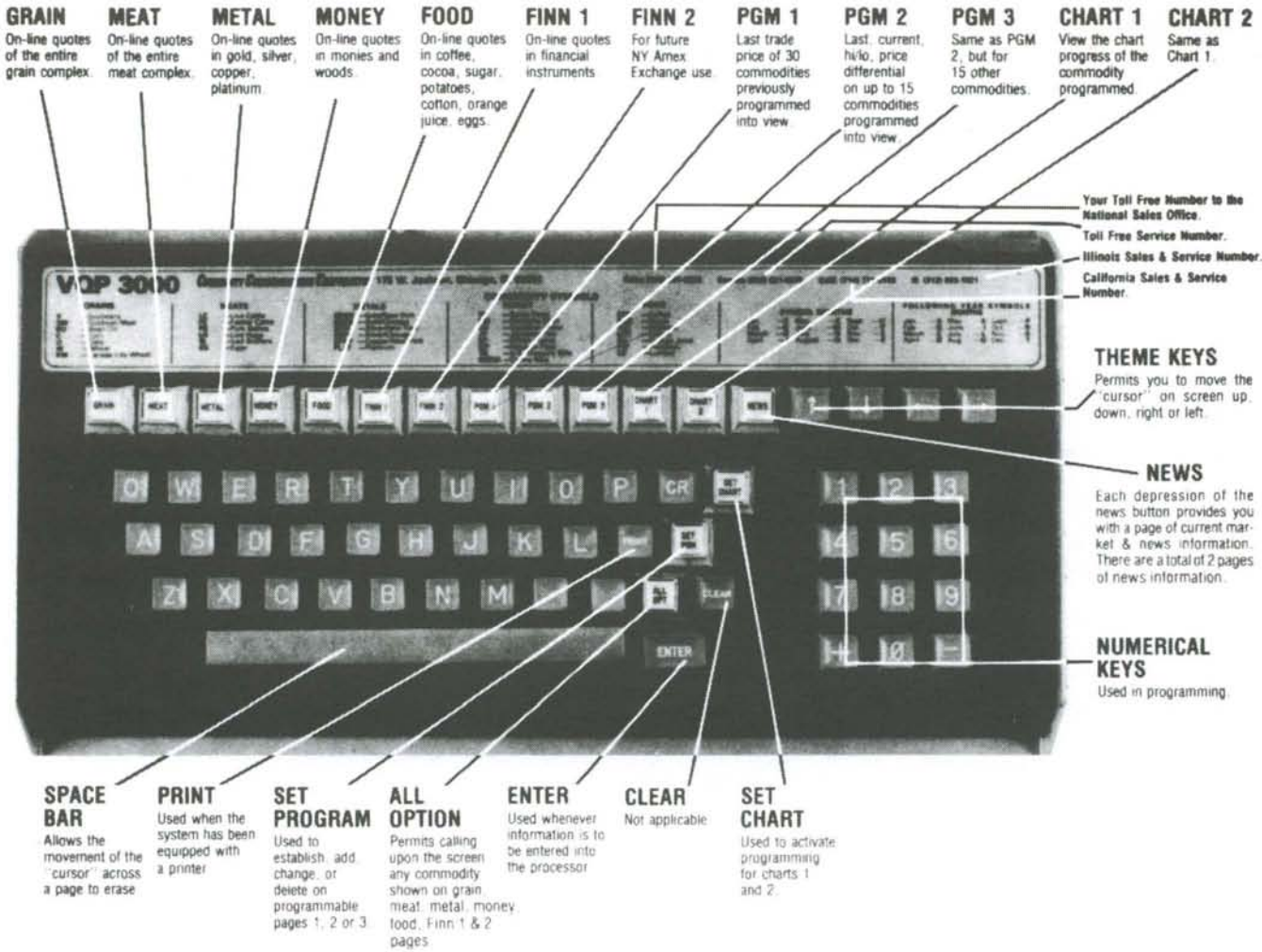
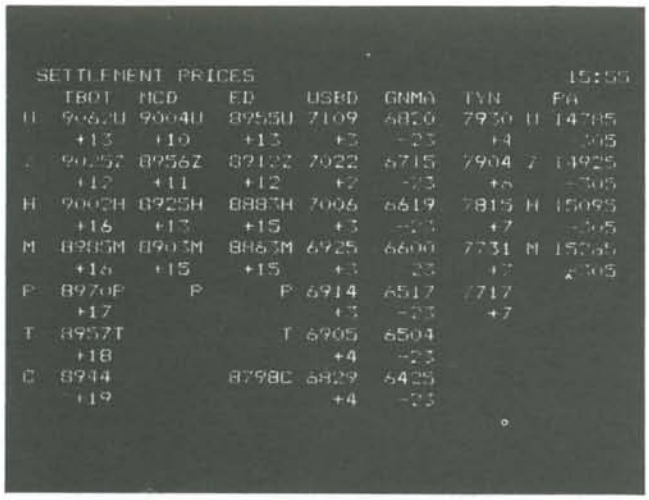
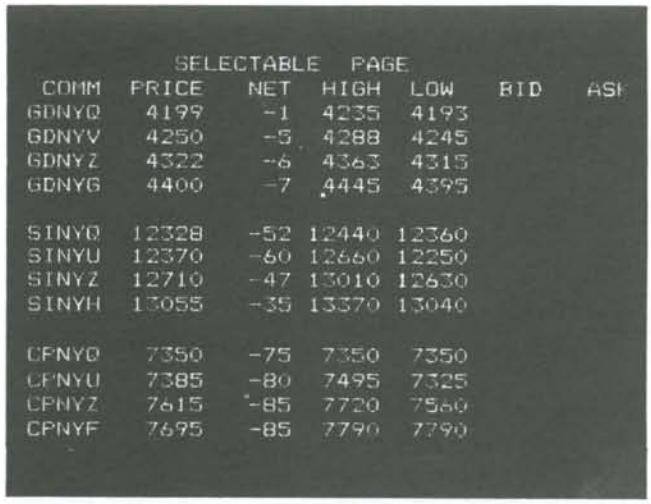


Figure 8.3 *The CCC VQP-3000 terminal showing all function keys and listings.*
Courtesy Commodity Communications, Corp.



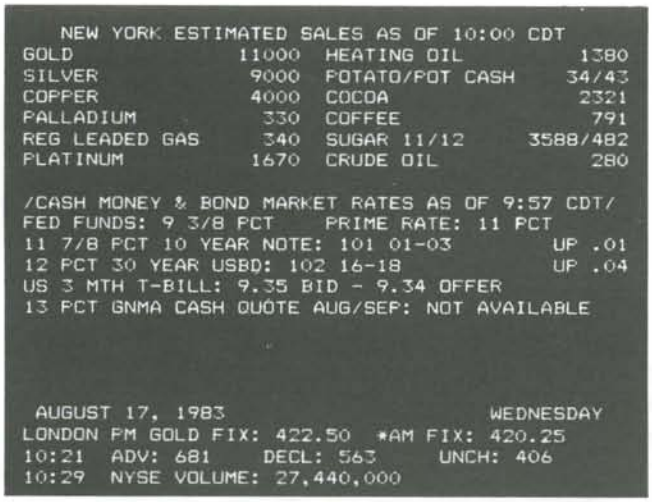


7 fixed format quote pages arranged by complex which display real-time prices. Screen shows last and change from previous close. Trend indicator appears when market reaches new high or new low for the day.





3 programmable pages allow you to format 58 contracts you monitor most displaying last, change from previous close, and trend indicator, high/low, and bid/offer appear for any contracts you program. Strike the key once more to see opening/closing ranges, volume/ open interest. Strike the key again for previous settlement and tick count.





5 commodity news pages keep you abreast of current fundamental information affecting commodity prices.

Figure 8.4 *Several screen prints of the services on the VQP-3000 system.*
Courtesy Commodity Communications, Corp.

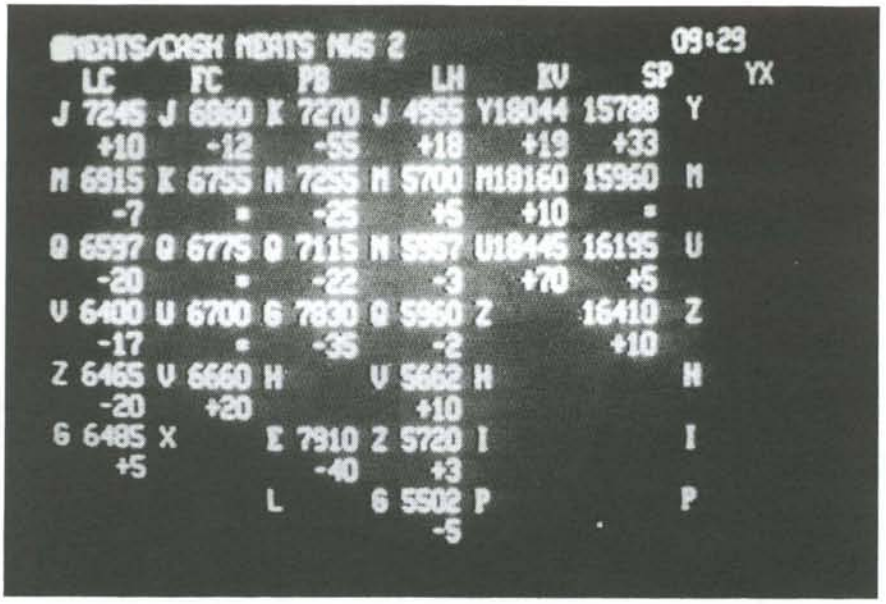


Figure 8.5 *Photo from screen of VQP-5000 terminal.*

livestock movement, floor trading from all major exchanges, financial auctions, and other sources. A printer must be used to receive Commodity World News.

COMPUQUOTE—This is yet another CCC service offered to the commodity traders and brokers. In short, it is a combination (single) commodity quotation and analysis system. CCC calls this an intra-day analyst. It is a program which tracks intra-day price movement of commodity futures contracts and concurrently performs technical analysis on this accumulated data.

The intra-day system operates on an Apple computer interfaced with a Commodity Communications Corporation VQP-3000 or VQP-5000 quote machine.

A summary of some of the Compuquote configuration is: Oscillator Program, Spread Program, Ratio Program, Momentum Program, Relative Strength, Stochastic Program, Point and Figure and Moving Averages.

CCC will furnish a two-foot or five-foot dish antenna and monitors for subscribers' use. **Figure 8.6.**

All CCC services can be printed with most standard dot matrix printers such as the Epson line with graphic features. The printers are furnished by the user or from Commodity Communications Corporation. There is now another fast and inexpensive way to reproduce the video information shown on the monitor screen. This new video printer from Mitsubishi is known as the P-50U Video Printer. This new video printer will print a total screen in about 15 seconds. The unit retails for approximately $500 plus. The P-50U will also produce photo quality prints about the size of a Polaroid camera print. **Figure 8.7.**

In summary, the Commodity Communications Corporation seems to have the most complete overall systems which can be purchased and used by individuals. These systems can be purchased at any level of needed information. **Figure 8.8.**

THE GALAXY DATA SYSTEM — PRESENT AND FUTURE

The successful launch of Galaxy 1 in June 1983 by Hughes Communications was the first in the three-satellite Galaxy system.

Galaxy 1 is primarily a commercial cable satellite located at 134° west longitude, followed by Galaxy 2 located at 74° west longitude, and Galaxy 3 at 93.5° west longitude.

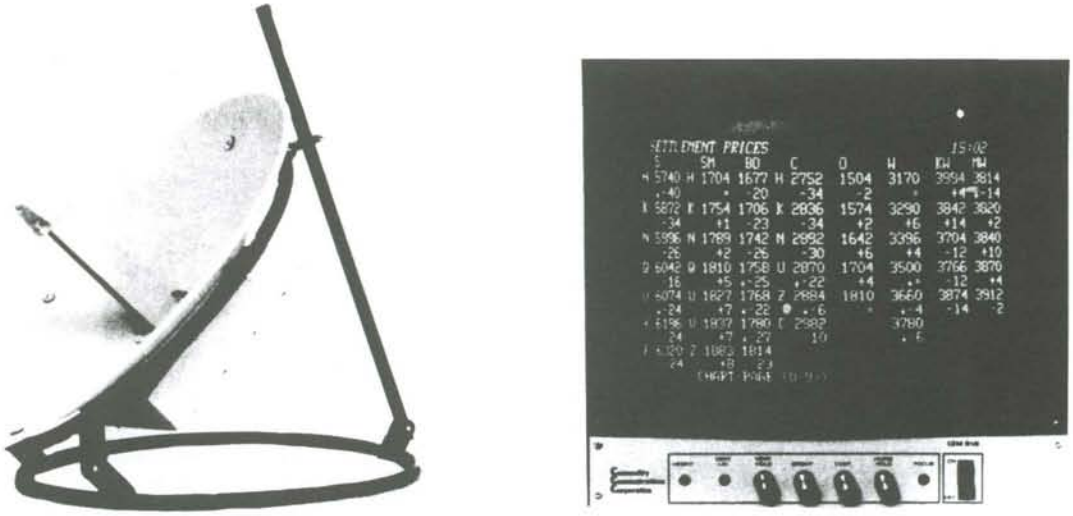


Figure 8.6 *Commodity Communications Corporation's two-foot dish antenna and monitor.*



Figure 8.7 *New Mitsubishi P-50U Video Printer with copy from the VQR-5000 system.*

occur when MCI begins receiving access to the rotary telephone market.

MCI will have access to the transponders through Hughes earth station facilities in New York, Los Angeles, Chicago, Dallas, Seattle, San Francisco, and Atlanta, as well as other earth stations to be constructed by MCI.

MCI provides a variety of domestic and international telecommunications services including long distance telephone services, paging, data services, private line telex and mobile radio.

The Hughes Group has also signed an agreement with Equatorial Communications for the purchase of satellite transponder capacity. This agreement provides for Equatorial's purchase of up to four transponders on Hughes Galaxy 3 satellite. **Figure 8.9.**

Galaxy 3 transponders will be used with Equatorial's micro earth station product line which utilizes both two-foot and four-foot diameter antennas. The system will use the spread-spectrum mode or type of transmission outlined in the previous chapter.

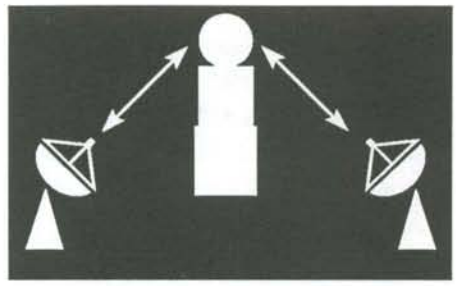
Equatorial's private data networks are currently used for the distribution of general news, commodity, and financial information. The company's customers include: Reuters, Limited, United Press International, Inc., Commodity News Services, Inc., and Market Information, Inc. Over 11,000 of its micro earth stations are in use and are located throughout the U.S., Alaska, Hawaii, and the Caribbean. **Figure 8.10.**

Galaxy 2 and Galaxy 3 are designed to serve the needs of the general business community and other data and information services.

HUGHES SATELLITE SYSTEM DESCRIPTION

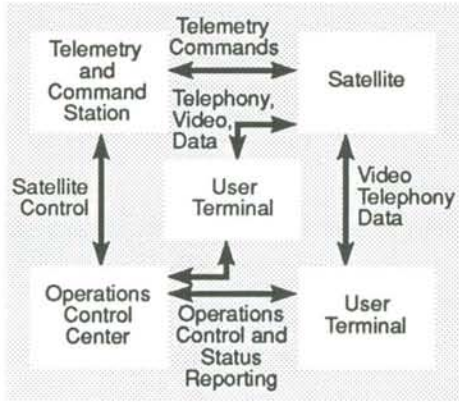
System Objectives

The Hughes Communications domestic satellite system provides facilities for C-band fixed satellite service to a variety of users within the continental United States, Alaska, and Hawaii. Users include video relay carriers, resale and value added carriers, specialized common carriers, public service groups, private companies, the federal government, and established telephone and telegraph carriers.



Satellite System

The system consists of two operational satellites at 74° and 135°W longitude, with a third satellite to be launched as user demand requires. All satellites will use the 4- and 6-GHz frequency bands for communications. The initial ground segment consists of two telemetry and command (T&C) receive-transmit earth stations, located at Brooklyn, New York and Fillmore, California, and an operations control center (OCC) at El Segundo, California. Additional receive-transmit and receive-only earth stations will be added to the system as necessary to meet customer demands. **Figure 8.11.**



System Operation

Uplink video, telephony, and data signals are transmitted from the user terminals at 6 GHz to the satellite where they are downconverted and retransmitted at 4 GHz. The OCC controls the satellite through the New York T&C earth station which transmits commands to the satellite and receives satellite status information. Satellite and transponder telemetry data are analyzed at the OCC which provides system and transponder status to the users.

Communications Satellite

The satellite is part of the HS 376 communications satellite family developed by Hughes Aircraft Company. It is spin-stabilized with a despun payload, and its antenna directs radiated RF power toward the continental United States, Alaska, and Hawaii. Power is generated through a series of solar cells on the exterior of the satellite; power capability is enhanced by the deployment of an extendible solar panel.

Seven HS 376 satellites are now operating. Three of the satellites, launched in November 1980, September 1981 , and November 1982, are providing communications services for Satellite Business Systems (SBS). Telesat Canada receives communications from Anik D, launched in August 1982, and Anik C, launched in November 1982. Western Union launched Westar IV in February 1982 and Westar V in June of that year.

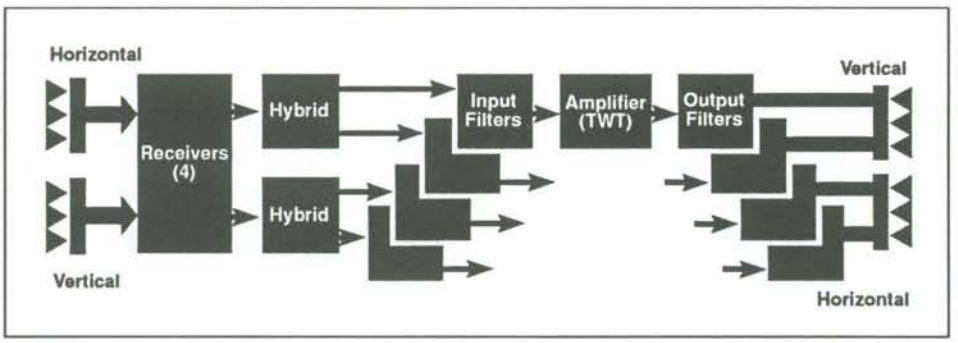
Eighteen satellites, including three for Hughes Communications, are under construction. Additional launches are planned for SBS, Telesat Canada, and Western Union.

Three ATT Telstar satellites, which will replace existing Hughes satellites. In addition, the Australian government has ordered three HS 376 satellites for its first national communications program to begin in 1985. The governments of Brazil and Mexico have also ordered HS 376 satellites for their communications satellite systems.

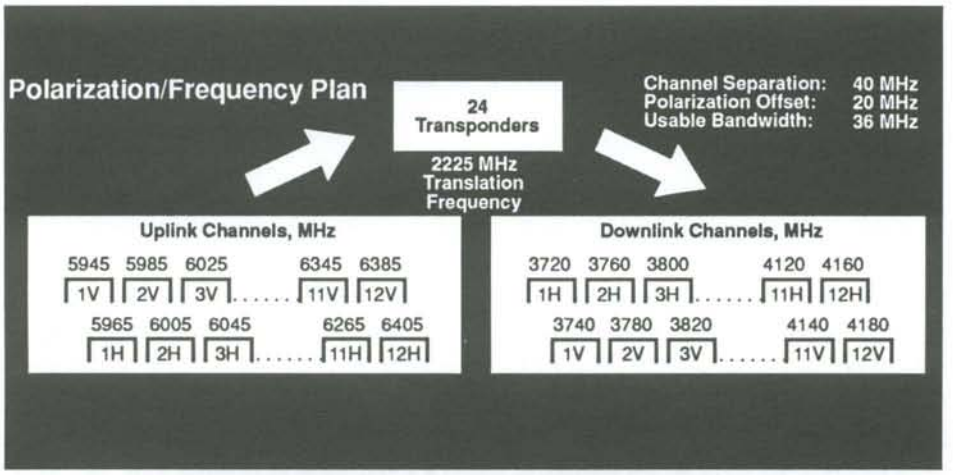
The HS 376 family allows considerable flexibility in communications payload frequency and transponder configuration.

Satellite Performance and Characteristics

The communications payload includes twenty-four 36 MHz wide channels, 12 vertically polarized



The communications payload uses a horizontally and vertically polarized antenna with associated feeds, receivers, 3 dB hybrid power dividers, input and output filters, and TWTAs with 9.0 watt output power.



The uplink channel center frequency band is from 5945 to 6405 MHz; the downlink center frequency range is from 3720 to 4180 MHz. Frequency separation between channels is 40 MHz. The offset between vertical and horizontal polarizations is 20 MHz, thereby minimizing interference levels. All uplink channels are translated by 2225 MHz to obtain downlink channel frequencies. Total usable bandwidth per channel is 36 MHz, standard for most U.S. domestic satellite systems.

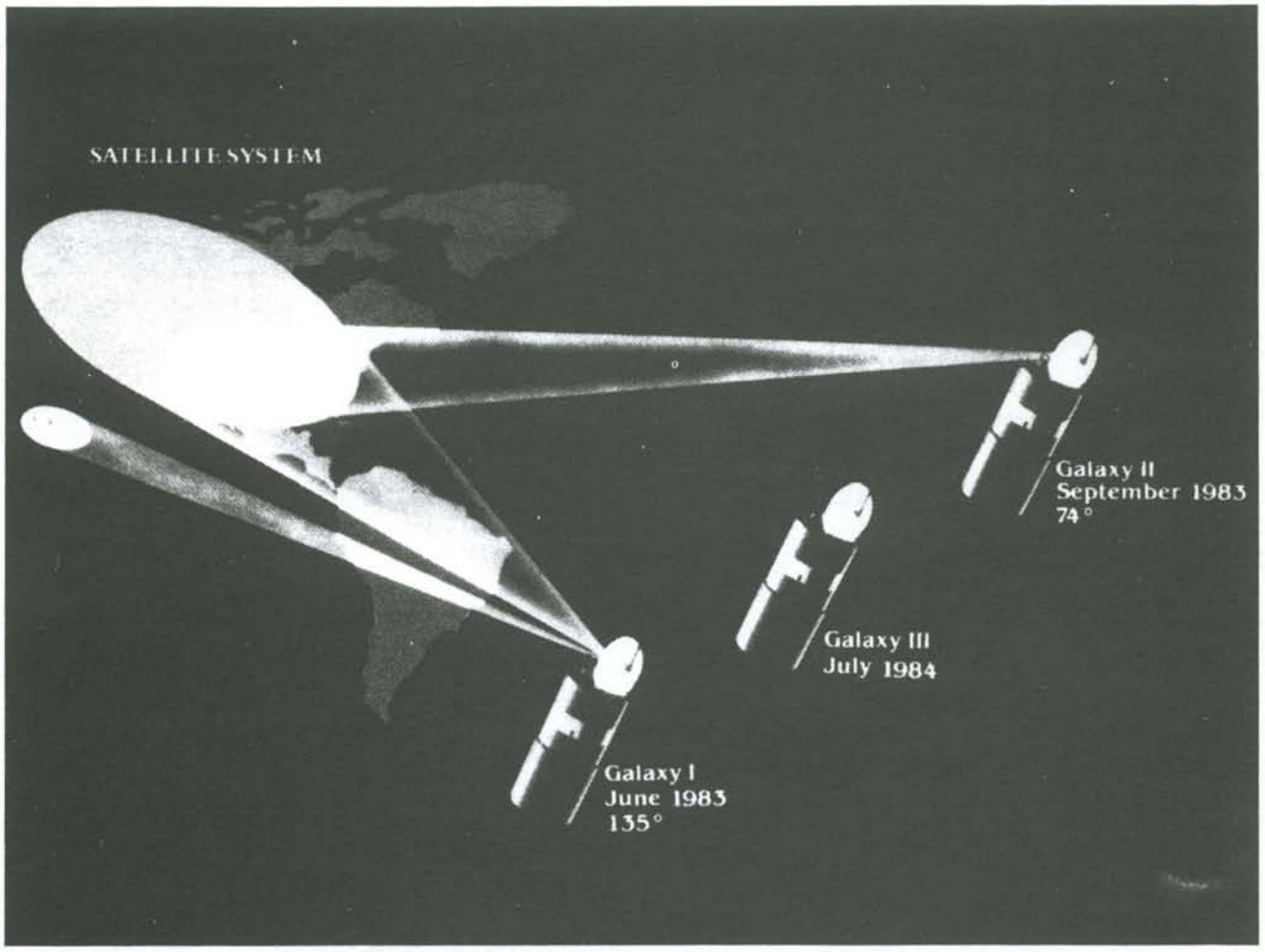


Figure 8.11 *The Hughes Galaxy Satellite System.*
Courtesy Hughes Communications

and 12 horizontally polarized. Each transponder produces 9.0 watts of output power. Six spare traveling wave tube amplifiers (TWTAs) provide the redundancy to increase transponder reliability. The communications antenna is a single reflector with dual polarized apertures. The satellite's mission life, determined by the amount of stationkeeping propellant stored onboard, is at least 9 years; it has a 10 year design life. Through the use of a hydrazine propulsion system, the satellite is maintained on station to within ±0.1 degrees in both east-west and north-south directions. A solar cell/battery power subsystem provides sufficient power for full operation during sun eclipse with 741 watts of DC power available at the end of the satellite's life. Satellite attitude is maintained through spin stabilization and a despun platform with pointing accuracy of ±0.05 degrees. The satellite's mass at the beginning of its mission life is 637 kg. An internal solid propellant motor, fired at the transfer orbit apogee to place the spacecraft in circular orbit, maintains the satellite at synchronous orbit altitude.

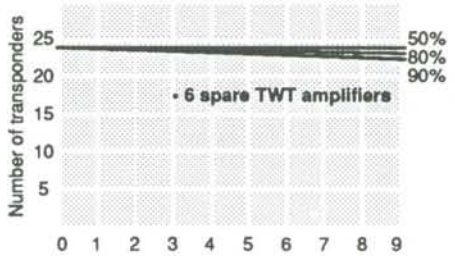
Typical Link Quality

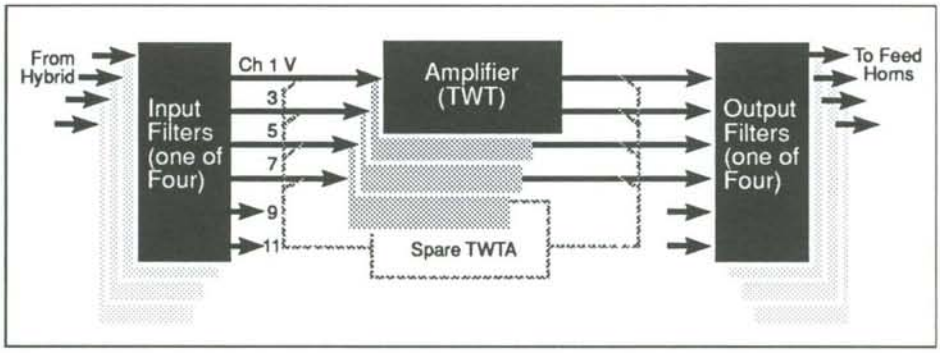
A typical video link from the satellite into a 5-meter diameter antenna will have a peak-to-peak signal-to-weighted rms noise ratio of 53 dB. If a 10-meter diameter antenna is used, signal quality is increased to 58 dB. For digitized video signals, the bit error rate is 1×10^{-6}. Four digitized video channels can be accommodated through one spacecraft transponder (6.3 megabits per second each). For single channel per carrier voice, the test tone-to-rms noise ratio is 35 dB into a 5-meter diameter antenna. With a 10-meter antenna, signal quality is increased to 40 dB.

Service	Quality Definition	Quality	
		10 M Antenna	5 M Antenna
Video	Peak-to-peak signal-to-weighted RMS noise	58 dB	53 dB
6.3 MBPS Digital video	Bit error rate	10^{-6}	—
SCPC voice 1000 channels	Uncompanded test tone-to-weighted RMS noise	40 dB	35 dB

Channels Available at Different Probability Levels

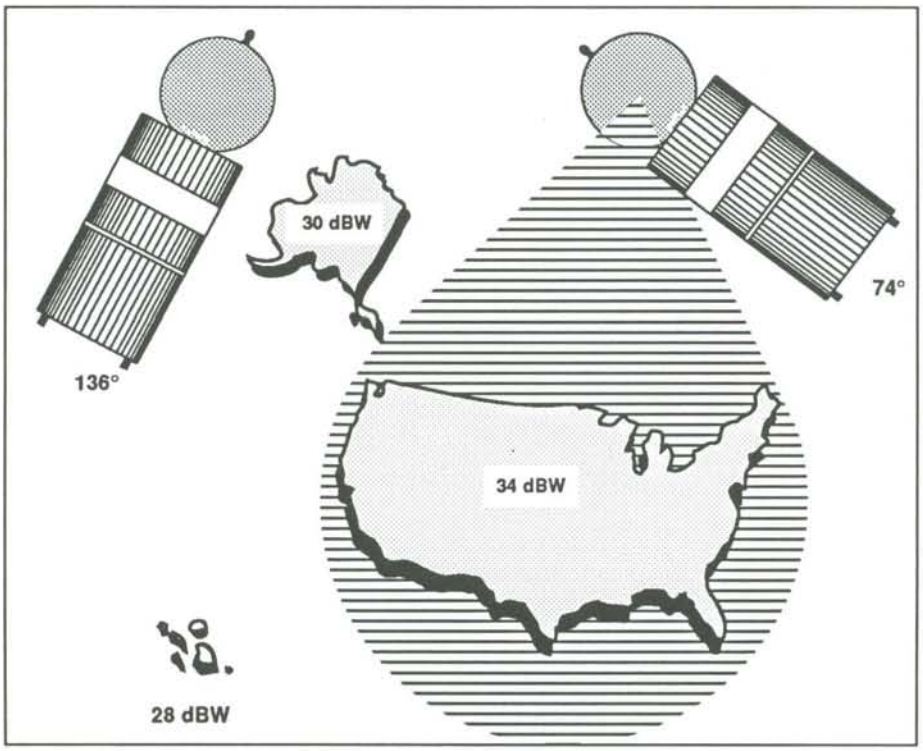
Reliability analyses for the communications transponder payload show a 50 percent probability that 24 transponders will be operational at the end of the 9-year satellite mission life. There is a 90 percent probability that 22 or more transponders will be operational at the end of mission life.





Transponder Redundancy

There are six spare amplifiers in reserve for 24 operating TWTAs. These 24 TWTAs are separated into six groups of four each. Each of these groups is protected by a spare TWTA which can be used to replace any of the four amplifiers.



Satellite Communications Performance

The satellite located at 135°W longitude provides 24 operational channels of at least 34 dBW, and 28 dBW to most of the continental United States. The satellite located at 74° provides 24 channels at a minimum of 34 dBW to most of the continental United States; Alaska and Hawaii are not visible from this easterly location.

THE FUTURE

Hughes Communications has applied to the FCC to construct, launch, and operate a fourth C-band satellite. Galaxy 4 will feature a technologically advanced transponder design that includes the use of state-of-the-art, high-efficiency solid-state power amplifiers on all 24 transponders in the communications payload.

Looking beyond its currently operating C-band system, Hughes Communications Galaxy has also submitted applications to the Federal Communications Commission to build, launch, and operate three new-generation satellite systems. The first of these systems will operate in the Ku frequency band and will feature wide-body spacecraft design. The second system, to operate in the virtually unused Ka frequency band, will provide enormous communications capacity via 16 high-power spot beams directed to specific geographical areas.

The third system will operate in the broadcast satellite service band and will transmit 32 channels of quality video programming directly to individual homes throughout the United States. The development of these advanced systems is designed to complement the existing Galaxy networks.

PRESS SERVICES VIA SATELLITE

(SCPC/FM/FDM)—UPI NEWS SERVICE

When tuning over the regular SCPC channels, one will pass over a wide signal that sounds much like a very raspy buzz saw. It is one of some 19 found on this transponder. Of these, several are radioteletype (RTTY) channels or sections each with approximately 25 channels. Each circuit contains the news service that is directed to a state or a specific geographical area of the U.S. The areas covered are divided again in the heavily populated states and areas. These are known as the Ohio Wire, the Western Pennsylvania-Eastern Pennsylvania Wire, etc. Between transmissions of state or area interest, these channels carry some national, international, and sports news.

Reception of this service requires the following equipment:

(1) A small TVRO antenna, 6 foot to 8 foot in size.

(2) A TVRO with a very stable down converter (Drake ESR-240 works well).

(3) A stable FM receiver that is converted to tune from 50 MHz to 85 MHz.

(4) A FDM unit, such as the new Info-Tech M-605, a complete FDM unit for HF, FM, and other multiplex work.

(5) A video character generator and conversion unit such as the M-6000 unit to furnish video out and printer output.

(6) And, of course, a video monitor for video output; and a printer, such as the Epson Printer, if you want hard copy. This equipment is shown in further detail in **Figure 8.12.**

These narrow bandwidth signals can be received using smaller antennas than found in the average TVRO system. Attention should be paid to the stable down converter used; the output of this down converter should be 70 MHz and not have any hum present caused by the Voltage Controlled Oscillators (VCO) control voltage being placed or run down the coax line from the receivers power supply to the down converter. The proper down converter will carry a separate set of wires going to the down converter from the receiver's rear terminal—any included hum in the audio will affect the final audio quality to the RTTY unit and will not produce satisfactory results (errors in printout). **Figure 8.13** and **Figure 8.14.**

For the FM section, several quality FM receivers that are setup to tune the television audio section (Channels 2 through 5), 55 MHz to 80 MHz can be used. Again, this FM receiver or tuner must be stable and have a bandwidth of approximately 60 kHz. Radio Shack and others sell these receivers and tuners.

AP NEWS SERVICE

There is an AP News Service that is thought to be directed to the Hawaiian Islands via Telstar 303, Transponder 16 on the subcarrier at 4.765 KC. This signal is single sideband and is treated much the same as a high frequency (HF) RTTY signal.

Lengthy investigation into this service has yielded little or no information (AP workers deny it exists). Its uplink location is unknown and the true purpose of the service is vague. The news contains a lot of Hawaiian news briefs and other island information. It is possible that this service could be uplinked from the islands and be directed to mainland USA. This also could be an auxiliary service of another satellite user group because it contains much of the same

news material as the regular U.S. AP service. Figure 8.17 shows the equipment hook up and simple tuning procedure using a quality general coverage receiver and the M-605 FDM unit with M-6000 decoder. **Figure 8.18**.

SATELLITE AP NEWSWIRE—TELSTAR 303 TRANSPONDER 16

(1) Hook up units with quality cable, satellite receiver to general coverage receiver, use 50-ohm coax. Other hook ups with quality audio cable. Peak satellite signal for maximum.
(2) Tune general coverage HF receiver to 4.765 KC, lower sideband.
(3) Set M-6000 unit in reverse phase, 50 baud, 170 Hz shift, ATC-on.
(4) Carefully tune general coverage receiver to obtain copy.

COPYING SATELLITES' FDM SIGNALS WITH A PERSONAL COMPUTER

The most successful FDM satellite system is the Universal M-7000. **Figure 8.19** shows the simple hookup.

The PC will need the proper software that is used for the reception of RTTY in amateur radio use. Some of these programs are the Kantronics, AEA, HAL, plus others. The communications software is as follows: Kantronics HAMSOFT™, AEA HAMTEXT™ and SWLTEXT™. Follow software manufacturer's directions for PC use depending on software. The satellite FDM system does not use the regular HF computer interface. Communications software is readily available for the IBM-PC, Tandy Computer, Apple II Series, plus others. Make sure the communications software package is specifically written for your computer.

COMMODITY QUOTATIONS, INC.

Below are the products offered by Commodity Quotations, Inc. via direct satellite with the use of personal computers.

COMSTOCK—This is a real-time 1200 Baud quotation line designed to interface with personal computers. The service allows a subscriber to select one, all, or any combination of the following exchanges:

Chicago Board of Trade (CBT)
Chicago Mercantile Exchange (CME)
Commodities Exchange Center (CEC)
Kansas City Board of Trade (KCBT)
New York Stock Exchange (NYSE)
American Stock Exchange (AMEX)
Over-the-Counter (NASDAQ) (OTC-NASDAO)

With CQI software, a personal computer can be turned into a quote machine with up to 10 programmable pages to display high, low, last, settlements, and other trading information. CQI will provide the software disk, at no charge, which is compatible with the Radio Shack TRS-80, the Apple IIE, Apple IIC, Apple II and the IBM.

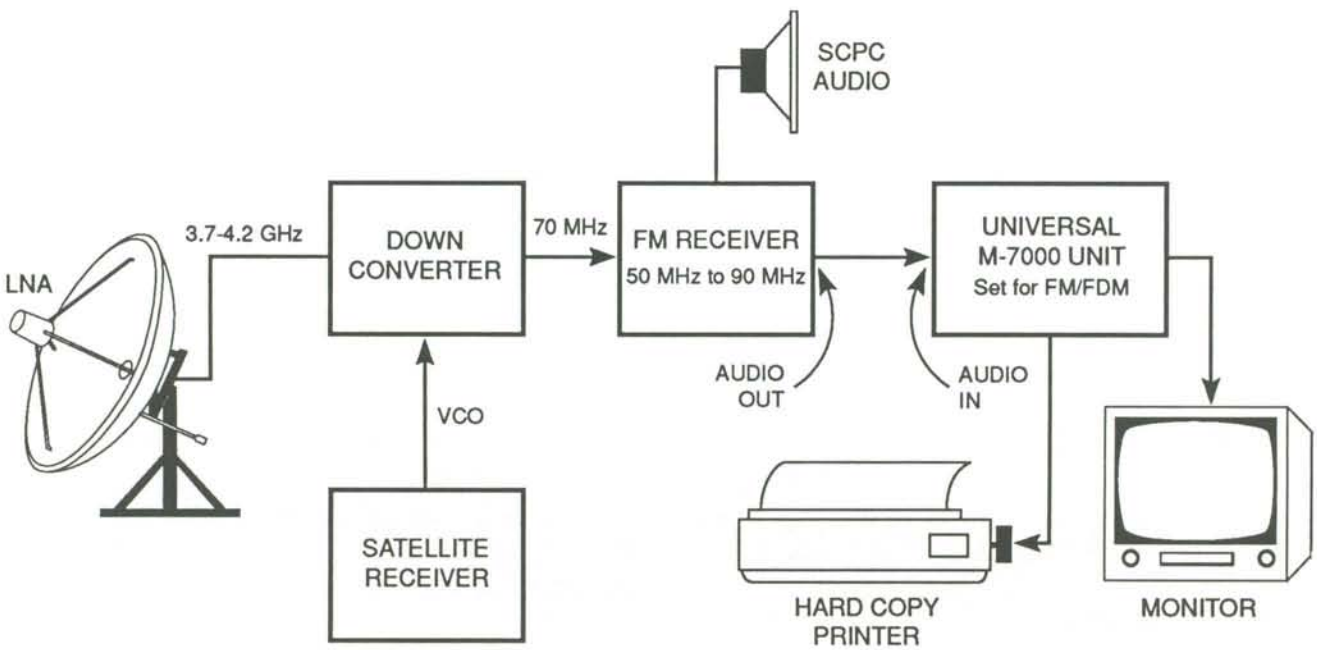


Figure 8.12 *SCPC/FM/FDM equipment diagram using the M-7000 decoding unit.*

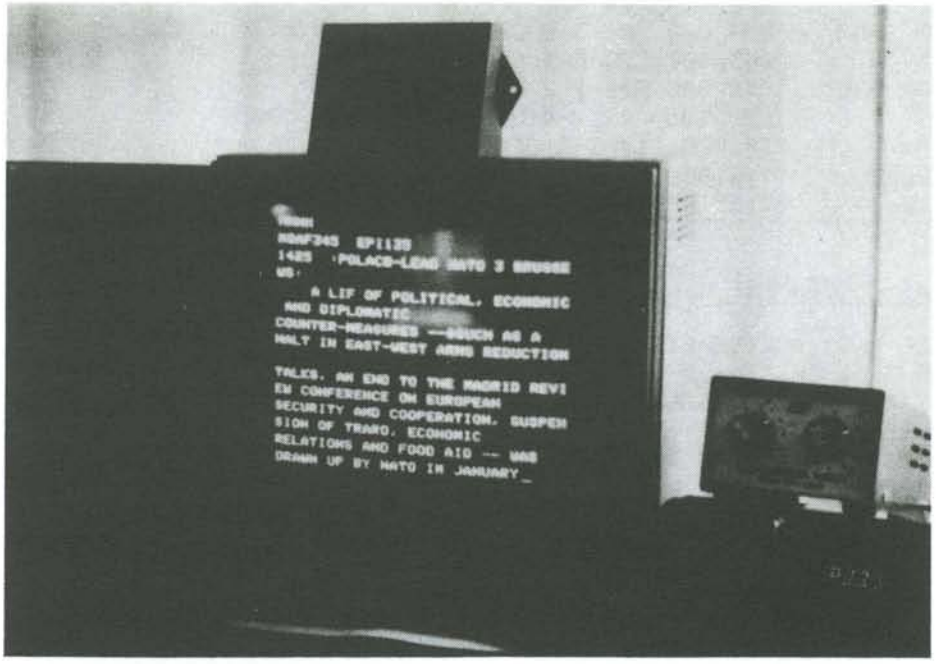


Figure 8.13 *Video read-out of a news service using FDM transmission.*

AP SATNET, a wholly-owned subsidiary of the Associated Press, is the satellite network carrier. The service is downlinked in approximately 900 cities in the U.S. and hardwired through the local phone company to the subscriber location if desired.

A slight variation on the ComStock service is a 300 baud service delivering CEC, CME and CBT quotations on Southern Satellite Systems cable network and by direct satellite downlink.

The Beets program is a commodities-only software package that runs on Apple personal computers and reads either the 1200-baud and 300-baud Comstock feed.

LOW SPEED SERVICES

Commodity Quotations also offers a low-speed, real-time quotation service for the Commodities Exchange Center, Chicago Mercantile Exchange, Chicago Board of Trade, and Kansas City Board of Trade. These services deliver real-time quotations at 135 baud and interface primarily with ticker printers and wall display units. AP SATNET is also the carrier for these services.

The Chicago Board of Trade low-speed quotations service is also delivered on the Equatorial direct dish satellite network for those subscribers outside of AP network cities.

Commodity Quotations, Inc. is the only commodity and stock information vendor offering a real-time service which consolidates all of the major exchanges.

BEN BEETS PROGRAM

The ComStock line will send prices to your Apple computer and a charting program is available. With this program, you may choose up to 100 commodities to retain the open, high, low, and last prices during the day. This information is saved to the disk at the end of each trading day to be used for daily analysis. You can display live charts for up to 20 contracts and one spread.

- Tick-by-tick charts
  The last 200 ticks are displayed
- Five-minute bar charts
  Displays the high-low last for each 5-minute period.
- Spread chart
  Displays one spread chart of your choice.
- Daily Analysis
  - You can automatically save prices on up to 100 commodities each day.
  - High, low, and last daily bar charts can be displayed.
  - Spread charts can be displayed.

```
     UPI 05-17    11:19 APD
178YR

     URGENT
NERVEGAS

   (WASHINGTON)-- FOR THE THIRD TIME IN AS MANY YEARS, THE HOUSE
HAS

VOTED TO REFUSE THE PENTAGON MONEY TO MAKE NERVE GAS WEAPONS

COMPONENTS. TODAY'S VOTE WAS 247-179. THE HOUSE REFUSED TO ACCEPT
THE

REAGAN ADMINISTRATION REQUEST FOR 95-MILLION DOLLARS TO BUILD WEAPON

PARTS, WHICH WOULD NOT IMMEDIATELY BE ASSEMBLEDIINTO WEAPONS. THE

ADMINISTRATION TRIED WITHOUT SUCCESS TO WIN BACKING FOR THE PLAN
BY

PROMISING THAT THE PENTAGON WOULD ASK CONGRESSIONAL PERMISSION BEFORE

ACTUALLY ASSEMBLING THE PIECES INTO BOMBS AND ARTILLERY SHELLS.

     UPI 05-17    11:20 APD
179YR


    WX-05-14    1702EDT

    STOCKS-CLOSE-MORE
  -0-
  THE 10 MOST ACTIVE STOCKS IN N-Y-S-E COMPOSITE TRADING...
  STOCK         SALES      LAST  NET CHANGE
  ENSERCH (DIV) 1,344,100  20 3-8 OFF 5-8
  PUB SVC IND     965,800   8 7-8 UP 1-2
  A-T-AND-T CO    959,500  15 5-8 OFF 1-4
  FORD            901,900  34 7-8 OFF 1-4
  DIAMOND SHAM  H 884,800  21 3-8 OFF 1-8
  MOBIL           863,100  28 3-4 OFF 5-8
  SUPERIOR OIL    848,000  41 1-2 OFF 1-4
  EXXON           828,100  42 1-4TLFN1-:
  SOUTHERV       739,000  14 3-4 OFF 3-8
  PHILA ELEC      702,900  13 3-8 OFF 1-4
    UPI 05-14    02:05 PPD
241YR

    STOCKS-CLOSE-MORE
  -0-
  THE FIVE MOST ACTIVE STOCKS IN AMERICAN EXCHANGE COMPOSITE
TRADING...
  STOCK       SALES    LAST   NET CHANGE
  COMMODORE    630,300   1 5-8 OFF 3-8
  TIE COMM     488,500  14 1-8 UP 3-8
  NATL AT DEVL 448,800  17 1-4 OFF 4 5-8
  GALAXY OIL   287,900   3     UP 3-8
  INSTRUM SYST 284,900   2 1-4 UNCH

    UPI 05-14    02:14 PPD
31
243YR
```

Figure 8.14 *Print out of World News Service.*

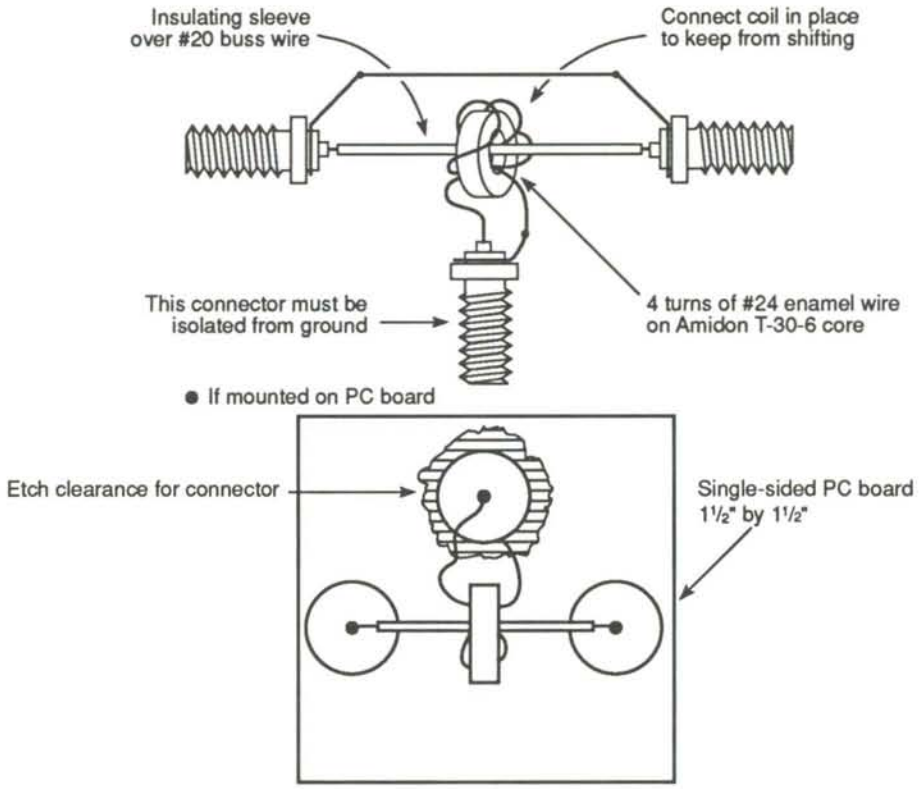
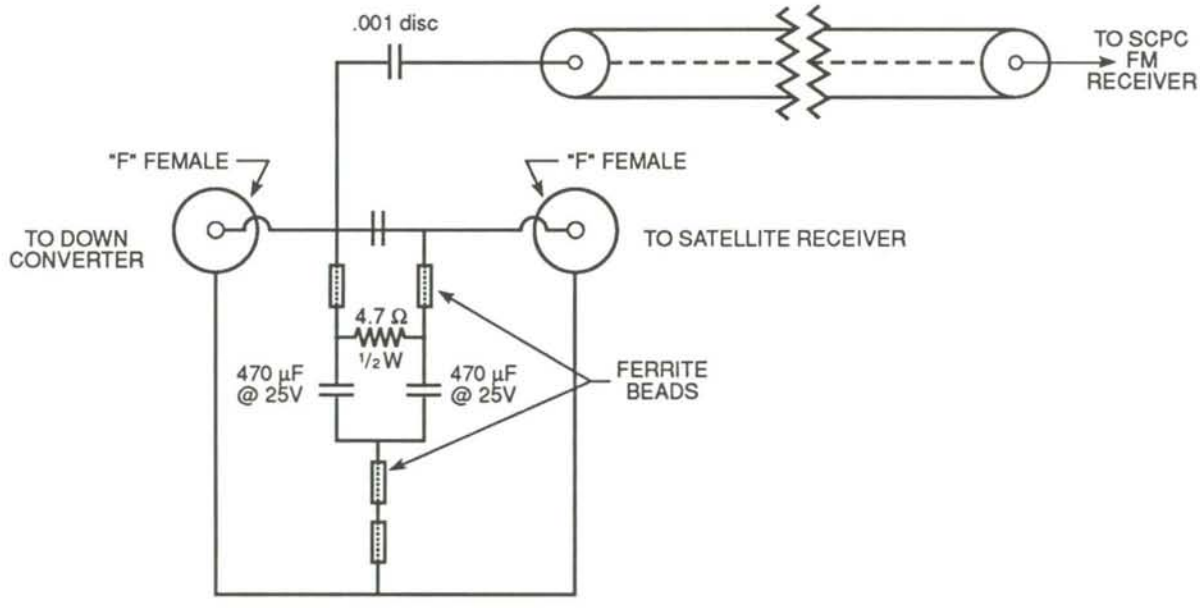


Figure 8.15 *SCPC hum (ripple) filter.*

VCO VOLTAGE HUM FILTER



NOTES:

1. May be constructed in a small plastic case.
2. Keep lead lengths to a minimum.
3. Ferrite beads should have relatively high impedance at 70 MHz.

Figure 8.16 *VCO voltage hum filter.*

- Moving average can be superimposed on bar and spread charts. User can choose accumulative, conventional, modified, and weighted averages. More than one average can be displayed at one time.
- Relative Strength can be displayed with the bar chart. Any number of days can be chosen.

SOFTWARE DISK AND CQI FEATURES

CUSTOM PROGRAMMING

Ten programmable pages allow a maximum display capacity of 202 issues.

Three formats for the first eight pages, 14 issues per page. One format for each of the last two pages, 45 issues per page.

A split-screen capability permits monitoring of several lines of stocks or commodities across the top of the screen-page with the ticker tape from one or several markets running across the bottom of the page.

At the end of day, issues and prices on the specific pages can be saved to disk or to a printer. The user must provide the proper equipment for this capability. Additional programming is required to build an historical data base.

INSTANT-ACCESS

Commodities: all commodities traded on the exchange or exchanges received are retained in memory. The last price, tictrend, change, low, high, open, and settlement can all be accessed.

Stocks: only pre-selected stocks (as many as 200 listed NYSE/AMEX stocks and up to 200 NASDAQ stocks) will be retained in memory for last, tictrend, change, low, high, open, previous day's close, market center, and day's total volume.

CQI can provide an expanded instant access program for capturing the last sale price on any stock traded on the NYSE and AMEX.

HIGH, LOW, SETTLEMENT, MARKET, AND VOLUME

All of the commodity exchanges contract prices for high, low, and either yesterday's or today's settlement, depending on the time of day, will be retransmitted constantly throughout the day. Within 30 minutes of the time the machine is turned on, high, low, and settlements will be updated automatically. If the machine is turned on after the market is closed, within 5 to 10 minutes the current day's high, low, and settlement prices are available. This feature eliminates the need to wait until the next day in order to have accurate market closing information. For full information on CQI, contact Commodity Quotations, Inc., 670 White Plains Road, Scarsdale, NY 10583. Phone: 914-725-3877.

COMMODITIES WIRE ON WESTAR 5

The CCC Commodities Exchange transmits full-market information on Westar 5, Transponder 18. The data is carried on the transponder's 6.2 MHz audio subcarrier. The service transmits only when the Midwest Chicago Commodity Market is open (approximately 8 AM to 4 PM Eastern Time).

Readable copy can be had by using the M-7000 decoder unit hooked directly from the unfiltered audio subcarrier output of the satellite receiver to the input of the M-7000 decoder unit. The M-7000 is set on normal phase, 1200 baud ASCII mode and carefully tuned to exact center of the 6.2 audio subcarrier signal.

COMMODITY WORLD NEWS NETWORK

This company's services are basically three satellite-delivered services for TVRO owners or from a two-foot equatorial dish and hardware. The C-Band delivery method requires a modem from the satellite receiver to your personal computer. All data is downlinked from Westar 5.

The basic service is known as:

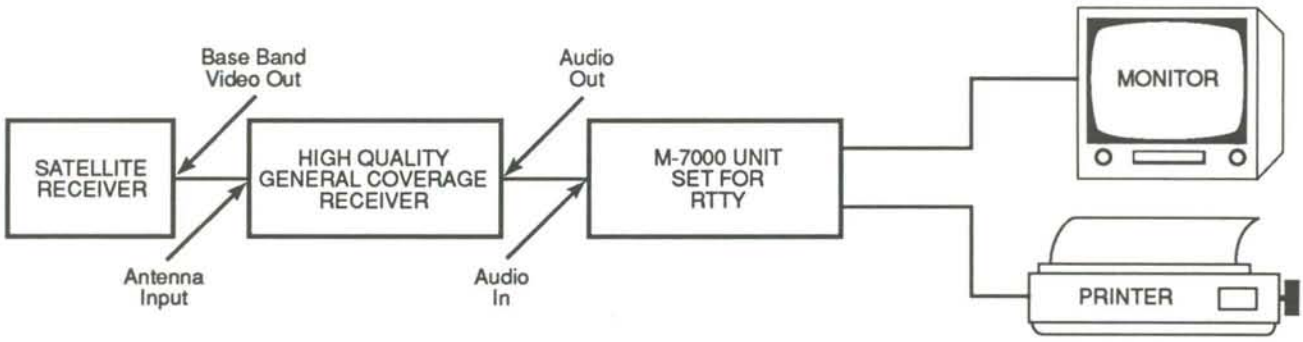


Figure 8.17 *Hook up and tuning of Telstar 303 AP Service.*



Figure 8.18 *M-7000 Demodulator Unit for new service copy.*

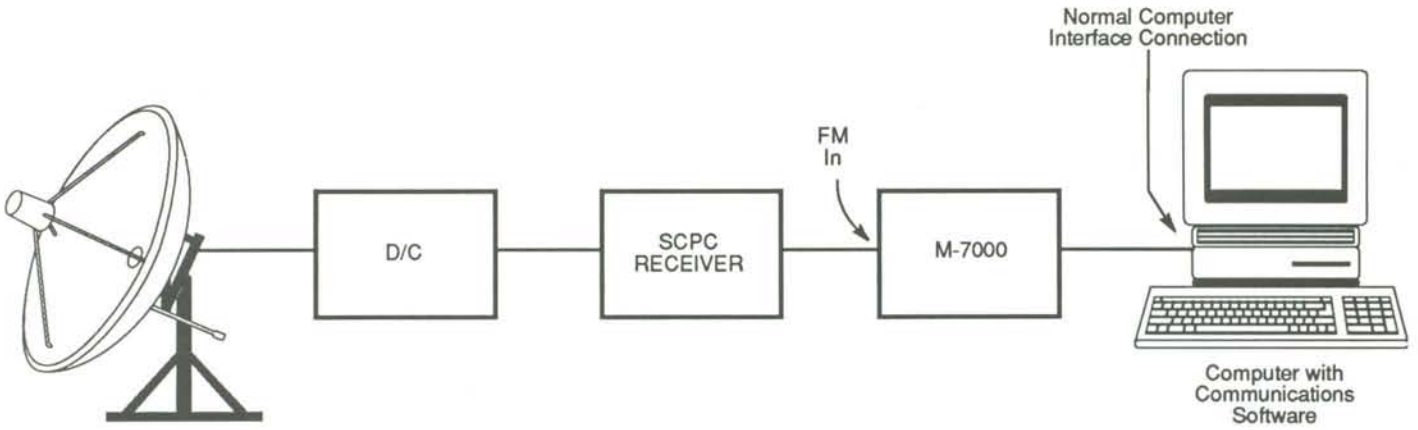


Figure 8.19 *FDM setup using M-605 FDM unit and home computer with proper software.*

CWN—This service is an international newswire that covers the futures markets in great detail and includes opening, major exchange price quotes every 15 minutes, and open, high, low, close, and change on each quote. In addition, there is focus on news items which move the markets, daily statistical reports, daily and weekly technical updates, cycles, moving averages, RSI's, and hi-low closes on the market.

INSTANT UPDATE—Daily coverage of all farm markets and alerts to focus on best opportunities to sell farm production at highest possible prices. There is instant access to both cash and futures prices to increase the average prices received from crop and livestock production, also there are farmer's market tactics and strategies to help planning for maximum return oil production. This service is available 24 hours a day, 365 days a week.

FUTURES UPDATE—The third service available from Commodity World News Network is a comprehensive futures and options service from the publishers of Futures Magazine and CWN. This service gives up-to-the-minute information on fast moving markets. Futures update contains 24 major categories of commodity futures and options information on a 10-minute update throughout the day, market shaping news around the world, reports from Washington and around the world, and technical and charting information. Over 500 pages of critical market information. **Figure 8.20.**

For information on these services, contact Commodity World News Network, 219 Parkade, Cedar Falls, Iowa 50613. Phone: 1-800-553-2910.

UNITED VIDEO SYSTEMS

United Video began operations in 1965 as a microwave transmission common carrier. As the microwave applications for cable decreased and the opportunities for satellite carriage and programming increased, the company established long-term objectives to become a company providing a balance of video, audio, and data transmission services. The programming and telecommunications services developed rapidly with the Electronic Program Guide, plus numerous audio services.

United Video was the first company to provide more than 20 services on a single satellite transponder (RCA's Satcom 3R, transponder 3.). A list of United Video's services are: WGN, Seeburg Music-Lifestyle, WFMT radio, Satellite Music Network, Electronic Program Guide, WPIX New York, KTVT Texas, Zephyr Weather Services, Argo Communications, UPI Cable Data, Moody Bible Institute, Siscom, Monchik-Weber Services, and Studio Line Audio Service.

BONNEVILLE SATELLITE SYSTEMS

The Satellite Systems division of Bonneville Telecommunications offers a full spectrum of satellite services to both domestic and international clients. The company owns and operates uplink transmitting facilities located across the nation. The business services include data communications and teleconferencing for the television industry. Bonneville provides program distribution, news gathering services, sports origination/distribution, earth station installation, and consulting services.

The company owns facilities in Salt Lake City, Utah, Los Angeles, California, San Diego, California, New York, New York, and Washington, D.C. They can provide earth links from remote locations to satellite uplink or from downlink to destination, and furnish transponder time from their leased and controlled transponders.

Bonneville is a full-service satellite distribution company that can handle most forms of program distribution on a lease basis.

PC QUOTE SYSTEM

PC Quote, Inc. is a financial quotation service for the private or professional investor. The service is downlinked to the subscriber via a Ku-band satellite system to the users IBM or IBM compatible computer.

PC Quotes provides up-to-the-second, real-time quotes on stocks and options from the following exchanges: New York Stock Exchange, American Stock Exchange, Philadelphia Stock Exchange, Pacific Stock Exchange, Midwest Stock Exchange, Boston Stock Exchange, and Cincinnati Exchange.

The service also provides NASDAQ (over the counter), Instinet and NASD, along with the Chicago, American, Philadelphia, and Pacific Options Exchanges.

Real-time futures and futures option quotations are also delivered to the IBM Computer System by PC Quotes. These exchanges are: Chicago Board of Trade, Chicago Mercantile Exchange/International Money Market, New York Futures Exchange, Commodities Exchange Center, Coffee, Sugar, and Cocoa Exchanges, New York Cotton Exchange, New York Mercantile Exchange, New York Commodity Exchange, Mid America Commodity Exchanges, plus others.

For further information on PC Quotes Services, contact: PC Quote, Inc., 327 S. LaSalle Street, Chicago, IL 60604. Phone: 312-347-4570.

SATELLITE BROADCAST NETWORK (SBN)

Satellite Broadcast Network has a new satellite delivered service via Ku-band (12 GHz) and direct C-band for personal computer owners to provide a high-speed, low-cost alternative to conventional telephone transmission of data. The SBN system includes a 12-GHz compact satellite receive antenna, a low-noise amplifier, a solid-state receiver, and the SBN demodulator for under $1,000. One main advantage of the 12-GHz satellite service is the elimination of terrestrial interference, allowing the placement of the receive antenna in virtually any location. See **Figure 8.21** and **Figure 8.22.**

SBN also has a new C-band direct satellite system which allows present 4-GHz television (TVRO) owners to receive the service. The C-band service requires only the use of the special demodulator to your present TVRO system, then into one of several personal computers such as IBM and its compatibles, Apple Macintosh, and Commodore.

The DM-1000 demodulator, a key component of the SBN system, unscrambles, decodes, and digitizes the signal which is uniquely addressed. This system allows millions of simultaneous users to have fast, inexpensive, personalized data access at their finger tips.

SBN is offering around-the-clock, up-to-the-minute financial data (stocks, bonds, options, commodities) news, weather, sports, along with specialized information, including agricultural, scientific, and medical data, and software program downloading. This system allows SBN users to request specific data, update data bases, and order specific documents or software from a central computer. Other features of this service include multi-channel reception capability and tiering, allowing subscribers to satisfy a broad base of data and software interests over dedicated channels.

The information explosion has created a demand for more financial and business data using business and personal computers. All but the largest corporations are still locked out of the data vault by the high costs of space technology and by expensive land-based telephone links.

The SBN system now furnishes the missing link that connects the personal computer to the world by eliminating the telephone system of relaying electronic information. SBN now plugs the PC directly into an unlimited information market place.

Wall Street offers one of the best examples of America's appetite for information. At this time, nearly 30% of all home computers are used to seek some type of financial information.

In conclusion, the new SBN system furnishes an affordable receiving service employing data encryption, data tiering for personalized delivery of information, individual unit addressability, and multiple channels of 9600 bits per second, and all within the grasp of every personal computer owner at an affordable price. The present price is $12.00 per month, plus cost of demodulator for C-band subscribers and other hardware costs for the 12-GHz (Ku band) customers. Contact: Satellite Broadcast Network, Inc., 212 W. Superior Street, Chicago, IL, 60610. Phone: 312-266-9844. See **Figure 8.23.**

ZEPHYR WEATHER INFORMATION SERVICE

Zephyr Weather Information Service transmits on transponder 17, Spacenet 3. A satellite receive facility for receiving Zephyr transmissions consists of the following components:

SATELLITE RECEIVE ANTENNA
LOW-NOISE AMPLIFIER (LNA)
and
ZEPHYR NETWORK RECEIVER

The Zephyr Network Receiver consists of the Wegener Communications Model 1606 Subcarrier Receiver and data demodulators which provide RS-232 and analog outputs for the appropriate services.

In order for the Zephyr Network Receiver to function properly and to output reliable, error-free data, it must be provided with a signal which meets certain minimum specifications. The following specifications are generally considered to be adequate for proper operation of the Zephyr Network Receiver:

CARRIER-TO-NOISE DENSITY (C/N°) > 87.4 dB/Hz
CARRIER-TO-NOISE (C/N) > 12.6 dB
TERRESTRIAL INTERFERENCE (C/I) < 18.0 dB
RF SIGNAL LEVEL RANGE AT THE -30 to -55 dBm
RECEIVER DOWNCONVERTER INPUT

Generally, a 3.6 or 3.7 meter antenna and a 100-degree LNA (frequency range of 3.7 to 4.2 GHz) should perform satisfactorily and meet the above specifications. However, look angle, microwave interference, and other local factors may require additional engineering to determine the correct antenna and LNA configuration for a specific location.

ZEPHYR SERVICES

As part of its total package of weather information, ZEPHYR currently provides a variety of services originated by the Federal Government, transmitted on Galaxy 1, transponder 3 subcarrier. **Figure 8.24.**

NWS DOMESTIC DATA SERVICE—A new 1800-baud text service which contains weather information for the United States, Canada, Mexico, Puerto Rico, the Caribbean, and Central America.

NWS DIFAX SERVICE—A 4800-baud digital facsimile service containing weather charts transmitted by the National Meteorological Center.

NWS NAFAX SERVICE—An analog facsimile service containing weather maps and charts transmitted by the National Meteorological Center.

FAA 604 SERVICE—FAA circuit GD90488-604, a 1200-baud text service which contains weather reports, forecasts, advisories, and other information of interest to the aviation industry.

To ensure that ZEPHYR continues to be the "total weather information source," arrangements are being made to add three members of the National Weather Service's new family of high-speed data services.

NWS PUBLIC PRODUCT SERVICE—A 1200-baud text service that contains severe weather advisories, watches, and warnings; public statements; travelers' forecasts; and state, zone, and local forecasts for the entire United States.

NWS INTERNATIONAL DATA SERVICE—An 1800-baud text service containing worldwide surface weather observations, upper air bulletins, ship reports, sigmets, aerodrome forecasts, and marine forecasts and warnings.

NWS NMC PRODUCT SERVICE—A 4800-baud data service containing analysis and forecasts derived from Limited Fine Mesh (LFM) and Global Spectral Models.

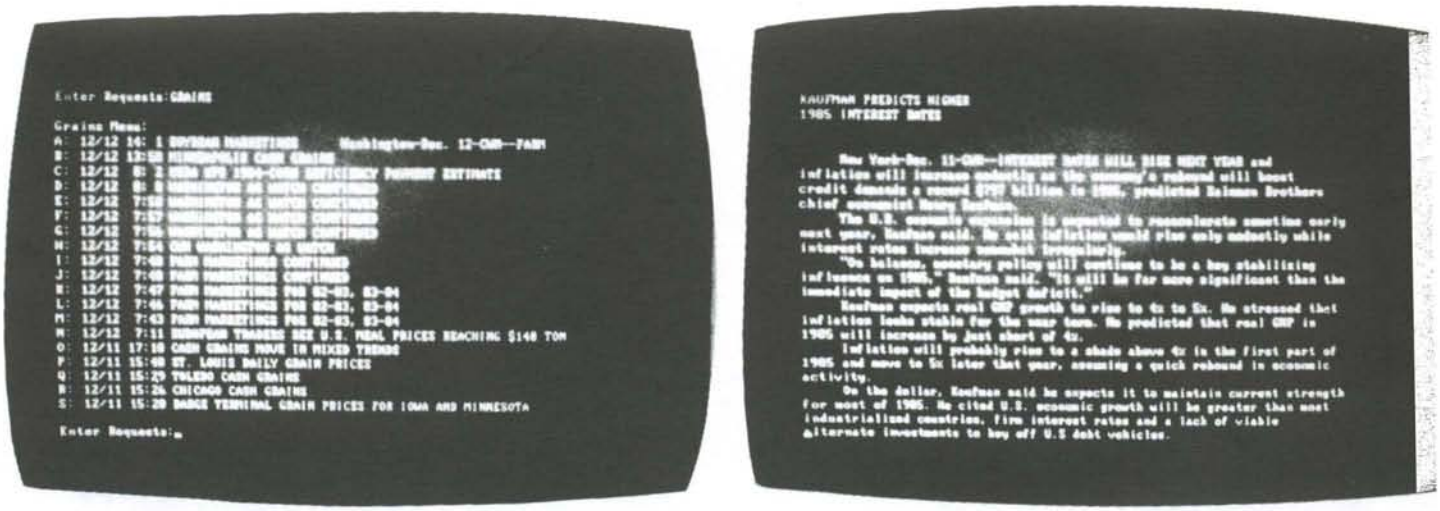


Figure 8.20 *Two screens on the CWN's instant update service. Screen on left shows a menu that contains every item on file in a category. Right-hand screen shows news items that affect markets.*

In addition, satellite imagery and weather graphics products generated by Environmental Satellite Data, Inc. will soon be transmitted.

ESD GOES IMAGE SERVICE—High resolution digital color satellite images of national and regional weather conditions derived from data broadcast by the Geostationary Operational Environmental Satellites.

ESD CONVENTIONAL WEATHER GRAPHICS—Ready-to-view weather graphics which depict National Weather Service observations of temperature, humidity, radar, and precipitation. Graphics are plotted in the satellite projection for instant comparison with the GOES imagery.

UNITED VIDEO FURNISHES SATELLITE TRANSMISSION SERVICE FOR ZEPHYR WEATHER SERVICES

United video services transmits the Zephyr weather services, weather facsimile charts, and digital data services on the subcarrier of Spacenet 3, transponder 17.

The facsimile services are found at the following:

NWS map photos on 1576 KC of subcarrier
Earth fax photos on 1875 KC of subcarrier

These subcarrier signals can be received by the simple hookup of a quality general coverage receiver to the unclamped baseband video of your satellite receiver as shown in **Figure 8.25**.

After the audio is recovered by the general coverage receiver, it is fed into the proper facsimile decoder for screen display and hard copy. Another system uses the PC and proper software to decode these signals for video display and hard copy printout.

ZEPHYR AND ENVIRONMENTAL SATELLITE DATA, INC.

From its facilities in the World Weather Building in Suitland, Maryland, Environmental Satellite Data, Inc. (ESD) receives and processes data from the Geostationary Operational Environmental Satellites (GOES) twenty-four hours a day. These infrared images provide a spectacular view of the earth and atmosphere that only a geosynchronous satellite can deliver form its vantage point 23,000 miles high.



Figure 8.21 *SBN system, Ku-Band Receive Antenna, Receiver and three Personal Computers, the Apple, COMPAQ, and IBM.*

As part of the ZEPHYR team, ESD applies the latest technology and processing techniques to produce images as fascinating to the layman as to the scientist. A wide array of fixed and floating sectors of the North American continent are provided in near real time. Precise color enhancement highlights significant meteorological features, while animation of time-sequenced images clearly depict the dynamics of the atmosphere. Conventional weather graphics are provided to portray temperature and humidity contours, precipitation activity, national radar reports, and other important weather parameters.

ZEPHYR'S NEW "WEATHERPLUS" SERVICE

This new service furnished by Zephyr is a completely new high-speed data weather service being made available to the private sector users of weather information. These four services, the Public Product Service, The Domestic Data Service, The International Data Service, and the NMC Product Service are designed to satisfy the requirements of the majority of users.

Zephyr distributes this complete family of data through its satellite network. There are no national weather services user charges on these services because Zephyr handles these directly with NWS.

SATELLITE DATA NETWORK (SDN)

This service is a new satellite-to-PC information system for business. Satellite Data Network can now deliver important up-to-the-minute news and information to support the serious businessman, investor, and farmer in his quest for increased earnings.

The heart of this system is the DM-1000 demodulator developed by Satellite Broadcast Network. This unit serves as the interface between your personal computer (PC) and satellite receiver by capturing the encrypted data and moving it to your PC at 960 characters per second. The "C" band satellite can now be used as a true business tool.

Up-to-the-minute news, commodity prices, and information are gathered and organized by Agri-Data Resources, Inc. and transmitted to Satellite Broadcast Network which delivers the data via Galaxy 1 to your C-band TVRO system. The data is transmitted 24 hours a day.

The customized software is individualized for each person's needs. This allows you to capture specific information addressed to you. You need the following equipment: C-band satellite system, and a 6- to 12-foot dish. Receiver should have unclamped unfiltered video output. This output is fed to the DM-1000 demodulator and then to your PC with a minimum of 256K memory, two disk drives, one for the disk operating system and the satellite data network program disk; the second drive for data storage.

This system is designed to work with the following PC,s: IBM-PC and IBM compatibles, Apple Macintosh 512, Tandy 1000 system, and Tandy 2000 system. **Figure 8.27.**

THE SDN service furnishes the following for business:

General Business Service reports are continuously updated with an easy scan digest and complete story versions of the most important business news of the day.

- **Wall Street Coverage** includes the latest news and stock market reports to keep you informed and allow you to take advantage of business opportunities as they present themselves.

- **Financial Market Reviews** help you stay on top of interest rates, precious metals, and dollar market news and reviews.

- **General and Economic News** will help you keep track of the important events which affect your clients, competitors, and prospects.

SUPPLEMENTAL SERVICES: As a detailed enhancement to the General Business Service, optional supplements are also available to these areas of specific interest:

Business News the top 25 business stories focusing on people, companies, industry, labor, law, mergers, acquisitions and transactions in the news.

- **Commodities**—Continuously updated futures prices, open and close options prices, and the latest market news from the leading exchanges and boards of trade.

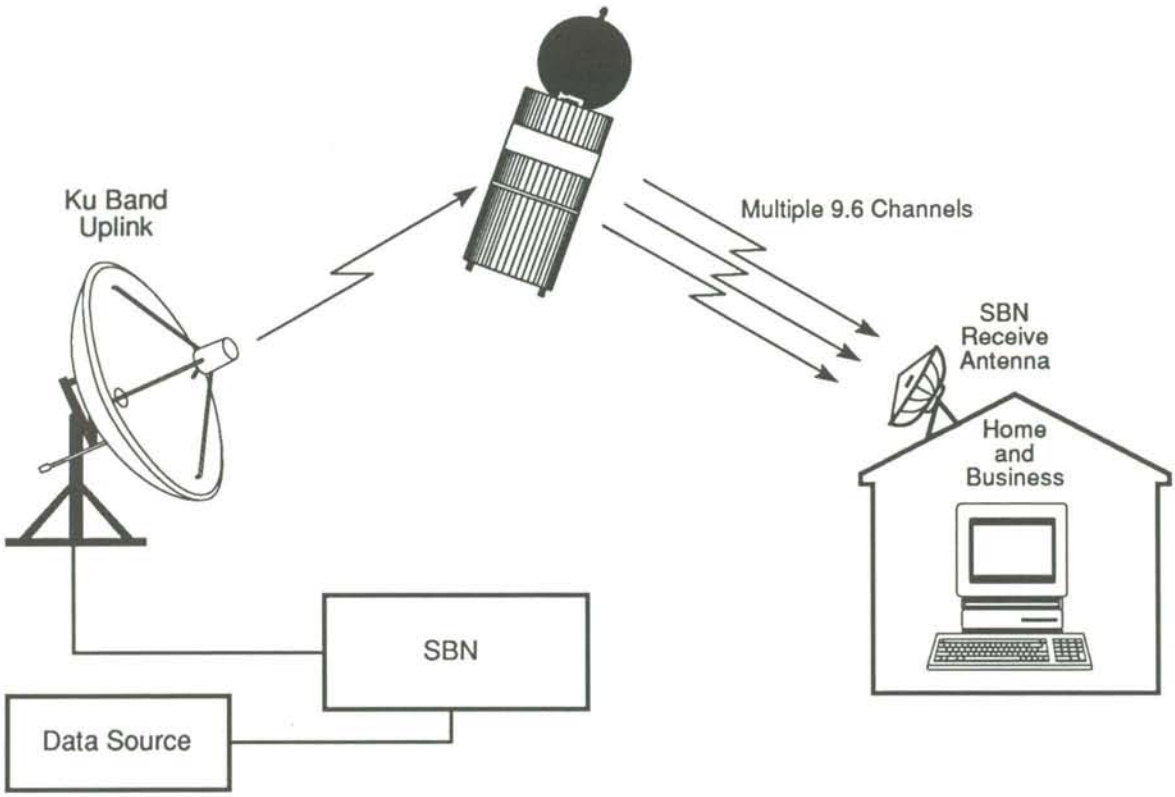


Figure 8.22 *SBN Ku-System for home or business use.*

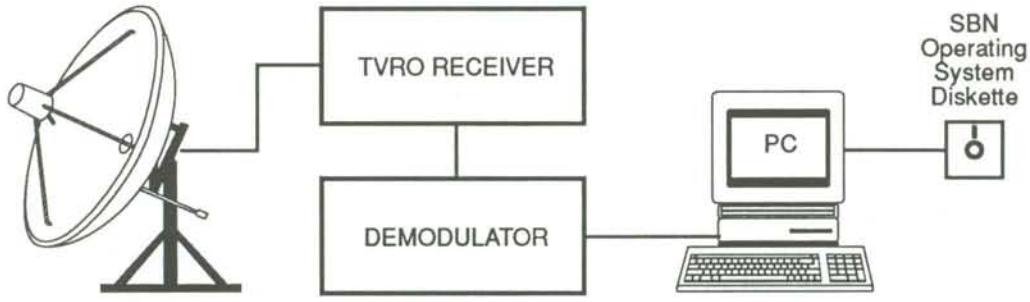


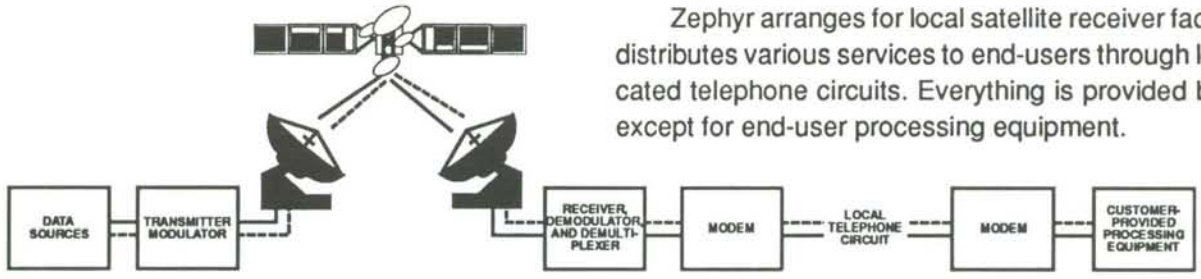
Figure 8.23 *C-Band SBN System using present home satellite hardware.*



NATIONAL DISTRIBUTION NETWORK

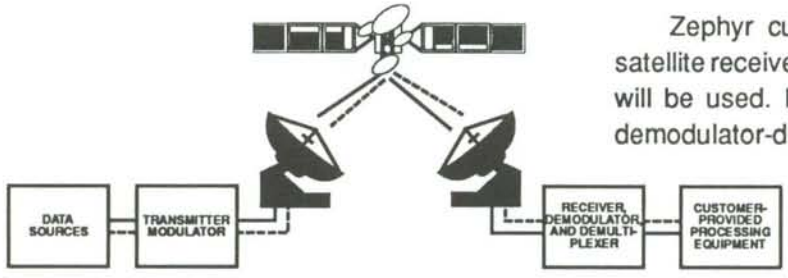
Data services are uplinked from United Video's Satellite Transmission Facility near Chicago to Galaxy 1 communication satellite. From there, they are beamed to a national network of over 4,000 local receiving systems. This network gives Zephyr a distribution capability unequalled by any other private weather service.

ZEPHYR PROVIDED DOWNLINK



Zephyr arranges for local satellite receiver facilities and distributes various services to end-users through local dedicated telephone circuits. Everything is provided by Zephyr except for end-user processing equipment.

CUSTOMER PROVIDED DOWNLINK



Zephyr customers may choose to locate their own satellite receive antenna at the facility where Zephyr services will be used. In this case, Zephyr provides the receiver-demodulator-demultiplexer unit as part of the service.

Data are normally transmitted from the Zephyr equipment to the processing equipment using local cable.

Figure 8.24 *How Zephyr Weather Services are distributed.*

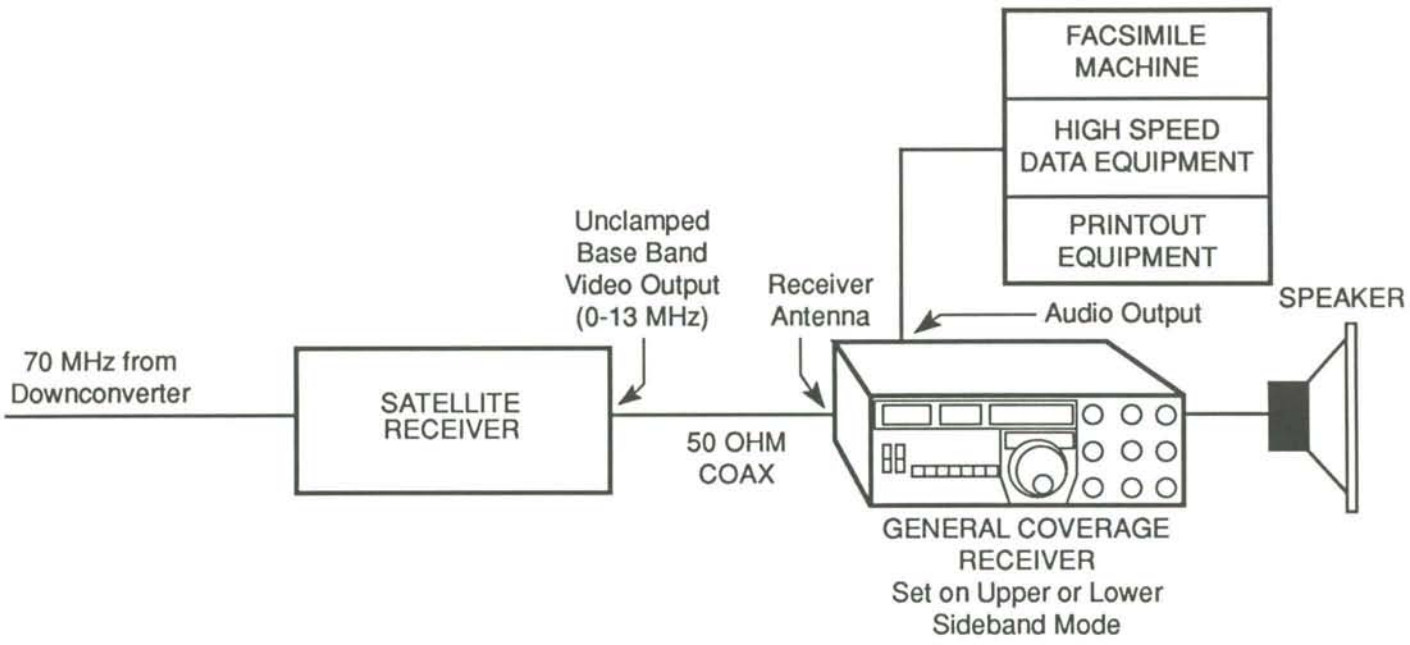


Figure 8.25 *Diagram for facsimile and data recovery on subcarriers.*



Figure 8.26 *Facsimile Receiver for print copy of weather services and photos.*

- **Financials**—Keep pace with the capital markets by tracing GNMA, bonds, notes, T-bills, certificates of deposit, and foreign currencies from the Chicago Board of Trade and International Monetary Market.

- **Precious Metals**—Current prices, volume and open interest reports, news and reviews for gold, silver, platinum, palladium, aluminum and copper.

- **AMEX Stocks**—Continuously updated news and prices from the American Stock Exchange.

- **NYSE Stocks**—Keep current with the latest news and prices on the New York Stock Exchange.
- **NASDAQ**—Important decision-making input for over-the-counter stocks. Agriculture Services reports are continuously updated throughout the day and include:

- **The latest agricultural news** covering the important events of the day that affect the world of agriculture. From the Associated Press, AgriData News Service, major newspapers and several universities.

- **Market reviews and news.** Detailed coverage of cash and futures markets, including barge grain prices, cash prices reported from around the country, livestock receipts and slaughter statistics, plus current reviews and analysis of the futures markets.

- **Crop and livestock weather.** Daily forecasts and weather summaries by crop region, weather conditions at terminal livestock markets, and international weather highlights.

SUPPLEMENTAL SERVICES: Additional specific commodity services are also available which are dedicated to cash and futures prices, trading reviews, and weather:

- Cattle
- Corn/Soybeans
- Cotton
- Feed grains
- Hogs
- Livestock
- Wheat

As a further enhancement, you may also select important market analysis and buy/sell recommendations from the leading market advisory services:

- Doane's Agricultural Report
- GRAINWIRE
- Helming Market Outlook & Advisory Report
- Top Farmer Strategies

SPORTSTICKER SERVICE

CQI furnishes a novel service dealing with the sports world and sports data transmission. This reporting media is vast in its scope and covers (See **Figure 8.28**):

Major League Baseball: Official score reporting, authorized reports from every regular season play-off and world series game, final game summaries, and some other major league game data.

Minor League Baseball: All AAA, AA, Pacific American and international reports.

National Football League: All coverage of each NFL game with complete up-to-the-minute data.

Canadian Football League: All official scoring and data reporting service.

Basketball: All official reporting and scores for NBA and CBA.

Hockey: Official score and reporting for National Hockey League and American Hockey League.

Other Reporting: All college sports, NCAA, football, basketball, baseball, and "top 20" ranked teams, pro soccer, pro golf, pro bowling, pro tennis, pro boxing, horse racing, Olympics, player drafts and more.

There are several reporting methods for printout. The first is a large moving message (LED) display from 4 feet to 25 feet in size for large audience viewing, and the "ticker tape" printer that yields the print on strip ticker tape. See **Figure 8.29**.

For information on the Sportsticker, contact: CQI Offices, 1-800-431-2602.

BONNEVILLE, APPLE MACINTOSH COMPUTER FINANCIAL SERVICE

Bonneville Telecommunications has introduced three new financial products for use with the Apple Macintosh computer. The service provides commodities and stock information from various exchanges and boards of trade within seconds after a transaction takes place.

The three financial products are MacMonitor, MacStock, and MacInvestor. They are designed to be used primarily by traders who handle large portfolios. These services combine three accepted technologies: satellite transmission, FM radio broadcasting, and computing.

Investors using these products on their Macintosh computers receive, within seconds, accurate financial quotes from the major trading and exchange floors along with news and premium price affecting information.

The MacMonitor service is a commodities-only quotation service which is patterned after Bonneville's Market Monitor Service.

MacStock delivers quotations for stocks, stock options, and some selected commodities including exchange information when an issue is traded on more than one exchange.

The third offered service, MacInvestor, is a complete and fully comprehensive communications package that can be customized to meet the needs of most stock and commodities brokerage houses and other financial institutions needing custom investment communications systems for their major clients.

All three services feature updated quotes, programmable pages, stop alerts, news and premium information services, expanded graphics complete with three types of charting (bar, line, ad point, and figure), extensive news coverage and storage of up to 50 pages, pull-down menus and multiple window technology.

In addition, MacInvestor can be further customized for the individual investor's needs in conjunction with his brokerage house or financial institution. MacInvestor features full-circle return path communication, point-to-multipoint technology, immediate client response, mail box and interactive communications.

Bonneville and Apple Computer are working closely to provide an extremely powerful set of financial and business applications. The composite program is beamed to Westar 4, transponder 10, from a central computer and then downlinked to selected FM radio stations across the nation. The electronic data signals are received by the FM station and then inserted into the sideband portion of the radio frequency. This data signal is invisible to the listener enjoying Mozart's Sonata or a local weather report, but with the use of a proprietary receiver, the table is turned; Mozart becomes invisible, and the data stream comes to life on the computer screen.

Not all data is equal. There is no risk that the receivers that are bringing in the commodities reports will succumb to temptation and take a peek at data that is being distributed by Bonneville for a chain of banks. The decoders look only at what they are instructed to by a computer signal controlled at the source of the transmission.

AGRI-SAT, AGRICULTURAL SERVICE

A new satellite service for direct reception is being broadcast specifically designed for agricultural America. This service is targeted to the over 20 million individuals and families who are currently, directly or indirectly, engaged in agriculture.

The present programming consists of ten hours of television programming and 24 hours of agricultural information and data services per day covering:

> Agri-news, Agri-weather, and Agri-sports, special televised forums and Agri-panels, timely topics of national, regional, local, and international interest. North American Forums for agriculture and Agri-business and FFA information. Various teletext services that cover co-op extension services, market reporting services (such as U.S.D.A.), agri-business advisory services, and weather bulletins. The present Agri-Sat service is free, because it is advertiser supported, but requires a teletext decoder and data hardware for reception. Agri-Sat is broadcast on Galaxy 1, transponder 22 for television ahead of the Discovery Channel. The data is running the balance of the time on the subcarrier transponder 22.

Full information on the Agri-Sat Service can be obtained from: Agricultural Information Foundation, Inc., Pioneer Tower, University of Wisconsin, Platteville, Wisconsin 53818. Phone, 608-348-3339.

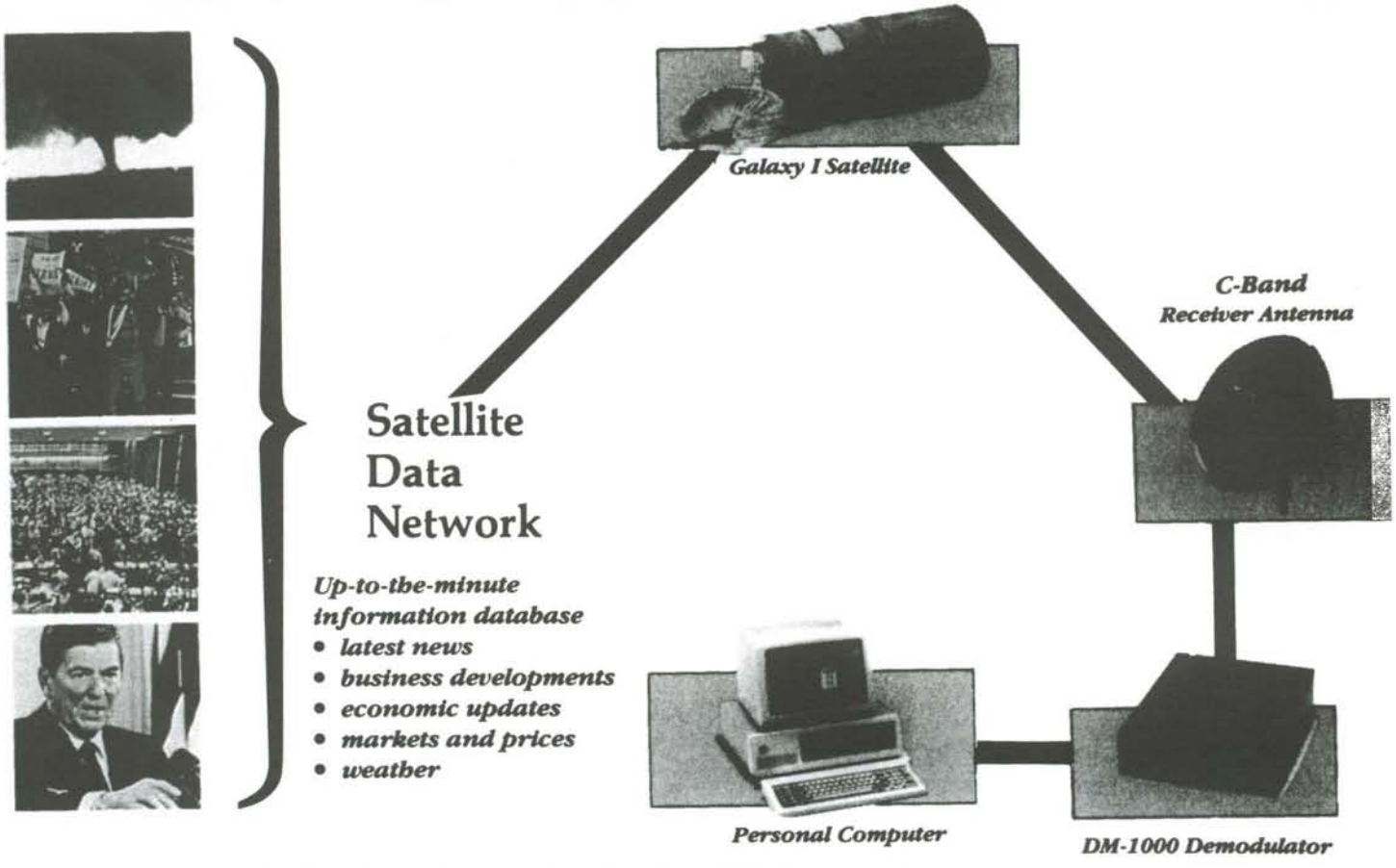


Figure 8.27 *Satellite Data Network using demodulator and various personal computers.*

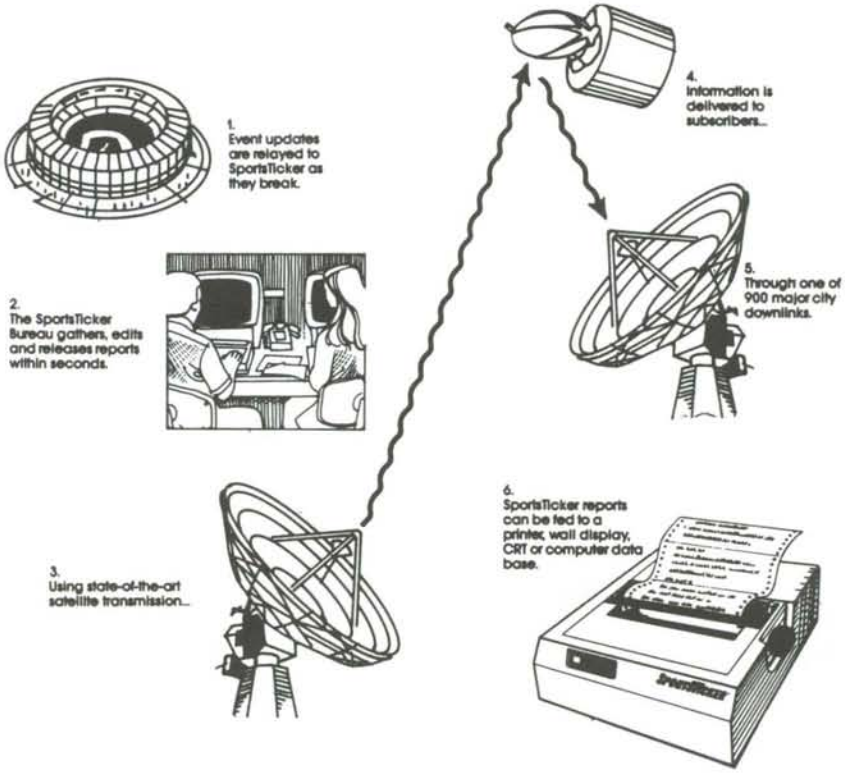


Figure 8.28 *Sportsticker Sports Reporting Services. Transmitted via Westar 5 by Equatorial Communications Services.*



Moving message (LED) displays are available in various sizes (4'–25') for audience viewing.

Reports are delivered on a ticker tape printer. The printout is on dry impact paper—no ink or ribbons required.

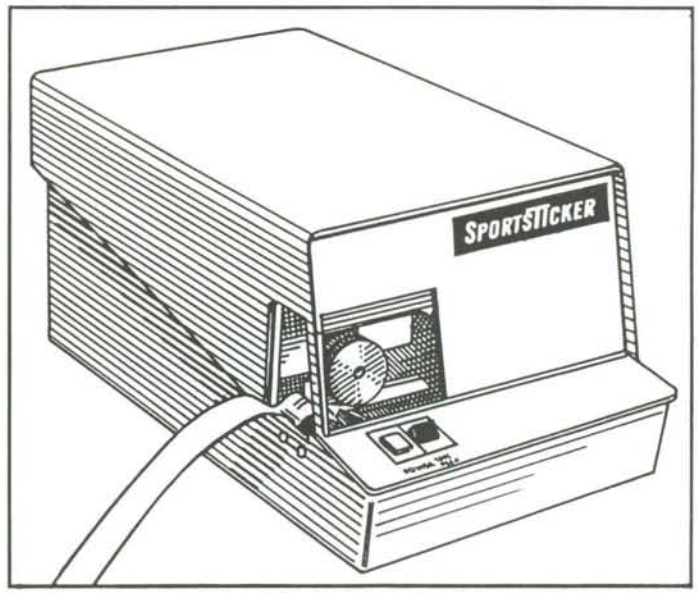


Figure 8.29 *Sportsticker's two delivery methods: moving messages and ticker tape printer.*

POTPOURRI OF "HIDDEN SIGNALS"

UPI SATELLITE FACSIMILE
UPI Fax has been noted on KU Bird K-2, transponder 14.
The frequency is 4017 KHz on an FM carrier with AM-FAX at 120 LPM.

ZEPHYR WEATHER FAX SERVICE
Westar 3, Transponder 2, SCPC Service consisting of farm and livestock reports.

MUTUAL SATELLITE SERVICES
GSTAR 1, transponder 13, KU Band.
C-Band - Spacenet 3, transponder 17.

AP SERVICES
AP Services are reported on C-Band, Satcom F-212, transponder 1, Press Wire (RTTY) on 803 KHz, LSB, 50/85/N. Voice on 804 KHz, LSB, FAX on 573 KHz.

STORY VISION
C-Band F-3, transponder 3 at 7.237 MHz frequency, 204 - 942 - 1005.

DBC MARKET WATCH
An investors and business service, stock/bond reports. Located on C-Band F-3, transponder 11 and Galaxy 3, transponder 24, 800 - 777 - 3334.

X-PRESS SERVICE
Offers two levels of service: "X-Change," provides financial information, national and international news, sports, weather, and variety features. A higher level of service called "Executive" carries more thorough financial information. Both services carried on Galaxy 1, transponder 7 and 18, 800 - 772 - 6397.

ELECTRA TELETEXT
This teletext service is located on Galaxy 1, transponder 18. It is a free service using "world standard" system. More teletext services are planned for future broadcasts.

FLORIDA NEWS NETWORK
A state-wide news service carried on SCPC via Spacenet 2, transponder 20. Also on subcarrier 6.2/6.8 MHz.

UPI RADIO NETWORK
Radio news on C-Band Westar 4, channel 1, C-Band, on half hour and hour.

BUSINESS RADIO
Business and financial news, SCPC service on F-1, transponder 21.

AGRICULTURAL RADIO
SCPC Agri-Service on Westar 4, transponder 2.

UPI SCPC FACSIMILE
SCPC FAX service on Westar 4, transponder 1(4), FM/SCPC at 1.430 MHz, 120 LPM.

DIGITAL AUDIO SERVICES (DATS)
Many channels of DATS located on Satcom C-1, transponders 3, 15, and 23.

STORY VISION NETWORK
Twenty-four hour service, story book library located on Satcom 3, transponder 3, 204 - 942 - 1005.

AP CABLE NEWS
Galaxy 1, transponder 18.

C-SAT PAD
Spacenet 3, transponder 9.

DATA LINE SERVICE
Galaxy 1, transponder 3.

DATA SAT SERVICE
Satcom F3, transponder 12.

IBN PAD
Westar 4, transponder 19.

REUTERS NEWS SERVICE
Satcom F3, transponder 18.

SUPERGUIDE PROGRAM SERVICE
Spacenet 1, transponder 17.

SUPERGUIDE II SERVICE
F-4, transponder 8.

TEMPO DATA
Galaxy 1, transponder 18.

UPI SERVICES
Spacenet 3, transponder 9. SCPC services at 75.18 MHz and 64.4 MHz.

AGDAY AGRICULTURAL NEWS
Farm news reports, Westar 5, transponder 24, 6.8/5.8/6.2 MHz.

INSTORE SATELLITE NETWORK
Safeway Chain, Spacenet 1, transponder 9, subcarriers.

BBC WORLD SERVICE
SCPC, Anik D-2, transponder 5B, at 57.5 MHz.

WGN AUDIO SERVICES
Transmits 3 SCPC signals in addition to many audio subcarriers, Satcom 3R, Transponder 3.

NBC, ABC, CBS, RKO, CNN
Satcom F1R being used by RCA to carry radio feeds to stations by these networks, most is digital audio.

CCC
Market and quote services Westar 5, Transponder 18 at 6.2 MHz audio subcarrier, high-speed ASCII.

SEEBURG MUSIC SERVICE
Transmitted on Galaxy 1, Transponder 18, subcarrier at 7.70 MHz and 8.15 MHz.

ELECTRONIC PROGRAMMING GUIDE
Text programming service listing the satellite programming, an up-to-date, latest guide on Galaxy 1, Transponder 18, subcarrier on 5.08 MHz for EPG, JR and main service on 7.23 MHz subcarrier.

SPORTRAK
Sports Reporting Service on Galaxy 1, Transponder 18, subcarrier at 8.05 MHz.

DATA CABLE SERVICE
Data Service located on Galaxy 1, Transponder 18, subcarrier located at 5.01 MHz.

NEW YORK STOCK EXCHANGE
Financial Service direct for NYSE Floor, 15-minute stock information on VBI of WTBS, Galaxy 1, Transponder 18.

NEW YORK STOCK EXCHANGE
Slow-speed ticker service carried on Westar 4 via equatorial spread-spectrum services. Available to individuals and businesses.

RADIO DATA SYSTEMS
RDS offers a data retriever system that furnishes a true tic-by-tic chart. The data retriever connects an Apple II computer directly to Radio Data System's high-speed data stream. The data stream runs at 2400 baud and is carried by Equatorial Communications System through their satellite delivery systems on Westar 2.

MUTUAL SATELLITE SERVICES (BROADCAST)
Mutual's decision to set up its own satellite network dates back to 1977. Until then it depended on AT&T long lines to distribute its programming to 1000-plus affiliates. After the completion of their system, they switched to satellite delivery; and the firm began to consider the transmission system as a source of additional revenue. MBS utilizes the Bren Mar, Virginia uplink facility for common carrier capacity for Associated Press and United Press International's audio and data services.
MSS is also involved in the distribution of data and services via the FM subcarrier frequencies of their affiliated stations through a division called MultiComm. Also, a service known as MutuaLink can access as many as 1,000 radio stations interconnected through Mutual's 700-plus downlinks and delivery of stereo or monaural audio and high-speed data up to 56 Kbps. Complete end-to-end services and private networks are also provided by MSS. Many services are transmitted via Westar 4, Transponder 1D and 2D.

CHAPTER NINE

Ku-BAND AND HIDDEN SIGNALS

The 3.7 to 4.2 GHz C-Band satellite system was first established in the early 1900's by international agreement for the purpose of relaying communications between two points via satellite. Unfortunately, these same frequencies were also set up for the vast terrestrial main truck systems for telephone and data transmission. As the use of C-Band satellite systems grew, so did the terrestrial interference (TI) problem. Severe interference is now being experienced in most urban and some rural areas that are in the path of these terrestrial transmission systems.

There are many countermeasures that can be used to overcome this terrestrial interference. These measures include special antennas, special traps, filters, shielding from TI source, plus other prevention and correction measures. The FCC has always maintained that all TVRO should be relegated to the 12 GHz Ku-Band because these band assignments are not shared with terrestrial users, and as a result, terrestrial interference will be less than with C-Band.

BROADCAST SERVICES AND KU-BAND

Some years ago, the major broadcasters, both radio and TV, were studying the future use of satellites for relaying signals to their affiliates. Each network chose the C-Band, with the exception of NBC. From the start, NBC saw satellite delivery of their programming as a two-way system. They were interested in getting programming out to their affiliates, but also recognized the importance of getting news and sports feeds from these same affiliates as equally important. NBC foresaw a number of problems with terrestrial interference in the C-Band and elected to bypass those problems by going to an untested Ku-Band. It was also much easier to send a mobile news van to a location equipped with a smaller Ku-Band dish than a twelve- or fourteen-foot C-Band dish.

ABC and CBS chose to build their networks around existing C-Band satellites, and both networks now routinely use AT&T's Telstar 301 and 302 satellites. PBS was one of the first to use satellite transmission and is still found on Westar 4 with audio, TV, and other modes.

NBC now is carrying all of its program feeds on Ku, much to the dislike of the pro football fans who own a TVRO system.

THE FUTURE OF KU-BAND

The Ku-Band has played an important part in the growth of non-video services, business services, and the many business data services that link up the offices and plants of large corporations around the world. At the present time, the non-video services far outnumber the video services. These commercial services will continue to grow at a rapid pace in the future as the cost of satellite transmissions come down and the cost of terrestrial services escalate upwards. There is no doubt that the video services will increase, but will never match the non-video uses due to the narrow bandwidths used to transmit data information. Literally thousands of data channels can be transmitted in the same bandwidth as one video channel. Most of the newer Ku-Band satellites have more usable bandwidth than C-Band satellites. Note in the following Ku Loading Charts that these bandwidths are now in the 54 MHz range and 72 MHz range. This increase in bandwidth allows many more channels of transmission to be utilized on these newer satellites. A rundown shows SSB-3 at 43 MHz while Spacenet 2, ANIK B, and Spacenet 1 all have 72 MHz, almost double the usable bandwidth, which means more active channels in the future.

All reports from satellite and transponder owners indicate that present and future Ku satellites will be entirely full and will contain many hundreds of services.

Ku-Band will indeed be the wave of the future in data transmission services. **Figure 9.0.**

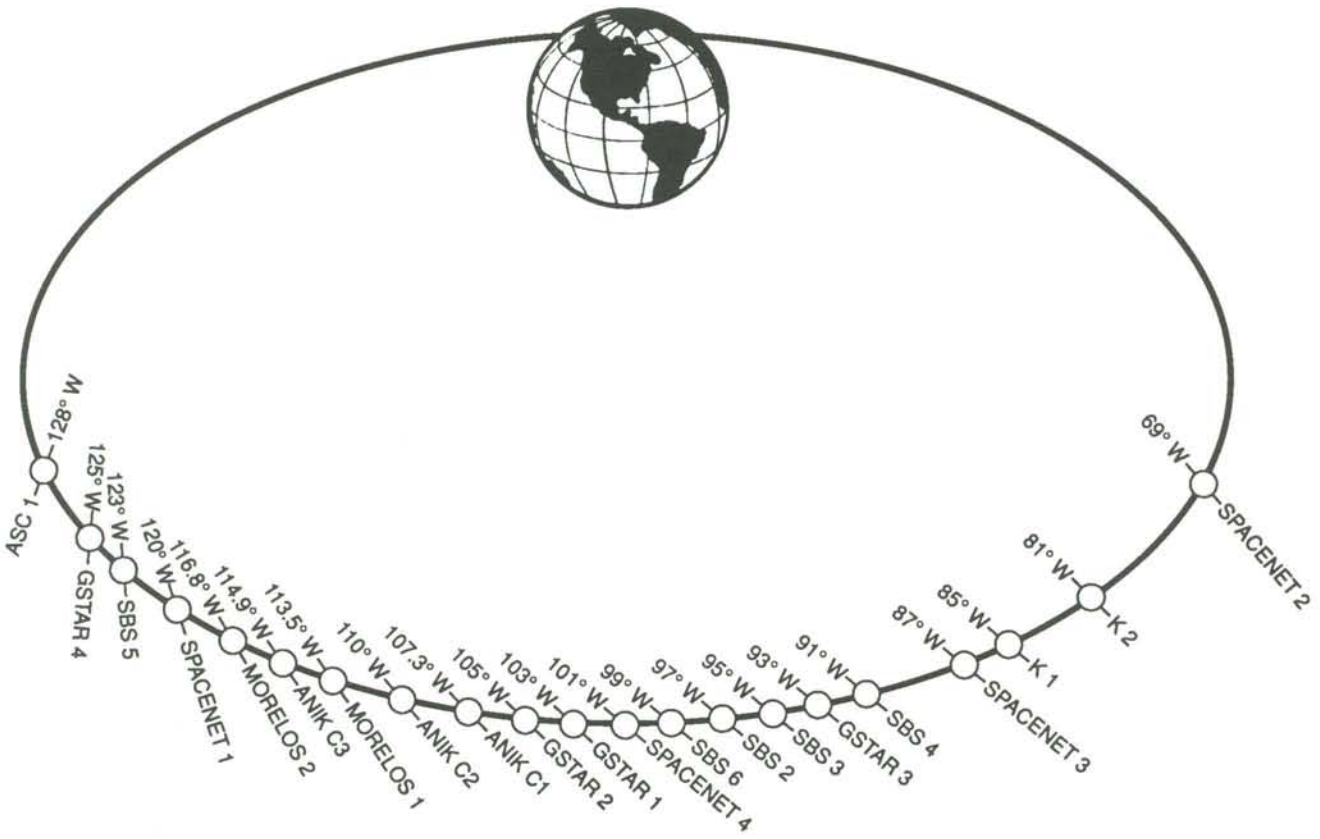


Figure 9.0 *Ku-Band Satellite positions in Clarke Belt.*

KU-BAND SATELLITE LOADING CHART

SPACENET 2 69.0° W

Transponder	Freq. MHz.	Emission
19	11740 (H)	SCPC
20	11840 (H)	TV/FM
21A	11880 (H)	TV/FM
21B	11920 (H)	TV/FM
22	11980 (H)	Various Data Services
23A	12040 (H)	TV/FM
23B	12060 (H)	TV/FM
24A	12120 (H)	TV/FM
24B	12160 (H)	TV/FM

Spacenet 2 Ku-Band 72 MHz transponders

SATCOM K2 81.0° W

Transponder	Freq. MHz.	Emission
1	11720	TV/FM (Feeds) NBC
2	11744	SCPC Services
3	Inactive	Inactive
4	11810	TV/FM
5	11836	TV/FM (Feeds) NBC
6A	11855	TV/FM
6B	11875	TV/FM
7	11895	TV/FM (NBC)
8A	11913	Data Services
8B	11939	TV/FM
9	11955	TV/FM (NBC)
10	11988	Data and Telecom.
11	12014	TV/FM (NBC)
12	12049	SCPC Radio Nets
13	12073	TV/FM (NBC)
14	12105	TV/FM
15	12133	TV/FM (NBC)
16	12171	Digital Services

K 1 85.0° W

Transponder	Freq. MHz.	Emission
2	11758	TV/FM (Pay Per View)
3	11780	TV/FM (WWOR)
4	11817	TV/FM (KTVU)
5	11847	TV/FM
6	11876	TV/FM
8	11935	TV/FM
9	11965	TV/FM (Business Network)
10	11994	TV/FM
11	12024	TV/FM
12	12053	TV/FM
13	12083	TV/FM
15	12142	TV/FM
16	12171	TV/FM

SPACENET 3 87.0° W

Transponder	Freq. MHz.	Emission
19	11740	Digital Networks
20	11820	Digital Networks
21	11900	TV/FM
22	11950	TV/FM
23	11990	TV/FM
24	12140	TV/FM

Ku-Band 72 MHz transponders

SBS 4 91.0° W

Transponder	Freq. MHz.	Emission
1	11725	TV/FM
2	11744	Digital Networks
3	11823	TV/FM
4	11872	TV/FM
5	11921	TV/FM
6	11970	Digital Networks
7	12019	TV/FM
8	12068	Digital Networks
9	12117	Digital Networks
10	12166	Digital Networks

GSTAR 3 93.0° W

Transponder	Freq. MHz.	Emission
1	11730	Digital Communications
9	11744	TV/FM
12	11927	TV/FM
15	12110	TV/FM

Including orbit satellite, out of geostationary belt most of time.

SBS 3 95.0° W

Transponder	Freq. MHz.	Emission
1	11725	TV/FM
2	11774	TV/FM
3	11823	TV/FM (Satellite Cinema)
5	11921	TV/FM (WTBS)
6	11970	TV/FM
7	12019	TV/FM
8	12068	TV/FM
9	12117	TV/FM
10	12166	TV/FM (NBC)

SBS 2 97.0° W

Transponder	Freq. MHz.	Emission
3	11823	TV/FM (NBC)
4	11872	TV/FM
7	12019	TV/FM
8	12068	TV/FM (NBC)
9	12117	TV/FM (NBC)
10	12166	TV/FM

Inclined orbit satellite

SBS 6 99.0° W

Transponder	Freq. MHz.	Emission
1	11725	TV/FM
2	11749	Digital Services
3	11774	TV/FM
4	11798	TV/FM
5	11823	TV/FM
6	11847	TV/FM
7	11872	TV/FM (I. D.)
8	11896	TV/FM
9	11921	TV/FM
10	11945	TV/FM
11	11970	TV/FM
12	11994	TV/FM
13	12019	TV/FM
14	12043	TV/FM
15	12068	TV/FM
16	12092	TV/FM
17	12117	TV/FM
18	12141	TV/FM
19	12166	Test Channel

SPACENET 4 101.0° W

Becomes operational first part of 1992.

GSTAR 1 103.0° W

Transponder	Freq. MHz.	Emission
1 (H)	11730	Digital Services
2 (H)	11791	Digital Services
3 (H)	11852	TV/FM
4 (H)	11913	Digital Services
5 (H)	11974	TV/FM
6 (H)	12035	Digital Services
7 (H)	12096	TV/FM
8 (H)	12157	TV/FM
9 (V)	11744	Digital Services
10 (V)	11805	Digital Services
11 (V)	11866	Digital Services
12 (V)	11927	TV/FM
13 (V)	11988	8 SCPC
14 (V)	12049	Digital Services
15 (V)	12110	TV/FM
16 (V)	12171	Inactive, spare

GSTAR 2 105.0° W

Transponder	Freq. MHz.	Emission
1 (H)	11730	SCPC (News)
2 (H)	11791	Digital Services
3 (H)	11852	TV/FM
4 (H)	11913	Digital Services
5 (H)	11974	TV/FM (CBS)
6 (H)	12035	TV/FM (CNN)
7 (H)	12096	TV/FM (CNN)
8 (H)	12157	TV/FM (News)
9 (V)	11744	Digital Services
10 (V)	11805	Digital Services
11 (V)	11866	TV/FM
12 (V)	11927	TV/FM
13 (V)	11988	TV/FM (LETN)
14 (V)	12049	Digital Services
15 (V)	12110	TV/FM (FSN)
16 (V)	12171	TV/FM

ANIK C1 107.3° W

Transponder	Freq. MHz.	Emission
T5	11839	TV/FM
T9	11961	TV/FM
T10	11987	TV/FM
T11	12022	TV/FM
T12	12048	TV/FM
T14	12109	TV/FM
T15	12144	TV/FM
T17	11730	TV/FM
T18	11756	TV/FM
T19	11791	TV/FM
T20	11817	TV/FM
T21	11852	TV/FM
T22	11878	TV/FM
T23	11913	TV/FM
T24	11939	TV/FM
T25	11974	TV/FM
T26	12000	TV/FM
T28	12061	TV/FM
T29	12096	TV/FM
T30	12122	TV/FM

Anik C1 will be switched to Anik E2 in early 1992.

ANIK C2 110.0° W

Transponder	Freq. MHz.	Emission
T7	11900	TV/FM
T8	11926	TV/FM
T11	12022	TV/FM
T23	11913	TV/FM
T24	11939	TV/FM
T25	11974	TV/FM
T26	12000	TV/FM
T31	12157	TV/FM
T32	12183	TV/FM

Most Anik C2 transmissions are occasional.

MORELOS 1 113.5° W

Transponder	Freq. MHz.	Emission
2K (H)	11888	TV/FM

Ku-Band 108 MHz, lower half transponder format.

ANIK C3 114.9° W

Transponder	Freq. MHz.	Emission
T3 (V)	11778	TV/FM
T4 (V)	11804	TV/FM
T19 (H)	11791	TV/FM
T20 (H)	11817	TV/FM
T23 (H)	11913	TV/FM
T24 (H)	11939	TV/FM

SPACENET 1 120.0° W

Transponder	Freq. MHz.	Emission
T19	11740	SCPC
T20	11820	TV/FM
T21	11900	TV/FM
T22	11980	TV/FM
T23	12060	TV/FM
T24	12140	TV/FM

SBS 5 123.0° W

Transponder	Freq. MHz.	Emission
3 (H)	11823	Data Services
4 (H)	11872	Data Services
5 (H)	11921	Business Data Services
6 (H)	11970	Digital (TDMA)
7 (H)	12019	TV/FM
8 (H)	12068	TV/FM
9 (H)	12117	TV/FM
10 (H)	12166	TV/FM
11 (V)	11748	Vsat Networks
12 (V)	11898	TV/FM
13 (V)	11994	TV/FM
14 (V)	12141	TV/FM

GSTAR 5 125.0° W

Transponder	Freq. MHz.	Emission
4	11913	TV/FM
5	11974	TV/FM
6	12035	TV/FM

ASC 1 128.0° W

Transponder	Freq. MHz.	Emission
19	11740	SCPC Services
20	11820	SCPC Services
21	11980	SCPC Channels
22	11980	Data-Telecommunications
23	12060	TV/FM
24	12140	TV/FM

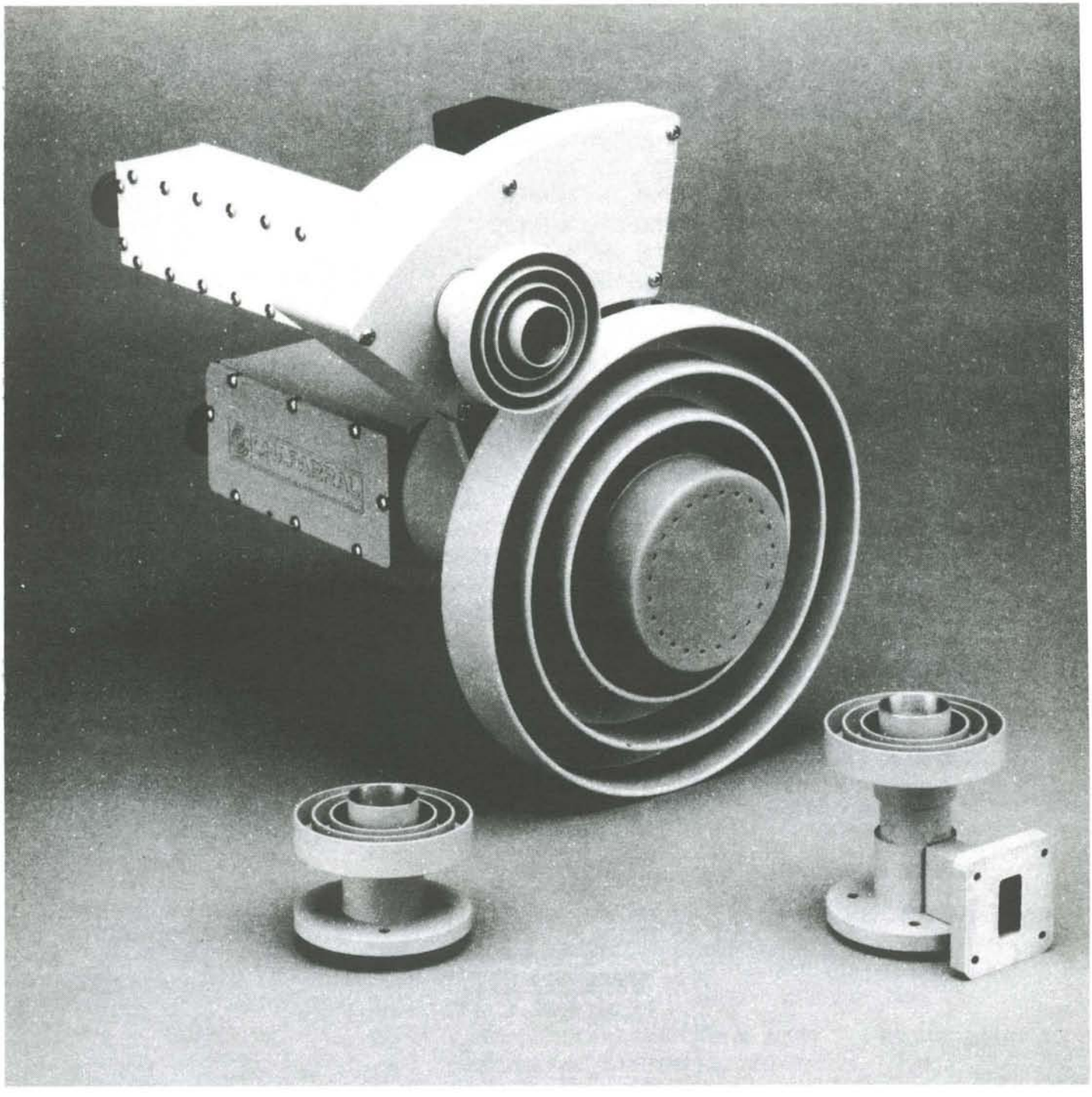


Figure 9.1 *Top Unit, 12 GHz Polarotor 1 attached to a 4 GHz Polaramp, for dual 12 GHz and 4 GHz reception from a single dish. Left bottom, single Chaparral 12 GHz feedhorn; Right bottom, dual feed 12 GHz feedhorn.*

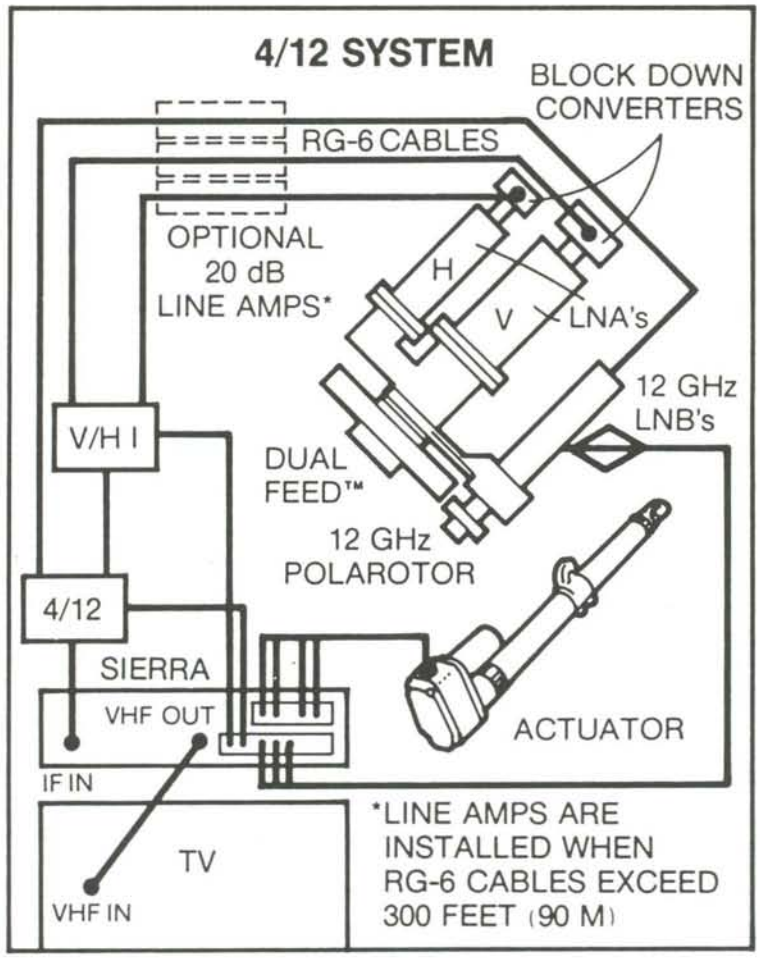


Figure 9.2 *Block diagram showing 4/12 GHz Sierra System.*

EQUIPMENT FOR KU-BAND

Many present manufacturers of C-Band receiving equipment are now looking for new products to receive this band. Several leaders in the industry presently are selling equipment that is compatible to Ku. These are: DX Antenna Company and Chaparral Communications of San Jose, California.

Reception of both 4 and 12 GHz satellites with one dish is possible with the new Sierra System. This is accomplished by connecting the Sierra receiver to a new 12 GHz Polarotor 1 Feedhorn. This unit attaches to any Chaparral 4 GHz Feed System. The 12 GHz Polarotor 1 receives Ku Band signals which are sent through a 12 GHz LNB to the Sierra receiver input via a A-B switch to select 4 or 12 GHz service. The Chaparral 12 GHz Polarotor 1 unit connects to the Polarotor terminals to allow reception of both signal polarities and complete skew adjustment on 12 GHz satellites. (12 GHz Polarotor 1 P/N 0835. **See Figure 9.1.**)

The ultimate is the Chaparral System shown in **Figure 9.2**. This is a 4 GHz dual feed and a 12 GHz Polarotor 1 unit for C-Band and Ku-Band using the same Sierra system and one dish.

For any "hidden signals" work, the same equipment for decoding C-Band signals would be used and the hookup is to the output on the receiver which will give you unclamped, unfiltered baseband video. On some systems this will be an output designed to interface with a video descrambler.

For pure audio work, you would again use the same equipment and hookup that is used in C-Band work and hook into the unfiltered audio output of the receiver. Most audio work can be accomplished by using a quality general coverage receiver hooked up to the baseband output of the receiver which will allow you to tune the entire subcarrier frequencies. Each Ku receiving system will vary slightly as to the outputs. This only requires a little study of the receiver to determine the correct placement of the needed output.

EARTH STATION GLOSSARY OF TERMS

ADJACENT CHANNEL INTERFERENCE: Signal distortion caused by signals in nearby frequencies which are not properly filtered. Use of a special bandpass filter allows only the selected frequency band to pass through it removing adjacent channels.

AFC AUTOMATIC FREQUENCY CONTROL: A satellite TV receiver feedback circuit which prevents the tuning oscillators from drifting away from the center frequency of the selected channel due to temperature change or other instabilities. A phase lock loop demodulator usually provides an AFC output back to the Local Oscillator.

AGC AUTOMATIC GAIN CONTROL: A satellite TV receiver feedback circuit which controls the gain (amplification) of the IF amplifiers so that the signal input to the demodulator will be constant, despite incoming signals of varying strength from different satellite transponders. AGC can be overridden by a manual gain control to make signal strength measurements in most receivers.

ALIGNMENT: The process of tuning (or tweeking) a circuit to compensate for the approximate tolerances of the components during assembly, using test equipment.

AM AMPLITUDE MODULATION: An easy method of transmitting program signals on a carrier frequency where the relative strength (amplitude) of the carrier is made proportionally equal to the amplitude of the program signal. AM is simpler but more susceptible to noise than FM. Satellite TV uses FM for both audio and video modulation but the user's TV set takes the satellite TV receiver's output and detects the video as AM, the audio as FM.

ANIK: The Canadian domestic satellite system used to transmit the Canadian Broadcasting Corp.'s network TV feeds. All ANIK satellites are operated by TeleSat Canada of Ottawa. ANIK satellites have both 4GHz C-band and 12GHz Ku-band transponders.

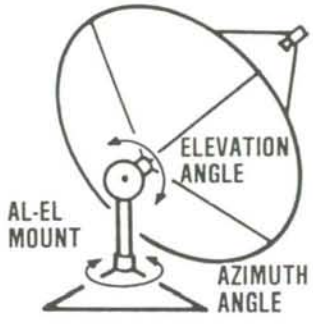
APERTURE EFFICIENCY: The ratio of captured signal to the theoretical maximum for a given dish antenna-feed combination. The design goal is 100% aperture efficiency, but most TVRO dishes perform at only 50-80% to attain low noise characteristics and ease of construction. Some VHF/UHF antennas on the other hand can approach the 100% goal with an array of reflective elements.

ARO AUDIO RECEIVE ONLY: Small dish antennas used by radio networks for music and news programming distribution from TV satellites (mostly WESTARS). Dishes 2 meters and smaller have been considered by radio broadcast stations.

ATTENUATOR: A passive device which causes a known insertion loss in the signal transmission line. It is commonly used to prevent a very strong signal from overloading a receiver.

AUDIO SUBCARRIERS: The sound in a TV satellite composite signal is encoded in a narrow portion of the video carrier, usually a high fidelity FM signal at 6.2 or 6.8MHz as measured after the main signal has been demodulated. Other satellite subcarriers can carry digital and test information as well.

AZIMUTH: Angle from the north to south line through the earth station's location. Measured in degrees clockwise.



AZIMUTH-ELEVATION MOUNT: A movable dish with an AZ-EL mount allows rotation in the horizontal-plane from the azimuth angle from the due north with one adjustment. Second adjustment provides elevation adjustment.

BANDPASS FILTER: A type of electronic frequency filter which severely limits signal frequencies above and below the selected frequencies, preventing adjacent channel interference. Satellite TV receivers use these also to remove noise from around the edges of the selected channel, usually 30MHz wide.

BASEBAND: This is the output signal of a video camera, videotape recorder or satellite TV receiver before remodulation (so that it can be viewed on an ordinary TV set). A signal in a satellite TV receiver goes from 4GHz through the downconverter to become IF and then through an FM demodulator to become baseband. American NTSC TV band width is 4.2MHz at baseband.

BEAMWIDTH: The beamwidth of a dish antenna is the angle of sky which can be illuminated (picked up or sent out) by the dish. Within that arc satellites can be seen from the TVRO dish. Large dishes have narrow beamwidths which reduce noise from its sides. Small dishes have wider beamwidths and are noisier, but easier to aim.

BIPOLAR: A type of silicon transistor used in LNAs and other high-frequency low-noise devices. They are superior in noise quality to ordinary transistors but are inferior to FETs especially GaAsFETs.

BNC CONNECTOR: Easy to lock coaxial cable fittings which interface signals in the IF portions of a satellite TV receiver. They work well in the 70MHz range.

BORE SIGHT: The center of the transponder "Footprint" where a signal strength is at its maximum.

C BAND: Designation for 3.7 - 4.2GHz microwave frequency band used for the downlinks of satellite TV signals. Wavelengths are between 8.10 and 7.14 centimeters (3.19 and 2.81 inches).

C/N: Carrier-to-Noise ratio. The ratio of the carrier strength and noise strength measured in dB. The higher the C/N, the higher the S/N and quality of the TV picture. 11dB is considered excellent. Above 7dB is good.

CARRIER: A radio wave of constant amplitude, frequency, and phase at the frequency of operation for the satellite communications system. Uplink carrier is 5,900 to 6,400MHz. Downlink carrier is 3,700 to 4,200MHz.

CASSEGRAIN FEED: A radiating system which includes the primary reflector (earth station dish) and a secondary reflector and feed horn.

CHANNEL: A frequency band allocation which defines the limits of the contained broadcast carrier signal. In the USA channels are allocated by the FCC.

CLOSE CAPTIONED TV: A text service for the hard-of-hearing TV audience which decodes a text subcarrier and displays it at the bottom of the TV frame on the accompanying video picture. It does not interfere with the standard audio FM subcarrier.

COMMON CARRIER: An operator or leasor of satellite TV transponders which in turn leases them to other parties, or transmits programming for others without controlling or owning the content. 4GHz satellite TV is not legally a broadcast service and the FCC does not make the satellite TV common carriers (RCA Americom, Western Union. . .) abide by the constraints of broadcasting law.

COMPARATOR: In an FM demodulator using a phase lock loop (PLL), this is the electronic component which compares the phase relationship of the input signal with the signal from the tracking local oscillator (LO). The output signal from the comparator is proportional to the phase

error between the two input signals and is used to control the LO.

COMPOSITE TV SIGNAL: Combination of video picture, color, audio and synchronization information.

dB AND dBW: dB is the standard unit for expressing relative power, voltage, or current, dBW indicates actual power of one signal compared to a reference of 1 watt.

DBS: Direct Broadcast Satellite, a technology used to transmit electronic signals directly from a communications satellite to the end user. The Federal Communications Commission has set aside frequency space in the 12/14GHz Ku-band for DBS services in the U.S.

COMSTAR: A series of C-band domestic satellites owned by the Communications Satellite Corp., a company created by an act of Congress in 1962 to operate the international satellites for the INTELSAT consortium of countries. Comstar satellites are currently leased to AT&T for television and other transmissions.

DETECTOR: A demodulator circuit in a satellite receiver which extracts the program signal from the carrier.

DIPOLE: An active antenna element located in the feed which collects the satellite TV signal and directs it to the LNA.

DISCRETE COMPONENTS: Assembly technique in which each part is built separately and then assembled.

DISH ANTENNA: A dish-shaped metallic or metallic-covered device which is used with a transmitter or receiver to amplify electronic signals relayed into or collected from the atmosphere.

DOMSATS: Domestic communication satellites including SATCOM, COMSTAR, GALAXY and WESTAR.

DOUBLE CONVERSION: This downconversion technique converts from 4GHz to the final IF (typically 70MHz) in two stages instead of just one, so that potential image noise from the first mixer stage is eliminated.

DOWNLINK: (Satellite to earth) Satellite programming is relayed via a downlink transmitter on the satellite back down to earth and spreads to cover a vast area. The satelite to earth transmission is carried at 3,700 to 4,200MHz.

DOWN CONVERTER: Device used to convert the 3.7-4.2GHz microwave downlink signal down to a VHF frequency range typically 70MHz.

DYNAMIC RANGE: The weakest through strongest signals that a receiver will accept as input. Signals which are too weak cause excess noise and signals which are to strong cause overloading and possibly modulation distortion.

EIRP: Effective Isotropic Radiated Power. A measure of the relative strength of the satellite TV signal expressed in dBW. EIRP figures range from 30dBW to 37dBW.

EARTH STATION: The complete satellite TV receiving system. Also referred to as TVRO (television receive only) system.

ELEVATION: Angle above the horizon measured in degrees. Zero is the horizon and 90° is directly overhead.

FEEDHORN: A component on a satellite TV receiving antenna which collects the signal reflected from the dish surface and "feeds" it into the low noise amplifier.

FET FIELD EFFECT TRANSISTOR: A low-noise high-frequency transistor amplifier which has a current source, gate and drain. The gate is a voltage controlled resistor which regulates the power flowing from the source to the dish.

FIXED SATELLITE: A form of international frequency band allocation where all the sending (uplink) and receiving (downlink) stations are identified. This is the current status of the 4GHz TV satellite systems. See also Broadcast Satellite.

FM IMPROVEMENT: The potential noise reduction in an FM signal due to the demodulation process in a satellite TV receiver. This figure is at most 38.6dB, and is attained above the FM threshold. Below this point it rapidly drops from 37.6dB. Above threshold: S/N = CN + 38.6dB.

FM THRESHOLD: An input signal level which is just enough to enable the demodulator circuits to extract a good picture from the carrier. With test equipment, static threshold is the point at which S/N drops more than 1dB from the straight graph line: S/N = C/N + 38dB. Typically FM threshold is 7-8dB in a satellite TV receiver with threshold extension.

FOOTPRINT: A signal strength map showing the EIRP contours of equal signal from a TV satellite transponder on a given part of the earth's surface.

FREQUENCY AGILE: This is a feature of satellite TV receivers which enables them to tune in all the 12 or 24 channels from a satellite. Receivers sold without this feature are dedicated to one channel and can be tuned by switchable crystals.

FREQUENCY COORDINATION: A service which implements a computer and a USA database to provide the user with information concerning whether there are undesired microwave signals that can affect the operation of satellite television receiver, to communicate with other microwave users to see if they have any planned stations which might later interfere with and disrupt operations of the earth station, or assist in FCC licensing, to register the earth station particulars so that future microwave users can avoid interference.

FREQUENCY MODULATION (FM): A method of transmitting program material which is more interference-free than AM. The frequency of the carrier signal is made proportional to the amplitude of the program signal.

FRONT-TO-BACK RATIO: The ratio in dB of the antenna gain in the forwards direction to the antenna gain in the rear direction. It is a measure of the noise potential from the rear.

G/T GAIN OVER NOISE TEMPERATURE. A TVRO measure of quality expressed in dB. The higher this figure, the better the system. It can be improved by increasing gain or by decreasing the system noise. G/T (degrees Kelvin) = Antenna gain/log (antenna noise temperature + LNA noise temperature).

GaAsFET GALLIUM ARSENIDE FIELD EFFECT TRANSISTOR: This low noise device, although expensive, is used in the highest quality LNAs. The term is pronounced gasfet.

GALAXY: A high-powered C-band satellite system owned by Hughes Communications.

GEO-SYNCHRONOUS ORBIT: The path that the DOMSATS are in at 22,300 miles above earth's equator. Travelling at 7,000/mph their speed and orbit are matched exactly to the earth's rotation and thus are stationary relative to the earth. This allows a fixed TVRO installation.

GHOST: One or more dim copies in a TV picture caused by reflected VHF or UHF broadcasts. Also called multipath distortion, this is not present in satellite TV signals because extremely directional dish antennas are used.

GHz GIGAHERTZ: The standard abbreviation for billions of cycles per second. 3.7 - 4.2GHz is the microwave frequency band allocated for satellite TV in the USA.

GUARD CHANNEL: Unused portions of the frequency spectrum which are located between program channels to prevent adjacent channel interference.

HARMONICS: Spurious signals produced by an oscillator circuit which occur at integral multiples above the resonant frequency of the oscillator. They appear like overtones on a single piano note. They can cause design problems in a receiver circuit unless proper filters are used to remove unwanted harmonics.

HEADEND: The point on a signal distribution system where UHF/VHF/FM and satellite TV signals are captured, combined and fed into the system.

HORN ANTENNA: A type of satellite TV antenna which is shielded against sidelobe interference. The incoming signal is reflected 90 degrees into a cone shaped feed horn. They are much more expensive than a dish antenna of the same aperture.

HPA: High Power Amplifier. A device which provides the energy for carrier amplification necessary to transmit to the satellite.

IC INTEGRATED CIRCUIT: A a solid state complex device which is mass produced on single silicon chips.

IF INTERMEDIATE FREQUENCY: For satellite TV receivers this is usually 70MHz and is the frequency at which most of the signal processing takes place because the design is simplified, and 70MHz parts are less expensive than 4GHz equivalents.

IF STRIP: A PC module which amplifies and filters the output signal of the downconverter in a receiver and inputs it to the FM demodulator. Its gain is controlled by the AGC circuit.

IMAGE NOISE: When a signal is downconverted using a mixer and LO, noise can be passed through the system that is on the mirror image frequency from the selected channel with the LO frequency as the point of symmetry, subsequent bandpass filters remove this noise in double conversion downconverters. A preselecter filter in single conversion receivers does the same thing.

IMPEDANCE MATCHING: The design of a signal interface such that the signal transmitted through it is maximized and the reflected signal is minimized. Standard impedance for LNAs is 50 ohms and for satellite IF circuits 75 ohms. Most signal distribution systems interface at 75 ohms impedance.

ISOLATOR: A device which is a one way valve for microwave signals which prevents stray receiver signals from leaking out past the LNA onto the antenna. It also facilitates the design of the LNA by impedance matching the feed probe to the first LNA amplifier stage. Most LNAs have an isolator attached between the CPR-229 feed flange and the main amplifier box.

KELVIN: The absolute Celsius temperature scale 0° Kelvin is equal to -273.1°C, or absolute zero. An LNA is rated by the amount of noise it contributes to the television picture. A perfect LNA with no noise would have a noise factor of 0 degrees Kelvin. Typical TVRO LNA's range from 120°k to 85°k.

LATITUDE: TVRO site latitude measurements given in degrees, minutes and seconds. Latitude numbers indicate how far north or south a point is.

LNA: Low Noise Amplifier that boosts the satellite signal picked up by the earth station dish. It is installed at a particular spot on the dish and is directly connected to the feed-horn.

LNB: Low Noise Block downconverter, a TVRO component combining an LNA with a block downconverter. (A block downconverter simultaneously converts the entire frequencies of one polarity received by the TVRO to a lower frequency.)

LNC LOW-NOISE CONVERTER: A 3.7 to 4.2GHz low noise converter is designed to mount at the prime focal point of the earth station antenna or at the rear of the antenna. LNC combines amplification and downconversion down to 270-770MHz range. Eliminates need for expensive coaxial cable such as used with LNA configuration.

LOBE: An area of strong reception in a graph of antenna gain versus angle off boresight. In highly directional dish antennas the front lobe is high gain and the side and back lobes are much weaker.

LOOK ANGLE: Angle above the horizon at your location from which the satellite signal arrives.

LONGITUDE: TVRO site longitude given in degrees west or the Greenwich, England longitude line for positive entries and negative entries for east of the line.

LOW PASS FILTER: A circuit which features high impedance of relatively high frequencies and low impedance for low frequencies, in effect blocking the high frequency component in a signal. *See also High Pass Filter and Bandpass Filter.*

MARGIN: A 3dB increase over the FM threshold, in a TVRO system, of the C/N which will provide an output signal completely free of impulse noise (sparklies). The FCC set this figure when CATV earth stations were more strictly regulated.

MHz MEGAHERTZ: The standard abbreviation for millions of cycles per second. Henri Hertz was a famous scientist who pioneered wireless communications.

MIXER: That part of a downconverter which joins together an input signal with that of an LO (local oscillator) to create an output signal which has a frequency that is the numerical difference between the two input frequencies. The program material in the FM carrier is not affected by the mixing process to a lower frequency.

MULTISTAGE LNA: Three or more transistor amplifier stages are placed end to end (cascaded) so that the gain contribution of each one will add up to approximately 50dB. In most LNAs the first stage, closest to the antenna feed probe, has the best noise characteristics to minimize the noise propagated along through the remaining stages.

N CONNECTORS: Coaxial cable fittings which interface cables between the LNA and satellite TV receiver. They carry 4GHz signals at 50 ohm impedance with low loss.

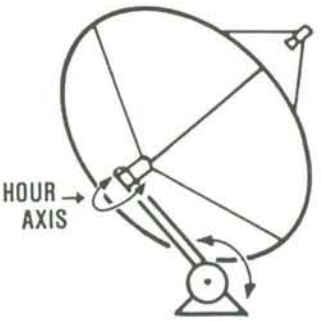
NF NOISE FACTOR: This measures the thermal noise contribution of LNAs and receiver front ends. LNAs typically measure 1.5dB (120 K) and receivers average 11-15dB.

P-P: Peak-to-Peak measurement of a waveform's amplitude as opposed to RMS (Root Mean Square) which is otherwise implied.

ORTHOMODE COUPLER: A section of the waveguide that allows two LNAs to be attached at right angles to each other and simultaneously receive both horizontal linear and vertical linear polarized satellite TV signals such as those that are transmitted by SATCOM.

PARABOLIC DISH: This antenna shape is commonly used to focus all the microwave energy collected on the dish surface into a single point in front of the dish called the focal point. It can be built from metal sheets, fiberglass, mesh or wood, covered with a metal reflecting surface which is accurate, with respect to a perfect parabola, to within 0.1 inch.

PLL PHASE LOCK LOOP: One form of FM demodulator which employs a feed back loop to lock a local oscillator to the same frequency and phase as the input signal. The error corrections applied back to the LO are equal to the original program signal that modulated the carrier and they are passed through the circuit as the output.



POLAR MOUNT: An earth station antenna mount used to aim reflector while making one adjustment. The hour axis is positioned to sweep the satellite arc. This mount is easier to aim than the azimuth-elevation mount.

POLARIZATION: Satellite signals that are polarized to oscillate only in one plane - horizontal or vertical. Two adjacent channels can be broadcast on overlapping frequencies simultaneously without interfering with each other if the signal for one is polarized vertically and the carrier wave for the other is polarized horizontally. Satellites that offer 24 channels of programming use this principle to provide 24 channels of

PORT: A physical signal interface. This can be a waveguide flange or connector.

POWER DIVIDER: A passive device similar to a signal distribution splitter but it is used at 4GHz to split an LNA's signal for up to 12 separate channels (either all vertical or horizontal). A full channel CATV or MATV system would require two LNAs and two power dividers to drive 24 separate receivers.

PRE-EMPHASIS: A selective amplification of the high frequency end of a satellite TV channel prior to uplink transmission to overcome potential noise problems. Each satellite TV receiver reverses the transformation in its de-emphasis circuits.

PRIME FOCUS FEED: The section of the antenna that receives the reflector and funnels the signal to the LNAs for amplification.

PROBE: The driven element in a microwave dish antenna system. It is located in the feed and converts RF energy in the waveguide to a signal on a transmission line to the LNA.

QUIETING CURVE: A graph of the signal-to-noise ratio (S/N) versus the carrier-to-noise ratio (C/N) for a particular satellite TV receiver. Generally for C/N above 8dB S/N=C/N + 38. The point on the curve below 8dB C/N where S/N rapidly falls off is the FM threshold.

REGISTERED TVRO: The FCC accepts registered earth stations so that it can be protected from possible terrestrial interference. Frequency coordination must be performed as part of the registration procedure.

RF: Radio Frequency. Any frequency between an audio sound and the infrared light portion of the spectrum, usually considered to be 10MHz to 10,000GHz.

RFI RADIO FREQUENCY INTERFERENCE: Any electrical spurious signals in the IF range causing static and noise in a receiver. RFI can also be caused by improperly shielded components within a receiver.

ROTOR SYSTEMS: A method of rotating an LNA feed 90 degrees to switch between vertical and horizontal polarizations. Many times an antenna rotor can be used with remote control from indoors.

S/N: Signal-to-Noise ratio. A ratio of the magnitude of a signal to that of the noise.

SATCOM: A group of U.S. C-band communications satellites owned and operated by RCA Americom.

SATELLITE RECEIVER: A microwave frequency range television receiver. Removes audio and video information off the 70MHz carrier signal. Provides additional amplification and selects transponders. Features transponder (channel select) control.

SCRAMBLING: Techniques to encipher a TV signal to prevent unauthorized reception without a descrambler device. Typically this is done by coding the sync information of the video signal.

SHROUDING: Protective walls or screens around a dish antenna which stop side interference. It is not needed at most earth station sites.

SIDELOBES: Areas from which noise can leak into a dish antenna from the side. Sidelobe performance is the ability of a given dish to reject these in favor of the satellite signal.

SIGNAL COMBINER: This is the reverse of a signal splitter. It allows several TV signals on different channels to be merged onto a single broadband transmission line. Many times this device can be substituted for by a signal splitter connected in the reverse direction.

SIGNAL SPLITTER: This is a passive device which enables two or more TV sets to divide a TV signal between them with proper balancing and isolation. It can be supplied in either 75 or 300 ohm impedances.

SINGLE CONVERSION: This technique uses just a single local oscillator and mixer to convert a satellite TV signal from 3.7 - 4.2GHz down to the final IF (usually 70MHz). Lower parts count and ease of assembly are important advantages over double conversion but care must be taken to prevent noise on the image frequency from leaking into the output.

SKY NOISE: Background microwave radiation coming from deep space which can be a noise source for dish antennas. Sky noise provides a lower boundary for the possible noise temperature of any dish antenna and is approximately 16-20K.

SMATV: Industry term for a Satellite Master Antenna System which distributes satellite signals throughout an apartment, hotel, motel, condos, etc.

SNOW: Dot type TV interference associated with weak signals in UHF/VHF TV pictures. *See also Sparklies.*

SPACE ATTENUATION: The loss in a TV satellite signal due to the fact that the beam spreads out after leaving the antenna. This is a major factor in path loss.

SPARKLIES: Signal noise which appears on the TV screen as white or black flashing dots. Indicates lack of signal or microwave interference.

STABILITY: The ability of a tuning circuit to avoid drift that most often is caused by ambient (surrounding) temperature changes. Lack of stability is the main reason that AFC circuits are used in satellite TV receivers. Crystal control provides the best stability. The term is also used to describe the ability of an amplifier to resist feedback of the output signal around to the input side.

SUBCARRIER: A second signal "piggybacked" onto a main electronic signal. In satellite TV applications, the video is transmitted via the transponder's main carrier while the audio goes out over an FM frequency subcarrier. Some satellite transponders carry up to four audio or data subcarriers, which carry information which can be related or unrelated to the main signal's programming.

TEARING: A form of weak signal interference which causes ragged streaks on the TV picture in vertical lines joining light to dark transitions. If this occurs in a satellite TV picture it is a good indication that the receiver is operating well below FM threshold.

TERMINATION: A connector or passive device at the end of a signal transmission line. This is like an end cap to maintain the impedance of the line.

TERRESTRIAL MICROWAVE: Communications links on the ground using microwaves. One of the allowed ground frequencies is the same as the band allocated to TV satellites and frequency coordination is needed by commercial TVROs to resolve conflicts.

THRESHOLD EXTENSION: A circuit technique, sometimes located in the loop filter of a phase lock loop demodulator, which improves the low signal performance of a receiver by lowering the FM threshold by 3dB C/N.

TRANSPONDER: Separate channels whthin the band of frequencies 500MHz wide (3,700 to 4,200MHz and 5,900 to 6,400MHz). One transponder occupies 40MHz of space. On ANIK and WESTAR satellites there is space within this 500MHz band for 12 channels on SATCOM and COMSTAR satellites. The manufacturers designed these birds so two separate channels or transponders share the same band of frequencies thus doubling the total of 24.

TRUE NORTH: Geographic north, determined by the earth's axis, as opposed to magnetic north, which is determined by the earth's magnetic poles. True north is one of the measurements used to align TVRO dish antennas with the North American satellite belt.

TV MODULATOR: Takes video and audio outputs of satellite receiver and converts baseband video and audio into a pattern which the standard TV receiver can use. TV channel position is usually set on Channel 3 or 4.

TVRO: Television receiver only. Industry term used to describe earth stations designed to receive satellite signals.

UPLINK: (Earth to Satellite) Satellite programming originates in a studio and is carried to a large transmitting antenna which is aimed precisely at the location in space where the desired satellite is in the geostationary orbit. The earth to satellite transmission is carried at 5.900 to 6.300MHz.

VHF VERY HIGH FREQUENCY: TV channels 2 through 13 in the following bands: channels 2-4 occupy 54 through 72MHz, channels 5-6 occupy 76 through 88MHz, and channels 7-13 occupy 174 through 216MHz.

VSWR VOLTAGE STANDING WAVE RATIO: A measure of the efficiency of a signal interface, especially the impedance match of the antenna to the LNA.

WAVEGUIDE: A transmission line consisting of a hollow conducting tube within which electromagnetic waves are propagated.

WESTAR: The domestic C-band satellite system owned by Western Union.

COURTESY OF

WINEGARD®

SATELLITE COMMUNICATIONS DIVISION

APPENDIX A

FUTURE DOMESTIC SATELLITE BELT 1995

Satellite	Proposed Location
Spacenet 2R	69° W
Satcom F-2R	72° W
Galaxy 2R	74° W
Satcom H1	79° W
Satcom K-2	81° W
Satcom F-4	82° W
Satcom K1	85° W
Spacenet 3	87° W
Telstar 402	89° W
Galaxy 6	91° W
SBS 4	91° W
Gstar 3	93° W
Galaxy 3R	93.5° W
SBS 3	95° W
Telstar 401	97° W
Galaxy 4H	99° W
SBS 6	99° W
Spacenet 1R	103° W
Anik D1	104.5° W
Gstar 2	105° W
Anik E2	107.3° W
Anik E1	110.75° W
Anik D2	111.1° W
Morelos 1	113.5° W
Anik C3	114.9° W
SBS 5	123° W
Telstar 303	125° W
Galaxy 5W	125° W
Gstar 4	125° W
Galaxy B	131° W
Satcom C3	131° W
Galaxy 1R	133° W
Satcom C4	135° W
Satcom C1	137° W
Aurora 2	139° W

Note: Some projected locations may change at later dates.

NORTH AMERICAN C-BAND SATELLITE FREQUENCY/TRANSPONDER CONVERSION TABLE

Channel or Dial Number	Uplink Frequency In MHz	Downlink Frequency In MHz	Satcom 1R, 2R, 4, C1 & C5	Telstar 301, 302 & 303 Comstar 4	Anik D1 & D2	Galaxy 1, 2, 3, 6 and Westar 4 & 5	Spacenet 1, 2 & 3	Spacenet 4 ASC 1	Morelos 1 & 2	Channel or Dial Number
1	5945	3720	1 (V)	1V (V)	1A (H)	1 (H)	1 (H)	1 (H)	1 W/L (H)*	1
2	5965	3740	2 (H)	1H (H)	1B (V)	2 (V)	13L (V)*	7 (V)	1N (V)	2
3	5985	3760	3 (V)	2V (V)	2A (H)	3 (H)	2 (H)	2(H)	1 W?U (H)*	3
4	6005	3780	4 (H)	2H (H)	2B (V)	4 (V)	13U (V)*	8 (V)	2N (V)	4
5	6025	3800	5 (V)	3V (V)	3A (H)	5 (H)	3 (H)	3 (H)	2 W/L (H)*	5
6	6045	3820	6 (H)	3H (H)	3B (V)	6 (V)	14L (V)*	9 (V)	3N (V)	6
7	6065	3840	7 (V)	4V (V)	4A (H)	7 (H)	4 (H)	4 (H)	2 W/U (H)*	7
8	6085	3860	8 (H)	4H (H)	4B (V)	8 (V)	14U (V)*	10 (V)	4N (V)	8
9	6105	3880	9 (V)	5V (V)	5A (H)	9 (H)	5 (H)	5 (H)	3 W/L (H)*	9
10	6125	3900	10 (H)	5H (H)	5B (V)	10 (V)	15L (V)*	11 (V)	5N (V)	10
11	6145	3920	11 (V)	6V (V)	6A (H)	11 (H)	6 (H)	6 (H)	3 W/U (H)*	11
12	6165	3940	12 (H)	6H (H)	6B (V)	12 (V)	15U (V)*	12 (V)	6N (V)	12
13	6185	3960	13 (V)	7V (V)	7A (H)	13 (H)	7 (H)		4 W/L (H)*	13
14	6205	3980	14 (H)	7H (H)	7B (V)	14 (V)	16L (V)*	13 (H)*	7N (V)	14
15	6225	4000	15 (V)	8V (V)	8A (H)	15 (H)	8 (H)	16 (V)*	4 W/U (H)*	15
16	6245	4020	16 (H)	8H (H)	8B (V)	16 (V)	16U (V)*		8N (V)	16
17	6265	4040	17 (V)	9V (V)	9A (H)	17 (H)	9 (H)		5 W/L (H)*	17
18	6285	4060	18 (H)	9H (H)	9B (V)	18 (V)	17L (V)*	14 (H)*	9N (V)	18
19	6305	4080	19 (V)	10V (V)	10A (H)	19 (H)	10 (H)	17 (V)*	5 W/U (H)*	19
20	6325	4100	20 (H)	10H (H)	10B (V)	20 (V)	17U (V)*		10N (V)	20
21	6345	4120	21 (V)	11V (V)	11A (H)	21 (H)	11 (H)		6 W/L (H)*	21
22	6365	4140	22 (H)	11H (H)	11B (V)	22 (V)	18L (V)*	15 (H)*	11N (V)	22
23	6385	4160	23 (V)	12V (V)	12A (H)	23 (H)	12 (H)	18 (V)*	6 W/U (H)*	23
24	6405	4180	25 (H)	12H (H)	12B (V)	24 (V)	18U (V)*		12N (V)	24

** 72 Mhz band width transponders*

Courtesy of Westsat Communications

YES, I WOULD LIKE TO RECEIVE UP-DATED

INFORMATION ON THE "HIDDEN SIGNALS AND OTHER DATA SERVICES ON THE SATELLITES." (PLEASE SEND SELF-ADDRESSED, STAMPED, NUMBER 10 ENVELOPE WITH THIS FORM)

NAME _____

STREET _____

CITY _____ STATE _____ ZIP _____

MAIL TO: UNIVERSAL ELECTRONICS, INC.
4555 GROVES ROAD, SUITE 13
COLUMBUS, OHIO 43232

THIS MATERIAL IS FOR INFORMATIONAL USE ONLY

This work published for the commercial trade to increase awareness of the many non-video opportunities existing in the satellite communication field. The publisher and author do not approve of the misuse of any of this information in any way by any individuals, companies, or groups.

DATA COMMUNICATIONS GLOSSARY

ANALOG: Information represented by continuous and smoothly varying signal amplitude or frequency over a certain range, such as in human speech or music.

ARQ: Automatic Retransmission Request, an error detection and correction technique which attempts a retry when an error is detected.

ASCII: American Standard Code for Information Interchange data communications code set.

ASR: Automatic send-receive.

ASYNCHRONOUS TRANSMISSION: a scheme in which data characters are sent at random time intervals.

BANDWIDTH: The range of signal frequencies that a circuit or network will respond to or pass.

BASEBAND: The frequency band occupied by information-bearing signals before they are combined with a carrier in the modulation process.

BAUD: A unit of signaling speed equal to the number of signal events per second.

BAUDOT: A five-level code set named for the early French telegrapher who invented it.

BINARY CODE: A pattern of binary digits (0 and 1) used to represent information such as instructions or numbers.

BIT: The smallest possible piece of binary information. A specification of one of two possible alternatives.

BROADBAND: Refers to transmission facilities whose bandwidth (range of frequencies they will handle) is greater than that available on voice-grade facillities. Also called wideband.

BYTE: A group of eight binary bits operated on as a unit.

CARRIER FREQUENCY: A constant signal transmitted between communicating devices that is modulated to encode binary information.

CHARACTER PARITY: A technique of adding an overhead bit to a character code to provide error-checking capability.

CPS CHARACTERS PER SECOND: A data rate unit used where circuits carry bits forming a data character.

CLOCKING: A technique used to synchronize a sending and receiving data communications device. Permits synchronous transmission at high speeds.

DATABASE: A repository of digital information requiring a computer system with extensive storage capability accessed by local and remote terminals for information retrieval.

DATA COMMUNICATIONS: The entire process and science of enabling digital devices such as computers to communicate with one another.

DATA COMPRESSION: The technique which provides for the transmission of fewer data bits without the loss of information. The receiving location expands the received dated bits into the original bit sequence.

DATA PACKET: A means of transmitting serial data in an efficient package that includes an error-checking sequence.

DATA RATE OR DATA-TRANSFER RATE: The speed at which data is sent to a receiving computer, given in bits-per-second (bps).

DECODER: Any device which modifies transmitted information to a form which can be understood by the receiver.

DEMODULATOR: A functional section of a modem which converts the received analog line signals back to digital form.

DIGITAL: Of or relating to the technology of computers and data communications wherein all information is encoded as bits of 1's or 0's that represent on or off states.

DISTORTION: The unwanted modification or change of signals from their true form by some characters of the communication line or equipment being used for transmission.

ERROR CHECKING: Software routines that identify, and often correct, erroneous data.

FDM: Frequency Division Multiplexing, a multiplexing technique where data line bandwidth is divided into different frequency subchannels used to share a data line between several user terminals.

FEC: Forward Error Correcting, a coding technique used to correct errors in transmission at the receiver by use of redundancy included in the transmission block.

FREQUENCY SHIFT KEYING, FSK: A form of frequency modulation in which the carrier frequency is made to vary or change in frequency at the instant when there is a change in the state of the signal being transmitted (i.e., the carrier frequency on the line during a "one" or marking condition would be shifted to another predetermined frequency during a "zero" or spacing condition.