NASA

National Aeronautics and
Space Administration
**Office of Mission to
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LOOKING AT EARTH FROM SPACE
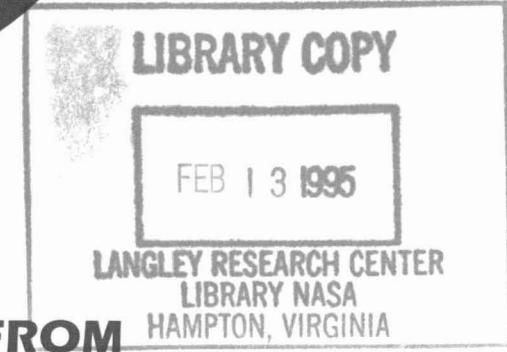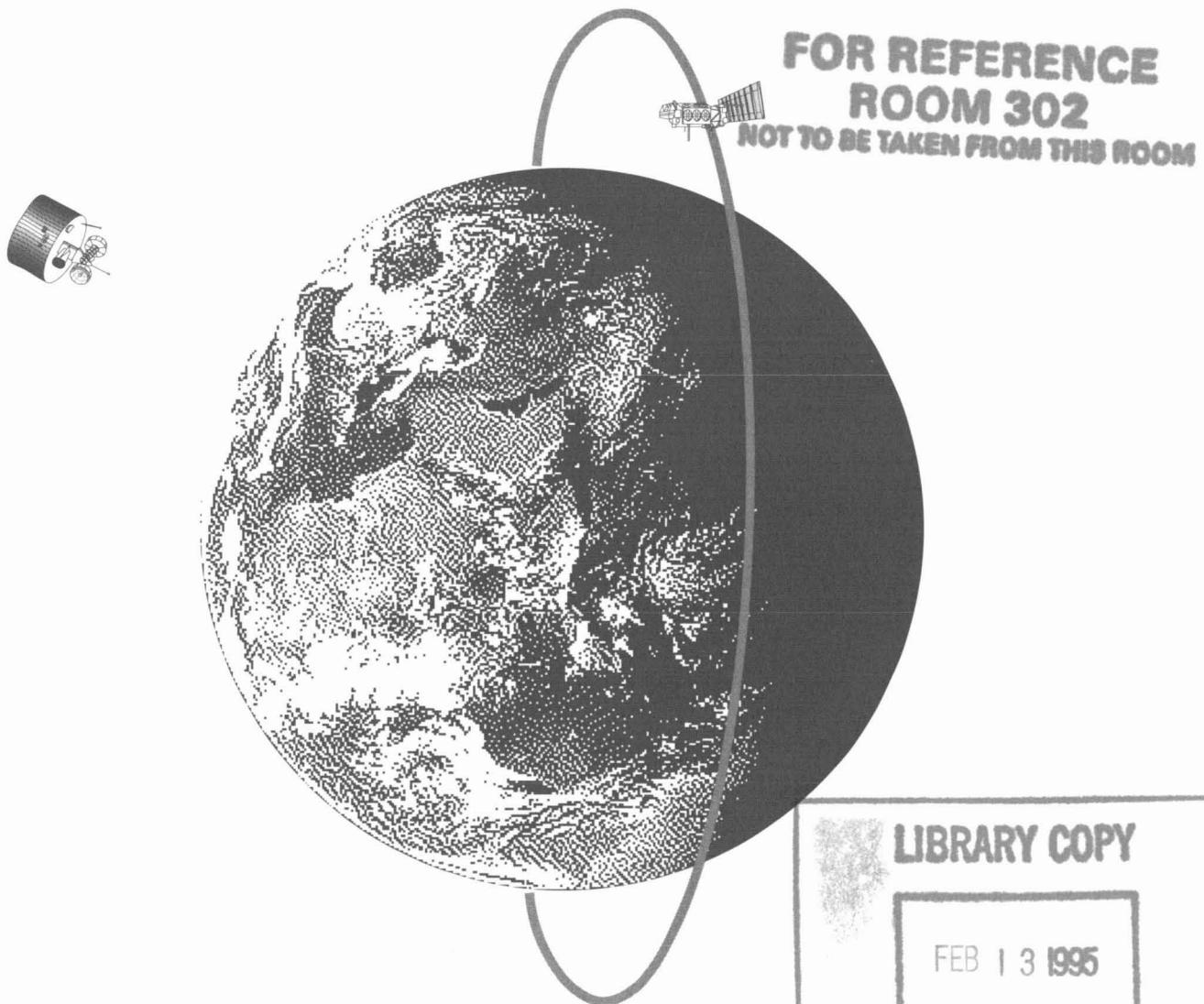
DIRECT READOUT FROM ENVIRONMENTAL SATELLITES
A GUIDE TO EQUIPMENT AND VENDORS

CONTENTS

About the Guide

The enclosed vendor equipment list was developed with NASA funding by the **D**allas **R**emote **I**maging **G**roup (DRIG) and the **MA**ryland **P**ilot Earth **S**cience and Technology Education **NET**work (MAPS-NET) project as a reference guide to low-cost ground station equipment for direct readout. NASA thanks Mr. Charlie Davis, DRIG member, and Ms. Colleen Steele, WT Chen & Company, for the initiation and production. Ms. Jan Timmons, Earth Science Support Office for editing; and Ms. Kelly Kavanaugh, Earth Science Support Office, for design, layout, and production of this guide

The information contained in this document should not be interpreted as an endorsement, recommendation, or guarantee for any person or product, nor does a listing here imply a connection with DRIG or MAPS-NET, or any organization that may distribute this guide. Vendors were invited to participate by submitting their products for review, all the reviewed products are for the IBM/compatible environment. The review process was completed in June, 1993. Some products have since changed their specifications or features, and new or upgraded products now may be available. You are encouraged to contact the vendors for the most current information.

Please note Federal Communications Commission (FCC) certification under Part 15 of the FCC rules and regulations. Products that emit radio frequency (RF) energy should be certified, indicating that the equipment complies with the standards specified in Part 15 of the regulations. Certified equipment carries either a Class "A" (meets institutional and educational standards) or "B" (meets the more stringent standards for home use) certification. Each electronic component of a ground station should meet the Part 15 standards in order to minimize interference to equipment. Note that certification does not apply to antennas or software, because they do not initiate RF energy.

Products were tested with the following standards in mind:

1. Ease of equipment use.

2. User friendliness and completeness of equipment manual and instructions.

3. Total system cost for computer, GOES, and APT capability is under $4,000.

4. Vendor stability in the industry.

January 1994

DIRECT READOUT

What *is* Direct Readout

Environmental satellites, equipped with a variety of sensors, monitor Earth and transmit the information back to Earth electronically. These electronic signals can be received by a ground station (also known as an Earth station), and displayed as images on a computer monitor. The capability to acquire information directly from environmental satellites produced the name direct readout.

Two types of environmental satellites provide direct readout service: geostationary and polar-orbiting. Their orbits and sensor equipment determine the scope and image resolution the satellites provide, as well as the equipment necessary to receive the data. The United States, Japan, Russia, and the European Space Agency currently operate environmental satellites that have direct readout capability. China operates environmental satellites but has discontinued direct readout services.

Image resolution describes the area represented by each picture element (pixel) in an image. The smaller the resolution number, the more detailed the image. For example, 8-kilometer resolution means each pixel represents a square having 8 km on a side, a lower resolution than 4 kilometers (each pixel representing a square with 4 km on a side).

Geostationary Orbits

Geostationary spacecraft orbit the Earth at a speed and altitude that allows them to hover continuously over one area of the Earth's surface, providing continuous coverage of that area. U.S. coverage is provided by Geostationary Operational Environmental Satellites (GOES). One of the GOES communication functions is to provide Weather Facsimile (WEFAX) services. WEFAX data, with a resolution of 8 kilometers, consists of retransmissions of processed GOES images, polar-orbiter data, and other meteorological information. With its seemingly stationary position relative to Earth, a result of its orbit 22,238 miles above Earth, GOES provides views of almost a third of the Earth's surface. Images from GOES combined with images from Japanese and European Space Agency geostationary satellites provide a global view of the Earth's environment.

Polar Orbits

Polar-orbiting satellites orbit approximately 600 miles above Earth, providing a more detailed look at a smaller area. Their orbital paths cross almost directly over the poles, and their sun-synchronous orbits mean that they cross the equator at the same time each day. U.S. polar orbiters, called TIROS satellites, provide low-resolution imagery called Automatic Picture Transmission (APT). APT is real-time data, with a resolution of 4 kilometers, that can be obtained when the satellite is within the receiving area of a ground station antenna—approximately every 102 minutes. High Resolution Picture Transmission (HRPT) from polar-orbiters has data resolution of 1.1 kilometers, but requires more costly equipment to obtain it.

Either WEFAX or APT services enable the user to obtain substantial environmental data. A dual system that accesses both types of data provides a comprehensive and continuous picture of the environment. Continuing technology improvements and cost reduction make that feasible and possible in a low-cost system.

GROUND STATION CONFIGURATION

A

PT & GOES Ground Station

The configuration shown is for a dual (APT and GOES) ground station. Even this basic set-up will vary among manufacturers. For example, some systems don't need a level adjust box or A-B switch box. The antenna switch box is needed only when accessing both APT and GOES data with a receiver that has a single antenna input.

Feedhorn

Downconverter

A-B
Switch Box

Level Adjust

Receiver

Power
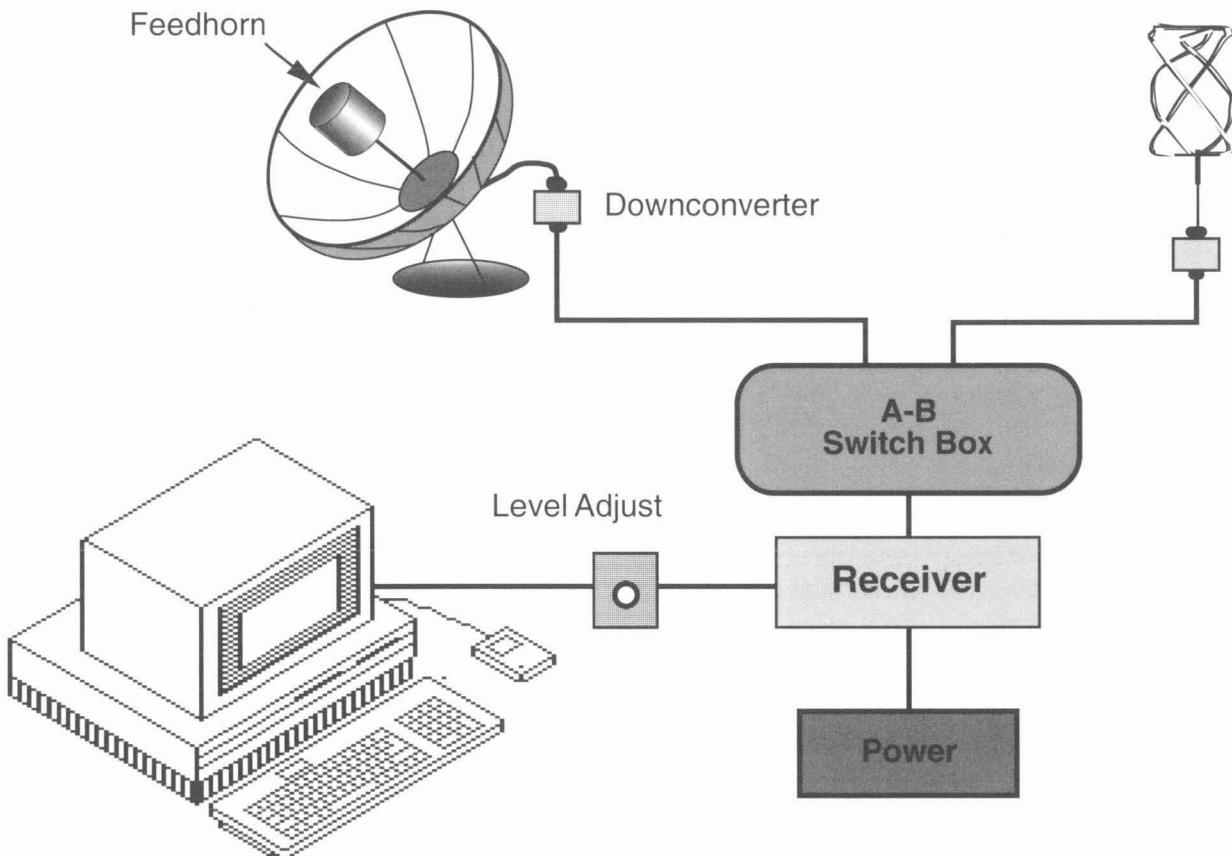
A less expensive option is to set up a system that accesses only WEFAX or APT. Consider whether that ground station will eventually become a dual system, and if so, select components that will support additions and upgrades.

Examine the total station needs in advance, both to project costs and to obtain all the components. Additional materials to set up the ground station shown above might include the following items:

- Pre-amp & weatherproof housing
- Coaxial cable (such as Belden 9913, 9311, or equivalent)
- Antenna tripod
- Coaxial connectors
- Antenna mast
- Male adaptor connectors
- Power/signal cable

- Type "N" RF connectors
- Plastic electrical tape
- TY-RAPS wire ties
- Hex/screw head bolts with nuts and washers
- Bagged white sand or other antenna ballast
- Plywood for tripod mounting
- A/B antenna switch

COMPUTER REQUIREMENTS

I **BM/Compatible Computers should meet these minimum specifications:**

- 386/33 MHz computer 64K cache* w/ 4 MB RAM*
- SVGA monitor 1024 x 768 x 256 .28 dot pitch non-interlaced
- SVGA graphics card with 1 Mb RAM 1024 x 768 x 265
- 200-watt power supply
- Standard mid-sized case
- I/O card with 1 serial port and 1 parallel port
- MS DOS installed (Version 5 or later)
- 120 MB IDE hard drive
- 5 1/4 inch floppy drive
- 3 1/2 inch floppy drive
- IDE hard drive/floppy drive controller
- 101 keyboard enhanced
- Power supply with surge suppression distribution device
- Microsoft or other compatible mouse
  (adaptor card may be required if external modem is used)
- 2400 to 9600 baud modem (with cables if external)
- Math co-processor
- VESA support

Optional
- Satellite tracking program
- Computer painting program such as PC PAINT 5+
- Dot matrix or laser printer and cable
  * Quorum Communications recommends 256K cache with 8 MB RAM

A **pple and Macintosh Specifications:**

Check with vendors. Macintosh currently is the most expensive environment for direct readout. Apple and Macintosh systems now offer fewer sources, software, and options for direct readout than IBM/compatible systems.

F **ifo**

First in, first out. Electronic storage device known as a buffer, fifo slows data down to a rate the computer can accept.

M **ulti-tasking Environment**

Multi-tasking environments permit the software window to be reduced and another program, such as a satellite tracking program, to run either on screen or in the background. Microsoft Windows is an example of a multi-tasking environment. The software included in this guide from Lone Eagle Systems and Tri-Space operates in a multi-tasking environment.

Most satellite imaging programs will not currently run in a multi-tasking environment because they use most of the computer's memory to complete their task. If you plan to use Microsoft Windows, OS/2, or Quarterdeck's Deskview, consult your vendor to determine whether the product under consideration will run in that environment.

F ile Compression Types

File compression is a process for reducing binary computer data files into a format that uses less of the computer's memory. Because saving satellite images can consume large amounts of memory, conserving disk space becomes an important consideration. The most commonly used compression formats are listed in descending order of popularity.

1. GIF	4. JPG
2. PCX	5. RLE
3. TIF	6. BMP

Satellite imaging programs can save files in a variety of formats but most commonly use PCX or TIF. Computer paint programs most commonly use PCX or TIF. However, most image viewing software use GIF or PCX formats. Programs such as Graphics Workshop, a shareware computer program that can be obtained from the MAPS-NET Bulletin Board (410) 239-4247, or DRIG Bulletin Board (214) 394-7438, can convert files from one format to another, ensuring compatibility for various applications.

Files of each compression type can be identified by the extension in the file name (filename.PCX). Shareware programs are available on local computer bulletin boards. Upgraded versions are available from the programmer for a modest fee—usually from ten to twenty dollars.

G round Station Features to Consider

Consult the Matrix of Electronics Cards (page 18) and the Matrix of Software Capabilities (page 19) for listings of options to consider when selecting a system.

T he Equipment

- Components are grouped by type (receivers, antennas, etc.) and listed alphabetically by vendor. The imaging cards and software are grouped together because many of these items are sold as a package.

- All the imaging cards are capable of receiving both APT and WEFAX.

IMAGING CARDS
AND SOFTWARE

P **roduct: Eagles View**

Compatible products: WEFAX Explorer, WEFAX-2, PC-137
Product use: Imaging software package
FCC certification: Not applicable to software
Price: $695
Vendor: **Lone Eagle Systems, Inc.**
      5968 Wenningoff Road
      Omaha, Nebraska 68134
      (402) 571-0102
      (402) 572-0745 (fax)

Eagles View is the first and only multi-tasking package available outside of a Windows environment. Operating in its own environment enables the package to receive APT and WEFAX, as well as receive and process Radio Weather Teletype data such as surface, upper air, and NOAA bulletins, while performing other tasks. Windows-like menus and title bars provide easy access to all the program's features. Eagles View allows the user to edit images with weather map symbols, text, and plotting and contouring of surface and upper air data. Distance calculation is provided in kilometers and miles, and is accurate to .01 percent. Also included are multiple gridding formats and satellite-pass mosaicking.

Full orbital prediction and satellite tracking are available at the click of a button. Weather charts are easily completed and understood with the aid of on-line help menus. Every step of the program's operation is explained. The software supports several electronics packages. WEFAX-2 will allow full multi-tasking with this program. The package also supports the new Quorum HRPT data acquisition package. Also included are tools that manipulate data from other sources, such as instrumentation or NOAA Bulletins.

P **roduct: MFMAP internal/external imaging card & software**

Compatible products: WEPIX-2000B, PC-137
Product use: Imaging card and software
FCC certification: Submitted and verified
Price: $300-$375
Vendor: **Multifax**
      143 Rollin Irish Road
      Milton, Vermont 05468
      (802) 893-7006
      (802) 893-6859 (fax)

This new product from an established source is available in either an internal or external version. The internal version is built on a half-size IBM electronic card. The external version is built into a small modem-style case and requires a 12-volt power source (supplied). The software is simple and easy to use, with full gridding and image enhancement. The low-cost package provides nice images and basic features, with more added to the program yearly. Full printer support along with unattended timer operation is an added plus. A sample kit that demonstrates the features of the program and includes two disks of images is available for $15. The $15 fee can be applied toward the purchase of their products. The product supports APT/WEFAX/HF fax.

roduct: WEFAX Explorer imaging card and receiver

Compatible products:	QFAX Software, Lone Eagle–Eagles View Software
Product use:	APT/WEFAX imaging card and receiver
FCC certification:	Supplied and verified
Price:	$695
Vendor:	**Quorum Communications, Inc.**
	8304 Esters Road, Suite 850
	Irving, Texas 75063
	(214) 915-0256
	(214) 915-0270 (fax)

A full-size, IBM-compatible, plug-in, 8-bit electronics card with a 1K fifo on board. This card also has a Quorum PC-137 internal receiver installed on the same electronics card, both FCC-certified. Introduced in early 1993, this is the first card to incorporate an onboard receiver—reducing the number of external components necessary. The receiver is a fully controlled 137 MHz scanning receiver. The UHF input can supply 13.8 volts DC for the WEFAX downconverter through an external power supply, decreasing the cabling necessary. The output voltage is fused by an onboard fuse on the electronics card. A complete manual aids in the installation of the card. A separate antenna connection is provided for both APT and WEFAX. The use of a pre-amplifier is recommended with this package.

roduct: WEFAX 2 imaging card

Compatible products:	FAX Software, Lone Eagle–Eagles View Software
Product use:	APT/WEFAX imaging card
FCC certification:	Supplied and verified
Price:	$895 with QFAX software
Vendor:	**Quorum Communications, Inc.**
	8304 Esters Road, Suite 850
	Irving, Texas 75063
	(214) 915-0256
	(214) 915-0270 (fax)

A full-size, IBM-compatible, plug-in, 8-bit electronics card with 32K fifo on board. The board is suitable for use with APT, WEFAX, or other FAX products. Unlike the WEFAX Explorer card, the WEFAX 2 does not have an on-board receiver and requires an external receiver such as a PC-137 or WEPIX-2000B. This card is one of two standard electronics packages in use for more than five years. The included manual provides complete installation information.

IMAGING CARDS
AND SOFTWARE

P **roduct: QFAX software**

Compatible products:	WEFAX-2, WEFAX Explorer
Product use:	Software
FCC certification:	Not applicable to software
Price:	Supplied with all Quorum electronics cards
Vendor:	**Quorum Communications, Inc.**
	8304 Esters Road, Suite 850
	Irving, Texas 75063
	(214) 915-0256
	(214) 915-0270 (fax)

QFAX is a new version of software that enables the user to control the on-board receiver in the WEFAX Explorer card, and the PC-137 receiver if used with the WEFAX-2 electronics card. This is the first and only program currently providing on-screen tracking while an image is ingested, or decoded and processed. Other notable features include the ability to do temperature conversion in the image (user can choose Fahrenheit of Celsius), zooming up to 20 times in each mode, automatic ingest and control of image ingest via timer, and a full gridding package. This program allows the user to save images in PCX, GIF, and TIF formats. Frequent enhancements are made to the software. Quorum customers' have received free software upgrades to date.

P **roduct: ESC-102 Electronics Imaging Card**

Compatible products:	WEPIX-2000-B, PC-137, SDSFAX, SDSFAX-PLUS
Product use:	Image display
FCC certification:	Submitted and verified
Price:	$479
Vendor:	**Satellite Data Systems**
	PO Box 219, 800 Broadway
	Cleveland, Minnesota 50617-0219
	(507) 931-4849 phone/fax

One of the first vendors to supply all the equipment needed by the WEFAX/APT user. The full-sized, plug-in card provides true 8-bit data. An on-board speaker is contained in the card for use with receivers without speakers, and allows the user to hear incoming signals. Connection from the receiver is made by an 1/8-inch male phone plug.

A shortened version of the ESC-102, Model ESC-120, will fit computers such as Tandy that require a 10-inch card. ESC-120 is available for $429.

IMAGING CARDS
AND SOFTWARE

roduct: SDSFAX

Compatible products:	ESC-102
Product use:	Software
FCC certification:	Not applicable to software
Price:	Included with ESC-102
Vendor:	**Satellite Data Systems**
	PO Box 219, 800 Broadway
	Cleveland, Minnesota 50617-0219
	(507) 931-4849 phone/fax

SDS produced the first full-featured package and continues to enhance it regularly. The software provides the user with the standard 640 X 480 X 16 color VGA images and enables the user to zoom, label, and loop up to 99 images (assemble a series of images and display them like a film). Manipulation capabilities include temperature measurement, timer function allowing the user to preset image capture times, and printer support for printing images. Image enhancement features provide a video equivalent to 64 shades of gray and full palette control for enhancement and coloring. This program supports APT, WEFAX, GOES, GOES-TAP, and weather map imaging.

roduct: SDSFAX-PLUS

Compatible products:	ESC-102
Product use:	Software
FCC certification:	Not applicable to software
Price:	$119
Vendor:	**Satellite Data Systems**
	PO Box 219, 800 Broadway
	Cleveland, Minnesota 50617-0219
	(507) 931-4849 phone/fax

SDSFAX-PLUS software has been a leader in developing new software features, and continues to enhance this package on a regular basis. The software package provides 800 X 600 x 256 shades of gray and the ability to assign a color to each pixel value. Capabilities include image stretching, zoom, pan and scroll, and easily produced histograms. Images can be annotated in three standard-size fonts, and saved in PCX, Binary, and ASCII file formats. SDSFAX-PLUS supports the VESA video standard. Pull-down, Windows-like menus make the software easy to operate. A demonstration disk is available from SDS, along with a full catalog of items for the weather satellite user.

IMAGING CARDS
AND SOFTWARE

Product: **Lockheed SATMAPPER/WINSAT 1.0**

Compatible products:	Lockheed
Product use:	Imaging card and software
FCC certification:	Card not certified
Price:	Contact vendor
Vendor:	**Tri-Space, Inc.**
	PO Box 7166
	McLean, Virginia 22106
	(703) 442-0666
	(703) 442-9677 (fax)

This product includes a Windows-environment imaging card and software (to date, WINSAT 1.0 and SATMAPPER are the only low-cost programs working in a Windows multi-tasking environment). Click to select one of the many functions, including on-screen tracking and ingest. A full set of NOAA enhancement palettes, and image stretching and enhancement are included. Custom palettes make it easy to enhance images. SATMAPPER, a gridding program to place country, state, and latitude/longitude lines on a captured image, was the first gridding program on the market, and to date is the most accurate. SATMAPPER works with Winsat 1.0 in either Windows or the DOS environment. Image enhancements and stretching can be correlated with temperature on infrared images. Because of its Windows framework, images can be saved in a variety of common formats including BMP, GIF, TIF, and PCX.

The Lockheed electronics card has been around for some time and originally was named the A & M card. Weather Radio, the receiver control program, operates in both the Windows and DOS environment. Weather Radio works with the PC-137 receiver from Quorum Communications and the Vanguard WEPIX-2000B. A click of the button selects the receiver mode and frequency in the PC-137.

Noise inhibits the production of a clear image; thus, an external amplifier, placed close to the antenna, provides the necessary signal amplification to insure a good signal-to-noise ratio. The pre-amp should be mounted at the antenna with a good quality cable such as Belden 9913 or 9311.

P roduct: PC-137 receiver

Compatible products:	WEFAX-2, Weatherfax, SDSFAX
Product use:	Internal receiver
FCC certification:	Submitted and verified
Price:	$419
Vendor:	**Quorum Communications, Inc.**
	8304 Esters Road, Suite 850
	Irving, Texas 75063
	(214) 915-0256
	(214) 915-0270 (fax)

The PC-137 is the first internal receiver and allows full scanning of the 137 MHz band. The software-controlled receiver supports both VHF and UHF inputs, and provides fused protection for an external 12-volt power supply to a downconverter. The receiver is built on a half-slot IBM plug-in card with all power for the receiver's operation coming from the computer's power source. External audio output is available on the card for use with other vendor products such as SDSFAX, SDSFAX-PLUS, WeatherFAX, Lockheed, and Eagles View.

P roduct: WEPIX-2000B receiver

Compatible products:	ESC-102, WEFAX-2, MULTIFAX, WEATHERFAX
Product use:	Receiver
FCC certification:	Not certified
Price:	$350
Vendor:	**Vanguard Electronic Labs**
	196-23 Jamaica Avenue
	Hollis, New York 11423
	(718) 468-2720

The WEPIX receiver has been employed by APT and WEFAX users worldwide for years. The WEPIX-2000B provides push-button selection of all known APT frequencies. A flick of a switch allows the downconverted GOES signal to be tuned. The unit is built into a full metal enclosure the size of a modem and requires a 12-volt power source. Outputs on the back of the receiver will accommodate a tape recorder and a meter to monitor the signal of the transmitting spacecraft. The use of a pre-amplifier is not required on cable runs less than 100 feet.

Antennas

Feedline

The antenna feedline is perhaps the most important component in a ground station. A good feedline will provide maximum signal while reducing stray RF or man-made noise (interference). Coaxial cable is feedline whose center conductor has been encased in dielectric material with an outer braided shield. The shielding greatly reduces the introduction of RF or man-made noise into the receiving system.

Cable such as Beldin 9913 and 9311 have a special foil wrap around the dielectric in addition to the copper braid. 9311 cable is approximately 1/4 inch in diameter and a good pick for cable runs less than one hundred feet. 9913 is about 1/2 inch in diameter, and will necessitate additional coaxial cable adapters if the antenna or receiver require a BNC-type of connection. The adapters can be purchased from an electronics store for approximately $2 each. Support for the cable must be provided at BNC connection to avoid damage to its mated connector on the receiver or antenna.

Avoid purchasing inexpensive cable that will not provide adequate shield or lasting construction. Vendors can supply this as well as put connectors on the cable for a small additional fee. Installation of the antenna may require cable to be fed through small holes drilled into walls or ceilings. For that reason, it would be wise to have only one connector put on the cable before installation, because additional pre-installed connectors may hamper running the cable.

Installation

Never: Run the antenna feedline next to power lines or electric cables.
Bend the coaxial cable sharply.
Run the cable through a window and shut the window on the cable.
Use twist-on cable connectors.
Pull or twist connectors installed on the cable.
Allow cable to be walked on or crushed.
Leave the antenna feedline connected to your receiver during electrical storms unless using a lightning arrester.

Always: Solder the shield of the coaxial cable to the connector (not applicable for crimp connectors).
Ground the antenna to a cold water pipe or grounding rod, or both.
Secure the antenna feedline so that the wind cannot sway it.
Seal the antenna connection with electrical tape or non-conductive sealant.
Purchase the best cable available.
Replace worn or broken cables and ground connections immediately.
Inspect the system at least once a year to reduce trouble-shooting time.

GROUND STATION ANTENNAS

All antennas should have the best cable available to prevent various forms of noise from entering your system. Quality cable, such as Belden 9913 or 9311, can be purchased from electronic supply houses or vendors.

Product: **V-20 Quadrifiler Helix Antenna**

Compatible products:	ESC-102, WEPIX-2000-B, PC-137, WEFAX Explorer
Product use:	APT ground station antenna
Price:	$625
Vendor:	**Quorum Communications, Inc.**
	Suite 850, 8304 Esters Road
	Irving, Texas 75063
	(214) 915-0256
	(214) 915-0270 (fax)

Designed for space communications, it provides the user with better signal coverage than a turnstile antenna. This antenna is housed in a 6"x 41" PVC container with a built-in 137 MHz pre-amplifier. The antenna mounts on a 2-inch PVC nipple that can be coupled to a 2-inch pipe or other suitable mounting device.

Product: **FEED-1691L Linear Feedhorn/Antenna**

Compatible products:	SDC-1691CW/P
Product use:	Feedhorn/antenna
Price:	$175
Vendor:	**Quorum Communications, Inc.**
	Suite 850, 8304 Esters Road
	Irving, Texas 75063
	(214) 915-0256
	(214) 915-0270 (fax)

A simple yet effective feedhorn/antenna for use with a 4 to 12 foot dish-type antenna. The unit is open faced, with a type "N" connector located on the back of the unit for connection to the downconverter. All mounting hardware is included.

GROUND STATION
ANTENNAS

P **roduct: QH-137 Quadrifiler Helix Antenna**

Compatible products:	WEPIX-2000-B, PC-137, WEFAX Explorer, Lockheed
Product use:	APT ground station antenna
Price:	$319
Vendor:	Satellite Data Systems
	PO Box 219, 800 Broadway
	Cleveland, Minnesota 50617-0219
	(507) 931-4849
	(507) 931-4849

This antenna is open-frame design and does not contain a built in pre-amplifier. The antenna stands 36 inches high and 12 inches in diameter, and can be mounted on top of any TV mast. As with all quadrifiler helix antennas, it will provide the user with stronger signals and fewer drop-outs of signal than a turnstile antenna.

P **roduct: APT-1 turnstile Antenna**

Compatible products:	WEPIX-2000B, PC-137
Product use:	APT ground station antenna
Price:	APT-1 $90
	APT-2 with built-in pre-amp $150
Vendor:	Vanguard Electronic Labs
	196-23 Jamaica Avenue
	Hollis, New York 11423
	(718) 468-2720

The simple but effective turnstile antenna has been used for years and will get the new user started at low cost. Designed for space communications, the turnstile will provide good results and noise-free reception for satellites 20 degrees above the horizon. The antenna is constructed of PVC and mounts on any normal TV antenna mount. Use a pre-amplifier such as the 104-G with this antenna.

DOWNCONVERTERS

P **roduct: SDC-1691CWP downconverter**

Compatible products:	WEFAX Explorer, WEFAX-2, ESC-102, PC-137, WEPIX-2000-B, Weather Fax, Lockheed
Product use:	1691 MHz WEFAX downconverter
FCC certification:	Submitted and verified
Price:	$598
Vendor:	**Quorum Communications, Inc.**
	Suite 850, 8304 Esters Road
	Irving, Texas 75063
	(214) 915-0256
	(214) 915-0270(fax)

The SDC-1691BWP downconverter converts 1691 MHz GOES signals to 137 MHz for processing by a APT/WEFAX demodulator electronics card. It has a typical noise figure of 1dB and a gain of 50 dB. The unit is housed in a metal case with two mounting holes for mounting on or near the WEFAX antenna. Power can be supplied either by a separate 12-volt source applied directly to the unit, or from a separate power supply feeding the PC-137 receiver or the WEFAX Explorer card. The output from either is fused to protect both the pre-amplifier/downconverter and the PC-connected receiver and demodulator card. This unit is very stable in any environment and requires no maintenance. A Type "N" connector is located on the bottom of the unit and connects to the feedhorn/antenna; a BNC connector also is located on the bottom of the unit that connects to a 137 MHz receiver. A solder type post also is located on the bottom of the unit for external 12-volt supply connection.

PREAMPLIFIERS

A pre-amplifier is an active device placed between the antenna and the receiver that amplifies the incoming 137 MHz signal. A pre-amplifier should be used in all antenna systems where the receiver gain is in question and noise prevents receiving a clean image. However, the trade-off to an amplified signal may be amplified ground-based noise as well.

P **roduct: 104-G**

Compatible products:	WEPIX-2000B, PC-137
Product use:	Antenna pre-amplifier
FCC certification:	Not certified
Price:	$75
Vendor:	**Vanguard Electronic Labs**
	196-23 Jamaica Avenue
	Hollis, New York 11423
	(718) 468-2720

The antenna pre-amplifier is powered by the receiver; the coaxial cable connecting the pre-amplifier to the receiver provides the conduit for the DC voltage necessary to operate the unit. The unit has two BNC connectors to connect to the antenna and the feedline. The unit is constructed of a small aluminum box that is not waterproof and should be protected from the elements. Vanguard also sells mounting hardware and a suitable PVC tube for water protection.

This does not represent an endorsement, recommendation, or guarantee for any person or product, nor does a listing here imply a connection with DRIG or MAPS-NET. Additions or corrections to this list should be submitted to University Programs, NASA/Goddard Space Flight Center, address on pg 17.

Amsat
PO Box 27
Washington, DC 20044
v (301) 589-6062
f (301) 608-3410

Clear Choice Education Products
PO Box 745
Helen, Georgia 30545
v 800 533-5708
f (706) 865-7808
(education materials only)

ERIM
Earth Observation Group
PO Box 134001
Ann Arbor, Michigan 48113
v (313) 994-1200, ext 3350
f (313) 668-8957

Fisher Scientific*
4901 West LeMoyne Street
Chicago, Illinois 60651
v 800 955-1177
f (312) 378-7174

GTI*
1541 Fritz Valley Road
Lehighton, Pennsylvania 18235
v (717) 386-4032
f (717) 386-5063

Lone Eagle Systems Inc
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Omaha, Nebraska 68134
v (402) 571-0102
f (402) 572-0745

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143 Rollin Irish Road
Milton, Vermont 05468
v (802) 893-7006
f (802) 893-6859

Northern Video Graphics, Inc.
511 11th Avenue South, Box 92
Minneapolis, Minnesota 55415
v (612) 338-6589

OFS Weatherfax
6404 Lakerest Court
Raleigh, North Carolina 27612
v (919) 847-4545
f (919) 847-4545

Quorum Communications, Inc
8304 Esters Boulevard, Suite 850
Irving, Texas 75063
v (800) 982-9614
v (214) 915-0256
f (214) 915-0270
BBS (214) 915-0346

Satellite Data Systems, Inc.
800 Broadway Street, PO Box 219
Cleveland, Minnesota 56017
v (507) 931-4849
f (same as voice number)

Software Systems Consulting
615 S. El Camino Real
San Clemente, California 92672
v (714) 498-5784
f (714) 498-0568

Tri-Space Inc.
PO Box 7166
McLean, Virginia 22106-7166
v (703) 442-0666
f (703) 442-9677

U.S. Satellite Laboratory
8301 Ashford Blvd., Suite 717
Laurel, Maryland 20707
v (301) 490-0962
f (301) 490-0963

Vanguard Electronic Labs
196-23 Jamaica Avenue
Hollis, New York 11423
v (718) 468-2720
f (718) 468-2720

* Equipment manufacturer, invited to submit equipment for review in the guide but did not participate.

MAPS-NET

The Maryland Pilot Earth Science and Technology Education Network (MAPS-NET) is a NASA-sponsored pilot project to enrich middle and high school curriculum and enhance teacher preparation through the use of remote-sensing technology, meteorology, and by introducing key Earth system science concepts.

A state-wide approach to the educational use of direct readout, MAPS-NET offers an intense, two-week, graduate-level accredited workshop to Maryland middle and high school science and math teachers. Participants develop the ability and knowledge to incorporate direct readout in their curriculum and develop lesson plans appropriate to their classroom setting. The workshop includes Earth system science concepts and provides extensive materials and support .

The guide is one of a series of education publications MAPS-NET is developing for NASA. The series, Earth Observations from Space, will be published fall 1993–fall 1994.

For additional information, please contact:

Dr. Gerry Soffen, Director
University Programs
NASA/Goddard Space Flight Center
Code 160
Greenbelt, Maryland 20771

Dallas Remote Imaging Group

The Dallas Remote Imaging Group is an international organization that consults with educators on remote-sensing and satellite tracking techniques. DRIG is comprised of professionals interested in researching image-processing techniques, methods of tracking satellites, and telemetry analysis.

The members of DRIG promote the educational use of imagery from environmental (weather) satellites to stimulate students' interest in mathematics, and physical and Earth sciences. DRIG works with educators nation-wide (at no charge) to help them set up and successfully operate classroom ground stations that access images from environmental satellites. DRIG is a supporting member of the MAPS-NET project, and provides consulting services to MAPS-NET teachers.

DRIG operates a world-wide computer network accessible with a personal computer and modem. The system offers electronic mail, file transfer of weather satellite images, current bulletins from NASA and NOAA, satellite tracking programs, and educational consulting. DRIG is accessible from the Internet world-wide. The DRIG information services may be accessed 24 hours daily at (214) 394-7438.

DRIG publishes free information kits for teachers and offers consultation by phone or computer bulletin board system. Send a 9 x 12 SAS envelope with $2 postage for the information and educator's kit to DRIG, or contact:

Dr. Jeff Wallach   (214) 394-7325
President   (214) 492-7747 (fax)
Dallas Remote Imaging Group   BBS (214) 394-7438
PO Box 117088   Internet sysop@drig.com
Carrollton, Texas 75011-7088   Fidomail 1:124/6509

ELECTRONICS CARDS *Guide* 10/93	Sat Data Sys ESC-120	Sat Data Sys ESC-102	Quorum WEFAX Explorer	Quorum WEFAX 2	Multifax MFMAP Internal	Multifax MFMAP External	OFS Weatherfax	Tri-Space SATMAPPER/ WINSAT
full-size IBM card		X	X	X				X
half-size IBM card	X				X	X	X	
FIFO on board (p 4)			X	X	X	X		X
on-board processor			X	X	X	X	X	
requires external power						X		
High Frequency fax support			X	X	X	X	X	
APT support	X	X	X	X	X	X	X	X
GOES support	X	X	X	X	X	X	X	X
GOES-TAP support	X	X		X	X	X	X	X
FCC certified	X	X	X	X	X	X		
receiver on board			X					

SOFTWARE Guide 10/93	Sat Data Sys SDS FAXPlus	Sat Data Sys SDS FAX	Quorum Comm QFAX	Multifax MFMAP	OFS Weatherfax	Lone Eagle Eagles View	Tri-Space SATMAPPER/ WINSAT
multi-tasking						X	X
Windows support							X
386-or-more computer recommended	X		X	X	X	X	X
4 MB memory recommended	X		X	X	X	X	X
file size above 3 MB			X	X			X
video board supports VESA (video standard)	X	X	X	X	X	X	X
SVGA supported	X		X	X	X	X	X
auto capture	X	X	X	X	X	X	X
auto save	X	X	X	X	X	X	X
printer support	X	X	X	X	X	X	X
free program upgrades	X	X					
on-screen satellite tracking	X	X	X			X	X
satellite pass schedule	X	X	X		X	X	X
date and time stamp	X	X	X			X	X
file save PCX	X	X	X		X		X
file save GIF			X	X	X	X	X
file save TIF			X		X	X	X
file save ASCIII	X						X
file save binary	X		X	X		X	
color annotate	X	X	X			X	X
image annotate	X	X	X	X		X	X
rotate image	X		X	X	X	X	X
image positive and/or negative	X	X	X	X	X	X	X
image stretching	X		X		X	X	X
profile image line (histogram of single line of pixels)	X						X
temperature conversion	X	X	X	X	X	X	X
affix temperature to screen image	X		X				X
NOAA curves	X	X	X	X	X	X	X
color palettes	X	X	X	X	X	X	X
griding			X	X	X	X	X
histogram	X		X	X	X	X	X
zoom 4 X	X	X	X	X	X	X	X
pan and scroll	X	X	X			X	X
line fix (repair)	X	X					X
bearing, latitude & longitude	X	X	X		X	X	X
image animation	X	X	X			X	X
mouse support	X	X	X	X	X	X	X
supports PC-137 intern. receiver	X	X	X		X	X	X

R esources

NASA Teacher Resource Centers offer a variety of print materials for distribution, and copyright-free slides and video tapes that may be duplicated.

If you live in: **Contact:**

AK, AZ, CA, HI,   NASA Teacher Resource Center
ID, MT, NV, OR,   NASA Ames Research Center, Mail Stop TO-25
UT, WA, WY   Moffett Field, CA 94035
(415) 604-3574

CT, DE, DC, ME,   NASA Teacher Resource Laboratory
MD, MA, NH, NJ,   NASA Goddard Space Flight Center, Mail Code 130.3
NY, PA, RI, VT   Greenbelt, MD 20771
(301) 286-8570

CO, KS, NE, NM,   NASA Teacher Resource Room
ND, OK, SD, TX   NASA Johnson Space Center, Mail Code AP-4
Houston, TX 77058
(713) 483-8696

FL, GA, PR, VI   NASA Educators Resource Laboratory
NASA Kennedy Space Center, Mail Code ERL
Kennedy Space Center, FL 32899
(407) 867-4090

KY, NC, SC,   Virginia Air and Space Museum
VA, WV   NASA Teacher Resource Center
600 Settler's Landing Road
Hampton, VA 23669
(804) 727-0800

IL, IN, MI,   NASA Teacher Resource Center,
MN, OH, WI   NASA Lewis Research Center, Mail Stop 8-1
21000 Brookpark Road
Cleveland, OH 44135
(216) 433-2017

AL, AR, IA,   NASA Teacher Resource Center
LA, MO, TN   Alabama Space and Rocket Center
Huntsville, AL 35807
(205) 544-5812

MS   NASA Teacher Resource Center
NASA John C. Stennis Space Center, Building 1200
Stennis Space Center, MS 39529
(601) 688-3338

JPL Activities   NASA Teacher Resource Center
JPL Educational Outreach
Jet Propulsion Laboratory, Mail Stop CS-530
4800 Oak Grove Drive
Pasadena, CA 91109
(818) 354-6916

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