

Model FRD2000
Frequency Response Detector
Instruction Manual
197331-A-MNL-A

FCC Notice

This equipment generates, uses, and can radiate radio-frequency energy and, if not installed and used in accordance with this manual, may cause interference to radio communications. As temporarily permitted by regulation, operation of this equipment in a residential area is likely to cause interference, in which case the user at his own facility will be required to take whatever measures may be required to correct the interference.

Company Names

Princeton Applied Research is part of Advanced Measurement Technology, Inc, a division of AMETEK, Inc. It includes the businesses formerly trading as EG&G Princeton Applied Research, EG&G Instruments (Princeton Applied Research) and PerkinElmer Instruments (Princeton Applied Research)

Declaration of Conformity

This product conforms to EC Directives 89/336/EEC Electromagnetic Compatibility Directive, amended by 92/31/EEC and 93/68/EEC, and Low Voltage Directive 73/23/EEC amended by 93/68/EEC.

This product has been designed in conformance with the following IEC/EN standards:

EMC: BS EN55011 (1991) Group 1, Class A (CSP1R 11:1990)

BS EN50082-1 (1992):

IEC 801-2:1991

IEC 801-3:1994

IEC 801-4:1988

Safety: BS EN61010-1: 1993 (IEC 1010-1:1990+A1:1992)

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Table of Contents

Chapter One, Introduction

1.1 How to Use This Manual.....	1-1
1.2 What is a Frequency Response Detector?	1-1
1.3 Key Specifications and Benefits	1-2

Chapter Two, Installation & Initial Checks

2.1 Installation	2-1
2.1.01 Introduction	2-1
2.1.02 Rack Mounting	2-1
2.1.03 Inspection	2-1
2.1.04 Line Cord Plug	2-1
2.1.05 Line Voltage Selection and Line Fuses	2-1
2.2 Initial Checks	2-3
2.2.01 Introduction	2-3
2.2.02 Initial Checks Software	2-3
2.2.03 Procedure	2-3

Appendix A, Specifications

Appendix B, Connectors

B1 Rear Panel.....	B-1
B.1.01 Line Power Switch	B-1
B.1.02 Line Power Input Assembly	B-1
B.1.03 RS232 Connector	B-1
B.1.04 AUX RS232 Connector	B-2
B.1.05 GPIB Connector	B-2
B.1.06 DIGITAL I/O Connector	B-2
B.1.07 PRE-AMP POWER Connector	B-3
B.1.08 OSC OUT Connector	B-4
B.1.09 REF IN Connector	B-4
B.1.10 REF MON Connector	B-4
B.1.11 REF TTL Connector	B-4
B.1.12 DAC 1 and DAC 2 Connectors.....	B-4
B.1.13 CH 1 and CH 2 Connectors	B-4
B.1.14 ADC 1, ADC 2, ADC 3 and ADC 4 Connectors.....	B-4
B.1.15 TRIG Connector	B-4
B.1.16 SIG MON Connector	B-5

Appendix C, Cable Diagrams

C1 RS232 Cable Diagrams	D1
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Index

Warranty.....End of Manual

1.1 How to Use This Manual

The Model FRD2000 Frequency Response Detector is normally supplied as part of a **Princeton Applied Research** electrochemistry impedance measuring system. As such it is operated via the GPIB interface from the PowerSuite or other PAR software packages, and consequently users do not usually need to concern themselves with any details of how to program the instrument.

This manual therefore gives general instructions for verifying that the Model FRD2000 is operating correctly, together with its specifications when used in standalone applications. The manual is split into the following chapters:-

Chapter 1 - Introduction

Provides an introduction to the manual, briefly describes what a Frequency Response Detector is and the types of measurements it may be used for, and lists the major specifications of the FRD2000.

Chapter 2 - Installation and Initial Checks

Describes how to install the instrument and gives a simple test procedure that may be used to check that the unit has arrived in full working order.

Appendix A

Gives the detailed specifications of the instrument

Appendix B

Details the pinouts of the connectors on the rear panel.

Appendix C

Shows the connection diagrams for suitable RS232 null-modem cables to couple the unit to an IBM-PC or 100% compatible computer.

New users are recommended to unpack the instrument and carry out the procedure in chapter 2 to check that it is working satisfactorily. Once this has been done the instrument can be connected to the associated **Princeton Applied Research** potentiostat and controlling software, using the information supplied with these items.

If at any stage in the future it is suspected that the FRD2000 has a fault then the procedure in chapter 2 can be used again to help isolate the problem.

1.2 What is a Frequency Response Detector?

In its most basic form a Frequency Response Detector (FRD) measures the gain (or attenuation) and phase shift of an external electrical network as a function of frequency. It includes a precision sinusoidal oscillator of programmable frequency and amplitude, the output of which is connected to the network under test, normally via the potentiostat. The resulting current and voltage are detected by the potentiostat and

passed back to the FRD, where a process of digital multiplication and filtering is used to measure their amplitude and phase with respect to the oscillator signal. The controlling software can then use this information to calculate the resulting network complex impedance, and plot this as the frequency is swept over the desired range.

Modern instruments, such as the model FRD2000, include many extra features beyond this basic function. This built in flexibility means that although such features may not be exploited by current releases of the system software, they may well be used by future versions, giving the possibility of upgrading systems without having to replace hardware.

In summary, the model FRD2000 can function as a:-

- Frequency Response Measuring System
- Vector Voltmeter
- Phase Meter
- Transient Recorder
- Precision Oscillator
- Noise Measurement Unit

These characteristics, all available in a single unit, make it an invaluable addition to any **Princeton Applied Research** impedance measuring system.

1.3 Key Specifications and Benefits

The **Princeton Applied Research** Model FRD2000 represents a significant advance in the application of DSP technology in the design of an FRD. Until recently, limitations in the available semiconductor devices have restricted the operating frequency range of such instruments to at most a few hundred kilohertz. The model FRD2000, with its use of the latest technology, extends this limit to 2 MHz. What is more, it does this without compromising any other important specifications.

Key specifications include:

- Frequency range: 0.5 Hz to 2.0 MHz
- Voltage sensitivity: 10 nV to 1 V full-scale
- Current input mode sensitivities: 1 pA to 100 μ A full-scale
10 fA to 1 μ A full-scale
10 fA to 10 nA full-scale
- Line frequency rejection filter
- Measurement of in-phase and quadrature components of the input signal, together with calculation of resulting magnitude and phase
- Very low phase noise of $< 0.0001^\circ$ rms
- Output time constants: 1 μ s to 100 ks

- Dual reference mode - allows simultaneous measurement of two signals at different reference frequencies up to 20 kHz, or 800 kHz with option -/99 or 2.0 MHz with option -/98
- Single and dual harmonic mode - allows simultaneous measurement of up to two different harmonics of a signal at up to 20 kHz, or 800 kHz with option -/99 or 2.0 MHz with option -/98
- Direct Digital Synthesizer (DDS) oscillator with variable amplitude and frequency
- Oscillator frequency and amplitude sweep generator
- 8-bit programmable digital I/O port for external system control
- Four auxiliary ADC inputs and two auxiliary DAC outputs
- Full range of auto-modes
- Standard IEEE-488 (GPIB) and RS232 interfaces
- 32,768 point internal curve storage buffer

Installation & Initial Checks

2.1 Installation

2.1.01 Introduction

Installation of the model FRD2000 in the laboratory or on the production line is very simple. It can be operated on almost any laboratory bench or be rack mounted, using the optional accessory kit, at the user's convenience. With an ambient operating temperature range of 0 °C to 35 °C, it is highly tolerant to environmental variables, needing only to be protected from exposure to corrosive agents and liquids.

The instrument uses forced-air ventilation and as such should be located so that the ventilation holes on the sides and rear panels are not obstructed. This condition is best satisfied by leaving a space of at least 2" (5 cm) between the side and rear panels and any adjacent surface.

2.1.02 Rack Mounting

An optional accessory kit, part number K02004, is available from **Princeton Applied Research** to allow the model FRD2000 to be mounted in a standard 19-inch rack.

2.1.03 Inspection

Upon receipt the model FRD2000 Frequency Response Detector should be inspected for shipping damage. If any is noted, **Princeton Applied Research** should be notified immediately and a claim filed with the carrier. The shipping container should be saved for inspection by the carrier.

2.1.04 Line Cord Plug

A standard IEC 320 socket is mounted on the rear panel of the instrument and a suitable line cord is supplied.

2.1.05 Line Voltage Selection and Line Fuses

Before plugging in the line cord, ensure that the model FRD2000 is set to the voltage of the AC power supply to be used.

A detailed discussion of how to check and, if necessary, change the line voltage setting follows.

CAUTION: The FRD2000 may be damaged if the line voltage is set for 110 V AC operation and it is turned on with 220 V AC applied to the power input connector.

The FRD2000 can operate from any one of four different line voltage ranges, 90-

110 V, 110-130 V, 200-240 V, and 220-260 V, at 50-60 Hz. The change from one range to another is made by repositioning a plug-in barrel selector internal to the Line Input Assembly on the rear panel of the unit. Instruments are normally shipped from the factory with the line voltage selector set to 110-130 V AC, unless they are destined for an area known to use a line voltage in the 220-260 V range, in which case, they are shipped configured for operation from the higher range.

The line voltage setting can be seen through a small rectangular window in the line input assembly on the rear panel of the instrument (figure 2-1). If the number showing is incorrect for the prevailing line voltage (refer to table 2-1), then the barrel selector will need to be repositioned as follows.

Observing the instrument from the rear, note the plastic door immediately adjacent to the line cord connector (figure 2-1) on the left-hand side of the instrument. When the line cord is removed from the rear-panel connector, the plastic door can be opened outwards by placing a small, flat-bladed screwdriver in the slot on the right-hand side and levering gently. This gives access to the fuse and to the voltage barrel selector, which is located at the right-hand edge of the fuse compartment. Remove the barrel selector with the aid of a small screwdriver or similar tool. With the barrel selector removed, four numbers become visible on it: 100, 120, 220, and 240, only one of which is visible when the door is closed. Table 2-1 indicates the actual line voltage range represented by each number. Position the barrel selector such that the required number (see table 2-1) will be visible when the barrel selector is inserted and the door closed.

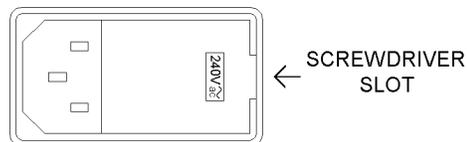


Figure 2-1, Line Input Assembly

VISIBLE #	VOLTAGE RANGE		
100	90	-	110 V
120	110	-	130 V
220	200	-	240 V
240	220	-	260 V

Table 2-1, Range vs. Barrel Position

Next check the fuse rating. For operation from a nominal line voltage of 100 V or 120 V, use a 20 mm slow-blow fuse rated at 2.0 A, 250 V. For operation from a nominal line voltage of 220 V or 240 V, use a 20 mm slow-blow fuse rated at 1.0 A, 250 V.

To change the fuse, first remove the fuse holder by pulling the plastic tab marked with an arrow. Remove the fuse and replace with a slow-blow fuse of the correct voltage

and current rating. Install the fuse holder by sliding it into place, making sure the arrow on the plastic tab is pointing downwards. When the proper fuse has been installed, close the plastic door firmly. The correct selected voltage setting should now be showing through the rectangular window. Ensure that only fuses with the required current and voltage ratings and of the specified type are used for replacement. The use of makeshift fuses and the short-circuiting of fuse holders is prohibited and potentially dangerous.

2.2 Initial Checks

2.2.01 Introduction

The following procedure checks the performance of the FRD2000. In general, this procedure should be carried out after inspecting the instrument for obvious shipping damage.

NOTE: Any damage must be reported to the carrier and to Princeton Applied Research immediately. In addition the shipping container must be retained for inspection by the carrier.

Note that this procedure is intended to demonstrate that the instrument has arrived in good working order, not that it meets specifications. Each instrument receives a careful and thorough checkout before leaving the factory, and normally, if no shipping damage has occurred, will perform within the limits of the quoted specifications. If any problems are encountered in carrying out these checks, contact ***Princeton Applied Research*** or the nearest authorized representative for assistance.

2.2.02 Initial Checks Software

The FRD2000 is supplied with a 3.5" floppy disk containing the Initial Checks software program and a model C01003 9-pin female to 9-pin male modem eliminator RS232 cable. An IBM-PC or compatible computer with a standard RS232 interface COM1 or COM2 port is required to run the software which provides a quick and simple check of some of the main operating parameters of the instrument and allows various instrument outputs to be measured. The program also allows the user to set the GPIB communications interface parameters if values other than the factory defaults are to be used, and to install extended operating modes.

Note that before the initial checks procedure can be performed it is essential to establish proper RS232 communications between the host computer and the FRD2000. If the supplied C01003 cable is not available, or unsuitable for the computer's connectors, then please refer to appendix D, RS232 Cable Diagrams, for information on the correct cable type to be used with your computer.

2.2.03 Procedure

- 1) Ensure that the FRD2000 is set to the line voltage of the power source to be used, as described in section 2.1.05

- 2) With the rear panel mounted power switch (located at the extreme left-hand side of the instrument when viewed from the rear) set to **0** (off), plug in the line cord to an appropriate line source.
- 3) Connect a 9-way RS232 cable to the lower RS232 connector on the FRD2000's rear panel, marked **RS232**. Connect the other end of the RS232 cable to the host computers COM1 or COM 2 RS232 connector. If the host computer has a 25-way connector then a 25-way to 9-way cable must be used or alternatively a 9-way to 25-way adapter used with a 9-way to 9-way cable.
- 4) Using a BNC cable, connect the **OSC** output connector to the **A** input connector on the rear panel of the FRD2000.
- 5) Turn the FRD2000 power switch to the **I** (on) position.
- 6) Turn on the host computer and wait for it to boot and display the Windows desktop.
- 7) Put the Initial Checks disk in the disk drive and use Run on the Start menu to start the program INITCHECKS.EXE
- 8) The Initial Checks program will now run. The opening screen will appear, as shown in figure 2-2.



Figure 2-2, Initial Checks Procedure, Opening Screen

Click the Next button to continue, which displays a second screen where the model number of the instrument being checked is entered. Click the FRD2000 button and then click Next. The following screen is shows the required connections, but since these have already been made, click the Next button again. This accesses the Program Options menu, shown in figure 2-3 below.

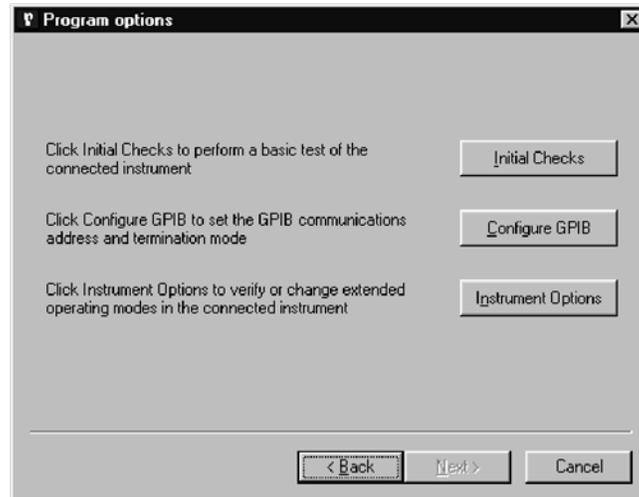


Figure 2-3, Initial Checks Procedure, Program Options Menu

- 9) The instrument is supplied set to a GPIB address of 12 and with a GPIB termination of <CR><LF> character pair. In addition the GPIB line EOI asserted with the last character that is sent. If the unit will be used under GPIB control and if these settings are not acceptable then it is useful to adjust them at this stage. Click the Configure GPIB button to access the Configure GPIB menu, shown below in figure 2-4.

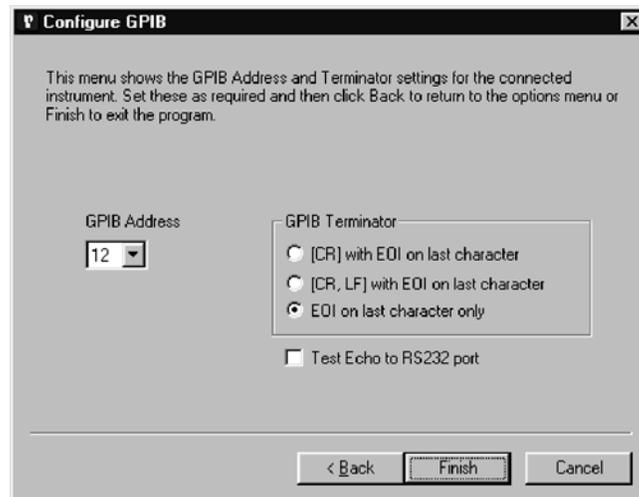


Figure 2-4, Initial Checks Procedure, Configure GPIB Menu

- 10) Set the GPIB address and terminator settings as required. Note that when the **Test Echo to RS232 port** box is checked, commands sent to the instrument and responses from it via the GPIB interface are echoed to the RS232 port. This can be of use during program debugging but in normal use the option should not be selected.

Once the required settings have been entered, click Back to return to the Program Options menu.

- 11) Click on the Initial Checks button to access the Perform Checks menu, shown below in figure 2-5.

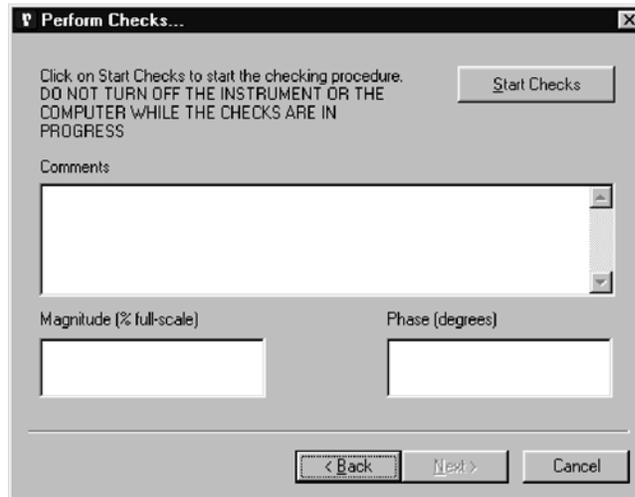


Figure 2-5, Initial Checks Procedure, Perform Checks Menu - Opening Screen

- 12) Click on the Start Checks button. The program automatically checks for and switches to the serial port (COM 1 or COM 2) to which the lock-in amplifier is connected.
- 13) Once communications have been established the Comments section shows a list of commands being sent to the FRD2000 which set it to a defined state. Once this has happened, the signal magnitude and reference phase are shown in the lower section of the display, as shown in figure 2-6.

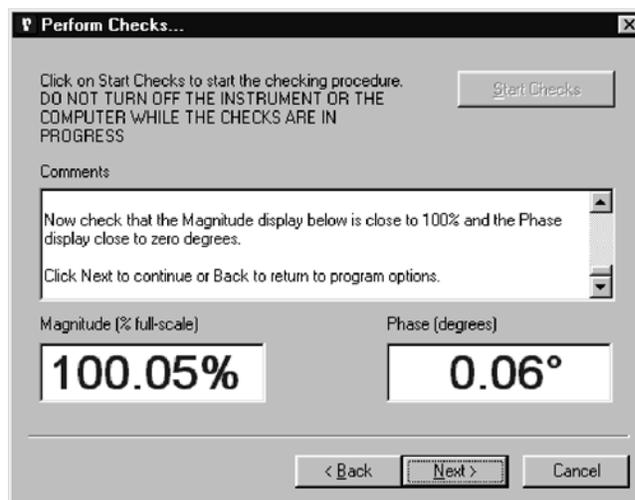


Figure 2-6, Initial Checks Procedure, Perform Checks Screen - Outputs Displayed

- 14) Note that although the actual output readings may vary from those listed above, they should be close to 100 % full-scale (magnitude) and 0° (phase). If this is achieved then one can be reasonably confident that the FRD2000 has not suffered

any shipping damage and is in good working order. Click on the Next button to finish the procedure.

Note: The FRD2000 is factory set with a baud rate of 9600 and Echo enabled. The initial checks program can only implement a baud rate of either 9600 or 19200 and Echo handshaking. If Echo is not implemented then full communication will be lost. Therefore before any subsequent use of the Initial Checks disk, it is essential to make sure that the FRD2000 is set for either 9600 or 19200 baud and Echo enabled. The Windows HyperTerminal program can be of use in such cases.

Specifications

Measurement Modes

<p>X In-phase Y Quadrature R Magnitude θ Phase Angle Noise</p>	<p>} } }</p>	<p>The unit can measure and report via the bus the value of any of these outputs</p>
Harmonic		Detection of signals at harmonics, n, of the reference frequency where $n \leq 32$
Dual Harmonic		Simultaneously measures the signal at two different harmonics F_1 and F_2 of the reference frequency
<p>Standard Unit With option -/99 With option -/98</p>		<p>F_1 and $F_2 \leq 20$ kHz. F_1 and $F_2 \leq 800$ kHz. F_1 and $F_2 \leq 2.0$ MHz.</p>
Dual Reference		Simultaneously measures the signal at two different reference frequencies, F_1 and F_2 where F_1 is the external and F_2 the internal reference.
<p>Standard Unit With option -/99 With option -/98</p>		<p>F_1 and $F_2 \leq 20$ kHz F_1 and $F_2 \leq 800$ kHz. F_1 and $F_2 \leq 2.0$ MHz.</p>
Virtual Reference		Locks to and detects a signal without a reference ($100 \text{ Hz} \leq F \leq 2.0 \text{ MHz}$)
Noise		Measures noise in a given bandwidth centered at the reference frequency F

Signal Channel

Voltage Inputs

Modes	A only, -B only or Differential (A-B)
Full-scale Sensitivity	
$0.5 \text{ Hz} \leq F \leq 250 \text{ kHz}$	10 nV to 1 V in a 1-2-5 sequence
$250 \text{ kHz} \leq F \leq 2.0 \text{ MHz}$	100 nV to 1 V in a 1-2-5 sequence
Dynamic Reserve	> 100 dB
Impedance	100 MΩ // 25 pF
Maximum Safe Input	20 V pk-pk
Voltage Noise	5 nV/√Hz at 1 kHz
C.M.R.R.	> 100 dB at 1 kHz degrading by 6 dB/octave
Frequency Response	0.5 Hz to 2.0 MHz
Gain Accuracy	0.3% typ, 0.6% max.(full bandwidth)
Distortion	-90 dB THD (60 dB AC gain, 1 kHz)

Line Filter	attenuates 50, 60, 100, 120 Hz
Grounding	BNC shields can be grounded or floated via 1 k Ω to ground
Current Input	
Mode	Low Noise, Normal or Wide Bandwidth
Full-scale Sensitivity	
Low Noise	10 fA to 10 nA in a 1-2-5 sequence
Normal	10 fA to 1 μ A in a 1-2-5 sequence
Wide Bandwidth	
F \leq 250 kHz	10 fA to 100 μ A in a 1-2-5 sequence
F > 250 kHz	100 fA to 100 μ A in a 1-2-5 sequence
Dynamic Reserve	> 100 dB (with no signal filters)
Frequency Response	
Low Noise	-3 dB at 500 Hz
Normal	-3 dB at 50 kHz
Wide Bandwidth	-3 dB at 1 MHz
Impedance	
Low Noise	< 2.5 k Ω at 100 Hz
Normal	< 250 Ω at 1 kHz
Wide Bandwidth	< 25 Ω at 10 kHz
Noise	
Low Noise	13 fA/ $\sqrt{\text{Hz}}$ at 500 Hz
Normal	130 fA/ $\sqrt{\text{Hz}}$ at 1 kHz
Wide Bandwidth	1.3 pA/ $\sqrt{\text{Hz}}$ at 1 kHz
Gain Accuracy (midband)	\leq 0.6% typ
Line Filter	attenuates 50, 60, 100, 120 Hz
Grounding	BNC shield can be grounded or floated via 1 k Ω to ground

Reference Channel

TTL Input (REF TTL)	
Frequency Range	0.5 Hz to 2.0 MHz

Analog Input (REF IN)	
Impedance	1 M Ω // 30 pF
Sinusoidal Input	
Level	1.0 V rms**
Frequency Range	0.5 Hz to 2.0 MHz
Squarewave Input	
Level	250 mV rms**
Frequency Range	2 Hz to 2 MHz

**Note: Lower levels can be used with the analog input at the expense of increased phase errors.

Phase

Set Resolution	0.001° increments
Noise at 100 ms TC, 12 dB/octave slope	
Internal Reference	≤ 0.0001° rms
External Reference	≤ 0.01° rms @ 1 kHz
Orthogonality	90° ± 0.0001°

Acquisition Time

Internal Reference	instantaneous acquisition
External Reference	2 cycles + 50 ms

Reference Frequency Meter Resolution

1 mHz

Demodulator and Output Processing**Output Zero Stability**

Digital Outputs	No zero drift on all settings
Displays	No zero drift on all settings
Analog Outputs	< 5 ppm/°C

Harmonic Rejection

-90 dB

Output Filters

X, Y and R outputs only:

Time Constant	1 μs to 1 ms in a 1-2-5 sequence
Slope (roll-off)	6 and 12 dB/octave

All outputs

Time Constant	2 ms to 100 ks in a 1-2-5 sequence
Slope	6, 12, 18 and 24 dB/octave

Synchronous Filter OperationAvailable for $F < 20$ Hz**Offset**

Auto and Manual on X and/or Y: ±300% FS

Absolute Phase Measurement Accuracy

≤ 0.01°

Oscillator**Frequency**

Range	0.5 Hz to 2.0 MHz
Setting Resolution	1 mHz
Absolute Accuracy	25 ppm

Distortion (THD)

-80 dB at 1 kHz and 100 mV rms

Amplitude (rms)

Range	1 mV to 1 V
Setting Resolution	1 mV
Accuracy	±0.2%

Stability	50 ppm/°C
Output	
Impedance	50 Ω
Sweep	
Amplitude Sweep	
Output Range	0.000 to 1.000 V rms
Law	Linear
Step Rate	20 Hz maximum (50 ms/step)
Frequency	
Output Range	0.5 Hz to 2.0 MHz
Law	Linear or Logarithmic
Step Rate	20 Hz maximum (50 ms/step)

Auxiliary Inputs

ADC 1, 2, 3 and 4	
Maximum Input	±10 V
Resolution	1 mV
Accuracy	±1 mV
Input Impedance	1 MΩ // 30 pF
Sample Rate	
ADC 1 only	40 kHz max.
ADC 1 and 2	17.8 kHz max.
Trigger Mode	Internal, External or burst
Trigger input	TTL compatible

Outputs

CH1 CH2 Outputs	
Function	X, Y, R, θ, Noise, Ratio, Log Ratio and User Equations 1 & 2.
Amplitude	±2.5 V full-scale but capable of operating to ±300 % full-scale
Impedance	1 kΩ
Update Rate:	
X, Y or R	
TC ≤ 500 μs	7.5 MHz
1 ms ≤ TC ≤ 4 ms	7.5 MHz or 1 kHz
TC ≥ 5 ms	1 kHz
All other outputs	1 kHz
Signal Monitor	
Amplitude	±1 V FS
Impedance	1 kΩ
Auxiliary D/A Output 1 and 2	
Maximum Output	±10 V
Resolution	1 mV
Output Impedance	1 kΩ

8-bit Digital Port

Mode	0 to 8 lines can be configured as inputs, with the remainder being outputs.
Status	Each output line can be set high or low and each input line read to allow interaction with external equipment
Trigger Input	Extra line acts as extra trigger input

Reference Output

Waveform	0 to 3 V rectangular wave
Impedance	TTL-compatible

Power - Low Voltage

±15 V at 100 mA rear panel 5-pin 180° DIN connector for powering compatible preamplifiers

Data Storage**Data Buffer**

Size	32k × 16-bit data points, may be organized as 1×32k, 2×16k, 3×10.6k, 4×8k, etc.
Max Storage Rate	
From LIA	up to 1000 16-bit values per second
From ADC1	up to 40,000 16-bit values per second

Interfaces

RS232, IEEE-488. A second RS232 port is provided to allow "daisy-chain" connection and control of up to 16 units from a single RS232 computer port.

General**Power Requirements**

Voltage	110/120/220/240 VAC
Frequency	50/60 Hz
Power	200 VA Max

Dimensions

Width	17¼" (435 mm)
Depth	19" (485 mm)
Height	
With feet	6" (150 mm)
Without feet	5¼" (130 mm)

Weight

25.4 lb. (11.5 kg)

All specifications subject to change without notification

B1 Rear Panel Connections

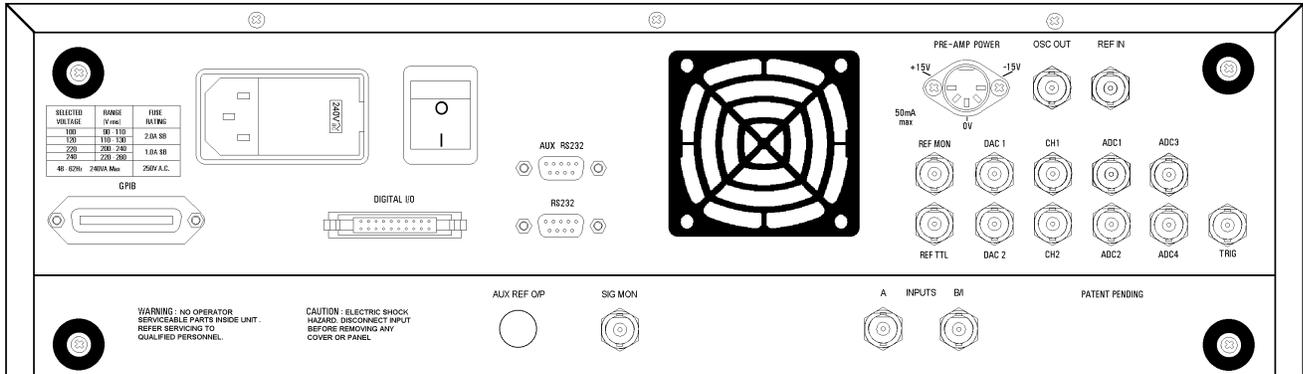


Figure B-1, Model FRD2000 Rear Panel Layout

As shown in figure B-1, the line power switch, line power voltage selector, two RS232 connectors, a GPIB (IEEE-488) connector, digital I/O port, preamplifier power connector and sixteen BNC signal connectors are mounted on the rear panel of the instrument. Brief descriptions of these are given in the following text.

B.1.01 Line Power Switch

CAUTION: The model FRD2000 may be damaged if the line voltage is set for 110 V AC operation and it is turned on with 220 V AC applied to the power input connector. Please ensure that the line voltage selector is set to the correct line voltage before switching on.

Press the end of the switch marked **I** to turn on the instrument's power, and the other end marked **O** to turn it off.

B.1.02 Line Power Input Assembly

This houses the line voltage selector and line input fuse. To check, and if necessary change, the fuse or line voltage see the procedure in section 2.1.05.

B.1.03 RS232 Connector

This 9-pin D type RS232 interface connector implements pins 1, 2, 3 and 7 (Earth Ground, Transmit Data, Receive Data, Logic Ground) of a standard DTE interface. To make a connection to a PC-compatible computer, it is normally sufficient to use a three-wire cable connecting Transmit Data to Receive Data, Receive Data to Transmit Data, and Logic Ground to Logic Ground. Appendix D shows the connection diagrams of cables suitable for computers with 9-pin and 25-pin serial connectors. Pinouts for this connector are shown below:

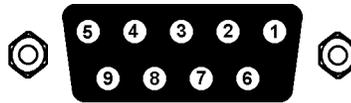


Figure B-2, RS232 and AUX RS232 Connector (Female)

Pin	Function	Description
2	RXD	Data In
3	TXD	Data Out
5	GND	Signal Ground
7	RTS	Request to Send - Always +12 V

All other pins are not connected

B.1.04 AUX RS232 Connector

This connector is used to link other compatible equipment together in a "daisy-chain" configuration. Up to 16 instruments can be connected in this way. Each unit must be set to a unique address. Pinouts for this connector are shown above in section B.1.04.

B.1.05 GPIB Connector

The GPIB interface connector conforms to the IEEE-488 1978 Instrument Bus Standard. The standard defines all voltage and current levels, connector specifications, timing and handshake requirements.

B.1.06 DIGITAL I/O Connector

This connector provides eight TTL lines, each of which can be configured as inputs or outputs. When set as an output, each line can be set high or low by the use of the Digital Port menu or via the computer interfaces, and when set as an input, the applied logic state can be read.

The port is most commonly used for controlling auxiliary apparatus, such as lamps, shutters and heaters, and reading status signals from auxiliary equipment. Pinouts for this connector are shown below:

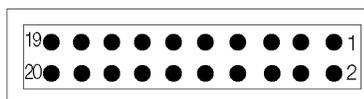


Figure B-3, Digital I/O Port Connector

8-bit TTL-compatible input/output port with each bit being configurable as an input or output. If configured as an output, the bit status can be set, and if configured as an input it can be read, from the front panel or via the computer interfaces. Each output line can drive three LSTTL loads, and each input presents one LSTTL load. The connector will mate with a 20-pin IDC header plug (not supplied). The pinout is as follows:-

Pin	Function
1	Ground
2	Ground
3	D0
4	Ground
5	D1
6	Ground
7	D2
8	Ground
9	D3
10	Ground
11	D4
12	Ground
13	D5
14	Ground
15	D6
16	Ground
17	D7
18	Ground
19	TTL Trigger Input
20	+5 V

D0 = Least Significant Bit

D7 = Most Significant Bit

B.1.07 PRE-AMP POWER Connector

This connector supplies ± 15 V at up to 100 mA and can be used for powering an optional remote preamplifier. Pinouts for this connector are shown below.

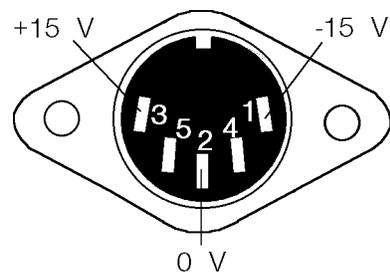


Figure B-2, Preamplifier Power Connector

Pin	Function
1	-15 V
2	Ground
3	+15 V

Pins 4 and 5 are not connected. Shell is shield ground

B.1.08 OSC OUT Connector

This is the output connector for the internal oscillator and has a nominal impedance of 50 Ω

B.1.09 REF IN Connector

This is the general purpose input connector for external reference signals.

Note: If the best possible phase accuracy at low external reference frequencies is required, then a TTL reference signal should be applied to the rear panel REF TTL input instead.

B.1.10 REF MON Connector

The signal at this connector is a TTL-compatible waveform synchronous with the reference. This output monitors correct reference channel operation but its polarity is not uniquely defined so that it does not necessarily show the correct phase relationship with the **SIG MON** output.

B.1.11 REF TTL Connector

This connector is provided to allow TTL-compatible pulses to be used as the reference input, if the best possible phase accuracy at low external reference frequencies is required, when it usually gives better results than the **REF IN** connector.

B.1.12 DAC 1 and DAC 2 Connectors

There are two digital-to-analog converter (DAC) output connectors. The output voltages at these connectors can be set by DAC command. The output range is ± 10.000 V and the resolution is 1 mV.

B.1.13 CH 1 and CH 2 Connectors

The signal at these connectors is an analog voltage corresponding to a selected output, such as X, Y, R, θ , etc., as specified by the CH command. The full-scale output voltage range is ± 2.500 V although the outputs remain valid to ± 7.500 V to provide up to 3 \times full-scale overload capability.

B.1.14 ADC 1, ADC 2, ADC 3 and ADC 4 Connectors

The input voltages at these connectors are digitized and can be read via the ADC command. The input voltages are sampled and held when the ADC is triggered, with several different trigger modes being available. These modes can be set by the TADC command. The input voltage range is ± 10.000 V and the resolution is 1 mV.

B.1.15 TRIG Connector

This connector accepts a TTL-compatible input and can be used for triggering the digitization of the voltages present at the auxiliary analog-to-digital converters (ADCs) or for triggering data acquisition to the internal curve buffer. The input operates on the

positive edge only.

B.1.16 SIG MON Connector

The signal at this connector is that immediately prior to the main analog-to-digital converter and after the preamplifier, line filter and anti-alias filters.

Cable Diagrams

C.1 RS232 Cable Diagrams

Users who choose to use the RS232 interface to connect the model FRD2000 FRD to a standard serial port on a computer will need to use one of two types of cable. The only difference between them is the number of pins used on the connector which goes to the computer. One has 9 pins and the other 25; both are null-modem (also called modem eliminator) cables in that some of the pins are cross-connected.

Users with reasonable practical skills can easily assemble the required cables from parts which are widely available through computer stores and electronics components suppliers. The required interconnections are given in figures C-1 and C-2.

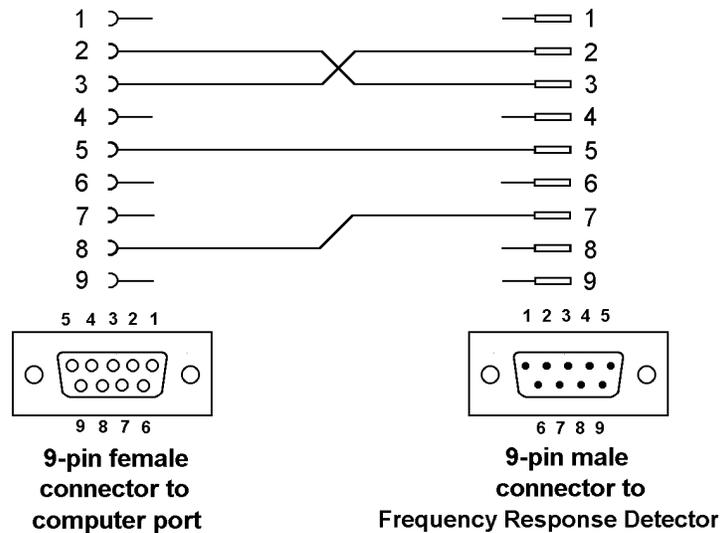


Figure C-1, Interconnecting RS232 Cable Wiring Diagram

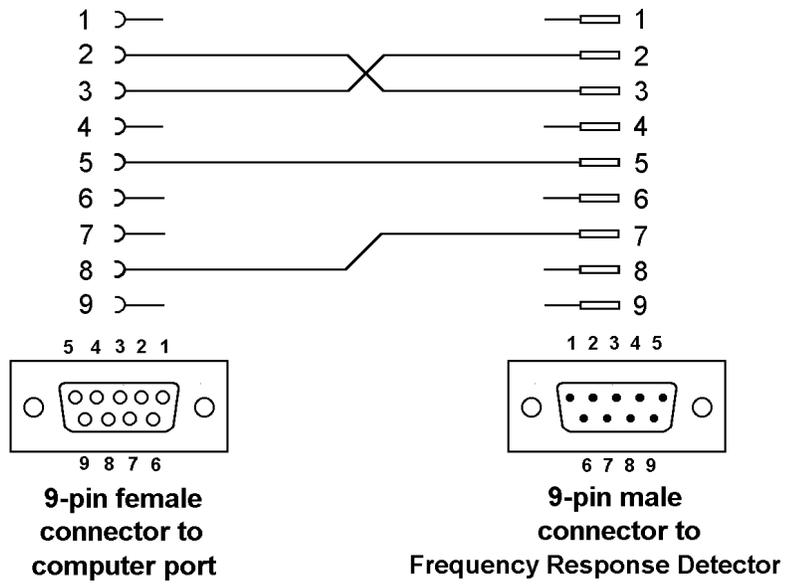


Figure C-2, Interconnecting RS232 Cable Wiring Diagram

- /98 option A-1
- /99 option A-1
- ADC
 - trigger input B-5
- ADC1
 - connector B-4
- ADC2
 - connector B-4
- Auxiliary ADC's B-4
- CH1
 - connector B-4
- CH2
 - connector B-4
- Curve storage
 - trigger input B-5
- DAC1
 - connector B-4
- DAC2
 - connector B-4
- DAC3
 - connector B-4
- DAC4
 - connector B-4
- DIGITAL OUTPUTS connector B-2
- Fuses
 - line 2-1
 - ratings 2-2
- GPIB interface
 - connector B-2
- Initial checks 2-3
- Inspection 2-1
- Key specifications 1-2
- Line cord 2-1
- Line power input assembly B-1
- Line power switch B-1
- Line voltage selection 2-1
- Operating environment 2-1
- OSC OUT connector B-4
- PREAMP POWER connector B-3
- Rack mounting 2-1
- Rear panel layout B-1
- REF IN connector B-4
- REF MON connector B-4
- REF TTL connector B-4
- RS232 interface
 - AUX RS232 connector B-2
 - connector B-1
- SIG MON connector B-5
- Specifications
 - detailed listing of A-1
 - for auxiliary inputs A-5
 - for data storage buffer A-6
 - for demodulator A-3
 - for measurement modes A-1
 - for oscillator A-3
 - for outputs A-5
 - for reference channel A-2
 - for signal channel A-1
- TRIG connector B-5
- What is a Frequency Response Detector? 1-1

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SHOULD YOUR EQUIPMENT REQUIRE SERVICE

- A. Contact your local **Princeton Applied Research** office, agent, representative or distributor to discuss the problem. In many cases it may be possible to expedite servicing by localizing the problem to a particular unit or cable.
- B. We will need the following information, a copy of which should also be attached to any equipment which is returned for service.

- | | |
|---|---|
| 1. Model number and serial number of instrument | 6. Symptoms (in detail, including control settings) |
| 2. Your name (instrument user) | 7. Your purchase order number for repair charges (does not apply to repairs in warranty) |
| 3. Your address | 8. Shipping instructions (if you wish to authorize shipment by any method other than normal surface transportation) |
| 4. Address to which the instrument should be returned | |
| 5. Your telephone number and extension | |

- C. If you experience any difficulties in obtaining service please contact:

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