

RubiSource[®] 2000



OPERATING MANUAL

RUBISOURCE[®] 2000 RUBIDIUM FREQUENCY STANDARD
#14832-201, Rev A



Timing, Test & Measurement



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RubiSource 2000 Rubidium Frequency Standard

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Chapter One

INTRODUCTION/PRODUCT OVERVIEW

GENERAL DESCRIPTION

The RubiSource 2000 is a portable AC powered rubidium frequency standard. For telecommunication applications, frequencies of 2048 kHz and 1544 kHz are output both in sine wave and square wave forms. For metrology and calibration applications, frequencies of 5 MHz and 10 MHz are generated in sine wave form.

The outputs exhibit the inherent accuracy and stability of the internal rubidium oscillator. An external frequency standard (e.g., cesium frequency standard or GPS time/frequency receiver) can be input via the Reference Input on the back panel to calibrate the frequency of the RubiSource 2000. There is also provision for a reference input from a Datum GPS-FC (GPS Frequency Controller).

LEDs (Light Emitting Diodes) on the front and a two-color LED on the back show the respective status of the RubiSource 2000.

APPLICATIONS

Telecommunications

The RubiSource 2000 can be used to measure and test the synchronization quality of PDH, SDH and SONET networks.

Metrology and Calibration Laboratories

The 5 MHz and 10 MHz sine wave outputs can be used in metrology and in calibration laboratories as a reference for standard measurement equipment such as universal counters, spectrum analyzers and signal generators.

ABOUT THIS OPERATING MANUAL

This operating manual provides installation and operation instructions for the RubiSource 2000 Rubidium Frequency Standard.

This operating manual contains the following chapters and appendices:

A. CHAPTER 1 – INTRODUCTION/PRODUCT OVERVIEW

Contains a functional description of the RubiSource 2000 as well as an overview about this operating manual and the stylistic and typographical conventions used.

B. CHAPTER 2 – SAFETY

Contains important instructions about the safe operation of the RubiSource 2000.

C. CHAPTER 3 – OPERATION

Describes the installation and the regular operation of the RubiSource 2000.

D. CHAPTER 4 – ADJUSTMENT AND EXTERNAL REFERENCE

Describes adjustments using an external reference source and a Datum GPS-FC.

E. CHAPTER 5 – MAINTENANCE AND TROUBLESHOOTING

Describes procedures for preventive maintenance and for troubleshooting the RubiSource 2000.



TYPOGRAPHICAL AND OTHER CONVENTIONS

This Operating Manual uses the following conventions:

Acronyms and Abbreviations – Terms are spelled out the first time they appear in this Operating Manual. Thereafter, only the acronym or abbreviation is used.

TABLE 1-1. TYPOGRAPHICAL CONVENTIONS

WHEN TEXT APPEARS THIS WAY ...	IT MEANS ...
<i>RubiSource 2000 Operating Manual</i>	The title of a document or the name of a product
CRITICAL PORT-1 J1	An operating mode, alarm state, status, or chassis label.
Press the Enter key. Press the Print Scrn key.	A named keyboard key. The key name is shown as it appears on the keyboard. An explanation of the key's acronym or function immediately follows the first reference to the key, if required.
A <i>re-timing</i> application ...	A term or a word being emphasized.
Datum does not recommend ...	A word or term given special emphasis so that you do not miss the idea being presented.

WARNINGS, CAUTIONS, RECOMMENDATIONS, AND NOTES

Warnings, Cautions, Recommendations, and Notes attract attention to essential or critical information in this Operating Manual. The types of information included in each are explained as follows:



WARNING ...

All warnings have this symbol. Do not disregard warnings. They are installation, operation, or maintenance procedures, practices, or statements that if not strictly observed, may result in personal injury or loss of life.



ELECTRICAL SHOCK HAZARD ...

All electrical shock hazard warnings have this symbol. To avoid serious personal injury or death, do not disregard electrical shock hazard warnings. They are installation, operation, or maintenance procedures, practices, or statements that if not strictly observed, may result in personal injury or loss of life.



CAUTION ...

All cautions have this symbol. Do not disregard cautions. They are installation, operation, or maintenance procedures, practices, conditions, or statements that if not strictly observed, may result in damage to or destruction of equipment or may cause a long-term health hazard.



CAUTION ...

All Electrostatic Discharge (ESD) cautions have this symbol. They are installation, operation, or maintenance procedures, practices, conditions, or statements that if not strictly observed, may result in electrostatic discharge damage to, or destruction of, static sensitive components of the equipment.



RECOMMENDATION ...

All recommendations have this symbol. Recommendations indicate manufacturer-tested methods or known functionality. They contain installation, operation, or maintenance procedures, practices, conditions, or statements that provide you with important information for optimum performance results.



NOTE ...

All notes have this symbol. Notes contain installation, operation, or maintenance procedures, practices, conditions, or statements that alert you to important information which may make your task easier or increase your understanding.

WHERE TO FIND ANSWERS TO PRODUCT AND DOCUMENT QUESTIONS

If you believe that this product is not performing as expected, or if you have comments about this Operating Manual, please contact your Datum representative or sales office

We appreciate your suggestions on ways to improve this Operating Manual. Please mark or write your suggestions on a copy of the page and mail or fax it to ...

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E-mail: ttmsales@datum.com

Thank you for providing the information.



NOTE ...

Datum offers a number of applicable training courses designed to enhance product usability. Contact your Datum representative or sales office for a complete list of courses and outlines.



Chapter Two

SAFETY

SAFETY INSTRUCTIONS

The operating manual, especially these safety instructions, should be read by everybody using the RubiSource 2000.

- The RubiSource 2000 may be connected only according to the voltage specifications at the back of the unit.
- All connected signal lines must be shielded. Please make sure that the shielding has contact to the collars of the connectors of cables used with the RubiSource 2000.
- Signal lines and supply lines must be separated.
- If water has condensed on the RubiSource 2000 during transport or storage, it must be thoroughly dried and allowed to acclimatize for a minimum of two hours before operation.
- The ventilation slots at the bottom and the ventilator at the back of the RubiSource 2000 must not be covered or blocked so as to limit the free passage of air.
- The RubiSource 2000 must not be operated while there are high atmospheric humidity, high dust level, danger of explosion and aggressive chemical influences.



NOTE ...

Repairs or modifications may only be executed at the Datum factory repair facility.



ELECTRICAL SHOCK HAZARD ...

Before opening the RubiSource 2000 or replacing a fuse the unit must always be switched off and the AC power plug must be disconnected!



CAUTION ...

The general ESD directives must be observed in order not to damage any electronic components.



CAUTION ...

There may be no changes to the RubiSource 2000 which could be detrimental to the electromagnetic compatibility (EMC) or the electrical safety.

CLEANING

The surface of the unit may be cleaned with a cleaning cloth moistened with methylated spirits.



WARNING ...

Before cleaning, always disconnect the RubiSource 2000 from AC power!

Chapter Three

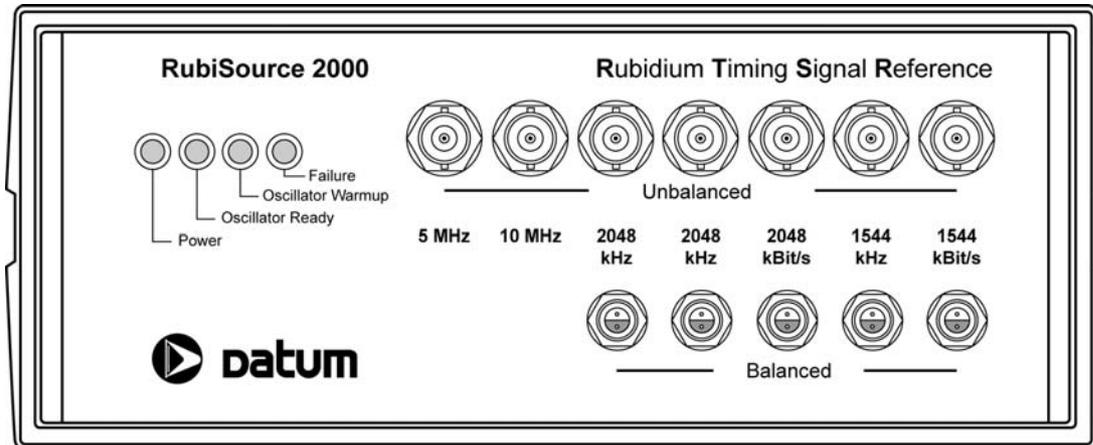
OPERATION

OPERATING ELEMENTS AND DISPLAYS

FRONT

The RubiSource 2000 front panel provides twelve outputs for frequencies and signals and four LED lamps to indicate status. The seven upper outputs are unbalanced (single-ended) and are connected by BNC coaxial cables. The five lower outputs are balanced (differential) and are connected by BNC twinaxial cables.

FIGURE 3-1. RUBISOURCE 2000 FRONT



The four LED indicators are defined in Table 3-1 below.

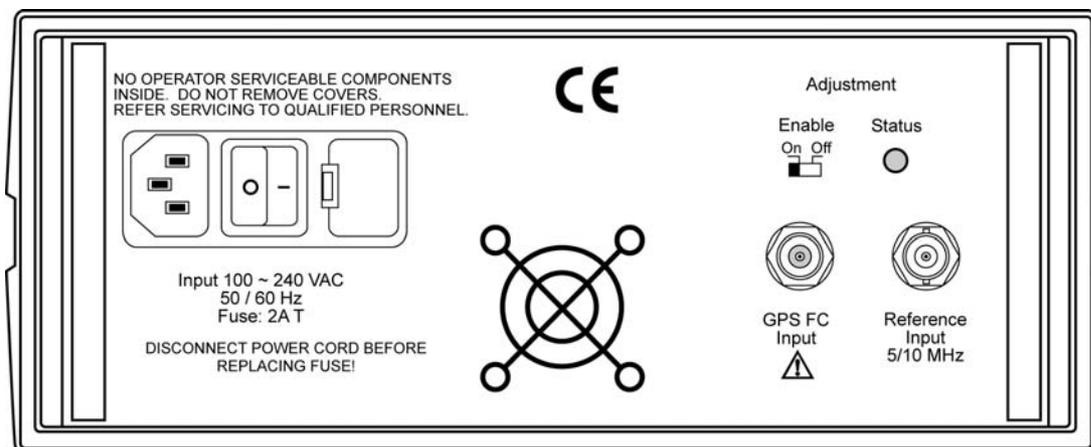
TABLE 3-1. FRONT PANEL INDICATORS

Power	Oscillator Ready	Oscillator Warmup	Power	Status Definition
Off	Off	Off	Off	Power switch is off or power is not connected.
On	Off	On	Off	Power is switched on. There are no faults. The unit is warming up. The signal outputs are not available within specified accuracy.
On	On	Off	Off	Power is switched on. There are no faults. Operating temperature has been reached. The unit is in normal operation. The signal outputs are available within specified accuracy.
On	Off	Off	On	Faults have occurred or the control voltage for the rubidium oscillator has reached the tuning voltage limit.

BACK

Primary AC power is connected via the IEC power module on the rear panel of the RubiSource 2000. Two calibration inputs are also on the back. Above the calibration inputs are one LED and a slide switch to turn the adjustment function on and off. The power on/off switch is located on the IEC power input module.

FIGURE 3-2. RUBISOURCE 2000 BACK



The Status LED indicator on the back panel changes color (red/green) and either blinks or is on steady. The meaning of these LED indications are defined in Table 3-2 below.

TABLE 3-2. REAR PANEL STATUS INDICATOR

LED Color	Operating Status
Red	Signal for adjustment not accepted.
Green Blinking	Adjustment is being performed.
Green Steady	Adjustment successfully concluded.
Off	No signal received or signal not recognized.

UNPACKING AND INSPECTION

The RubiSource 2000 is packaged to protect it from normal shock, vibration and handling damage during shipment. The unit is portable and may be carried unpackaged in normal environment conditions.

To unpack and inspect the RubiSource 2000:

- Unpack all equipment carefully and check it against the purchase order.
- Inspect the equipment for shipping damage, including bent or loose parts, broken connectors, or other visible defects. Notify Datum and the carrier who delivered the equipment if you suspect that it was damaged in transit.



RECOMMENDATION ...

Keep all packaging materials in the event the RubiSource 2000 or any component must be returned to the factory or shipped to another location.

ACCLIMATIZATION

In the event that water has condensed on the RubiSource 2000 during transport or storage, the unit must be thoroughly dried and allowed to acclimatize for a minimum of two hours before operation.



CAUTION ...

Condensed moisture may damage the RubiSource 2000.

VENTILATION

The ventilation slots at the bottom of the RubiSource 2000 must not be covered and the fan at the back in must not be blocked.



CAUTION ...

Failure to provide proper ventilation can result in excessive heat buildup, resulting in equipment damage.

PREPARATION FOR OPERATION

VOLTAGE SUPPLY

The unit must be connected to a 100-230 V, 50-60 Hz AC socket with ground wire. A standard IEC power cord is included.

Switching Power On and Off



CAUTION ...

The RubiSource 2000 must not be operated while there are high atmospheric humidity, high dust level, danger of explosion or aggressive chemical influences.

The power on/off switch is on the back of the unit. The "Power" LED on the front panel indicates power is on.

After power is switched on, the LED indicators will automatically be tested, followed by the warmup phase of the rubidium oscillator.

REGULAR SYSTEM INDICATIONS AFTER SWITCHING POWER ON

As the RubiSource 2000 powers up, the "Power" LED turns green and stays green.

During the LED test the LED indicators go through the following sequence:

- The "Oscillator Ready", "Oscillator Warmup" and "Failure" LED indicators on the front will turn on for a second and then turn off for a second.
- The LED indicators will turn on and then off in sequence for 0.5 seconds. The Status LED on the back will turn green and then red.

After the LED test the warmup phase will be started automatically:

- The yellow "Oscillator Warmup" LED is lit during the warmup phase.
- After completion of the warmup phase the yellow "Oscillator Warmup" LED turns off and the green "Oscillator Ready" LED is lit.

In the case of malfunctions the red "Failure" LED is lit.

AFTER POWER ON

This completes the turn-on procedures. After turn-on, twelve output frequencies and clock rate signals are available and can be connected on the front. The connecting of the outputs is described below.



NOTE ...

For applications demanding very high accuracy the RubiSource 2000 should be operated for several hours before using the outputs.

OPERATION OVER A LONGER TIME PERIOD

In order to ensure the frequency stability of the RubiSource 2000 over a longer time period (e.g., for long-term measurements) it is possible to connect a Datum GPS-FC to the "GPS-FC Input" connector.



NOTE ...

To avoid confusion with the "Reference Input" the "GPS-FC Input" connector is a TNC jack, because it outputs a 24 VDC supply voltage for the Datum GPS-FC.



CAUTION ...

Connecting an other device to the input "GPS-FC" may damage the RubiSource 2000 as well as the connected device.

The adjustment procedure using the GPS-FC is described in Chapter Four.

CONNECTING THE OUTPUTS



NOTE ...

Strong magnetic fields, extreme humidity, hard shocks and extreme temperature differences may degrade frequency accuracy.

The seven upper outputs are unbalanced (single-ended) and are connected by BNC coaxial cables.

The five lower outputs are balanced (differential) and are connected by BNC twinaxial cables.



CAUTION ...

All connected signal lines must be shielded. Make sure that the shielding has contact with the collars of the jacks of the RubiSource 2000.

Signal lines and supply lines must be separated.

All twelve signal outputs can be connected at the same time without overloading the power supply. The exact specifications can be found in Chapter Five.

Chapter Four

ADJUSTMENT AND EXTERNAL REFERENCE

In order to improve the stability and accuracy of the output signals, it is possible to adjust the RubiSource 2000 or, in the case of a longer time period, to operate the unit with an external reference.

Before connecting an external reference (Reference Input or GPS-FC input), wait for the "Oscillator Ready" status indication. If "Oscillator Ready" status is off, the external reference will not be recognized.



NOTE ...

The "Enable" slide switch is recessed in the back panel of the unit to prevent accidental actuation and to make possible the affixing of a calibration marking. The slide switch can be moved with a tool, such as a small screwdriver. If the slide switch is in the "Off" position, an applied adjustment frequency or an external reference from a GPS-FC will not be recognized, thus preventing an accidental adjustment.

ADJUSTMENT USING THE "REFERENCE INPUT"

An external primary frequency reference source, such as a cesium frequency standard or a GPS time/frequency generator, are suitable as a source for adjustment of the RubiSource 2000 (see the specifications in Chapter Five).

To enable adjustment of the RubiSource 2000 the "Oscillator Ready" status indicator must be on.

1. Move the "Enable" slide switch on the back to the position "On".
2. Connect external reference source to the input "Reference Input" on the back (BNC jack).

The adjustment procedure begins automatically when the reference signal is connected and takes a maximum time of thirty minutes.

- When the applied signal has been recognized and the adjustment procedure is being executed: the "Status" LED blinks green.
- When the adjustment procedure has been completed successfully: the "Status" LED lights steady green.
- If during adjustment the connected signal fails or the external reference source is disconnected, the adjustment procedure will be aborted and the green blinking "Status" LED turns off. If the signal used for adjustment is unsuitable, (e.g., because the reference is not stable enough) the green blinking "Status" LED turns to steady red.

In case the adjustment procedure is aborted the originally stored adjustment value for the rubidium oscillator will be used.

A repetition of the adjustment procedure can be started only if the external reference source has been first disconnected and then reconnected.

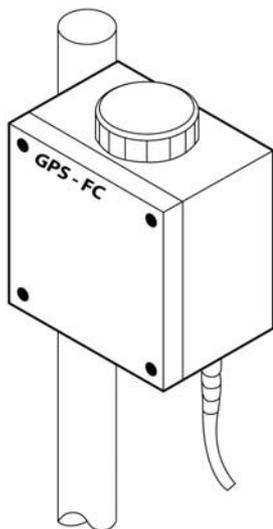
3. After the successful completion of the adjustment (steady green "Status" LED) reference source can be disconnected. The "Status" LED light turns off.
4. Position the "Enable" slide switch to "Off" to prevent an accidental readjustment.

The adjusted control voltage of the rubidium oscillator will now be stored in memory permanently and will be available after switching power off.

Adjustment Using the Datum GPS-FC GPS Frequency Controller

The Datum GPS-FC is a compact GPS-disciplined low cost frequency system. Making use of the accurate GPS timing signals, the GPS-FC generates high performance frequencies.

FIGURE 4-1. DATUM GPS FC



CAUTION ...

Connecting an external unit other than the Datum GPS-FC to the "GPS-FC Input" connector may result in damage to the RubiSource 2000 as well as the external device.

The GPS-FC antenna, receiver and oscillator are integrated in a single small unit, which is suitable for mounting on a mast. One cable carries power up to the GPS-FC, and connects the output frequency to the RubiSource 2000. Power (24 VDC) is furnished by the RubiSource 2000 up to the GPS-FC.

The GPS-FC is built in a robust, waterproof aluminum die cast case, and will perform under extreme weather conditions.

Contact Datum Sales at 1-800-544-0233 (US toll free) or +1-978-927-8220 for more information on the GPS-FC.

To enable adjustment of the RubiSource 2000 the status must indicate, "Oscillator Ready."

1. Move the "Enable" slide switch on the back to the "On" position.
2. Connect the Datum GPS-FC to the "GPS-FC Input" jack on the back (TNC jack).

The adjustment procedure will begin automatically when the Datum GPS-FC is connected. It may take up to 30 minutes until the GPS-FC provides a frequency. The GPS-FC suppresses the frequency output until the frequency accuracy is within specifications.

The adjustment procedure takes one to several hours with a small frequency error and approximately one day with a large frequency error.

- The "Status" LED blinks green when the GPS-FC signal has been recognized and the adjustment procedure is being executed.
- The "Status" LED lights steady green when the adjustment procedure has been successfully completed.

As long as a difference exists between the GPS-FC input and the internal LPRO oscillator, the control procedure will continue. The "GPS-FC Input" is designed in such a way that a GPS-FC can be connected permanently to the RubiSource 2000.

- If the GPS-FC is disconnected before the adjustment is complete, the adjustment procedure will be aborted. The green blinking "Status" LED light turns off.

After calibration, the RubiSource 2000 continues normal operation. If the calibration procedure is aborted the originally stored adjustment value for the rubidium oscillator will be used.

- Disconnecting the GPS-FC after completion of the adjustment procedure causes the adjusted control voltage of the rubidium oscillator to be stored permanently and to be available after switching off and switching on again.

3. Position the "Enable" slide switch to "Off" to prevent an accidental readjustment.



NOTE ...

If both adjustment inputs are in use, the "Reference Input" will be used for the adjustment.

Chapter Five

SPECIFICATIONS

Power supply	100 - 230 VAC; 47 - 63 Hz
Power consumption	Approximately 23 W typical Maximum 45 W (warm up)
Operating temperature area	+5°C to +40°C
Frequency accuracy	$\pm 5 \times 10^{-11}$ at 25°C
Aging	$< 5 \times 10^{-11}$ / month, $< 1 \times 10^{-9}$ over 10 years
Size	98 x 253 x 365 mm
Weight	approx. 4.5 kg

Table 5-1 is a list of the frequencies and signals with the respective standards and specifications.

TABLE 5-1. FREQUENCIES/SIGNALS OF THE RUBISOURCE 2000

Frequency/ Clock Frequency	Standard/Signal Form	Specifications
5 MHz		Sine, 1 Vrms, 50Ω, BNC
10 MHz		Sine, 1 Vrms, 50Ω, BNC
2048 kHz	G.703/13:1998	75Ω, unbalanced, BNC
		120Ω, balanced, twinaxial
2048 kBits/s ¹⁾	G.703/9:1998, E1	HDB3, 75Ω, unbalanced, BNC
		HDB3, 120Ω, balanced, twinaxial
1544 kHz		2.5 Vpp, 75Ω, unbalanced, BNC
		3 Vpp, 120Ω, balanced, twinaxial
1544 kBits/s ¹⁾	G.703/5:1998, TTL	AMI, 75Ω, unbalanced, BNC
		AMI, 120Ω, balanced, twinaxial



NOTES ...

Data format:

1) HDB3 coded, frame: CAS, CRC running digital sum generation, no SSM.

2) B8Zs coded, frame: D4 (ESF) ZS

TABLE 5-2. TECHNICAL DATA FOR THE RUBIDIUM OSCILLATOR (LPRO)

	at =20 °C	at =20 °C
Warm-up time (indicated "Oscillator Ready")	<8.7 min	<5.4 min
Accuracy of <1 E-9 after:	<10.2 min	<7.3 min
Accuracy of <4 E-10 after:	<12.7 min	<10.6 min
Short-term stability:		
t = 1 sec	<2.5 E-11	
t = 10 sec	<0.8 E-11	
t = 100 sec	<0.25 E-11	

TABLE 5-3. ADJUSTMENT INPUTS OF THE RUBISOURCE 2000

Adjustment Input	Connection	Remark
"Reference Input"	BNC jack: 50Ω	5 MHz or 10 MHz ¹⁾ (0.2 ... 1.8 Vrms Specification for the adjustment reference: MTIE (200 sec) must be better than 1 nsec.
"GPS FC Input"	TNC jack: 50Ω	 Caution! At the TNC jack are applied 24 VDC for the supply of a GPS FC!



NOTE ...

1) The adjustment accuracy of the 10 MHz output to the adjustment references will be 2X10-11 immediately after adjustment.



6502 TEN CHANNEL RF DISTRIBUTION MODULE

The DATUM 6502 Distribution Module is a ten channel, RF distribution amplifier packaged in a 1U rack mount chassis. It is comprised of ten low phase noise RF amplifiers that maintain high channel isolation (>100dB). Up to ten units can be daisy chained together to give up to 100 outputs or each output of one unit can be used as a source for other 6502 units to give almost infinite expansion capability with virtually no signal degradation



6512 MILITARIZED TEN CHANNEL RF DISTRIBUTION MODULE

The Datum 6512 Militarized Distribution Module is a ten channel, RF distribution amplifier packaged in a 1U rack mount chassis. It is comprised of ten low phase noise RF amplifiers that maintain high channel isolation (>100dB). Up to ten units can be daisy chained together to give up to 100 outputs or each output of one unit can be used as a source for other 6512 units to give almost infinite expansion capability with virtually no signal degradation.



6530 TEN CHANNEL FIBER OPTIC TRANSMITTER

The Datum 6530 Fiber Optic Distribution Module is a ten-channel fiber optic distribution amplifier packaged in a 1U rack mount chassis. The 6530 accepts input frequencies of 100kHz, 1MHz, 5MHz or 10MHz and provides ten, low noise optical outputs of the same frequency that can be distributed over distances up to 2km without degradation of signal integrity. Multiple 6530 modules can be daisy chained together to provide an infinite number of distribution channels with virtually no signal degradation. Each output and input has an alarm indicator that warns of either a loss of signal or a signal of insufficient amplitude.



6531 TEN CHANNEL FIBER OPTIC RECEIVER

The Datum 6531 Fiber Optic Receiver Module is a ten-channel fiber optic receiver packaged in a 1U rack mount chassis. The 6531 accepts 850nm amplitude modulated optical input signals and provides ten buffered, low noise RF signal outputs. Multiple 6531 modules can be daisy chained together to provide an infinite number of distribution channels with virtually no signal degradation. Each output and input has an alarm indicator that warns of either a loss of signal or a signal of insufficient amplitude.



6602 TEN CHANNEL PULSE DISTRIBUTION MODULE

The Datum 6602 Pulse Distribution Module is a ten-channel, pulse distribution amplifier packaged in a 1U rack mount chassis. The 6602 buffers and provides one pulse per second signal distribution to ten separate locations. The module's Summary Fault Alarm Output feature indicates an alarm whenever there is a single output fault condition. The Datum 6602 preserves input phase characteristics over a wide range of environmental conditions and is available with front or rear input and output connection access.



6612 MILITARIZED EIGHT CHANNEL PULSE DISTRIBUTION MODULE

The Datum 6612 Militarized Pulse Distribution Module is a eight channel pulse distribution amplifier packaged in a 1U rack mount chassis that is capable of withstanding tactical military environments. The 6612 buffers and provides one pulse per second signal distribution to eight separate locations. The module's Summary Fault Alarm Output feature indicates an alarm whenever there is a single output fault condition. The Datum 6612 preserves input phase characteristics over a wide range of environmental conditions.



Limited Warranty

DATUM - TT&M guarantees its products to be free from defects in material and workmanship for a period of one year from the date of shipment. Datum - TT&M shall, at its option, either repair or replace hardware products which prove to be defective.

DATUM - TT&M software and firmware products designed to be used and installed in Datum - TT&M hardware products are warranted not to fail to execute their programming instructions due to defects in material or workmanship. If Datum - TT&M receives notice of such defects during the warranty period, Datum - TT&M will repair or replace software media and firmware which do not execute their programming instructions due to such defects. Datum - TT&M does not warrant that operation of the software, firmware or hardware shall be uninterrupted or error free.

All warranty service will be carried out at the Datum - TT&M – TT&M facilities at 34 Tozer Rd, Beverly, MA 01915. The purchaser shall prepay shipping charges and shall pay all duties and taxes for products returned for warranty service. Datum - TT&M will pay for the return of products to the purchaser except for products returned from another country.

LIMITATION OF WARRANTY: The above warranty does not apply to defects of, or resulting from the following:

1. End items included as part of a system or product selected by, but not designed by, Datum - TT&M are subject only to warranty as may be obtained from the original manufacturers. Such items include, but are not limited to, test equipment, accessories, batteries, computers, printers, software, etc.
2. Items manufactured by Datum - TT&M pursuant to detailed designs furnished by purchaser or specific components, accessories, support equipment and software specified by purchaser.
3. Improper or inadequate maintenance by purchaser.
4. Unauthorized modifications, misuse or mishandling.
5. Operation outside of the environmental specifications of the product.
6. Purchaser's supplied software or interfacing.

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