Symmetricom®

Modular Frequency Timing Systems

Models MFTS and MFTD

Description and Operation Manual

S/O/104300H

July 2003

Symmetricom is the world's leading supplier of synchronization and timing solutions. We are building a stronger, more capable company to support your needs. We've merged with Datum and TrueTime to expand our product line, worldwide support and research and development capabilities.

www.symmetricom.com/buildingstrength

+

+

MFTS Technical Notice

11/11/99

MFS and MFTS System Compatibility

This technical notice contains information not included in the MFTS Operation Manual.

Upgrading from the discontinued MFS design to a MFTS system provides better accuracy

Upgrading a site that currently uses one or more of Datum's Modular Frequency Systems (MFS) for timing or frequency disciplining to a Modular Frequency and Timing System (MFTS) provides better accuracy because in the MFTS the frequency is corrected continuously to maintain 1 PPS accuracy. The MFTS displays GPS time, not Universal Time Coordinated (UTC) time. If 1 PPS outputs from a MFS and MFTS system are connected to an oscilloscope a time difference of approximately 1.4 µsec will be detected. This is due to differences in the method of correcting the 1 PPS timing and internal circuitry delays. The newer MFTS system, which uses continuous GPS updates, is more accurate at any given instant. Compared to NIST, the 1 PPS output of Datum's MFTS system demonstrated less than a 300 nsec delay and was less than 100 ns off from UTC (30 to 60 nsec RMS).

MFS and MFTS modules must not be swapped

If a site has both MFS and MFTS systems, it is important to remember that MFS and MFTS modules are not interchangeable even though they may fit into each other's slots. The MFTS system is a more advanced design that is not backwards compatible with older MFS systems.

CAUTION

Do not swap MFTS modules into a MFS system, or swap MFS modules into a MFTS system. Damage to the module and to the system rack can occur due to different power requirements and connections.

If you require additional information, contact Symmetricom's Customer Service or Symmetricom's Application Engineering: 1-888-367-7966 toll free (U.S.A. only)

MFTS Technical Notice

02/18/00

O&M Software Behavior in a MFTS System Without GPS

This technical notice contains information not included in the MFTS Operation Manual.

Using O&M software in a MFTS System without a GPS Module

During operation of a MFTS system without a GPS module, the O&M status message will read “WARM-UP” instead of “LOCKED TO GPS”. This is normal and should not be interpreted as a system fault.

If you require additional information, contact Symmetricom's Customer Service or Symmetricom's Application Engineering: 1-888-367-7966 toll free (U.S.A. only)

LIMITED 2 YEAR WARRANTY

"The seller warrants that each article of goods sold by it will at the time of shipment be free from defects in materials furnished and workmanship performed by the seller. This warranty and seller's liability are limited to either granting credit or repairing or replacing, at seller's option, with reasonable promptness after return to seller of any article which is disclosed to seller's satisfaction to be defective, and only if said article is returned to the seller promptly after discovery of such defect and in no event later than ***24 months*** (or such other time period as may be specified in writing as a warranty period for a particular article) from the date of delivery thereof. Normal transportation charges in connection with an article returned shall be at the seller's expense, but only if the seller is responsible under the terms of this warranty. This warranty does not extend to any article which has been subject to misuse, neglect, or accident, nor does it extend to any article which has been repaired or altered by other than the seller. THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE AND THE RIGHTS AND REMEDIES PROVIDED HEREIN ARE EXCLUSIVE AND IN LIEU OF ANY OTHER RIGHTS OR REMEDIES. IN NO EVENT SHALL SELLER BE LIABLE FOR CONSEQUENTIAL DAMAGES."

Technical support is provided through Symmetricom's Customer Assistance Center 24 hours a day. Telephone support is available by the hour, in multi-hour blocks, or on a contract basis. For technical assistance, contact the following:
USA Call Center: 888-367-7966 (USA only — toll-free); 408-428-7907 (worldwide); Fax: 4098-428-7998
E-mail: support@symmetricom.com (Contract customers only)

Internet: http://www.symmetricom.com (select Support section of the Internet site and register to receive a User ID and password)

Europe, Middle East, and Africa (EMEA) Call Center:
+44 (0) 1189 699 799 Fax: +44 (0) 1189 277 520

Symmetricom reserves the right to make changes to its products and specifications without notice.

Printed in the United States of America

User safety summary

Terms in Manual:

CAUTION	Conditions that can result in damage to the equipment.
WARNING	Conditions that can result in personal injury or loss of life.
TIP	Information that assists operation or trouble-shooting.

Safety instructions: Read all installation instructions carefully before you plug the product into a power source.

Terms on product: A personal injury hazard exists that may not be apparent. For example, a module's panel may cover a hazardous area.

Care of system: Disconnect the power plug by pulling the plug, not the cord. Disconnect the power plug if the power cord becomes frayed or otherwise damaged, if liquid is introduced into the system chassis, if system is exposed to excessive moisture, or if system is dropped or damaged.

WARNING: To reduce the risk of electric shock, do not perform any servicing of the system or modules other than that contained in the operating instructions unless you are qualified to do so.

WARNING: Do not operate in an explosive atmosphere:
Operating the system in the presence of flammable gases or fumes could cause a fire or explosion.

WARNING: Do not substitute parts or modify system:
Because of the danger of introducing additional hazards, do not install substitute parts, or perform any unauthorized modification to the system chassis or its modules.

CAUTION: Electrostatic sensitive devices. Observe precautions and wear grounding devices when removing system modules.

Returns

If a failure of the system or a module is indicated by BIT and or LED indicators, call Symmetricom to obtain a Return Material Authorization (RMA) number and shipping address.

Customer Assistance Center: Telephone (408) 428-7907 (worldwide) or 888-367-7966 (toll-free USA)

CHANGE PAGE RECORD SHEET

The incorporation of a change page or technical notice to this manual should be recorded below, when adding the update.

If pages are replaced, the obsolete sheets should be removed and their replacements inserted in the appropriate locations.

Release date: March 1, 1998

Tech. Note No.	Added by	Page reference	Date
TN 11/11/99	R.B.		11/11/99
TN 02/18/00	R.B.		02/18/00

List of Major Abbreviations:

ASCII	American Standard Code for Information Exchange
BFO	Module, Buffer Frequency Output
BFI	Module, Buffer Frequency Input
˚C	Degrees Celsius (centigrade)
CTS	Conventional Terrestrial System
DAC	Digital Analog Converter
dBc	Decibels Below Carrier
DIN	Deutsche Industrie Norm (German Industry Norm)
DMM	Digital Multimeter
GPS	Global Positioning Satellite System
GND	Ground
h	Hour
Hz	Hertz (frequency)
LED	Light Emitting Diode
MBF	Module, Buffer Amplifier
MDP	Module, Digital Pulse
MFTD	Modular Frequency and Timing Distribution
MFTS	Modular Frequency and Timing System
MPS	Module, Power Supply
NVM	Non-volatile Memory
ns	Nanosecond
µs	Microsecond
PMM	Performance Monitor Module
PRS-RB	Primary Reference Source, Rubidium Oscillator
PRS-XO	Primary Reference Source, Crystal Oscillator
OSC	Oscillator
PC	Personal Computer
PLL	Phase Locked Loop
PPS	Pulse Per Second
PRI	Primary
PWR	Power
Rb	Rubidium
REC	Recorder
REG	Regulated
rf	Radio Frequency
RH	Relative Humidity
SA	Selective Availability
SEC	Secondary
TEMP	Temperature
TIC	Time Interval Counter
TTL	Transistor-Transistor Logic
UUT	Unit Under Test
W	Watt
VCXO	Voltage Controlled Crystal Oscillator
XTAL	Crystal Oscillator

Table of Contents

MFTS & MFTD Modular Frequency & Timing System Manual

(cont.)

Table of Contents (cont.)

System Module Descriptions (cont.)

SECTION 1 - INTRODUCTION & SPECIFICATIONS

1.0 Introduction

1.1 Scope of Manual

This manual provides the necessary information for the site planning, installation, operation, and troubleshooting of MFTS and MFTD modular frequency and timing systems. It is provided for site engineers, installers, and operators. A printable electronic PDF version of this manual is on the CD included with all MFTS systems. Because the manual documents both MFTS and MFTD systems, a MFTS/MFTD order will include one manual per MFTS system. MFTD systems ship with a manual if the MFTD chassis is ordered separately. Manuals shipped with MFTD systems do not include the CD.

The manual has 6 sections and 3 appendices

- Section 1 - Introduction and Specifications
  contains an overview of the system function, Quick-Start information for the MFTS and MFTD systems, system specifications, and planning guidelines for power, equipment location, and GPS antenna installation,

- Section 2 - System Installation
  contains information on the unpacking, setup, installation, and start-up of the system.

- Section 3 - System Module Descriptions
  information on individual modules, their specifications, and function.

- Section 4 - Operations and Diagnostic Tools
  covers the operation of the system through the PMM module firmware, simple troubleshooting, and instructions for returning faulty modules for repair.

- Section 5 - In Case of a Problem
  provides general troubleshooting tips.

- Section 6 - Accessories
  describes MFTS and MFTD system accessories.

- Appendix A - System Outline Drawings and Connector Pinouts
- Appendix B - MFTS Operations and Management system software
- Appendix C - Application Notes

NOTE: because this manual is distributed in electronic form, page numbering is consecutive and starts with the cover, which is page 1.

MFTS System Quick Set-up

1. Check shipping containers of system, antenna cable and antenna for damage. Report any damage to both Datum-Efratom and the shipper.

2. Check that the system configuration matches what you have ordered.

3. Paying attention to ESD requirements, remove system and GPS antenna from shipping containers. Refer to enclosed manual and antenna setup guidelines in antenna carton.

4. Install GPS antenna(s) per recommendations (if your system has two GPS modules, you will receive two GPS antennas).

5. Run antenna cable(s) from antenna location to system location. Check continuity after installation. Note length of cable(s).This is important and needs to be referenced in the utility software.

6. Install system in rack (refer to Figure 2-2 and text). Attach a ground wire to the terminal lug mounted to the side of the chassis, or the center mount flange.

7. Attach power cable(s) to MPS module(s). System will begin to start up.

8. Attach antenna cable(s) to GPS module(s). Refer to Sect. 2.5 for start-up indicators.

9. Attach signal cables to distribution modules (typically MBF and/or MDP modules).

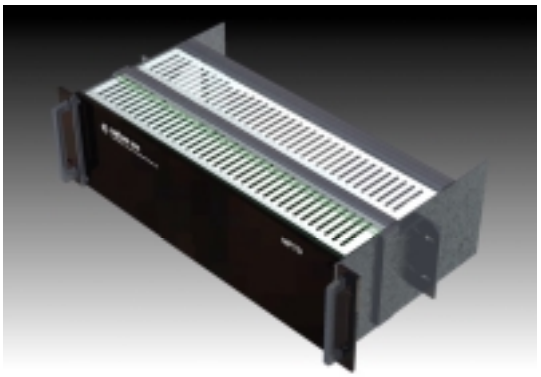
10. Attach RS-232 cables to CH A, and CH B (if there are two PRS modules), connector of PMM module, and the RS-232 connector on the PRS module(s) for PC utility software interfaces. The J3 connector on the BFO (or BFI) module allows alarm indications from a MFTD system to be monitored by remote indicators. Refer to Appd. A.

11. Monitor oscillator warmup. Rubidium oscillators should reach lock in 8 to 10 minutes. Once the primary oscillator is locked, distribution modules will begin providing outputs.

12. If antenna cable length is longer than 50 feet (the cable delay is factory set at 50 feet), use PMM screens 9, 10A and 10B to set the actual cable delay for the site (see Sect. 4).

13. Monitor the GPS module's establishment of the site location and acquisition of GPS timing. This may take between 10 to 30 minutes. Front panel LEDs on the PRS and GPS modules will indicate when GPS timing starts.

14. The MFTS system is now operational.



MFTD System Quick Set-up

1. Check shipping containers of system for damage. Report any damage to both Datum and the shipper.

2. Check that the system configuration matches what you have ordered.

3. Paying attention to ESD requirements, remove system from shipping container. Refer to enclosed manual.

4. Install system in rack (refer to Figure 2-2). Attach a ground wire to the terminal lug mounted to the side of the chassis, or the center mount flange.

5. Attach power cable(s) to MPS module(s). System will power up.

6. Attach input signal cables to connectors J1 (sine output) and J2 (1 PPS TTL output) on the BFO module on the MFTS system providing reference signals to the MFTD system. Attach the other ends of these cables to connectors J1 and J2 of the BFI module in the MFTD system.

7. The J3 connector on the BFO (or BFI) module allows alarm indications from the MFTD system to be monitored by remote indicators. Refer to Appd. B for pinouts.

NOTE: if there are multiple MFTD systems, use one output each from a MBF and MDP module to provide the reference signal input to J1 and J2 of the BFI module.

8. Attach signal cables to distribution modules (typically MBF and/or MDP modules).

9. The MFTD system is now operational.

Module Replacement

Modules in both the MFTS and MFTD systems can be replaced with power applied to the system. Card guides align the module. Each is held in place by captive screws located at all four corners of the module. Loosen the captive screws and use the extractor handle at the bottom of the module to slide the module free. When inserting a replacement module, push firmly so that the module's rear connector seats in the backplane connector. The last step in the process is to tighten the captive screws.

MFTS Software Quick Set-up

PMM Module

Once the MFTS system is powered up and the GPS receiver is looking for satellites, the operator should monitor the display of the PMM module to determine system status.

The GPS receiver will automatically acquire satellites and establish the GPS time, date, latitude of the site (antenna), longitude of the site, and the altitude. The PMM keypad and display are used to enter this information if, because of a temporary lack of satellite visibility, the GPS receiver is unable to perform a 3D fix (requires four satellites). Refer to Section 4 for information on using the PMM keypad to enter this information.

During setup, it may also be necessary to change the factory set cable delay length. Refer to the descriptions of screens 9 and 10 in Section 4.

Once the MFTS system is operational and all settings are as desired, the operator can establish passwords for position edit, and for the PRS and GPS unlock modes (the PRS and GPS select menus are locked upon power up and remain locked until the operator unlocks them and establishes a password. Document this password and keep it in a secure location for later reference.

The PMM display can now be used to monitor the operation of the MFTS system and health of the system modules.

> **TIP:** If your MFTS system lacks a PMM module, use the RS-232 DB-9 connector on the front panel of the PRS module(s) to connect to the COM port of a PC and use the MFTS Operations and Management Software to monitor and manage the system.

MFTS Operations and Management (OMS) system software

The OMS software allows remote monitoring and management of the MFTS system once it is powered up and operational. Appendix B of this manual, and the liner insert of the MFTS OMS software CD describes the installation procedure for the software.

Once the software is installed, use RUN PROGRAM to launch, or double-click on its shortcut.

Click the **Help Text** icon to activate the help text feature. Once activate, by placing the cursor over an area of the menu, a text box will appear describing what the feature is for, and how to use it.

The functions of the OMS software are similar to the firmware of the PMM module. It can be used to remotely monitor the operation of up to 16 MFTS systems and the health of their modules.

It can also be used to adjust system parameters, such as site latitude, longitude, altitude, and the antenna cable (length) delay.

1.2 System Overview

1.2.1 Functional Description

The Modular Frequency & Timing System (MFTS) is a highly stable synchronization unit disciplined by precision (Stratum 1 level) primary timing signals (GPS). The system provides frequency (5 MHz) and timing (1 PPS) reference outputs through distribution modules. Additional types of distribution modules are available to accomodate 10 MHz and 1.544 MHz, and other outputs. Contact DATUM-EFRATOM sales for more information on these features.

The system is offered in a 5.25” high by 19” wide chassis and can be installed in a 19” cabinet or an optional portable case. MFTS modules can be swapped with system power applied, allowing uninterrupted service.

Although the MFTS is designed primarily to be a GPS referenced device, it is capable of operating without a GPS disciplining module installed. The built-in primary frequency source may be a single Rb or XO oscillator or a pair of redundant oscillators. With a GPS module installed in the system the primary oscillator is disciplined to GPS while the backup oscillator is phase locked to the primary. Should the primary oscillator fail, the backup oscillator will switch to the GPS mode and become the primary oscillator. It will continue to receive updates from GPS. If the GPS disciplining is lost, the primary oscillator will continue to discipline the output frequency, running on its own in a mode known as “flywheeling”. Typically, this provides enough time for service and module replacement, while the cell remains operational.

The MFTD (Modular Frequency & Time Distribution) is also modular in nature. This expansion chassis provides frequency (5 MHz) and timing (1 PPS) distribution when additional output capacity is needed from the MFTS system. Additional types of distribution modules are available to accomodate 10 MHz and 1.544 MHz, and other outputs. Contact DATUM sales for more information on these features. The input reference signal to the MFTD comes from the MFTS system through a BFO module. The MFTD is offered in a 5.25” high by 19” wide chassis with rear-facing modules only.

1.3.2 Site Considerations

Although it is beyond the scope of this system manual to document all aspects of the site requirements, some general guidelines are presented below to help with the installation. Refering to the following publications may prove useful during the site planning stage:

QUALITY STANDARDS, Fixed Network Equipment Installations, Motorola publication R56, Systems Center Engineering, 1301 E. Algonquin Road, Schaumburg, IL 60196

Bulletin 37916C, Grounding Kits, Type 204989, ANDREW Heliax® Products (included with kit).-

Bulletin 237196, Ground Kits for Heliax® FSJ1 and LDF2 Coaxial Cable, ANDREW Heliax® Products (included with kit).

1.3.2.1 Buildings, Equipment Cabinets and Grounding Systems

Structures housing telecommunications equipment should have a concrete foundation and a wood or concrete floor whose surface has been sealed to prevent equipment contamination from dust, dirt, and other airborne particulates. Minimum floor loading should be 300 pounds per square inch. Remember when calculating the weight of new equipment to consider the rated load carrying capacity of the structure.

Equipment cabinets need to be bolted securely to the floor and arranged in such a way to have a wide and stable footprint for earthquake protection. Center mount cabinets can be fitted with outriggers and bolted to the floor. Top supports are important to prevent cabinets from toppling over on personnel. If a potential hazard of water entry exists at the site, cabinets can be anchored to *Uni-strut* rails or wooden pedestals to elevate them above the floor.

Grounding of the structure and the antenna is necessary to protect equipment and personnel. An external ground ring with a grounding system attached to the antenna tower ground ring with one or more conductors is recommended. The optimum grounding system for the structure places a ground rod at each corner of the building (2’ out from the building foundation) and every 15’ between these corner rods. Rods should be placed at a minimum depth of 18 inches below either the finished grade or below the freeze line (whichever is the greater depth). The top and bottom of antenna cables should be grounded to either a tower member or tower down conductor to create a lightning path toward earth. Follow local codes and install grounding kits per the manufacturer’s instructions (included in the kits).

1.3.2.2 Power Requirements

When planning for site electrical design, present and future power loading should be considered. AC power requirements should be determined before construction. Continuous load should not exceed 80% of the electrical wire rating.

1.3.2.3 Heating, Cooling and Ventilation Requirements

Equipment operating within its design environment is less likely to experience failures. Structures should be insulated and have air handling equipment capable of maintaining an ambient temperature range of +41˚ to +86˚F (+5˚ to 30˚C). Humidity should be controlled so that it is neither too low (causing ESD problems) or excessively high (causing moisture condensation on electrical equipment).

1.3.2.4 Cabling Issues

Cable tray systems of adequate strength and rigidity provide support and protection for cable runs. Adding expansion connectors between the trays will accommodate thermal expansion and contraction of the system. Supports should be located within 2’ of either end of an expansion connector. Cable trays and ladders can extend through walls and floors as long as the openings are firestopped with an approved technique that maintains the fire resistance rating of the structure.

Cables should have broad service loops and strain relief. This keeps cables loose and gives them a better appearance.

Do not place cable trays in such a way to block building sprinkler systems or smoke detectors, or under lights or other electrical fixtures.

Cables should be routed neatly with a 2” gap (minimum) between conductor bundles. Group cables according to type so that rf lines are not mixed in with ground or control and interconnect lines.

When cables enter the building from the outside, a weatherproof port assembly should be used. This should consist of a waveguide entry plate and boot assembly. Typical commercial antenna ports will have 1 to 12 entry ports per plate. If it is necessary to insulate the opening, two plates can be installed, on the inner and outer walls with foam insulation between the plates. Two sets of cable boots are needed with this type of installation. Unused ports must be sealed with blank caps.

Ports that introduce antenna cables should not also be used to pass lighting power (to antenna lights), and building ground and control cables. This will prevent electrical interference.

1.3.2.5 GPS Antenna Installation

The GPS antenna must be mounted in an unobstructed location away from tall buildings and trees that would block its view of the horizon (and the GPS satellites passing overhead). The roof of a structure or on an antenna tower is ideal. It is important that the GPS antenna be mounted so that it is vertical. Bolt the antenna bracket to a center cross member, or to a sidearm. Sidearms extend the antenna three to six feet away from the tower and reduce the influence of the tower mast on the antenna’s reception.

Cables should be secured with service loops for strain relief and corrosion-resistant hardware. The cable can be attached to the tower by means of beam clamps, butterflies, donuts, snap-in clamps, etc. The method is dictated by the type of tower. Attach mounting hardware every three feet for both vertical and horizontal runs. To prevent water from following the cable into the structure entry port, allow enough slack for a drip loop. In areas where snow and ice may be present, a horizontal ice bridge mounted above where the cable crosses from the tower to the structure entry port will prevent damage from ice chunks falling off the tower.

In climates where electrical storms occur, the Polyphaser® lightning arrestor should be installed according to the manufacturer's instructions included with the arrestor and grounded to a single point ground window inside the structure.

Refer to the GPS Antenna Installation Guide included in the shipping container of the antenna and to Figure 2-1.

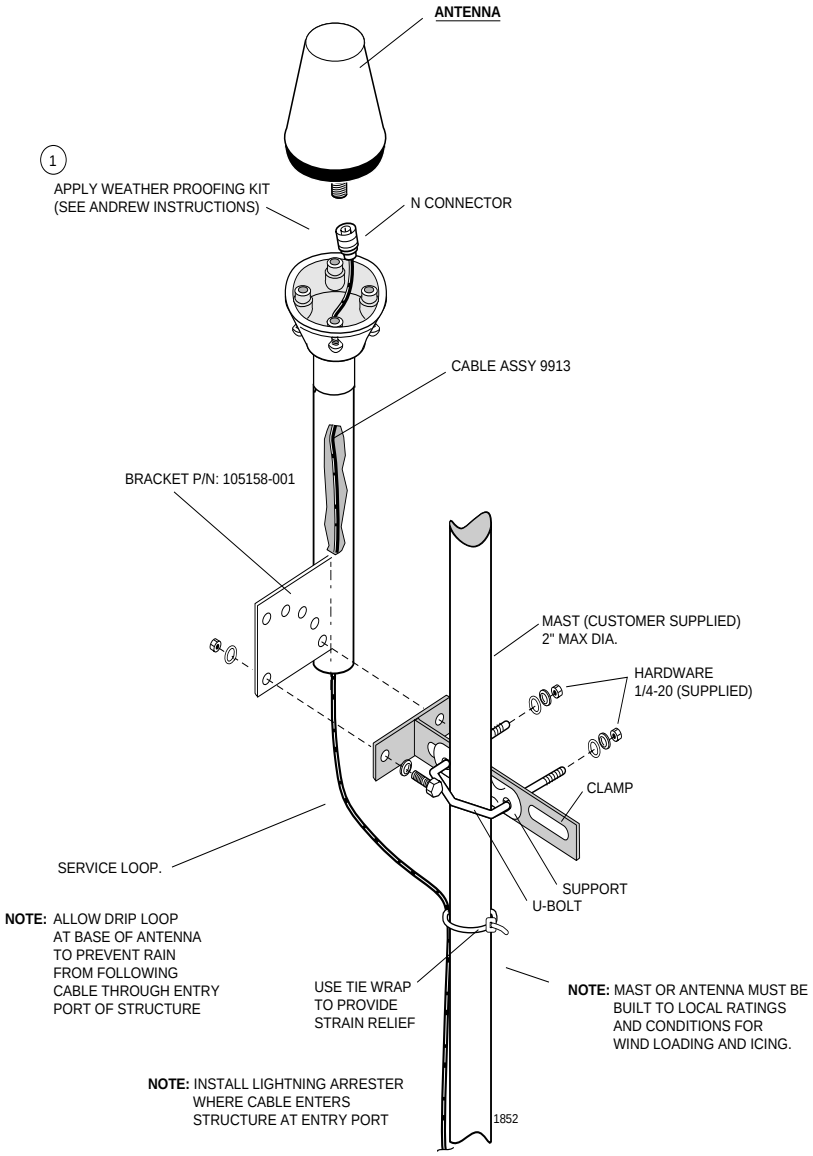


Figure 1-2. GPS Antenna and Mounting Hardware

1.3 PLANNING AND ENGINEERING

1.3.1 Electrical Specifications

Outputs/Frequency/Waveform:

MFTS Series: 4 to 40/5, 10 MHz sinewave and/or 1 PPS outputs

MFTD Series: 4 to 40/5, 10 MHz sinewave and/or 1 PPS outputs

Output Levels into 50 Ohms:

Sinewave Outputs:	3 - 5 Vpp
1 PPS Output:	TTL compatible
TTL Outputs:	1.544 and 2.048 MHz outputs (optional) Max. Low 0.25 Vdc Min. High 2.5 Vdc Rise Time ≤20 ns Fall Time ≤100 ns Min. Pulse Width 10 µ s (typical 400 µ s) Jitter ≤10ns pulse to pulse

Short Term Stability Rubidium:

1.0 Second (Allan Variance):	3E-4
10 Second (Allan Variance):	1E-11
100 Second (Allan Variance):	0.3E-11

Short Term Stability Crystal:

1.0 Second (Allan Variance):	1E-10

Frequency Accuracy at shipment: ≤5E-11*

Timing Accuracy: ±100 ns*

24h Flywheel (no GPS disciplining): ≤3 µ s (Rb)**
≤30 µ s (XO)**

---

* Includes SA and assumes 24h continuous operation in a fixed stationary position. Temperature changes of ≤10˚C/day at a rate of change ≤2˚C/hour. Subject to sufficient satellite availability.

** Assumes 24 hour continuous GPS lock prior to start of flywheel with maximum temperature change of ±2˚C.

Isolation:	Between Outputs*	≤-80 dBc
	Between Outputs Available	≤-80 dBc
	Between Modules	≤-90 dBc

Phase Noise (Rb):	10 Hz from carrier:	-88 dBc/√Hz
	100 Hz from carrier:	-125 dBc/√Hz
	1 kHz from carrier:	-130 dBc/√Hz
	10 kHz from carrier:	-130 dBc/√Hz

Phase Noise (XO):	10 Hz from carrier:	-88 dBc/√Hz
	100 Hz from carrier:	-125 dBc/√Hz
	1 kHz from carrier:	-130 dBc/√Hz
	10 kHz from carrier:	-130 dBc/√Hz

Harmonic/Non-Harmonic Distortion: -40 dBc/-75 dBc

Power Required:		115 Vac ±10%/220± 10%
	Option 1:	-48 Vdc only
	Option 2:	+24 Vdc only
	Option 3:	220 Vac, ±10%
	Option 4:	Dual power supply modules (for redundancy)

		Warm-up	Steady State
Power Consumption:	MFTS	~130W	~95W
(fully loaded systems)	MFTD	~40W	~40W

"Hot Pull" Modules - Insertion and removal of modules is possible with power applied.

Switchover Difference: (after 3 GPS updates)	Rb/Rb	Rb/XO
Primary to secondary		
Timing of 1 PPS:	<1 µs	<1 µs
Frequency offset:	<2E-11	<3E-10
Secondary to primary:		
Timing of 1 PPS:	<1 µs	<1 µs
Frequency offset:	<2E-11	<3E-10

Switchover Interval: (after 3 GPS updates)	Rb/Rb	Rb/XO
Primary to secondary		
Timing of 1 PPS:	<5 µs	<5 µs
Frequency offset:	<5E-12	<1E-9
Secondary to primary:		
Timing of 1 PPS:	<5 µs	<5 µs
Frequency offset:	<5E-12	<1E-9

* of same MBF module

1.3.2 Environmental Specifications:

Operating Temperature Range: 0˚C to +50˚ C (ambient) (32˚F to ~120˚F)

NOTE: In a well controlled environment where cabinet and chassis ambient temperatures do not exceed 60˚C, multiple MFTS/MFTD systems can be placed directly on top of each other without any airflow gap between front panels. If temperatures are not maintained at this level it is recommended that MFTS and MFTD systems be installed in a cabinet so that there is not less than .5" of open space between the top and bottom of each system chassis to provide adequate convective air flow. Equipment installed below the system must not be a severe producer of heat.

Storage Temperature Range:	-20˚C to +70˚C
Altitude:	0 to 10,000 feet (operating)
Relative Humidity:	10% to 95% Non-condensing
EMI:	certified to meet CE and FCC Part 15, Class B, requirements, conducted and radiated susceptibility, CE/FCC/UL
Vibration: (non-operating)	Ground benign

1.3.3 Mechanical Specifications:

Size:	MFTS	5.25"H X 19.0"W X 20"D (w/handles & connectors) (13.33 cm X 48.26 cm X 50.80 cm)
	MFTD	5.25"H X 19.0"W X 10.0"D (w/handles & connectors) (13.33 cm X 48.26 cm X 25.40 cm)
Weight:	MFTS	<35 pounds (15.75 kg)
	MFTD	<25 pounds (11.25 kg)

SECTION 2 - System Installation

2.1 Unpacking the System (MFTS or MFTD)

The system is shipped in a carton with protective foam on the top, bottom, and sides. The top section is removed to expose the MFTS or MFTD system, manual and PC utility software CD.

Unpack the system carefully and check what you have received against the shipping list. Protect the equipment against ESD damage by using a protective wrist strap and normal equipment grounding.

CAUTION! Observe ESD precautions when handling the MFTS system and its modules, especially if they are removed from the system chassis.

Inspect the system for shipping damage, which could show up as a warped frame, bent or loose hardware, broken connectors, and other visible defects. Notify DATUM and the carrier that handled the shipment if such damange is discovered, and you suspect it was damaged in transit.

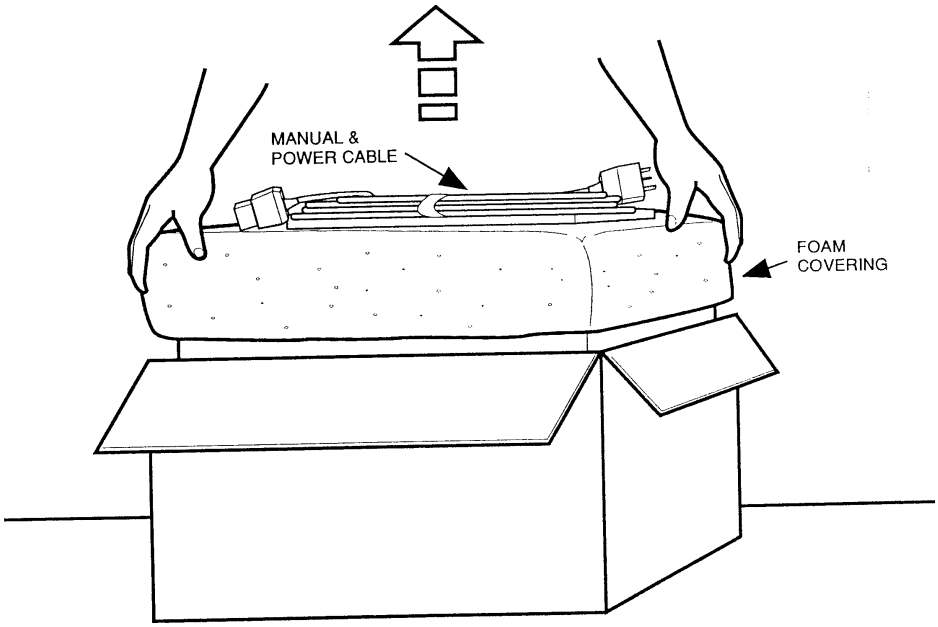
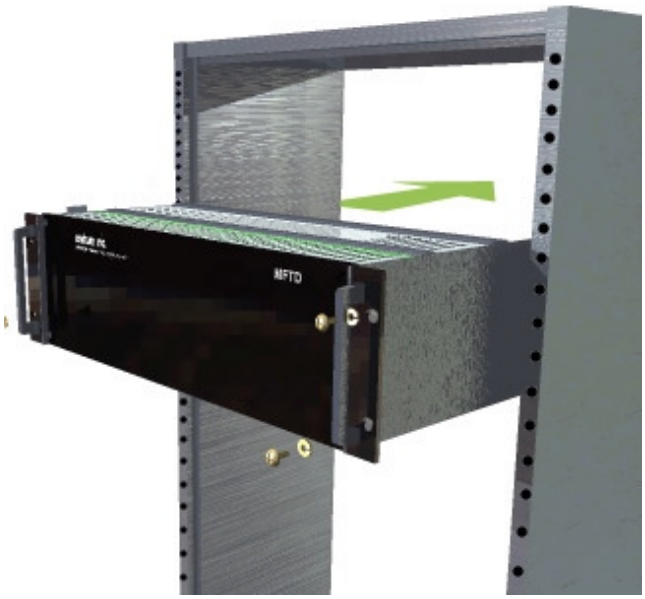


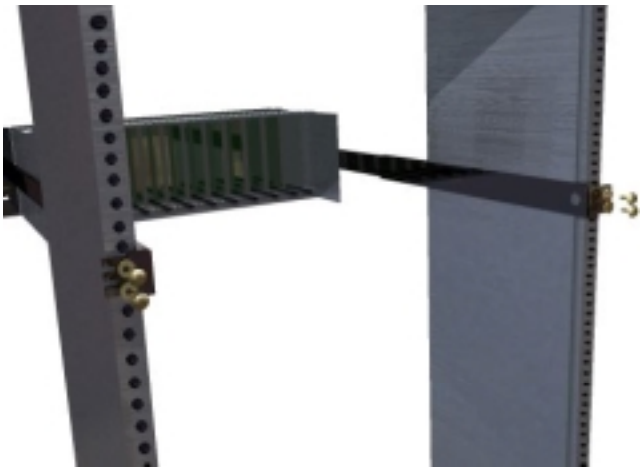
Figure 2-1. Removing Packing From Shipping Container

Center Mount Installation



Front Mount Installation

Mounting Slides to System Chassis



Mounting Slides to Cabinet

Installing Chassis Slides

Figure 2-2. Types of Cabinet Mounts

NOTE: In a well controlled environment where cabinet and chassis ambient temperatures do not exceed 60˚C, multiple MFTS/MFTD systems can be placed directly on top of each other without any airflow gap between front panels. If temperatures are not maintained at this level it is recommended that MFTS and MFTD systems be installed in a cabinet so that there is not less than .5” of open space between the top and bottom of each system chassis to provide adequate convective air flow. Equipment installed below the system must not be a severe producer of heat. Avoid areas of strong magnetic fields produced by generators and motors.

2.2 Cabinet Mounting Instructions

2.2.1 Cabinet Mounting Considerations

The MFTS is 5.25" high and 20" deep including its handles and connectors. The MFTD is 5.25" high and 13.4 inches deep including its handles and connectors. Multiple MFTS and/or MFTD systems can be stacked one above the other in a 19" cabinet without additional ventilation.

2.2.2 Chassis Mounting Procedure

The MFTS system can be front mounted, front mounted with chassis sides, center mounted, or installed in a portable case. The portable case is ordered as an option from DATUM. Refer to Figure 2-2 for illustrations of other installation methods.

To front mount the unit, slide the MFTS (or MFTD) chassis into the cabinet and attach mounting hardware through the four mounting holes on the front mounting flanges. Two people should do this, one attaching the hardware while the other supports the unit.

Chassis slides come in two pieces. The larger portion of the slide attaches to the rear of the cabinet (rear view). The smaller slide attaches to the sides of the system (front view), and is then inserted into the slide that has been mounted to the cabinet. Two people should do this installation. First mount the rear attachment flanges of the main support slide to the rear of the cabinet using the included mounting hardware. Remove the front portion of the chassis slide and attach it to the sides of the system chassis using the predrilled holes. Once all screws have been tightened, two people can then lift the system and carefully guide the ends of the front chassis slides into the main support slide.

To center mount the system, one person should support the chassis while the second affixes the mounting hardware through the chassis mounting flanges into the holes of the cabinet uprights.

2.3 Attaching Cables (signal cables are not included with unit)

1. Attach the connector of the cable coming from the GPS antenna to the antenna input on the front panel of the GPS module marked ANT. If there are two GPS modules, two GPS antennas must be installed.

2. Attach all signal cables to the outputs of the MBF and MDP modules (BNC connectors).

3. Attach a signal cable to J1 of the BFO module of a MFTS system (to provide the reference input to a MFTD system). When "daisy-chaining" this reference signal between MFTD systems, use the output of one MDP or MBF connector and connect it to the input connector of the BFI module in the second MFTD system.

4. Attach a female 9 pin, D-sub connector to J3 of the BFO module. This permits relay closure fault alarms to be monitored by external indicators and alarms.

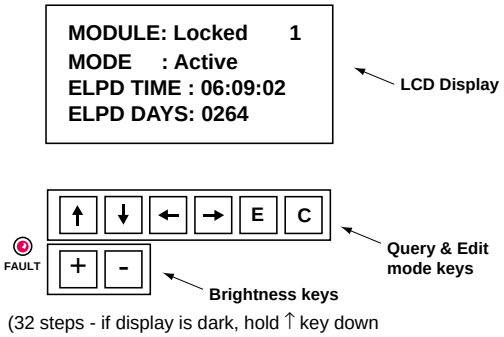
2.4 Operating the System

When all signal connections have been made (if the antenna connection has not been made, or the antenna or antenna cable is defective, the NO GPS LED blinks) and the power cable has been attached to the front of the MPS module of the MFTS, the oscillator in the PRS module automatically begins its warm-up phase. The red FAULT LED (which indicates that the Rb oscillator has yet to achieve lock and that there are no rf or 1 PPS outputs) and the yellow LED for NO GPS (indicating that the GPS receiver has not yet established a position fix) will be illuminated. In a cold start this warm-up phase lasts less than 30 minutes. As soon as the Rb oscillator attains lock output signals become available at MBF and MDP output connectors. The green ON LED will illuminate on the PRS module that will be the Ref 1 module, which is both the startup and primary oscillator. (the STBY LED illuminates on the "backup" PRS module).

While the Rb oscillator warms up, the GPS receiver begins its initialization phase. Using four visible satellites, or the site information from a manual position fix, the GPS receiver establishes an initial 3-D position and time fix. During warm-up the RED FAULT LED on the PRS module(s) will light for approximately 5 seconds, after which the PRS will switch to either ACTIVE or STBY. Outputs are generated from the ACTIVE PRS. Once the MFTS system's 1 PPS signal has been synchronized to the GPS reference, the yellow NO GPS LED will go dark. The GPS almanac and satellite ephemeris of the PRS module(s) are established automatically without user prompting. However, if three or less satellites are visible, then the operator will have to use the keypad and display on the PMM module to establish the site location and altitude (see Section Four). The number of satellites visible and those being used for a position fix are indicated on the PMM display. If four satellites never become available the location of the GPS antenna may need to be changed to improve the view of the horizon. Tall buildings and large trees, particularly when their leaves are wet with rain, will block GPS reception.

The MFTS transmits a message once per second to the external diagnostic PC containing the current system status. If a fault occurs, the LED on the faulted module will illuminate and the PMM and PRS modules will send failure information to the external diagnostic software running on a remote PC. All faults will trip relay closures on the PMM and/or BFO/BFI modules.

The PMM module's LCD display and keypad is used to retrieve fault conditions and information on system status. Refer to **Section 4, Installation/Diagnostic Tools** for information on all screens of the PMM monitoring firmware. Refer to the MFTS Utility Software online HELP text for more information on the PC diagnostic software.



(32 steps - if display is dark, hold ↑ key down

Figures 2-2 and 2-3 are front and rear views of typical MFTS and MFTD systems (your configuration may vary). Both systems can be equipped to meet many different timing needs. The MFTS can have rubidium or crystal oscillators installed, GPS, T1 or E1 receivers, and can distribute 5 and 10 MHz (sine or TTL), and 1 PPS TTL outputs.

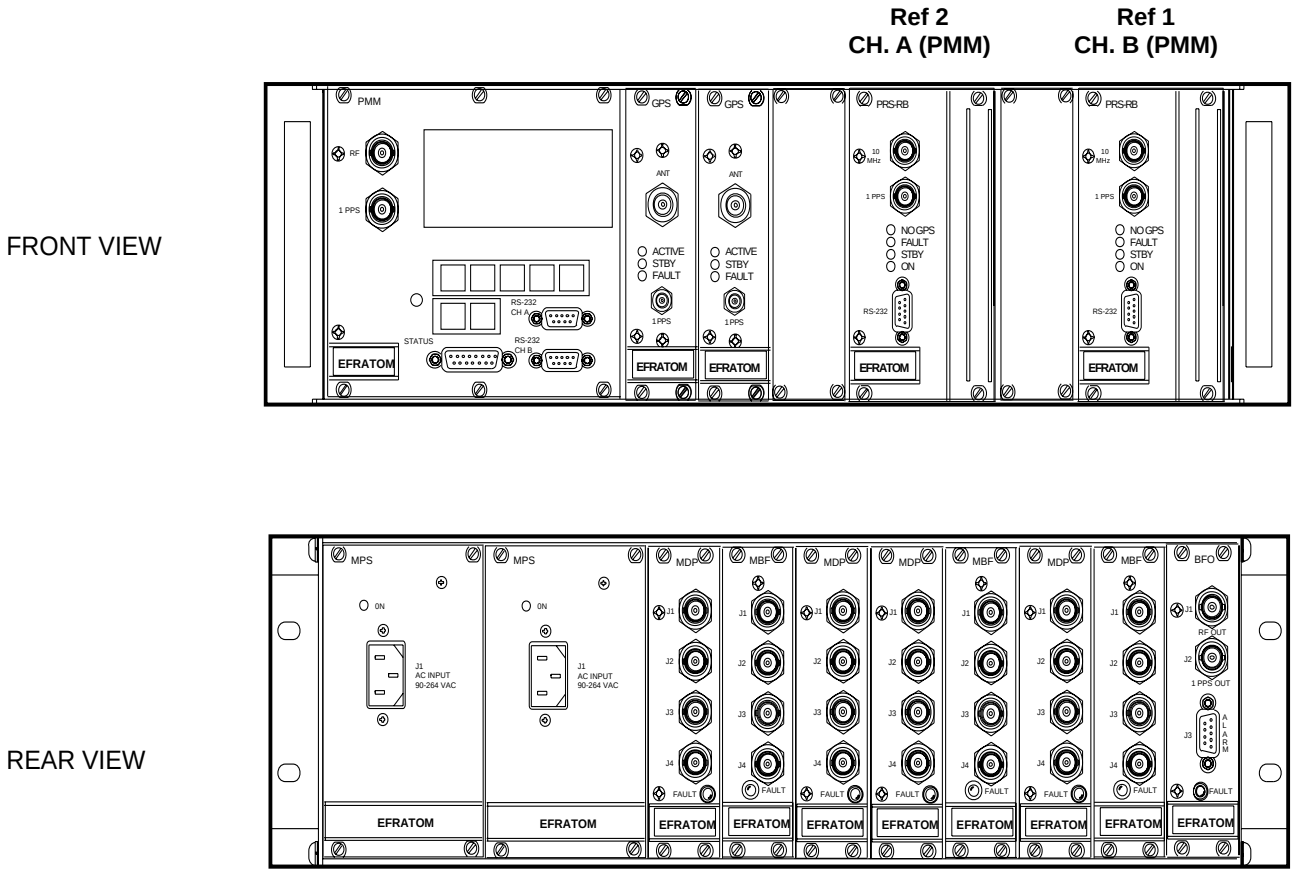


Figure 2-2. Front and Rear Views of the MFTS System

The MFTD system, which is primarily a distribution rack, can be set up to distribute 5 and 10 MHZ (sine or TTL) outputs, and 1 PPS TTL outputs simply by installing the desired number of MBF and MDP modules.

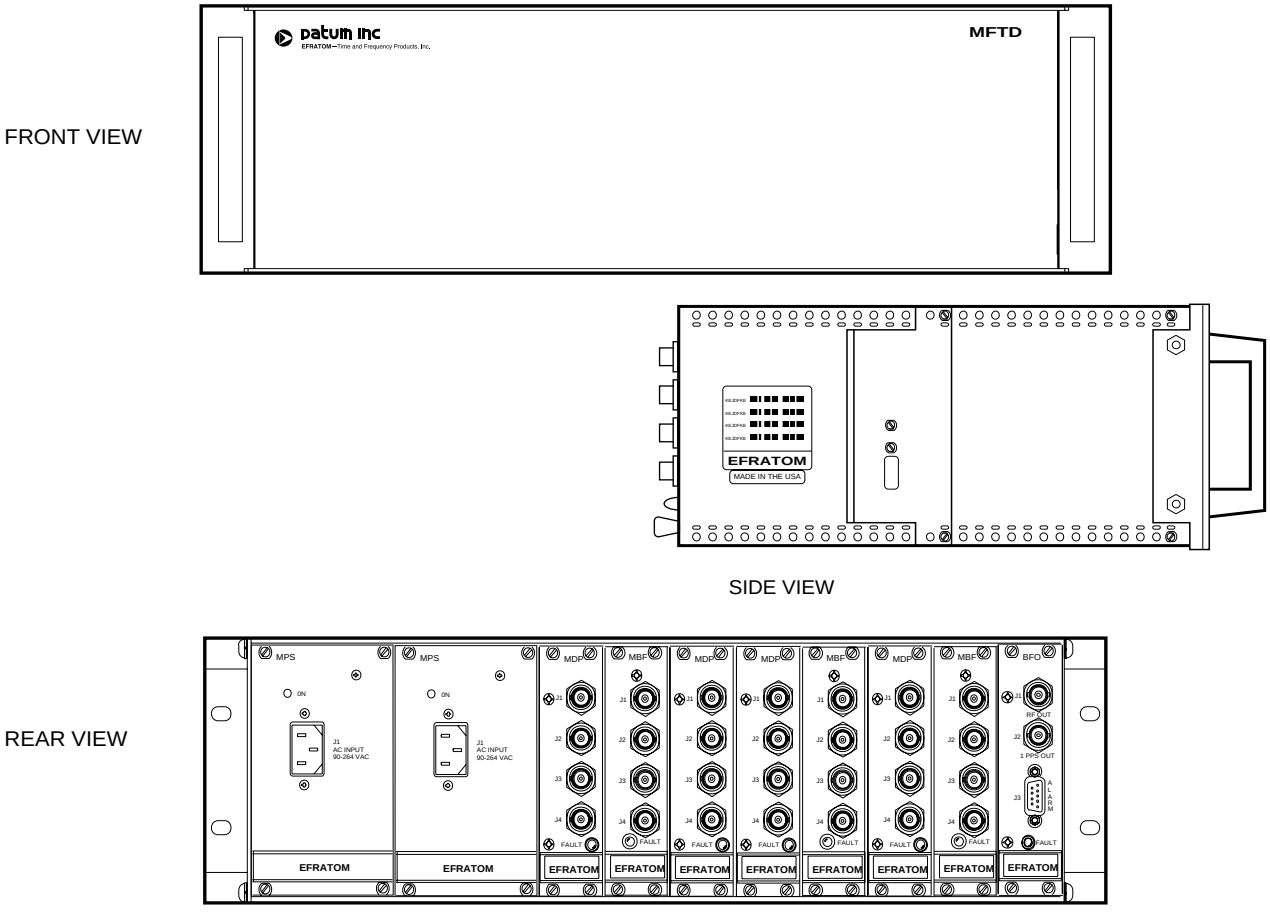


Figure 2-3. Front, Side and Rear Views of the MFTD System

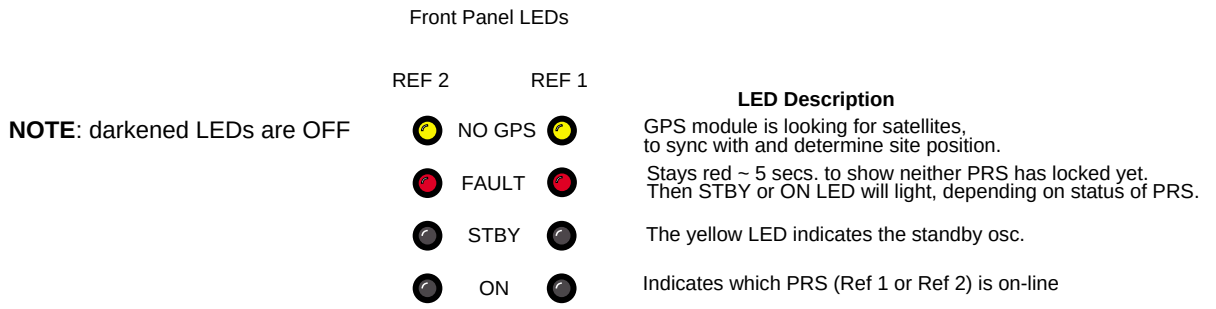
2.5 Power Up and Initialization

When all signal connections have been made and the power cord is plugged into the front panel of the MPS module of the MFTS system the oscillators in the PRS modules begin their warm up phase. The start-up routine is automatic once ac and dc power and the GPS antenna input are connected. No operator input is required except to set the GPS antenna cable delay (the cable delay is preset 50 ft at the factory) for the site.

The red, yellow, and green LED indicators on the front panels of the PRS modules signify when there is a fault and when GPS synchronization and output signals are available from the distribution modules. The FAULT LED indicates when a fault (a lack of output signals) is present at the MBF and/or MDP modules. The system synchronizes to GPS automatically.

In the following diagrams the LEDs for Ref 2 are shown in the left column, and the LEDs for Ref 1 on the right. Actually, either PRS module could be active and acting as the primary reference. If the active oscillator fails, the backup PRS will go on-line, switching over without affecting system timing.

During MFTS initialization the LEDs on the front panels of both PRS modules will appear as shown below (shaded LEDs are OFF):



NOTE: If Ref 1 or Ref 2 fails during warm-up, the NO GPS and FAULT LEDs will light on the appropriate module.

Start-up Summary:

5 to 25 minutes after power on:

- Rubidium oscillators lock. Output signals become available at MBF and/or MDP, and BFO modules.
- Acquisition of GPS almanac and ephemeris occurs.
- The 10 MHz output of the Rb oscillator (divided down to 5 MHz and 1 PPS) is synchronized to the GPS reference (time to lock is 30 minutes, if site characteristics are poor)*.

The MFTS automatically determines the geographic position of the antenna (the site location). This has to be known if the system is to accurately determine the time. If the antenna is able to see 3 to 4 satellites, this should happen within 30 minutes.

*If, after 1 hour of operation, the system has been unable to acquire four satellites, it will use the position stored in NVM memory to lock to GPS. This is why it is sometimes necessary for the operator to enter the position manually into system memory (the site location is identified on the site registration papers).

2.6 Rubidium Oscillators Achieve Lock

Once the 5 MHz and 1 PPS outputs are synchronized to GPS the yellow NO GPS LEDs will go off on both PRS modules, the green ON LED will light on the front panel.

Front Panel LEDs

REF 2	REF 1	LED Descriptions:
NO GPS	NO GPS	The GPS module is locked to GPS.
FAULT	FAULT	The Ref 1 Rb has locked; the Ref 2 Rb is locked. MBF/MDP outputs are present.
STBY	STBY	The yellow LED indicates the standby osc.
ON	ON	Ref 1 Rb is selected and on-line.

NOTE: darkened LEDs are OFF

If the Ref 1 oscillator loses lock, Ref 2 goes on-line. In the diagram below the GPS receiver has lost the GPS reference, the Ref 1 oscillator has lost lock and Ref 2 is now on-line. The front panel LEDs appear as shown.

Front Panel LEDs

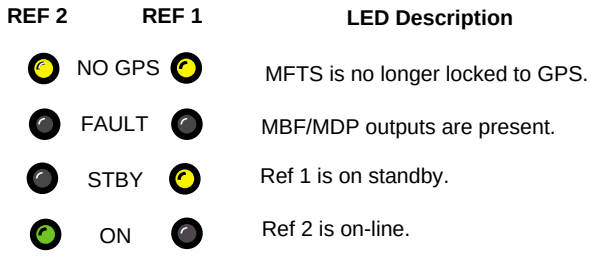
REF 2	REF 1	LED Description
NO GPS	NO GPS	GPS module has lost GPS sync. Ref 2 is in "flywheeling" mode.
FAULT	FAULT	MBF/MDP outputs are present.
STBY	STBY	Ref 1 has failed and is not on standby.
ON	ON	Ref 2 is on-line.

NOTE: darkened LEDs are OFF

2.7 'Flywheeling' Mode

If GPS synchronization is not available because there are no visible satellites or some other non-fault condition the NO GPS LEDs will light and remain on (no blinking) to indicate that the MFTS is in “flywheeling mode”. If GPS synchronization is not available through loss of antenna discipline circuitry or a fault in the GPS receiver, or the GPS receiver is not installed, the NO GPS LEDs will begin to blink. This indicates the MFTS is now relying solely on the accuracy of the primary PRS oscillator to discipline all output signals. When Ref 2 is the primary reference and the MFTS system is in "flywheeling" mode the front panel LEDs on the PRS modules will appear as shown below. Under this condition the MFTS should remain operational (within the specified timing and frequency drift rate) for eight hours.

Rb-PRS Front Panel LEDs



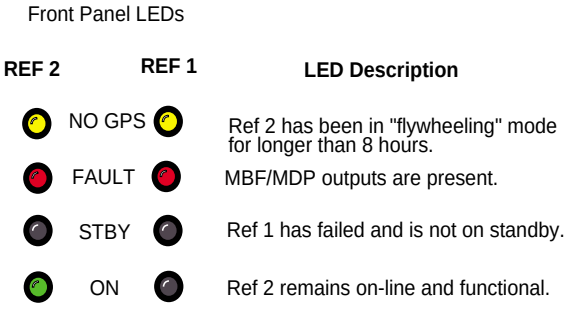
NOTE: darkened LEDs are OFF

2.8 Free-run Timer

The "free-run" timer monitors the duration of the free-running period. After 8 hours have elapsed without the system re-establishing GPS synchronization, a failure indication is initiated by the system and sent to the monitoring PC in the base station via the RS-232 status information line. Output signals will still be available.

In the diagram shown below, the GPS reference has been lost, the Ref 1 oscillator has lost lock, and the Ref 2 PRS module has timed out of its free-running period.

Front Panel LEDs



NOTE: darkened LEDs are OFF

SECTION 3 - SYSTEM MODULE DESCRIPTIONS

3.0 MFTS/MFTD System Module Descriptions

The MFTS system is a modular concept designed around an EIA 19 inch equipment chassis. The minimum height is 5.25 inches, although units can be stacked in the cabinet for additional output capacity. Module access can be from the front or rear of the rack, and the depth of the rack can be 22.0 inches (front and rear modules), or 10 inches (front or rear facing modules only).

System dimensions are based on the DIN Euroboard system. The width of each module is measured in multiples of 0.2 inches (I). For example, a module front panel 7(I) wide is 7 X 0.2 in, or 1.4 inches wide. The total width available for module installation is 16 inches, or 80(I). The backplane has been designed for flexibility in placing most modules, however the location of the plug-in sockets do restrict the location of some modules. The PMM, GPS, and PRS oscillator modules are installed in the front panel. The MPS, signal distribution modules and BFO modules are installed facing the rear. A system with two MPS modules, but without a BFO module installed, can have a maximum of eight distribution modules. With one MPS module installed, two additional distribution modules (MBF or MDP) can be installed, for a total of ten.

Figures 3-1 and 3-2 are block diagrams of the MFTS and MFTD systems.

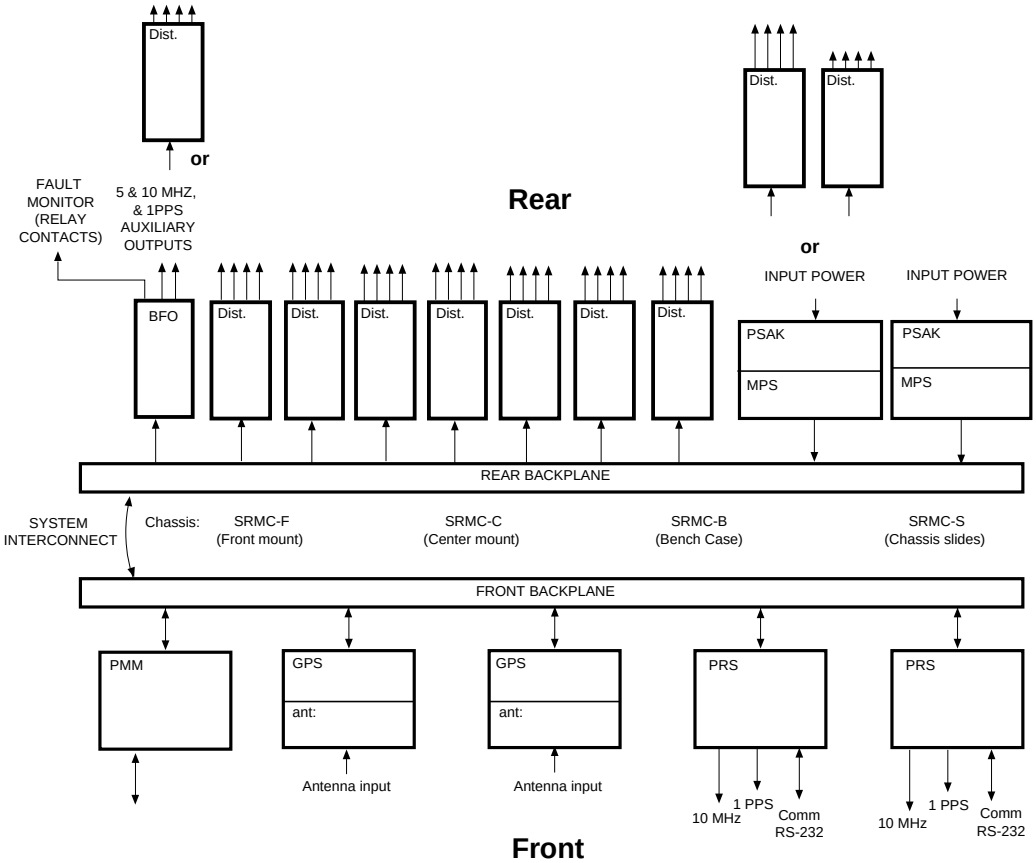


Figure 3-1. MFTS System Block Diagram

Modular Frequency Timing System

The Modular Frequency and Timing Distribution System (MFTD) is the expansion and distribution chassis for the MFTS system. The MFTD provides amplification and distribution functions for the frequency and timing signals generated by the MFTS. A BFO module serves as the signal output from the MFTS and a BFI module serves as the signal input to the MFTD.

A MFTD can be installed above or below the MFTS in a 19” cabinet, depending on the space and cabling requirements.

A single MFTD system supports 9 individual signal distribution modules (for a total of 36 outputs). When multiple MFTD systems are installed as extensions of a MFTS system they can support up to 64 individual distribution modules, each with four outputs, for a total of 256 outputs.

All MFTD modules can be “hot-swapped”, which simplifies maintenance and upgradebility.

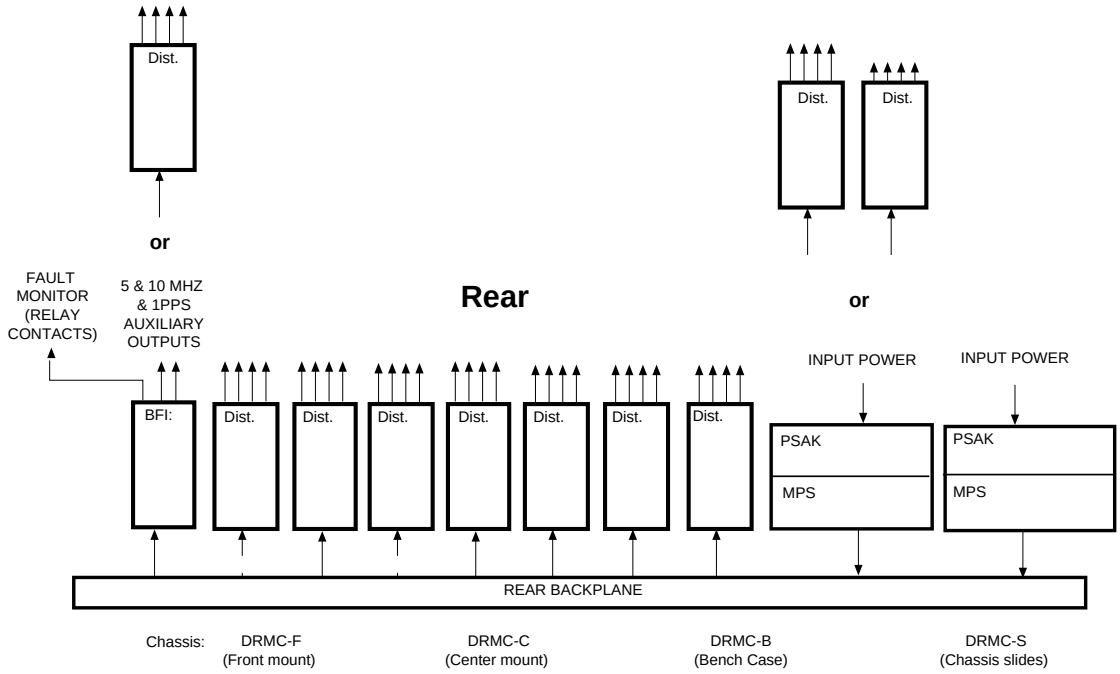


Figure 3-2. MFTD System Block Diagram

3.1 GPS Receiver Module

The GPS module provides an interface between Global Positioning System (GPS) reference signals and system electronics. The module provides +5 Vdc power to the GPS antenna and receives a timing reference through the antenna connector. The 1 PPS output signal from the GPS module is directed to the backplane for use by the PRS module as a synchronizing signal. RS232 serial communications are performed through the backplane.

TIP: The antenna input signal to the MFTS must be ~26 dB. If signal strength is stronger it will overdrive the receiver and, when observed with diagnostic software, will appear as a "low" signal instead of a "high". Avoid this by ensuring that the antenna input signal is within specified limits.

Figure 3-3. GPS Module

When a system with redundant GPS modules powers up, the first GPS module to come on line will go to active mode (only one GPS receiver module can be active at a time). The inactive receiver will still track satellites and if the active receiver experiences a fault, or is removed from the system, it will become the active GPS module. If a replacement GPS module is plugged into a system with an active GPS module, it will come on line in standby mode. During this changeover there will be a momentary indication of fault during switchover with no interruption of signal or impact on accuracy

Communications to the system PRS module(s) is by way of RS-232 protocol.

3.1.1 Troubleshooting

A fault indication is given if there is a problem with the antenna, the antenna feed line or loss of the GPS module's 1 PPS output reference signal. The FAULT LED on the front panel will light and an error message will be sent to both the PMM and external monitoring software by way of the BFO module's DB-9 ALARM output.

3.1.2 GPS Module Specifications

Electrical:

Input from GPS antenna:	1575.42 MHz (L1), 50±5 ohms impedance
Max signal loss:	5 dB
Outputs from module:	GPS1 PPS TTL for use by PRS module
	Switched 1 PPS derived from system bus 1 PPS
1 PPS Timing Accuracy:	±150ns RMS
Flywheel Accuracy of 1 PPS:	PRS-Rb: ≤3 μ sec change in 24 hours
	PRS-XO: ≤8 μ sec change in 4 hours
Input power:	+24 Vdc
power consumption:	<3 watts
Fault sensing:	front panel LED indicators
	Green = ACTIVE receiver
	Yellow = receiver on STANDBY (locked and operational,but not transmitting serial data)
	Red = antenna feed FAULT, or loss of 1 PPS GPS signal
Communications:	Serial, RS-232
Protocol:	9600 kbps, 8 data bits, 1 stop bit, no parity

Environmental:

Operating temp.:	-30˚C to 60˚C ambient
Altitude:	sea level to 10,000 ft
Mechanical	
(valid only when installed in system rack)	
Vibration:	MIL-T-28800, non operating
Shock:	MIL-T-28800, non-operating
Humidity:	10 to 95%, non-condensing

Physical:

Dimensions:	5.25”H X 1.4”W X 6.0”L max.
	(13.33 cm X 3.55 cm X 15.24 cm)
Weight:	<1 lb (0.45 kg)
Mounting:	3U high, 7I wide (Eurocard style rack)
Connectors:	
GPS ant.:	N-type, female
Main board:	DIN 41612 connector
Front panel 1 PPS:	BNC female

3.1.4 Accessories:

GPS-R: GPS Receiver Module with rear GPS antenna connector input panel

Antenna kits: 26.5 dB GPS antenna, 100’ coaxial r.f. cable, mounting hardware, surge arrester, and 24” grounding strap (AK100’)

40 dB GPS antenna, 250’ coaxial r.f. cable, mounting hardware, surge arrester, and 24” grounding strap (AK250’)

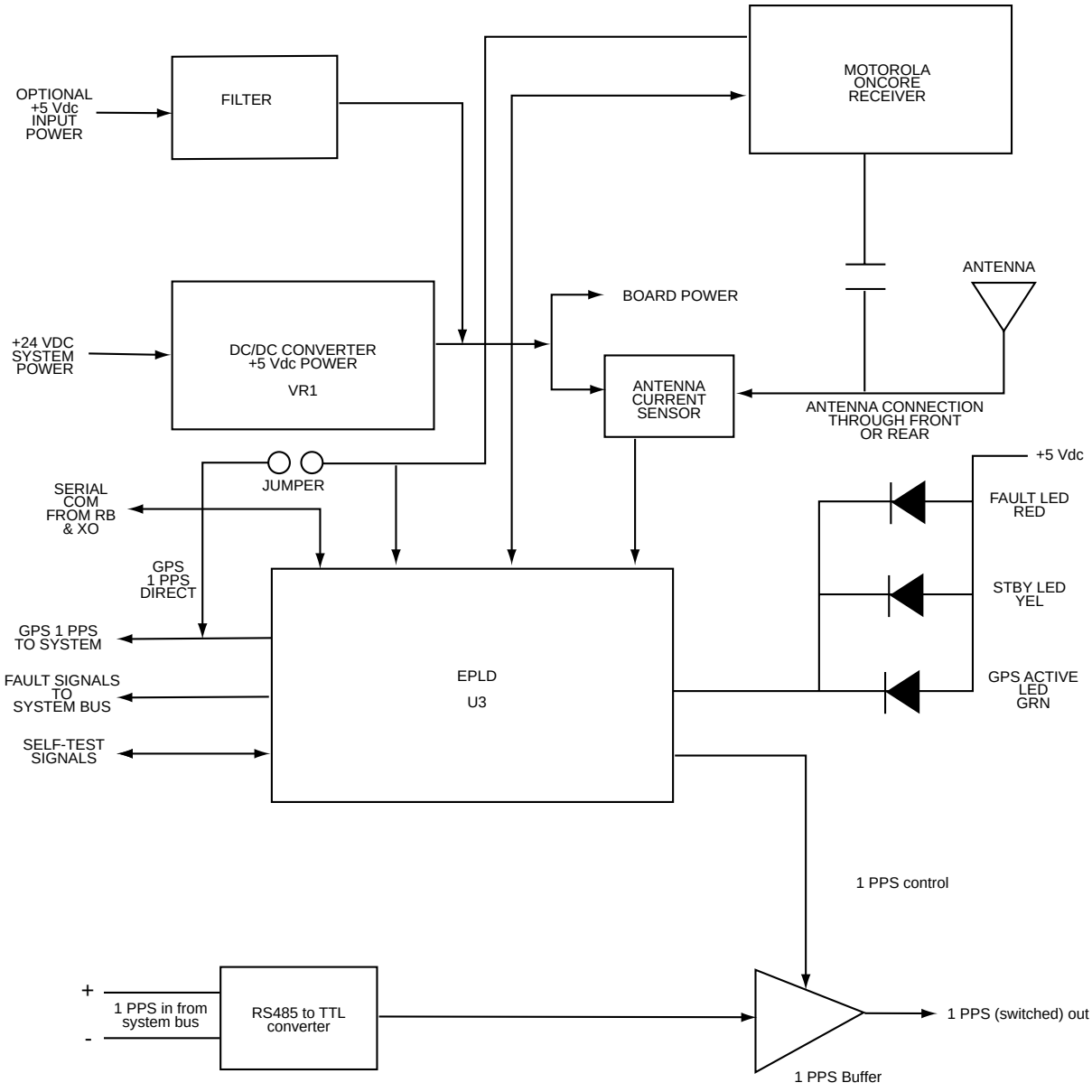


Figure 3-4. GPS Module Block Diagram

3.2 Performance Monitor Module (PMM) Module

The Performance Monitor Module (PMM) is both the remote as well as the local interface to the Modular Frequency and Timing System (MFTS). It provides the combined functions of the GPS module controls, status and monitor ports, LCD display, and RS-232 I/O ports. In addition it provides complete system status, control, monitoring, and performance measurement abilities all in one. Located on the front panel are two RS-232 ports (for communications to the PRS-Rb modules), a summary fault interface, as well as relay contacts. The two BNC connectors are for monitoring the master 1 PPS and 10 MHz from the backplane, LCD display of status information and data entry, and a keypad that allows local interrogation and updating of the PMM software. Figure 3-3 is a block diagram of the PMM module.

The RS-232 ports are female DB-9s connectors and are DCE format PC compatible in order to use standard interface cables. Refer to Appendix A for pinouts of the connectors. Channel A communicates to PRS #1 and Channel B communicates to PRS #2.

Status Interface: A DB-15 pin Status Interface provides a form-C relay contact signal to indicate that the system has a fault. This duplicates and enhances the BFO interface.

LCD Display: The front panel LCD display is a 4 by 20 character display. It provides operating information, status, and access to local control entry menus. In addition, it provides all of the I/O information of the PRS oscillator modules. The display has an LED back light and a wide viewing angle to provide optimum visibility.

TIP: While working with the PMM in a darkened area it is possible to adjust the display to such a low level of contrast that later in more brightly lit conditions the LCD display will appear to be completely dark. If the display does not seem to be working, even though the MFTS is powered

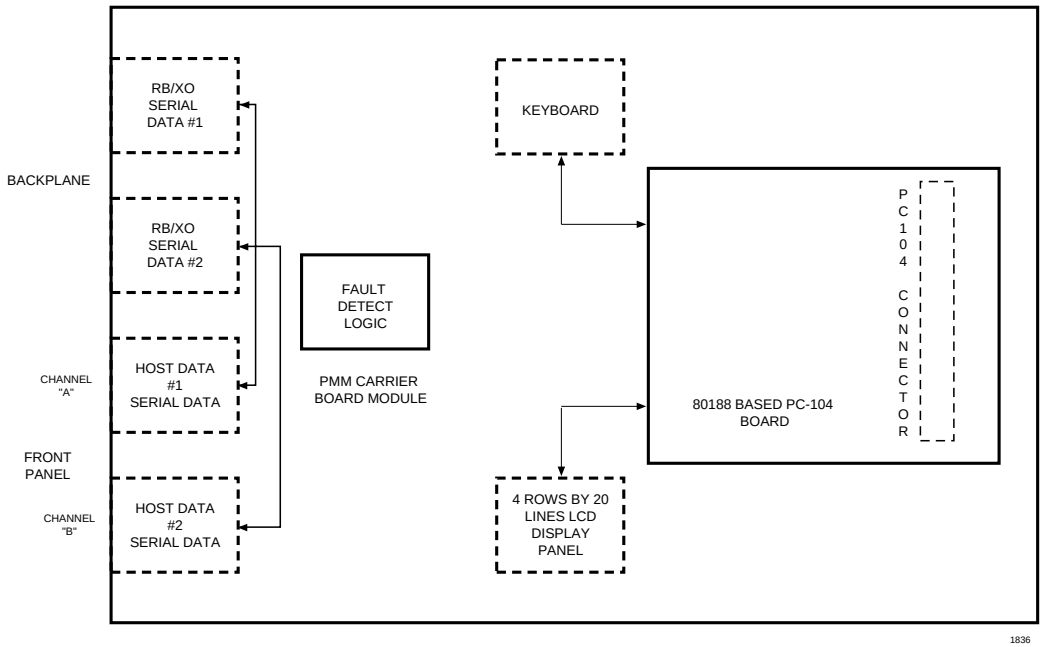


Figure 3-3. PMM Block Diagram

up, hold down the "+" key until the display increases in brightness (the control has 32 steps).

Keypad: The keypad provides input/output capability for the LCD display. A key sequence password prevents inadvertent changes to system operating parameters.

3.2.1 Troubleshooting

Output monitoring: Two BNC connectors provide monitoring capability for the backplane 1 PPS (1 PPS) and 10 MHz signals (RF). Both monitor signals are TTL compatible. If there is a major system fault, the LED will light on the module's front panel and the LCD panel will display a fault message. External monitoring software receives a fault indication through the ALARM connector of the BFO module.

Figure 3-4 is a photo of the front panel showing the keypad, connectors, and LCD display.

Figure 3-4. PMM Module

3.2.2 PMM Specifications

Electrical:

Outputs:	front:	1 PPS (400 ±10 µ sec/ rise ≤20 nsec, fall ≤100 nsec) 10 MHz sine, 1 VRMS ±10% RS-232 (1) Serial ports (2)
Accuracy:	<50 nsec delay from system 1 PPS at the connector	
Input:	power:	+24 Vdc, +5V and ±12Vdc from internal dc-dc supply
Fault Monitoring:	active at low TTl logic level (FAULT LED)	

Environmental:

Operating Temp:	-30˚C to 50˚C
Altitude:	sea level to 10,000 ft
Humidity:	relative humidity of 10% to 95%, non-condensing
Vibration:	Mil-T-28800, non-operating
Shock:	Mil-T-28800, non-operating

Physical:

Dimensions	5.24”H X 3”W X 6.0”L (13.3 cm X 7.62 cm X 15.24 cm)
Weight	3 lb (1.35 kg)
Mounting	standard eurocard style rack, 3U high, 28I wide

3.3 Primary Reference Source (PRS) Modules

3.3.1 PRS Rb and XO Modules

The PRS modules provide an accurate clock rate of 5 and 10 MHz and a 1 PPS signal synchronized to UTC. The PRS-Rb uses a Model LPRO rubidium oscillator accurate to 1E-11 over a 24 hour period and the PRS-XO uses a crystal oscillator accurate to 1E-9 over a 24 hour period. When PRS modules are disciplined to GPS satellite time transmissions through the GPS module the accuracy of the system is ±100 ns. In the GPS mode the primary PRS module makes frequency corrections using the GPS reference timing sign. This maintains the good short term stability of the reference oscillators and emulates the long term stability of a cesium oscillator.

The standard disciplining method is coherent frequency and time pulse with continuous correction. Frequency preferred and timing preferred disciplining are available as options. Check with DATUM Sales for more information on these options.

Important data such as control voltage, antenna cable length, position, and the error log are stored in non-volatile memory and are made available at user request through the external monitoring software.

3.3.2 Troubleshooting

The PRS firmware monitors internal temperature, Rb lamp volts, Rb crystal volts, and 24V supply voltage. Any abnormal condition on the levels will be sent out to external monitoring software as a RS-232 message from the ALARM connector of the BFO module.

Figure 3-5. PRS-Rb Module

3.3.3 PRS (Rb and XO) Specifications:

Electrical:

Oscillator:	LPRO:	Rubidium (module option 1)
	OCXO:	Crystal (ovenized) oscillator (module option 2)
Outputs (Diff.):	5 and 10 MHz sine, and 1 PPS TTL	
Accuracy:	Oscillator (LPRO):	±5E-11 at shipment,
	System:	<50 nsec delay from system 1 PPS at the connector
Inputs:	Electronics power:	24 Vdc ±20%, 20 W (continuous)
	Heater power:	18.5/32 Vdc, 40 W (during warm-up)

Output Control/Status Signals:

Active/Standby feedback
GPS switch control
5 MHz Phase locking/status
1 PPS for time sync./status
Fault indicator
Serial Communication: Two ports, front panel, and PMM mod.
Serial Communication to GPS modules

Input Monitor Signals:

GPS active indicators
GPS fault indicators
Companion PRS module type: Rb or XO
Companion PRS module fault
Companion PRS module 5/10 MHz Phase locking/status
Companion PRS module 1 PPS Time sync/status/time interval
GPS 1 PPS (inputs)

Switchover: (all time/freq. outputs)		Primary to secondary switch, (no power down required for module removal)
Fault Monitoring:	LED indicators:	NO GPS (Yellow)
		FAULT (Red)
		STBY (Yellow)
		ACTIVE (Green)

Alarm Outputs:	rf Monitor Resonance Lock Adjust Crystal Crystal Volts (analog) Lock Volts (analog) Lamp Volts (analog)

Environmental:

Operating Temp:	-30 to +60˚C
Altitude:	sea level to 10,000 ft
Humidity:	relative humidity of 10% to 95%, non-condensing
Certification:	FCC Part 15 Class B, CE

Physical:

Dimensions	14I wide, 3U high, 160 mm deep
Weight	3 lb (1.35 kg)
Mounting	standard eurocard style rack, 3U high, 28I wide

3.4 Sine and 1 PPS Output Modules

The output modules can be either MBF buffer modules that amplify and buffer the 5 MHz signal or MDP modules that provide amplified and buffered 1 PPS signals from the bus. Each module provides four individually buffered outputs.

3.4.1 MBF Module

The Modular Buffer Frequency amplifier module (MBF) receives a 5 or 10 MHz input from the active primary reference module. The module then provides buffering and distribution of the rf signal for use by external equipment. The output circuitry consists of four identical driver/amplifier circuits. The input circuitry consists of a wave shaping network which feeds a push-pull amplifier/ driver circuit. Each buffer also contains fault indicator circuits. If any of the buffered outputs are absent, an indicator light on the affected buffer module will illuminate.

3.4.1.1 Troubleshooting

The fault LED illuminates when an absence of rf level on any output is detected. Each output is individually monitored for signal loss at the output connector. Because of the characteristics of normal transmission lines (cables), faults that occur at the far end of output cables may not be sensed and indicated, or may falsely indicate a failure because of reflected signals.

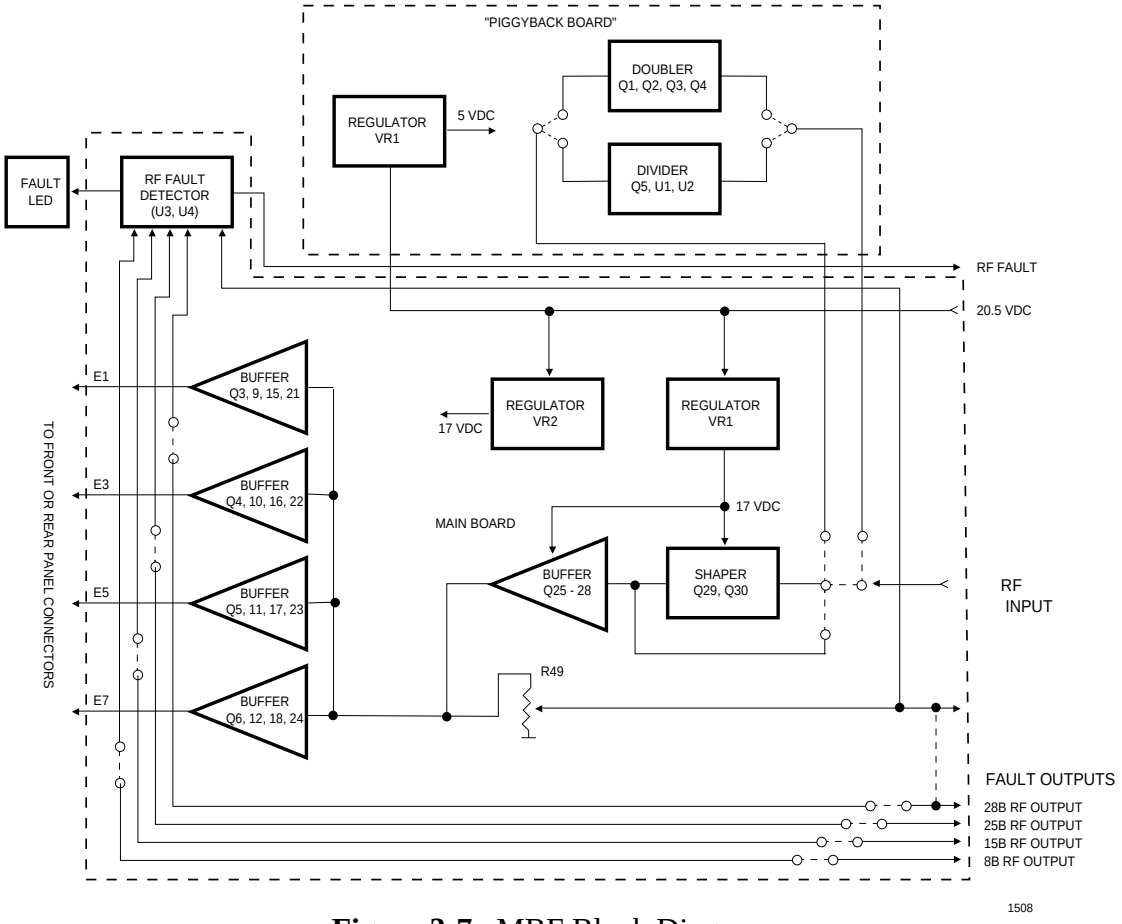


Figure 3-7. MBF Block Diagram

Figure 3-8. MBF Module

3.4.1.2 MBF Specifications

Electrical:

rf Outputs:	4 front (1 Vrms into 50 ohm, adjustable from 0.5 to 5 V pp) 50 ohm source impedance
rf Inputs:	5/10 Mhz differential, 0.4 Vrms into 50 ohms, maximum accepted VSWR <5:1
Input Power:	+24 Vdc, ±10% @ 200 ma max.
Power Consumption:	5 W (max) 3 W typical
Harmonic:	5 MHz: <-?? dBc 10 MHz: <-?? dBc
Non-Harmonic:	5 MHz: <-?? dBc 10 MHz: <-?? dBc
Isolation:	Between input/outputs: 80 dB at 10 MHz Between modules: 90 dB
Phase Noise, floor:	<-155 dBc @ 1 kHz
Fault Detection:	Fault LED illuminates when any output drops below 300 mv pp

Environmental:

Operating Temp:	-30˚C to 60˚C
Altitude:	Sea level to 10,000 ft
Humidity:	Relative humidity of 10% to 95%, non-condensing
Certification:	UL, FCC, CE

Physical:

Dimensions	7 I (rack increments)
Weight	1.25 lbs (0.57 kg)
Mounting	Standard eurocard style rack, 3U high, 28I wide

3.4.2 MDP Module

The Modular Digital Pulse (MDP) module provides four 1 PPS TTL/CMOS compatible outputs through BNC connectors on its front panel. The module receives an internal 1 PPS signal and performs buffering and amplification of the output signals provided for use by external equipment.

All 1 PPS outputs are derived from a differential 1 PPS input that is applied to the MDP at backplane input P1. If this 1 PPS signal is removed, the fault detector will illuminate the FAULT LED within 5 seconds.

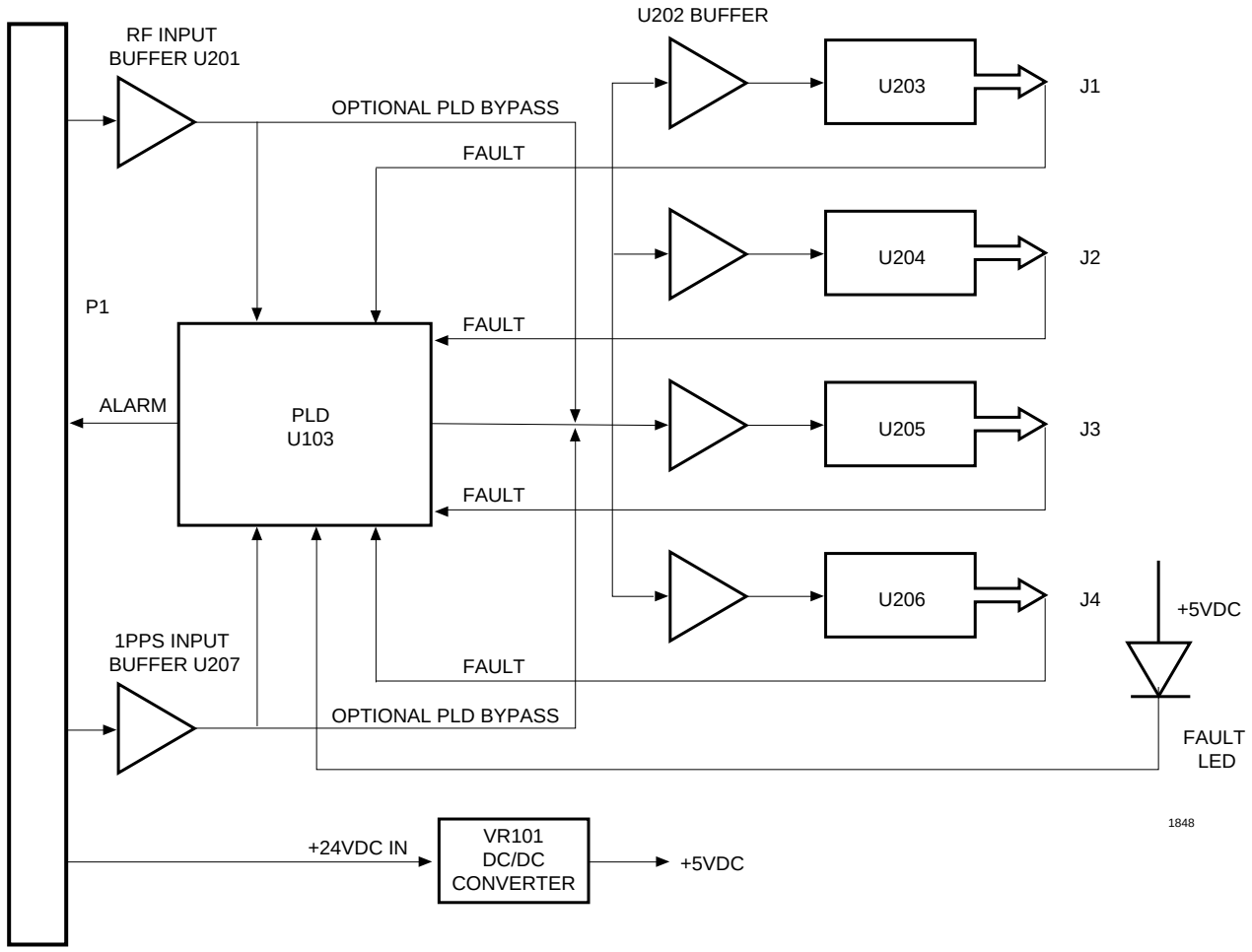


Figure 3-10. MDP Block Diagram

3.4.2.1 MDP Specifications

Electrical:

Outputs:	Front:	Four TTL/CMOS 1 PPS outputs
Inputs:	Rear (from backplane):	1 PPS reference from GPS module
	Electronics power:	24 Vdc ±20%

1 PPS Characteristics:

Amplitude:	5 Vdc +10%/-20%
Pulse width:	400 µ sec (determined by system)
Rise time:	<20 nsec
Fall time:	<100 nsec
Input to output delay time:	<25 nsec

Connectors:	Front:	BNC jack
	Rear:	DIN M42
Fault Monitoring:	LED indicator:	FAULT (Red)
	Fault Outputs:	Shorted output (J1 through J4)
		No input
Electrical Protection:	Output terminals shorted to ground, input reverse voltage diode, fuse	

Environmental:

Operating Temp:	-30 to 60˚C
Altitude:	Sea level to 10,000 ft
Humidity:	Relative humidity of 10% to 95, non-condensing
Certification:	UL, FCC, CE

Physical:

Dimensions	7I wide, 3U high, 160 mm deep
Weight	1.25 lbs (0.57 kg)
Mounting	Standard eurocard style rack, 3U high, 28I wide

Figure 3-11. MDP Module

3.5 Buffer and Fault Monitoring (BFO and BFI) Modules

The BFO and BFI modules provide auxiliary 5 or 10 MHz and 1 PPS signal distribution and relay contact alarms for remote monitoring of fault signals. A BFO module is used to output reference signals from a MFTS unit to an expansion MFTD unit, or to "daisy-chain" signal outputs from a MFTD unit to another MFTD. The BFI module accepts the reference signal output by the BFO module in the MFTS system. When linking reference signals between MFTD systems it is not necessary to install a BFO in a MFTD system that already has a BFI module. An output from one of the MBF or MDP modules will serve as the signal input to the next BFI module in line.

3.5.1 Trouble-shooting

Four system faults are monitored and sent to external PC utility software by the BFO/BFI modules:

Output fault: Activates when any output on any MBF module is below a set amplitude threshold (~300 mv rms). It also activates after 1 or 2 pulses are missed when any MDP module experiences a loss of the 1 PPS signal.

Power fault: Activates when any installed MPS module indicates a fault condition.

Oscillator fault: Activates when any installed PRS module indicates a fault condition.

GPS fault: Activates when an Antenna Feed Fault or GPS 1 PPS fault is detected from any installed GPS module.

The fault signals are output on a DB-9 type connector. Pins are normally shorted to each other and open on fault. The fault connections are reed relay contacts rated at a maximum of 100 milliamps at 28 Vdc.

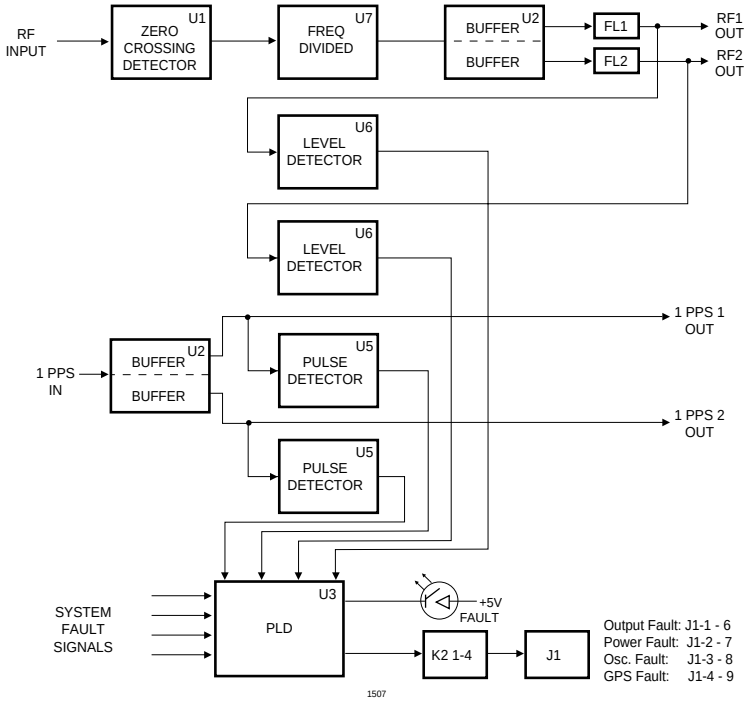


Figure 3-13. BFM Block Diagram

Figure 3-14. BFO/BFI Module

3.5.2 BFO/BFI Specifications

Electrical:

BFO Module:

Front Outputs:	One rf output (BNC connector)	
	One 1 PPS output (Bnc connector)	
	Fault monitoring signal (Db-9 connector)	
Rear Input:	Electronics power:	20.5 Vdc, 3 W
(P1 internal conn.)		
Fault Monitoring:	LED indicators:	FAULT (Red)
	Fault Outputs:	Output fault
		Power fault
		Oscillator fault
		GPS fault

BFI Module:

Front Inputs:	One rf input (BNC connector)	
	One 1 PPS input (BNC connector)	
Front Output:	Fault monitoring signal (Db-9 connector)	
Rear Input:	Electronics power:	20.5 Vdc, 3 W
Fault Monitoring:	LED indicators:	FAULT (Red)
	Fault Outputs:	Output fault
		Power fault
		Oscillator fault
		GPS fault

Environmental:

Operating Temp:	-30˚C to 60˚C
Altitude:	sea level to 10,000 ft
Humidity:	relative humidity of 10% to 95%, non-condensing
Certification:	UL, FCC, CE

Physical:

Dimensions	7 I (rack increments)
Weight	1.25 lbs (0.57 kg)
Mounting	standard eurocard style rack, 3U high, 28I wide

3.6 MPS Module

The Modular Power Supply (MPS) module provides system power to both front and rear backplanes of the MFTS system, and to the rear backplane of a MFTD system.

MPS modules are available to provide 115/230 Vac, +24 Vdc, -48 Vdc power, depending on the MFTS/MFTD's system requirements.

Figure 3-16. AC MPS Module

Figure 3-17. DC MPS Module

3.6.1 Troubleshooting

The front panel LED is green when the output voltage of the module is nominal. If the output goes out of spec, the LED will go dark and a logic low indication of a fault will be sent to the PMM and to the BFO/BFI modules. External utility software and the LCD display of the PMM module will both show FLT (fault) for MPS1 or MPS2, depending on which has failed. If two MPS modules are installed in the MFTS or MFTD system, the failed module may be swapped out with a replacement MPS module without having to remove power from the system.

3.6.2 MPS Specifications (115/230 Vac Power Module)

Electrical:

Input Voltage:	90 - 132, 180 - 263 Vac @ 50 - 60 Hz
Output Power:	150 W peak (@ power up for 5 minutes), 100 W (continuous) (75˚C, convection cooling)
Output Voltage:	115/230 Vac nominal, ripple -.5 V p-p (no load to full load), 10% line & load regulation

Efficiency:	75%
Isolation & Protection:	1000 Vrms (to chassis)
Power Entry:	Front panel IEC with line filter, internally fused
Fault Monitoring:	LED (GRN) lit when no fault, dark when fault exists

Physical:

Size:	14 (I) rack increments
Weight:	~3 lbs (1.35 kg)

3.6.3 +24 Vdc Power Module Specifications

Electrical:

Input Voltage:	+24 Vdc
Output Power:	150 W peak (@ power up for 5 minutes), 100 W (continuous) (70˚C, convection cooling)
Output Voltage:	24 Vdc nominal, ripple 500 mV p-p (no load to full load), ±10% line & load regulation
Efficiency:	75%
Isolation & Protection:	1000 Vrms (to chassis)
Power Entry:	Front panel IEC with line filter, internally fused
Fault Monitoring:	LED (GRN) lit when no fault, dark when fault exists
Front Panel Fuse:	10 amp, 24 Vdc

Physical:

Size:	14 (I) rack increments
Weight:	~3 lbs (1.35 kg)

3.6.4 -48 Vdc Power Module Specifications

Electrical:

Input Voltage:	-48 Vdc
Output Power:	150 W peak (@ power up for 5 minutes), 100 W (continuous) (70˚C, convection cooling)
Output Voltage:	-48 Vdc nominal, ripple 500 mV p-p (no load to full load), ±10% line & load regulation
Efficiency:	75%
Isolation & Protection:	1000 Vrms (to chassis)
Power Entry:	Front panel IEC with line filter, internally fused
Fault Monitoring:	LED (GRN) lit when no fault, dark when fault exists
Front Panel Fuse:	10 amp, -48 Vdc

Physical:

Size:	14 (I) rack increments
Weight:	~3 lbs (1.35 kg)

SECTION 4 - OPERATIONS & DIAGNOSTIC TOOLS

4.1 PMM Display Utility Software

The PMM utility software for the front panel display provides system status information. Using the keyboard on the front panel, the user can scroll through menus to view system status, enter position, and edit the cable length using menus. The status information is updated at a rate of once per second.

The user can switch displays between Reference 1 and Reference 2 by toggling the 'C' key while in query mode. The currently selected oscillator is referenced in the upper right of the display (1=REF1 or 2=REF2).

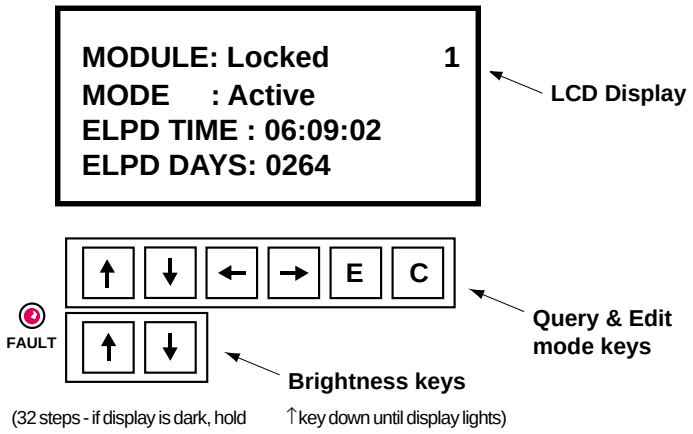


Figure 4-1. PMM Keypad and Display.

4.1.1 Key Pad Operation Descriptions

C - Query Mode: toggle between REF1 and REF2.
Edit Mode: cancel the entry, returns to Menu #1.

E - Query Mode: switch between 'LCD MODE' and 'EXTERNAL PC MODE'.
Password Unlock Menu's: if password is valid, switch to edit menu.
Edit Mode: accept the entry.

↑ - Query Mode: move up one frame (previous frame).
Edit Mode: increase one digit.

↓ - Query Mode: move down one frame (next frame).
Edit Mode: decrease one digit.

← - Query Mode: password combination to switch to edit mode.
Edit Mode: move cursor to the left one digit.

→ - Query Mode: password combination to switch to edit mode.
Edit Mode: move cursor to the right one digit.

4.1.2 Menu Display Format

The PMM liquid crystal display (LCD) can be toggled through twelve menus, as shown below. The first screen shown is the Main Menu.

Screen 1: Main Menu

```
GPS1TIME : HH:MM:SS      *
GPS1DATE: YY-MM-DD
STATUS: LOCKED TO GPS
DURATION: XXX HRS
```

GPS TIME: Hours:Minutes:Seconds

GPS DATE: Year-Month-Day

STATUS: "Warm up"
"Locked to GPS"
"Free Running"
"Failure"

DURATION: Operation Mode Elapsed Hours (0-255 Hours)

Screen 2: Main Menu

```
GPS2TIME : HH:MM:SS      *
GPS2DATE: YY-MM-DD
STATUS: LOCKED TO GPS
DURATION: XXX HRS
```

GPS TIME: Hours:Minutes:Seconds

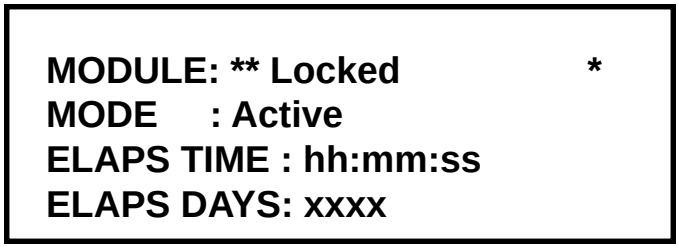
GPS DATE: Year-Month-Day

STATUS: "Warm up"
"Locked to GPS"
"Free Running"
"Failure"

DURATION: Operation Mode Elapsed Hours (0-255 Hours)

The "*" at the end of line one is the PRS primary source indicator. It will be either a 1 or a 2. The user can switch between source 1 and 2 by pressing the 'C' key on the keypad.

Screen 3: Module Status



MODULE: (RB OR XO) “Locked” or “Unlocked”

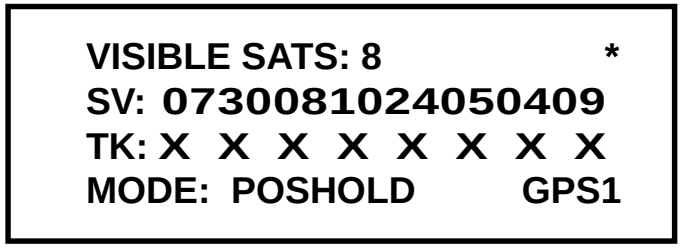
MODE: “Active” or “Non-Active”

ELAPS TIME: Elapsed Hours:Minutes:Seconds

ELAPS DATE: Elapsed Number of Days

The “**” area in the LCD display will show either RB or XO.

Screen 4: Display GPS1 Receiver Status



NOTE: PMM can show up to 12 satellites

VISIBLE SATS: Number of visible satellites according to Almanac calculation

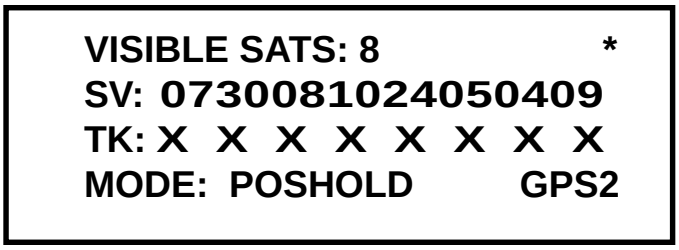
SV: List of the visible satellite’s vehicle IDs (sample IDs shown)

TK: Tracking satellites (an X indicates the satellite is being tracked)

Receiver Status

- Position Propagate Mode
- Poor Geometry (DOP>20)
- 3D fix
- Altitude Hold (2D fix)
- Acquiring Satellites/Position Hold
- Differential
- Insufficient Visible Satellites (less than 3)
- Bad Almanac

Screen 5: Display GPS2 Receiver Status



NOTE: PMM can show up to 12 satellites

VISIBLE SATS: Number of visible satellites according to Almanac calculation

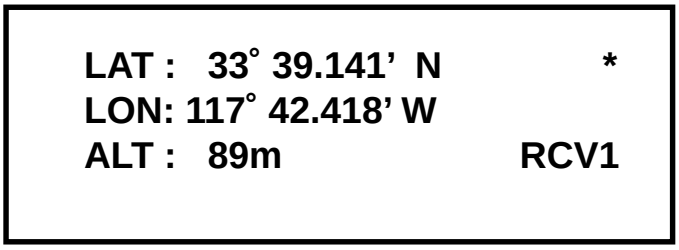
SV: List of the visible satellites vehicle IDs (sample ID numbers shown)

TK: Tracking satellites (an X indicates the satellite is being tracked)

Receiver Status

- Position Propagate Mode
- Poor Geometry (DOP>20)
- 3D fix
- Altitude Hold (2D fix)
- Acquiring Satellites/Position Hold
- Differential
- Insufficient Visible Satellites (less than 3)
- Bad Almanac

Screen 6: Display GPS1 Positions

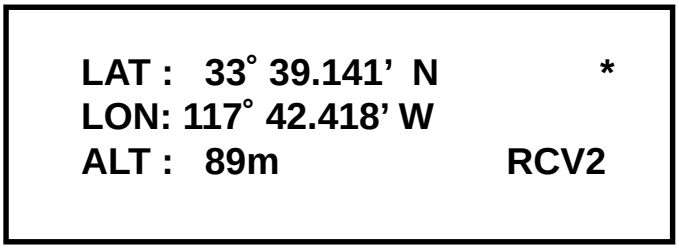


LAT: Latitude (degree, minutes with 3 decimal digits, N/S)

LON: Longitude (degree, minutes with 3 decimal places, E/W)

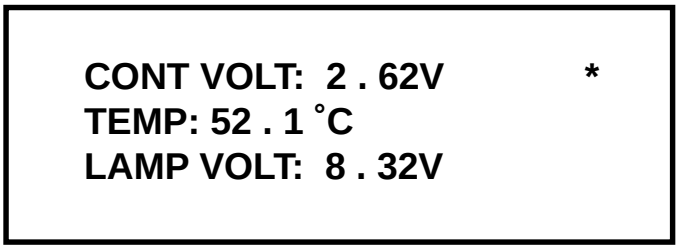
ALT: Altitude (meters)

Screen 7: Display GPS2 Positions



LAT:	Latitude	(degree, minutes with 3 decimal digits, N/S)
LON:	Longitude	(degree, minutes with 3 decimal places, E/W)
ALT:	Altitude	(meters)

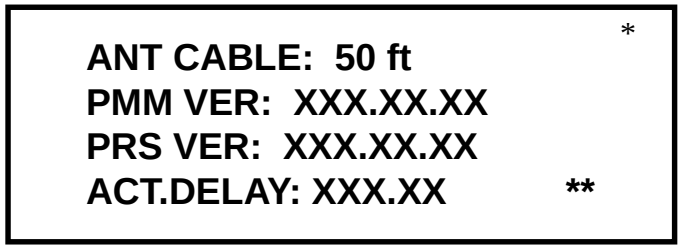
Screen 8: Display Control Volt, Temperature and Oscillator Voltage



NOTE: when XO is selected LAMP VOLT is not shown.

CONT VOLT:	C-field Voltage (0-5V)
TEMP:	Temperature (°C)
LAMP VOLT:	lamp voltage (5-12V)

Screen 9: Cable Length Setting, PMM & PRS Firmware Version, and 1 PPS Phase Error

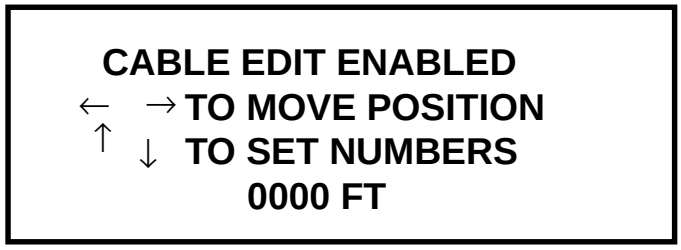


This menu displays the cable length (in feet) for PRS1 or PRS2.
The PMM version is the released version of the PMM firmware.
The PRS version is the released version of the PRS firmware.
ACT.DELAY: The 1 PPS phase error between the active GPS 1 PPS and PRS source 1 PPS. (Use the 'C' key to select other PRS source data - the ** signifies display of ns, μ s, or ms (for nano, micro, and mili seconds)

Screen 10A: Cable Length Password, Unlock Menu

As a safety feature, the edit menu is locked upon power up and remains locked. To unlock the edit menu, the keypad combination ← , → , →, →, **E** must be entered to unlock the menu.

Screen 10B: Cable Length Edit Menu

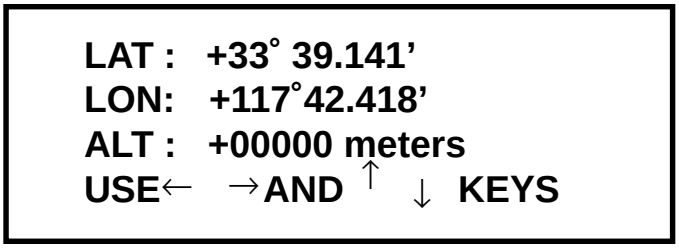


Use this screen menu to edit the cable length. Use the ← and → keys to move the cursor to the digit to be edited and use the ↑ and ↓ keys to change the value. The **CLEAR** key can be used to delete the entry and the **ENTER** key is used to save the cable length value as entered. Once the **ENTER** key is pressed, the cable length value will be retained in the system. The new cable length value will be sent to both PRS modules.

Screen 11A: Position Edit Password, Unlock Menu

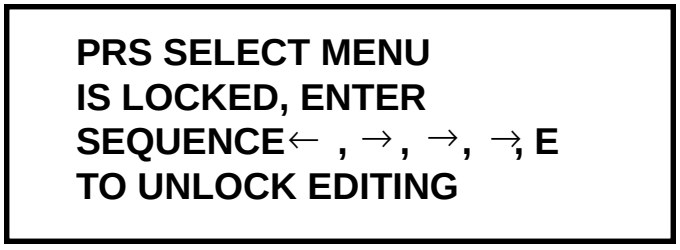
The position edit menu is locked upon power up and remains locked.
To unlock the edit menu, the keypad combination← , → , → , → , **E** must be entered to unlock the menu.

Screen 11B: Position Edit



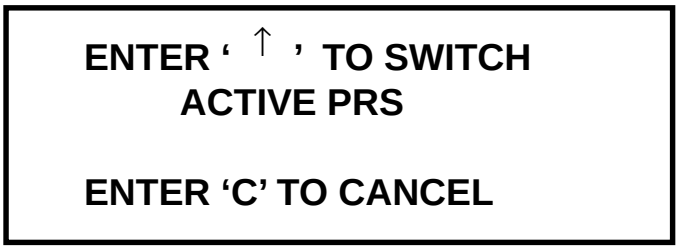
Use this screen menu to edit the position for the site. Use the ← and →keys to move the cursor to the digit to be edited and use the ↑ and ↓ keys to change the value. The **CLEAR** key can be used to delete the entry and the **ENTER** key is used to save the new position value as entered. Once the **ENTER** key is pressed, the new position value will be retained in the system. The new position value will be sent to both PRS modules.

Screen 12A: PRS Select Password, Unlock Menu



The PRS Select menu is locked upon power up and remains locked.
To unlock the edit menu, the keypad combination← , → , → , → , **E** must be entered to unlock the menu.

Screen 12B: PRS Select Menu

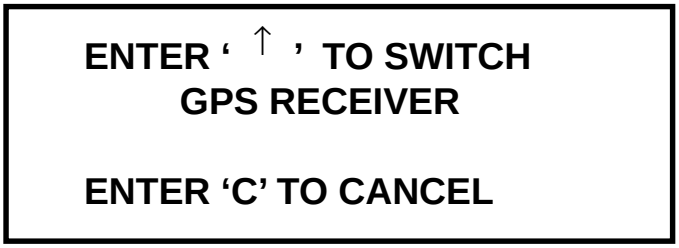


This menu allows the user to switch the active PRS to standby mode and the standby PRS to active mode by pressing the ↑ key, **providing the standby unit is operational**. Pressing the 'C' key cancels the entry and returns the display to menu 1.

Screen 13A: GPS Receiver Select Password, Unlock Menu

The GPS Receiver Select menu is locked upon power up and remains locked. To unlock the edit menu, the keypad combination← , → , →, → , **E** must be entered to unlock the menu.

Screen 13B: GPS Select Menu



This menu allows the user to switch the active GPS receiver to standby mode and the standby GPS receiver to active mode by pressing the ↑ key, **providing the standby unit is operational**. Pressing the 'C' key cancels the entry and returns the display to menu 1.

Screen 14: Input Fault Status Line Monitoring, First Menu

REF1	**OK**	**10 MHZ**	**OK**
REF2	**OK**	**5 MHZ**	**OK**
GPS1	**OK**	**1PPS**	**OK**
GPS2	**OK**		

For Screens 14 through 16, which display fault status lines, the line status is indicated as **OK** or **FLT** (fault). The lines are identified by module location (i.e., A10) or name (i.e., MPS2).

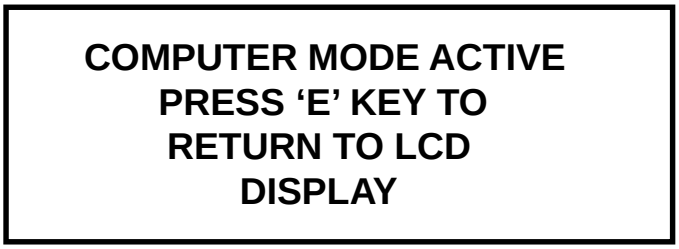
Screen 15: Input Fault Status Line Monitoring, Second Menu

A06	**OK**	**A10**	**OK**
A07	**OK**	**A11**	**FLT**
A08	**OK**	**A12**	**FLT**
A09	**OK**	**A13**	**OK**

Screen 16: Input Fault Status Line Monitoring, Third Menu

MPS1	**OK**
MPS2	**OK**

Screen 17: External PC Mode Active Message



This screen is displayed when the system is in external PC mode and the remote diagnostic software is running.

4.1.3 Fault Sensing and Indication

The PMM module provides fault sensing of all modules plugged into the MFTS and MFTD system. This is in addition to the FAULT LEDs on the front panels of every module. The master fault sensing LED on the front panel of the PMM lights to indicate an internal failure of the PMM, or a fault sensed from any of the modules in the MFTS system. The user can then interrogate the PMM through the keypad to look at status information on all the fault status lines.

SECTION 5 - IN CASE OF A PROBLEM

5.0 Dealing with the Unexpected

The diagnostic firmware of the PMM module and the remote utility software that runs on a PC are the two main troubleshooting tools of the MFTS system. Use these tools to determine if a module is operational, or the type of failure.

The following tips can be used to identify and solve general problems.

GPS Cable and Antenna Problems

Symptom: Hours after startup the GPS module still cannot establish GPS Lock, and only one or two satellites are being tracked.

Check the antenna location and determine if:

1. The antenna is mounted vertically. A GPS antenna is designed to be more sensitive to signals coming from above. Signals hitting the sides are filtered out because they are assumed to be reflected interference from obstacles, such as buildings.

2. The antenna is mounted above obstructions that prevent clear view of the horizon. Signals reflecting off of buildings, mountains, or trees with dense leaf canopies cause “multipath” interference. This interference reduces the antenna’s ability to acquire satellite transmissions and reduces the GPS receiver’s accuracy. Make sure the antenna is mounted above such obstructions.

3. The antenna’s coax connectors have been installed properly (perform a continuity test).

4. The antenna’s connections are secure and a lightning arrestor or grounding kit is installed according to the manufacturer’s instructions.

5. Check the antenna cable length against the cable delay setting using the PMM or the PC utility software tools.

Symptom: The ability of the GPS receiver to maintain GPS lock has suddenly deteriorated

Check the antenna location and determine if:

1. The antenna cable or antenna has been contaminated with moisture. Trace the antenna cable along its run and check the seals around the connectors and the grounding kits. If the cable or antenna has water inside, these areas will have to be dried and made water tight.

Symptom: The PMM LCD screens show errors in the data and the PC utility software shows a blank screen, or errors in the data.

Check the cable delay setting (through the PMM module) and determine if:

1. The actual antenna cable length is longer than the cable delay setting. If the cable is longer than the setting in software, or longer than 100 feet, data errors will result.

Symptom: System timing is erroneous compared to other systems on the network. Poor audio performance on simulcast systems. Poor synchronization of network nodes.

Probable fault: Cable length setting may be incorrect for installation.

This is a subtle fault. It often will not show up at all. But in those installations where timing is absolutely critical (accuracy better than 100 nanoseconds required) it is best to set the cable length setting to match the actual length of the antenna cable to match the timing. This provides an internal time correction to the 1 PPS signal so that multiple systems will be matched more accurately to GPS timing. For non critical or less critical applications, the factory default setting of 50 feet may be used. This may be done through the PMM or with the O & M Software. See the appropriate manual for instructions on how to set the cable length delay.

GPS Receiver Problems

Symptom: The diagnostic utility software indicates an antenna fault even though the GPS antenna is installed properly and operational.

Check the antenna input signal and determine if:

1. The antenna input signal to the GPS receiver should be around 26 dB. If the signal strength is stronger than this it will overdrive the receiver and the diagnostic software will read a “low” signal instead of a “high”. This erroneous fault indication can be avoided by making sure the antenna input signal is ~26 dB.

Symptom: The second GPS module in a MFTS system will not go to ACTIVE mode.

Check the FAULT LED:

1. If the FAULT LED is dark, and the other GPS module is in ACTIVE mode, the GPS module is operating normally. Only one GPS module can be active at a time. Even though it is inactive, the second GPS module is still tracking satellites. If the active GPS module is removed, or fails, this module will immediately switch to ACTIVE mode.

PRS Problems

Symptom: Outputs are not present at the front panel of the PRS module.

Check the MFTS system and determine if:

1. Is the FAULT LED lit? If so, replace the PRS module. If the FAULT LED is not lit, check to see if . . .

2. A power cord is plugged into the MPS module (i.e., power is ON)? If not, insert a power cord and observe if the system starts up.

3. Are there outputs present from the distribution modules and is the RS-232 output sending data?

4. Use the remote diagnostic utility software or PMM display to check the status of the PRS module. If it shows an output failure, replace the module.

PMM Display Problems

Symptom: The LCD display of the PMM module does not show data.

Check the MFTS system and determine if:

1. A power cord is plugged into the MPS module, but the PMM display is not active. Hold down the "+" key on the PMM keypad. This control has 32 steps. Does the LCD display begin to brighten? If it does, the contrast control ("-" key) was set to its lowest level. If the display does not brighten . . . .

3. Use the remote diagnostic utility software to check the status of the PMM module. If it shows a failure, check to see if the module is seated properly.

MBF/MDP Output Module Faults

Symptom: Red LED on one MBF/MDP module is on.

Probable Fault:

1. Module has one or more low level or missing outputs. The fault is indicated the same regardless of how many outputs show a fault. The fault should also be indicated on the PMM Fault monitor screen as Ax, where "x" indicates the position of the faulted module. In addition, the BFM, if present, will indicate a fault by opening the relay contact connecting Pins 1 to 6 of the J3 connector.

Symptom: Red FAULT LED on multiple modules is ON.

Probable Fault(s):

1. If all MBF or MDP modules in the system have fault LEDs ON, the problem exists at the source, and the PRS module (or modules if two are installed) have no output. Note that the fault LED on any installed BFM or PMM will also be ON.

2. If all MBF or MDP modules in the system have their fault LEDs ON, the problem may be that one module is shorting the bus connection. This is unlikely, but is possible, especially if a module has been recently replaced. Remove the most recently installed module. If the LEDs on the rest of the modules go out, the module removed is at fault. If this does not work, all modules must be removed one by one to determine which module is shorting the bus.

3. If several but not all MBFs or MDPs have their fault LEDs lit, most likely each of the individual modules has a fault as above.

Power Distribution Faults

Symptom: A module has no output, but its fault indicator LED is not ON.

Probable fault: Internal fuse is blown on module which has no output. All modules are designed to indicate a fault to the PMM and BFM modules if module power is lost. Check the module status screens. Replace faulted module.

SECTION 6 - ACCESSORIES

6.0 Enhancing Your Applications

DATUM provides standard and optional accessories that can make the MFTS and MFTD systems a better fit for your applications. They include the following:

Power Supply Accessory Kits

AC Accessory Kit (includes ac power cable, 2 fuses) - order PSAK-AC
DC Accessory Kit (includes banana plugs, wire and 2 fuses) - order PSAK+24
DC Accessory Kit (includes banana plugs, wire and 2 fuses) - order PSAK-48

GPS Antenna Accessory Kits

GPS Receiver Module with rear Antenna input port panel - order GPS-R

26.5 dB GPS antenna, includes 100’ coaxial r.f. cable, mounting hardware, surge arrester, and 24” grounding strap - order AK100’

40 dB GPS antenna, includes 250’ coaxial r.f. cable, mounting hardware, surge arrester, and 24” grounding strap - order AK250’

Included Accessories

Diagnostic software, (specify 2 channels or 16 channels)
Mating connectors (BMC, DB9, DB25, SMA, RJ11, or N)
Operation manual (S/O/104300)
Special System Acceptance Test Procedure (ATP)
Acceptance Test Procedure (ATP) Data

Optional Accessories

Additional manuals and diagnostic software may be ordered from DATUM Sales, call 1-800-337-2866, if in U.S.A., or 949-598-7600, FAX: 949-598-7650

NOTES:

APPENDIX A - Outline Drawings & Connectors

The following drawings provide physical dimensions of the MFTS and MFTD sytem hardware.

Connector information for attaching cables from the RS-232 ports of the PMM module and the RS-232 ports of PRS modules to the COM ports of a personal computer, and the J3 connector of BFO/ BFI modules to external alarms are also provided.

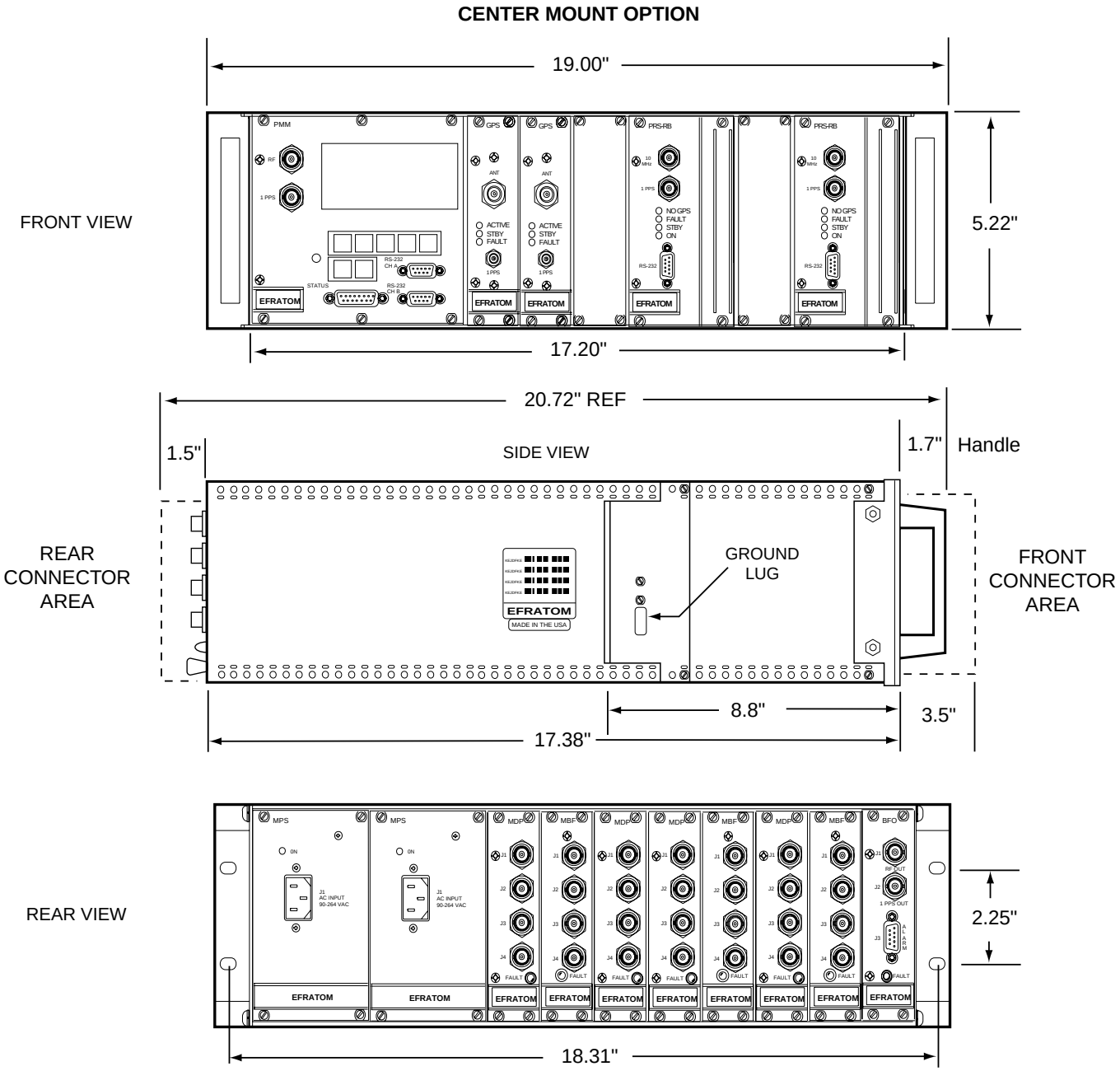


Figure A1. Outline Drawing, MFTS System

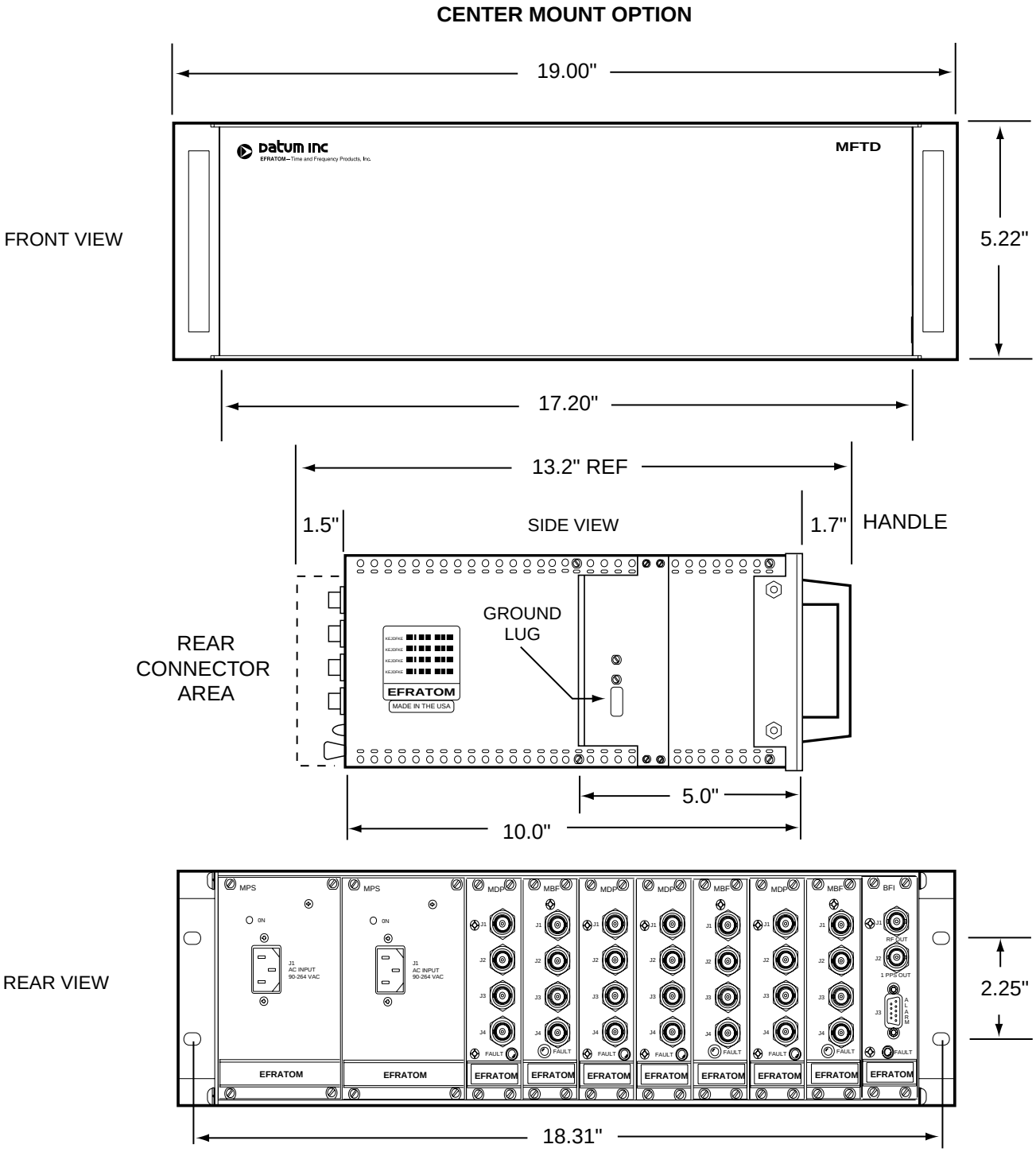
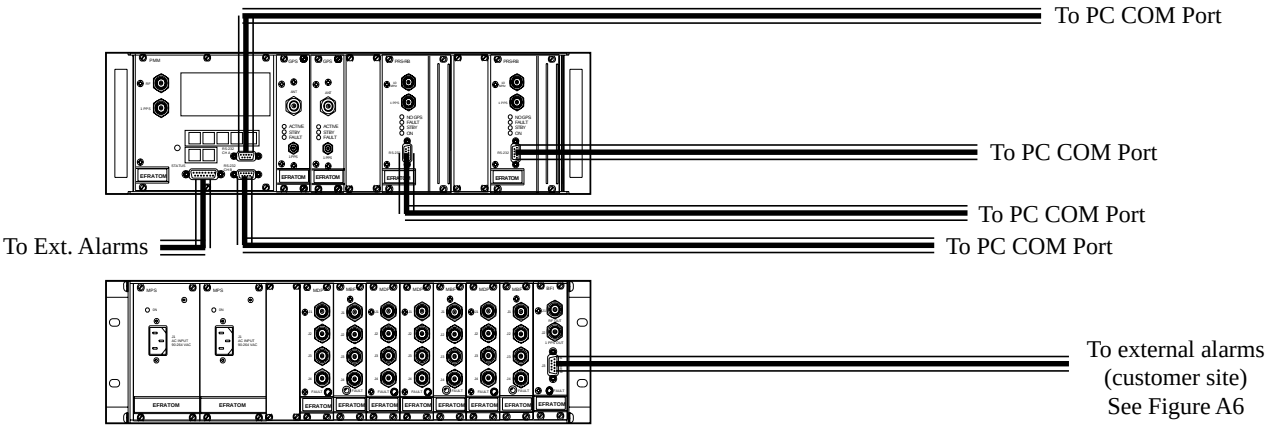
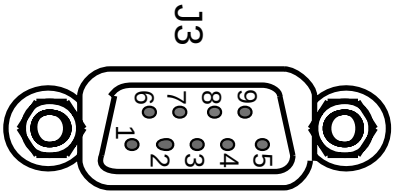


Figure A2. Outline Drawing, MFTD Expansion System

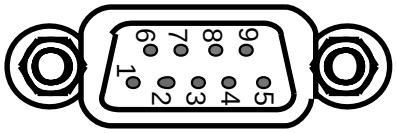


NOTE: J3 on the BFO/BFI module sends fault data to ext. alarms. The 15 pin STATUS connector on the PMM module sums these alarms to two signals for external indicators

Figure A3. Connections from MFTS System to PC Com Ports



CHANNEL A



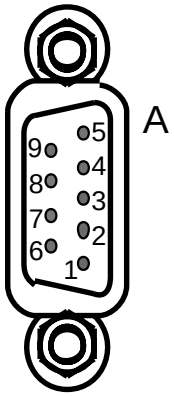
CHANNEL B

DB9 Connector pinouts

CHANNEL A	CHANNEL B
1. NC	1. NC
2. TX REF 2	2. TX REF 1
3. RX REF 2	3. RX REF 1
4. NC	4. NC
5. GROUND	5. GROUND
6. TX REF 2(future use)	6. TX REF 1 (future use)
7. NC	7. NC
8. RX REF 2 (future use)	8. RX REF 1 (future use)
9. NC	9. NC

Figure A4. PMM Front Panel Connector Pinouts

RS-232

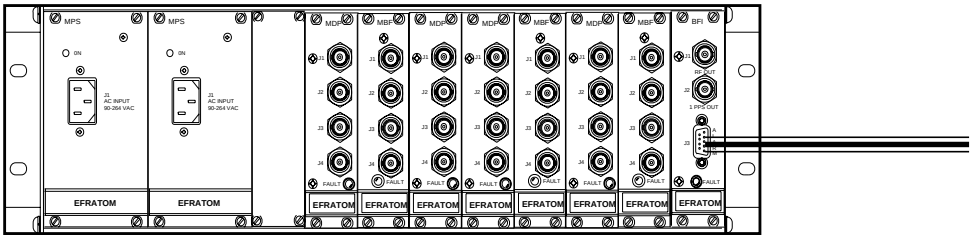


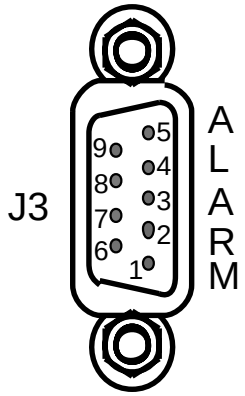
RS-232 DB9 Connector pinouts

1. NC
2. TX
3. RX
4. NC
5. GROUND
6. NC
7. NC
8. NC
9. NC

Figure A5. PRS Front Panel Connector Pinouts

NC = No Connection



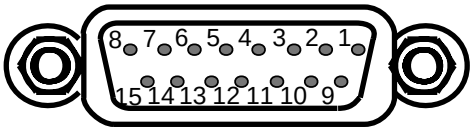


J3 DB9 Connector pinouts

1. OUTPUT FAULT - K1_COM
2. POWER FAULT - K2_COM
3. OSCILLATOR FAULT - K3 - COM
4. GPS RECEIVER FAULT - K4_COM
5. GROUND
6. OUTPUT FAULT - K1NO
7. POWER FAULT - K2NO
8. OSCILLATOR FAULT - K3NO
9. GPS RECEIVER FAULT - K4NO

Figure A6. Connections fromBFO/BFI Modules to External Alarms

STATUS



J11 DB15 STATUS Connector pinouts

1. NC
2. Open - shorted on FAULT or loss of power
3. Shorted - open on FAULT or loss of power
4. COMMON
5. GROUND
6. NC
7. NC
8. NC
9. NC
10. NC
11. NC
12. NC
13. NC
14. NC
15. NC

Figure A7. Connections from PMM module (STATUS conn.) to External Alarms

APPENDIX B - Operations & Management Software

1.1 OMS Software Installation

The CD-ROM included with the MFTS operations manual includes the MFTS OMS software created by DATUM for the MFTS Modular Frequency System. A comprehensive Getting Started manual is included on the CD. This PDF file is a guide to installing, configuring, trouble-shooting and managing the MFTS Operations and Management System (OPS) software.

What you need to install and run this software:

- An Intel 486 66 MHz, or greater PC.
- Microsoft Windows 95
- 32 MB RAM min., 48 MB RAM is recommended.
- 0.5 GB system disk to run 2 channel MFTS OMS option.
- 640x480 system monitor, 600x800 monitor recommended.
- CD-ROM Reader
- Mouse

Read the README.TXT file on the installer. This file is copied to the MFTS OMS software directory during installation. Use the Windows 95 Notepad to read or printout this text file after the software installation is completed.

Prior to installation:

1. Install the MFTS hardware per the MFTS manual.
2. Verify com ports used by MFTS and the PC.
3. Build any special cables (refer to MFTS manual or the Getting Started guide.
4. Start Windows 95.
5. Close all other running applications.
6. Insert the CD ROM in your CD ROM reader.
7. From the Windows 95 desktop, you can:

    a. Click **Start**, **Run**, and type d:/setup ("d:" is your CD ROM drive), click **OK** and follow all instructions.Or, you can:

    b. Click **Start**, point to **Settings**, Click **Control Panel**, double-click the **Install/Uninstall** tab in the **Add/Remove Programs Properties** page, click **Install** and follow all installation program prompts.

Appendix B - Operations and Management Software

After Installation, reboot your PC from the Windows 95 desktop.

After rebooting your PC,

1. Select Start/Programs/ MFTS Operations and Management System.
2. Use the OMS software to assign COM port settings, username, system administration password, and the system name (select system/properties from the main menu).

You can create a MFTS OMS program shortcut that appears as an icon on your desktop.

1. From the Windows 95 desktop, right click, and point to **New**.
2. Click **Shortcut** from the menu.
3. The Create Shortcut dialog box appears.
4. Use the Browse button in the Create Shortcut dialog box and navigate to directory: “Program Files\MFTS”
    a. Select MFTS Operations and Management System, click **Open**, then click mftsdiag, click **Open**.

NOTE: This is providing Setup has installed the MFTS OPS files to the default folder “c:\Progra~1\MFTS\mftsdiag”. If the files have been installed to a different drive or folder, enter this destination path.

For more information about creating program icons, refer to the Microsoft Windows 95 User’s Guide.

To Remove the MFTS OMS software:

1. Select Start, point to Settings and click Control panel.
2. Double-click Add/Remove programs in control panel dialog box.
3. Select the Install/Uninstall tab in Add/Remove Programs Properties page.
4. Select MFTS Operations and Management and click **Remove**.
5. When the uninstallation is complete, click OK.

Trouble-shooting the software:

If the link between the PC communications port and the MFTS system has a wiring error communications problems may be encountered. This may cause data errors or the OMS software may not launch and run. Check Appendix A to ensure that the communications cables and connectors have been built properly.

Isolating wiring link problems between the MFTS and the PC:

1. Verify that the MFTS is installed and has power applied to the MPS module(s).
2. Verify the physical connection (cabling) between the COM port on the PC and the selected connector on the PMM or PRS modules (refer to Appendix A).
3. If the cable is connected properly, do a continuity check on the cable. It may be defective, or built incorrectly.
4. Set the modem-assigned COM port to “NONE” in the Set COM port dialog box of the OMS software. Then assign the COM ports that are in use.
5. Try connecting a PC next to the MFTS system, or try another PC (the PC itself may be faulty).
6. Call DATUM for technical support. In the U.S.A., call 1-800-337-2866. Or call (949) 598-7600, or FAX us at (949) 598-7650

APPENDIX C - APPLICATION NOTES

1.1 The Global Positioning System (GPS)

GPS is a satellite-based radio navigation system designed by the US Department of Defense to provide continuous velocity, timing and three dimensional positioning information on a global basis.

To ensure a global coverage of any given point on earth so that 4 satellites are in view at any time of the day, the GPS network must consist of a minimum of 18 satellites in 6 different orbits forming a “birdcage” approximately 10,000 miles above the earth. Each satellite circles the earth twice a day in a 12 (sidereal) hour orbit.

When the MFTS is first powered up, four satellites must be visible on a continuous basis until the initial parameters for the site have been determined. After the site position, altitude and time have been established, only one satellite is required for the MFTS to establish and maintain precise timing.

Since the accuracy of any position fix or velocity computation is directly proportional to the accuracy of the time reference employed, precision timing is the key element of the GPS concept. Each satellite transmits precise time and frequency information as uniquely encoded data transmissions derived from a precision on-board clock, which enables a receiver to determine the distance to the satellite by measuring the arrival time of the signal. Because each satellite broadcasts its own position data, three position dimensions and the site’s receiver clock bias can be derived from simultaneously tracking four satellites and their transmissions.

Satellite data transmissions include orbital parameters that describe the satellite’s position and allow identification of the position (in orbital coordinates) of any unknown receiver/antenna locations on the earth’s surface. These positions are given in a three-dimensional Cartesian coordinate frame as defined by the Conventional Terrestrial System (CTS). These coordinates are transformed from Cartesian to curvilinear systems by defining an ellipsoid of revolution that has its origin at the mass center of the earth and has its axes coincident with those of CTS. Standard geodesy documents contain the formulas for transforming the Cartesian coordinates into geodetic coordinates - latitude, longitude, and ellipsoidal height.

The positions of all GPS satellites and the baseline vector are referenced to the World Geodetic System 1984 (WGS84). WGS84 defines the reference ellipsoid and the realization of the CTS presently used for GPS work. Site positions derived from GPS measurements are ellipsoidal positions given in the CTS and referred to the ellipsoid defined by WGS84. Refer to these documents if you require a more indepth understanding of GPS technology.

All GPS satellites transmit codes on two L-band frequencies (L1 and L2). The secure precision (P) and coarse acquisition (C/A) codes are transmitted on the L1 frequency (1575.42 MHz). The L2 frequency (1227.6 MHz) is used for P code only. Access to the P code is restricted to authorized users.

Commercial receivers operate on the C/A code. A ground based system of antennas, master control stations, and monitor stations track the satellites through their broadcast signals as the satellites rise over the horizon. Data is uploaded at least once a day to provide a prediction of satellite ephemeris (orbital characteristics) and clock behavior for the next day's operation.

The precision of the GPS Master Control Station is traceable to UTC through the time standards at the United States Naval Observatory, USNO, Washington and the United States National Institute of Standards and Technology, NIST.

The DATUM GPS MFTS receives the L1 C/A coded signals from the GPS satellites and using them automatically computes its position and maintains precise timing.

1.2 Acquisition of GPS Satellites

The MFTS fix acquisition and tracking process features the ability to determine position without any initialization. The receiver has the ability to track up to 6 satellites simultaneously. This allows the system to adapt to constellation changes without having to perform new satellite acquisition.

The following sections describe the acquisition, tracking, and GPS solutions performance of the MFTS for determining position data.

Upon powering the system, the MFTS will begin a search for satellites that are expected to be above the horizon. This calculation is based on the almanac of satellite orbits, an estimate of current position (based on receiver's last calculated position fix), and the current time. If this information is reasonably accurate (i.e., the position is within 1000 km of the site, and the time is within 5-10 minutes of actual time) rapid acquisition of the available satellites will occur. Once locked, if the elapsed time from the previous fix taken by the unit is more than one hour, current satellite ephemeris must be collected from the data message of each satellite. Given that the appropriate number of satellites being tracked and the ephemeris data for each satellite is current, the solution of user position and time will be performed.

The time required for the MFTS to acquire satellites and calculate position and velocity states is dependent upon a number of factors. Primarily, it will depend on whether the unit has a representative satellite almanac already stored in memory, the time elapsed since the previous operating fix, and the distance the unit has been moved since the last operating fix (i.e., where the receiver currently "thinks" it is).

Given the conditions that the MFTS has current almanac, current ephemeris, and has not been moved a great distance since its last fix, acquisition and position/time solution occur within 5 to 10 minutes from power up.

The following paragraphs describe processes that will lengthen time to first fix, the circumstances under which they are required, and the approximate time impact.

1.3 Almanac

The satellite almanac consists of approximate orbit parameter data that assists the MFTS as it acquires satellites. The initial turn-on after manufacture of a unit, or a significant change in the satellite constellation (i.e., a satellite failure or launch of a new satellite) are circumstances that would require collection of a new almanac via the satellite data message. The process takes 30 seconds for each satellite, or 12 minutes for 24 satellites. However, depending on the order of satellite almanacs in the data message, the almanacs for satellites currently above the horizon may be obtained before cycling through all existing satellites. Therefore, collection of almanac data to allow acquisition requires 12 minutes.

1.4 Ephemeris

The satellite ephemeris provides an accurate estimate of satellite position at any given time. This data, like the almanac, is collected from the satellites on roughly an hourly basis during operation. Should satellite tracking be interrupted for more than an hour (due to either signal blockage or the MFTS being powered off), the GPS receiver will need to collect data for a new ephemeris before a solution can be made. Collection of this data requires 30 seconds per satellite or 2 minutes for 4 satellites (the number required for a 3-dimensional solution). The ephemeris data can be acquired in parallel.

1.5 Initial Reference Position

At power-on, the MFTS uses the estimate of current position to estimate which satellites are visible and their frequencies. By default, the MFTS will use the last calculated position stored in memory. If the initial reference position is indeed a reasonable estimate of the true current position, the satellite dopplers will be accounted for correctly and acquisition will occur rapidly (a matter of seconds). However, if the search does not yield acquisition at the expected frequencies, the frequency search is expanded around the expected frequency for each satellite that is estimated to be above the horizon.