RPR-4000

PULSER-RECEIVER

Operations Manual

RITEC, Inc.
www.ritecinc.com

REV. 8-21

Certification

Ritec, Inc. certifies that this product met its published specifications at the time of shipment.

Warranty

RITEC instruments are warranted against defects in material and workmanship for a period of one year after date of shipment. For full warranty and disclaimer statement, see the Appendix C of this manual.

Service

For warranty service or repair return the product only to Ritec or an authorized Ritec representative. A list of Ritec representatives is available at our website:

http://www.ritecinc.com/index.php/contact-us

Model numbers

This document is the user manual for the Ritec RPR-4000, RPR-4000-HP, RPR-4000-VHP and RPR-4000-HD.

The RPR-4000 is a highly configurable instrument. Please consult the calibration data in the appendix of this manual for the performance for your particular system. All specifications and figures are for a typical system unless otherwise stated.

Unless otherwise stated, information and examples in this manual are given for the high frequency, standard power model RPR-4000-HF-8KW.

Information in this manual is subject to change without notice.

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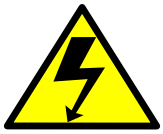
Table of Contents

Safety

Symbols

The table below shows the symbols that you may see on the RPR-4000 instrument. Please consult the manual regarding any connection on the RPR-4000 marked with either a warning symbol or a caution symbol.

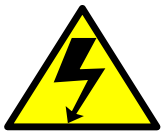
Symbol	Description
	A **WARNING symbol** denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death.
	A **CAUTION symbol** denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in injury and/or damage to the product.
	Alternating current
	Earth (ground) terminal

Intended Use

The RPR-4000 is a high powered ultrasonic pulser and receiver system primarily used for NDT (non-destructive testing) and NDE (non-destructive evaluation). It is intended for use by qualified laboratory personnel only. Do not use this product in any manner that is inconsistent with the manufacturer's recommendations.

Important Safety Instructions

To reduce the risk of fire, electric shock, or injury to persons, basic safety precautions should be followed:



1. Read and understand this manual before attempting to operate the RPR-4000.
2. Do not defeat power cord safety ground feature. Always plug the RPR-4000 into a grounded AC power outlet.
3. Replace fuses with only that exact style and rating as listed on the rear panel
4. Keep liquids at a safe distance from the RPR-4000 which has an IP rating of 20
5. Do not use product in any manner inconsistent with manufacturer's specifications.
6. The RPR-4000 produces high voltage RF pulses and is intended for use by qualified personnel only.
7. **There are no user serviceable parts inside. Return the product to Ritec or an authorized Ritec representative for service and repair.**

For technical assistance and service contact either RITEC or your RITEC representative.

Preparation for Use

Unpacking

We recommend that you keep the packing material should you ever decide to send the unit back for an upgrade or repair.

Placement

It is suggested to place the RPR-4000 on a hard level surface capable of safely supporting 35kg. The RPR-4000 is cooled by drawing air in via the vented bottom panel and pushed out via the fans on the rear panel. The RPR-4000 has feet on the bottom of the instrument which keep the instrument approximately 15mm above the surface it is placed on. Placing the instrument on a soft surface such as carpet is not recommended as this will reduce the airflow to the bottom of the instrument and may cause overheating. Also be sure not to place the unit in such a way that it obstructs the airflow out of the rear panel fans. It is suggested that there be at least a 4" open air gap at the back of the instrument for air flow and access to the AC main power switch. These gaps should also be maintained if rack mounting.

Failure to ensure proper clearances for air flow may result in the instrument overheating and shutting down.

Connecting AC Power

The RPR-4000 has an auto switching AC mains input. Acceptable inputs are 95-125VAC ±5% and 195-250VAC ±5% at 300VA. Always connect the RPR-4000 to a properly grounded source using the supplied line cord. Failure to properly ground this instrument could result in injury. Should the AC line cord need to be replaced, only replace with a cord with equal or greater ratings (10A at your specific line voltages).

Always connect the RPR-4000 to a properly grounded AC source using the supplied line cord.

System Operation

For information on getting started with the RPR-4000, including verifying system function, please see the heading "*Getting Started"* of "*Section 1: Introduction"*.

Specifications

Gated Amplifier

Frequency Range
HF model .....200 kHz to 20 MHz
LF model.....50 kHz to 20 MHz
Custom Range (CF) .....Contact Ritec
On/Off Ratio .....>140 dB
Nominal Output Impedance.....50 Ω
RF Pulse Monitor.....-40 dB into 50 Ω
Output Level Control Range.....>30 dB

Maximum Output (Peak Envelope Power)* .....400 W to 20 kW PEP

Maximum Pulse Width† .....100 µs to 5 ms depending on model

Maximum Duty Cycle† .....0.3% to 10% depending on model.

Trigger Sources.....Internal rep. rate generator
External
Remote trigger via RS-232 interface

Internal Clamping Diplexer .....RPR-4000 & RPR-4000HD models only

Bias Level Control .....0 to 4.99V
RF Gain Control.....0 to 4.99V
Tracking Control.....0 to 100

Protection Provisions‡.....Over-current turn-off
Over-temperature turn-off
Over-voltage turn-down

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* Measured into a 50 Ω load and calculated by PEP=Vpeak2 / 2R. Maximum power specified is achieved for 1 decade of frequency starting at the specified low end frequency. Beyond one decade the maximum power reduces as the frequency is increased. Consult the calibration data for power verses frequency data of your specific instrument

† Depending upon the model; consult the configuration table and/or the calibration data for information on your specific instrument

‡ All conditions have audible alarm and are shown on front panel display.

Receiver

Multiplexed Receiver Inputs.....2 ea.
Frequency Range (LF model).....50 kHz to 20MHz
Frequency Range (HF model).....200 kHz to 20MHz
Frequency Range (VHF model).....200 kHz to 95MHz
Nominal Input Impedance (both inputs).....50 Ω
Minimum Gain.....20 dB
Maximum Gain1 .....100 dB
Gain Control Range .....80dB in 0.4dB steps
Maximum Output Level.....1 V peak to peak into 50 Ω
Output Impedance.....50 Ω

LF model

High Pass Filters .....50, 100, 200, 400, 800 kHz,
.....2, 4, and 8 MHz

Low Pass Filters.....100, 200, 500 kHz, 1.5, 2.5,
.....6, 12 and 22 MHz

HF model

High Pass Filters .....200, 400, 800 kHz, 2, 4, 8,
.....18 and 45 MHz

Low Pass Filters.....700 kHz, 1.5, 2.5, 6, 12, 27,
.....55 and 100MHz

Keypad and Display

Keypad.....4 by 4 tactile feedback membrane
Display.....4 rows by 20 character backlit LCD

Power Requirements

Power Input.....95-125 VAC or 195-250 VAC,
50-60 Hz, 300VA max

Packaging

Enclosure.....Bench top, 19” Rack compatible
(4U x 19”)

Enclosure Ingress IP20
Enclosure Impact Rating.....IK08

Dimensions .....19" x 5" x 17"
(483 mm x 127mm x 432mm)
Shipping Weight .....45 pounds
(21 kg)

Auxiliary Power Connector

-12V @ 100 mA.....pin 1
+12V @ 100 mA.....pin 3
Ground .....pin 2

Front panel connections

Input Number 1 .....Receiver input number 1
Input Number 2 .....Receiver input number 2
Output .....Receiver output (1V P/P into 50 Ω)
Diplexer Output To Receiver.....Internal diplexer received signal out
to receiver or pre-amplifier

RF Pulse Monitor.....High power pulse monitor
(-40 dB into 50 Ω)

High Power RF Pulse Output.....Primary RF pulser output

Voltages as high as 2850 Vpp can be present at this point during normal operation. Only connect appropriately rated transducers and accessories to this point.

Rear panel connections

External RF Input (CW input) .....(up to 1V P/P into 50 Ω)
Trigger Out.....(positive TTL level)
RF Gate Monitor.....(positive TTL level)
Amp Gate Monitor.....(positive TTL level)
Trigger Input .....(positive TTL level)
Amp Gate Input.....(positive TTL level)
Synth. Monitor (-20dB into 50 ohms).....(0.1V P/P into 50 Ω)
Clock Output (80MHz) .....(2V P/P into 50 Ω)
Power Supply Output.....(+/-12V)

HP RF Output .....Rear panel amplifier output which does not pass through the internal diplexer and/or internal attenuator.

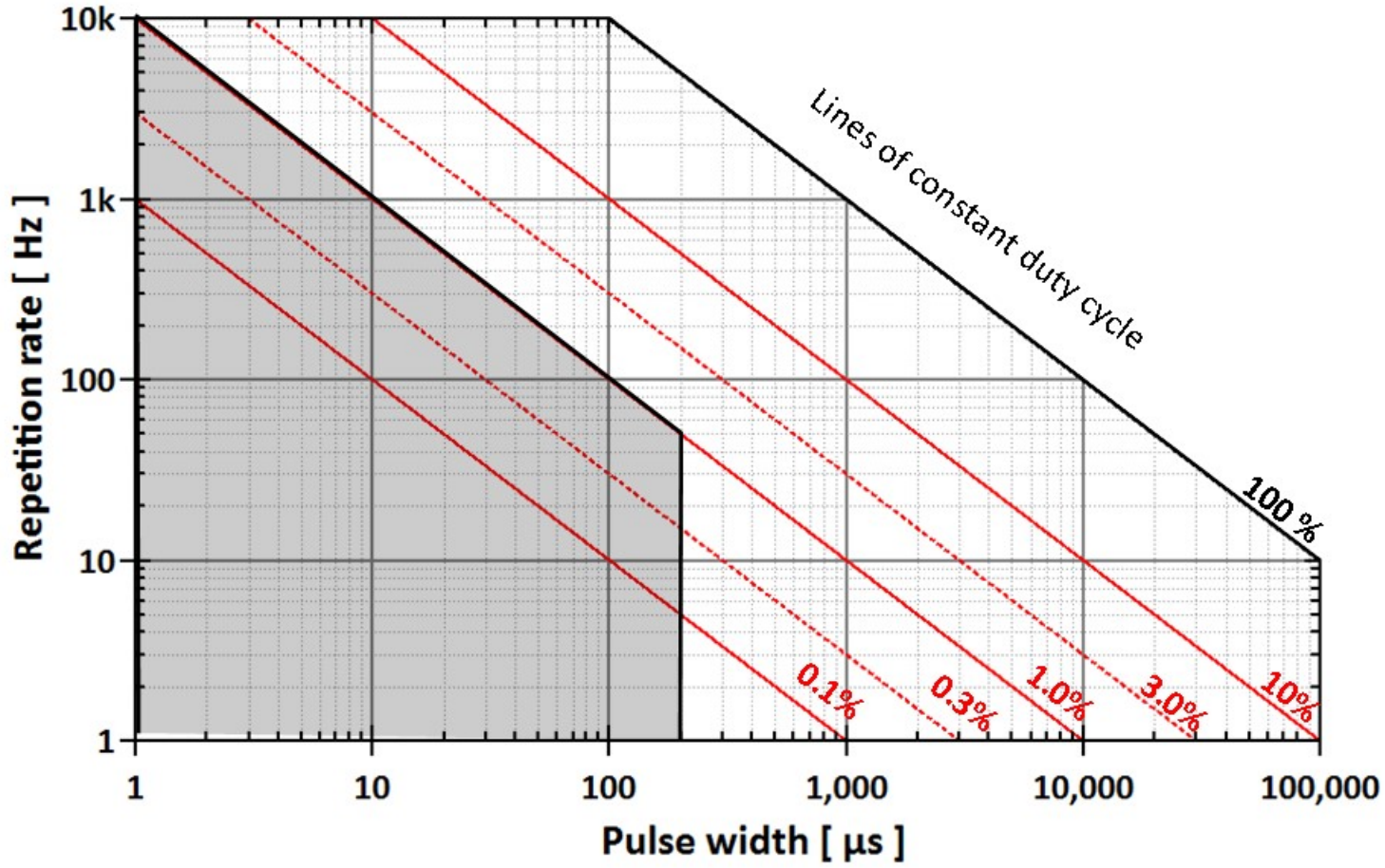
Voltages as high as 2850 Vpp can be present at this point during normal operation. Only connect appropriately rated transducers and accessories to this point.

RPR-4000 Standard Pulser Configurations

	RPR-4000-VHP	RPR-4000-HP		RPR-4000	RPR-4000-HD
Pulser Configuration:	Very High Power	High Power		Standard	High Duty Cycle
		Option 1	Option 2		
Maximum Output Power[1]	20 kW	15 kW	15 kW	8 kW	400 W
Equivalent Output Voltage into 50 Ω	2850 Vpp	2450 Vpp	2450 Vpp	1800 Vpp	400 Vpp
Maximum Duty Cycle	0.6%	0.3%	0.3%	1.0%	10%
Maximum Pulse Width	100 µs	200 µs	100 µs	200 µs	5 ms
Optimum Frequency Range (Standard)	50 kHz – 0.5 MHz	50 kHz – 0.5 MHz	250 kHz – 2.5 MHz	250 kHz – 5 MHz	100 kHz – 10 MHz
Optional Frequency Range[2]	0.25 MHz – 1 MHz			50 kHz – 1 MHz	50 kHz – 2 MHz
Bandwidth @ Maximum Output	~1 decade	~1 decade	~1 decade	~1 decade	~2 decades
Internal Diplexer[3]	No	No	No	Yes	Yes

[1] Output power specified is the Peak Envelope Power (PEP = $(Vrms)^2 / R_{load}$) when operating with a low VSR 50 Ω load.
[2] Custom frequency ranges are available – please contact RITEC for details.
[3] Used for pulse-echo operation. For systems without internal diplexers, an external diplexer accessory suitable for your application may be available – please contact RITEC for details.

Safe Operating Area for Standard Power -8KW units



The shaded grey area in this figure represents the safe operating area for a standard power (8 kW) model RPR-4000.

1 Introduction

This section provides an overview of the main features of the RPR-4000, including a full description of all of the inputs and outputs available on the front and rear panels of the instrument. Procedures to help the first time user to get started with the instrument are also included.

Feature overview

Intended Use

The RPR-4000 is a high powered ultrasonic pulser and receiver system intended for use by qualified laboratory personnel, primarily for NDT (non-destructive testing) and NDE (non-destructive evaluation) applications.

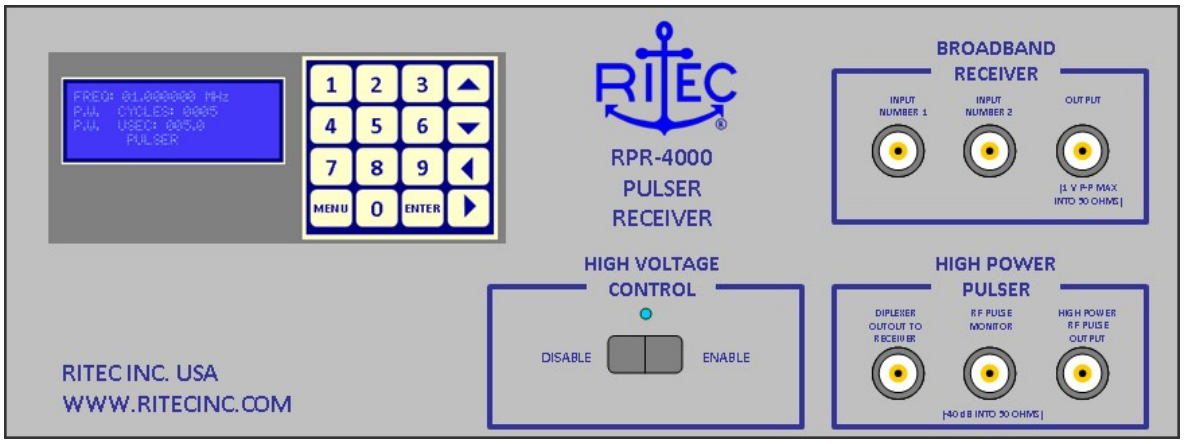
The high power RF tone burst (up to 20 kW depending on model) provides the ability to drive inefficient transducers such as EMATs (Electromagnetic Acoustic Transducers) or high capacitance, low frequency piezoelectric transducers. This can enable the user to make measurements that would be unachievable using more conventional instrumentation.

Environmentally Tolerant Packaging

The internal volume of the RPR-4000 has been designed to divide the available space into two sections; one for critical electronics and one for cooling air flow across heat radiators. Outside air brought into the cabinet to circulate over the heat radiators is exhausted out the rear panel; critical electronics are never exposed to the air brought in. This means that the RPR-4000 is ideally suited for harsh industrial environments. High efficiency zero-voltage-crossing switching power supplies are used for all DC voltage requirements. All power supplies are fully shielded.

The RPR-4000 has been tested at full duty cycle in environments up to 100 degrees Fahrenheit (38 degrees Celsius). If an over temperature condition should develop, an automatic shutdown feature will be enabled.

Front panel overview



High voltage control area

Enable / Disable switch rocker switch turns the high voltage power supply on. When the high voltage power supply is enabled, the blue LED will be lit.

Broadband receiver area

This area contains the inputs and output of the broadband receiver module.

Input number 1/2:

Multiplexed receiver inputs; each has an input impedance of 50 Ω. Maximum recommended input level is 100 mV peak to peak.

Output

Broadband receiver output. Maximum recommended output level is 1 V peak to peak into 50 Ω.

High power pulser area

This area contains the high power pulser output along with a monitor point. Some models also have a signal diplexed output available for pulse-echo mode operation.

High power RF pulse output

This is the main RF pulse output. During normal operation, very high voltage RF signal are present at this point. Please double check your connections before turning on the high voltage power supply, and only use accessories that are appropriately rated.

RF pulse monitor

This is a monitor signal output. The voltage present at this point is 40 dB less (a factor of 100) than the voltage present on the High power RF pulse output. Connect this to an oscilloscope with a 50 Ω terminated input.

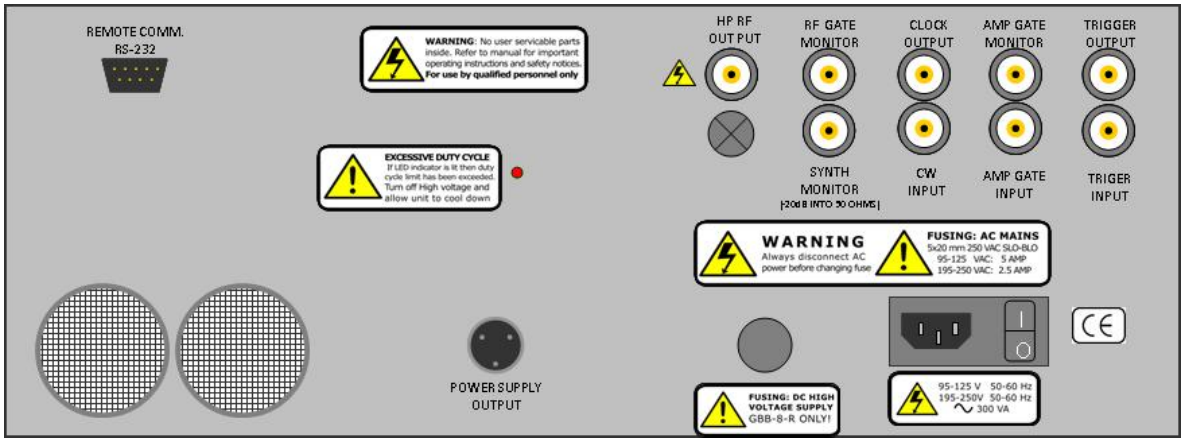
Diplexer output to receiver

This is the output of the internal signal diplexer. Connect this to one of the receiver inputs to do pulse-echo mode operation.

Keypad and display

Local interface for controlling the system. For information on using the keypad interface please see *"Section 2: System Operation."*

Rear panel overview



AC entry module

This module includes a rocker switch for the main power and a built in fuse holder for the AC mains.

Rear panel BNC connectors

Additional utility and monitoring signals, as well as a high power pulse output, are brought out to the rear panel.

HP RF Output

For models that have an internal signal diplexer, this signal bypasses the internal signal diplexer.

Clock output

A buffered system clock output has been provided for synchronizing high speed digitizers, etc.

RF gate monitor / Amp gate monitor / Synth monitor

These are monitor signals that are usually only used for troubleshooting and system verification.

CW input

Only used in Amplifier Mode – input connector for the RF signal to be amplified.

Amp gate input

Only used in Amplifier mode – input connector for the TTL gate signal to gate the power amplifier.

Trigger input / Trigger Output

Trigger output acts as a trigger source when trigger mode is set to INT. Trigger input is active when trigger source is set to EXT.

Remote Comm. RS-232

Female DB-9 connector for the RS-232 interface. For information on using the remote interface please see *"Section 3: Remote Programming."*

Power supply output

A +12V and -12V power supply, each rated for 100 mA, has been brought out for powering accessories such as pre-amplifiers, etc.

High voltage power supply fuse holder

This holds the fuse for the high voltage power supply. For information on changing the fuse, please see *"Section 4: Trouble shooting and maintenance."*

Getting Started

This information is intended to help first time users get started. This section contains procedures for verifying that the system is functioning correctly and for getting measurements set up. Operation of the RPR-4000 requires parameters, such as the receiver gain, pulse width, pulse frequency, etc. to be optimized for a particular measurement.

Verifying system functionality

Two short procedures are provided that verifies that both the pulser and receiver are functioning correctly. It does not provide any information on calibration of either module; for information on calibrating the instrument, please contact RITEC or your RITEC representative.

Verifying pulser functionality

1. Connect coax cable from "High Power RF Pulse Output" to an appropriate high power load. Acceptable loads include:

   -A low VSWR high power 50 Ω coaxial attenuator rated for at least 500 W CW.

   -An RT-150, which is a 150 Ω high power termination that is often supplied with the RPR-4000 system.

2. Connect a coaxial cable from "Trigger Out" on the rear panel of the RPR-4000 to the external trigger input on the oscilloscope.

3. Connect a coaxial cable "RF Pulse Monitor" to a 50 Ω terminated input on the oscilloscope. Set the channel's vertical sensitivity to 1 V per division. Because the monitor output is down 40 dB (100:1 ratio), this vertical sensitivity then corresponds to 100 V per division.

4. Set the time oscilloscope horizontal scale for 1 μs per division. Verify that the oscilloscope is triggering on the trigger signal from the RPR-4000.

5. Using the keypad on the front panel set the various operating parameters as follows:

   <u>Page 1 – Pulser settings 1/2</u>
   Frequency: 1 MHz
   Pulse Width: 5 cycles

   <u>Page 2 – Pulser settings 2/2</u>
   Tracking: Y
   Control: 10

Page 3 – Receiver settings
Receiver Input: 1
Receiver Gain: 20dB
High Pass Filter: 200 KHz
Low Pass Filter: 12 MHz

Page 4 – Trigger Settings
Repetition Rate: 25 Hz
Trigger: INT

6. Turn on the high voltage using the rocker switch on the front panel. The LED on the front panel above the switch should illuminate.

7. View the "RF Pulse Monitor" signal on the oscilloscope. You should see a burst with a center frequency of 1 MHz and 5 μs wide. The amplitude will depend upon your RPR-4000 model and the load impedance, but should be in the range of 100 V to 500 V peak to peak.

Verifying receiver functionality

The receiver functionality can be tested by using an external signal generator or function generator. An oscilloscope will be required to view the receiver output signal.

1. Connect a coax cable from signal generator to "Input Number 1" on the front panel. The signal should be 100mV peak to peak at a frequency of 1 MHz

2. Connect a coaxial cable from the connector labeled "Output" in the broad band receiver area of the front panel to a 50 Ω terminated input on the oscilloscope. Set the channel's vertical sensitivity to 500 mV per division.

3. Set up the triggering for the external oscilloscope. If provided, use the trigger output or synch output from the signal or function generator, otherwise trigger on the receiver output signal itself.

4. Use the front panel keypad interface to enter the following settings:

Page 3 – Receiver settings
Receiver Input: 1
Receiver Gain: 20dB
High Pass Filter: 200 KHz
Low Pass Filter: 12 MHz

5. Set the time oscilloscope horizontal scale for 1 μs per division. Verify that the oscilloscope is triggering.

6. View the broadband receiver output on the oscilloscope. You should see the signal from your signal generator amplified to 1 V peak to peak.

7. Please note that the receiver has a blanking function which will not be coherent with your signal. Because of this seen you may see a randomly appearing or moving blank space in your signal on the oscilloscope. This is normal.

Setting up a pulse-echo measurement

Operating the RPR-4000 Pulser/Receiver in the two standard modes of operation (Pulse-Echo and Through Transmission) is very straight forward.

For Pulse-Echo operation, proceed as follows:

1. Connect a short coaxial cable from "Diplexer Output to Receiver" to Receiver "Input Number 1".

2. If using a piezo-electric transducer, connect coax cables from "High Power RF Pulse Output" to an RT-150 (150 ohm high power load) and then to an appropriate transducer.

3. If a low impedance transducer (e.g., an electromagnetic acoustic transducer) is used, then 150 ohm load is not required.[4]

4. Connect a coaxial cable from "Trigger Out" on the rear panel of the RPR-4000 to the external trigger input on the oscilloscope.

5. Connect a coaxial cable from receiver "Output" to a 50 ohm vertical input on the scope. Set scope vertical sensitivity to 0.5 V per division.

6. Connect a coaxial cable from "RF Pulse Monitor" to a 50 Ω terminated input on the oscilloscope. Set the vertical sensitivity to 1 V per division.

   (Because the monitor output is down 40 dB [100:1] this vertical sensitivity then corresponds to 100 V at the pulser output per division).

7. Using the keypad on the front panel set the various operating parameters as follows:

   Page 1 – Pulser settings 1/2
   Frequency: Transducer center frequency
   Pulse Width: 5 cycles

[4] The 150 Ω termination on the output serves two functions: 1.) Cleans up the base line during the RF pulse and 2.) Allows the control algorithm for output level to function with higher resolution.

Page 2 – Pulser settings 2/2
Tracking: Y
Control: 10

Page 3 – Receiver settings
Receiver Input: 1
Receiver Gain: 40dB
High Pass Filter: 200 KHz
Low Pass Filter: 12 MHz

Page 4 – Trigger Settings
Repetition Rate: 25 Hz
Trigger: INT

Turn on the high voltage, and view the signals on the oscilloscope.

It should now be possible to obtain return signals from the test sample. Fine adjustments of all control parameters can then be carried out.

Some things to try:

1. Adjust the pulser frequency (FREQ, menu page 1)

   Tune through the center frequency around the transducer. It is very rare for a commercial transducer to give the best response at its marked center frequency. Try adjusting 10-20% above and below the marked center frequency and see if you get better signal to noise in your received signal.

2. Adjust the pulse width (PW or CYCLES, menu page 1)

   The optimal pulse width will depend on a host of factors. Some transducers will take 5-10 cycles to build up to maximum amplitude, while others have sufficient bandwidth to reproduce a 1-2 cycle burst.

3. Adjust the output level (CONTROL, menu page 2)

   Please note that some piezo-electric transducers will not tolerate the very large pulse outputs available from the RPR-4000. The maximum output available is dependent upon your particular model and can be in excess of 2500 Volts peak to peak; caution is advised when using a transducer for the first time. Low impedance loads (e.g., electromagnetic acoustic transducers or EMAT's) can typically tolerate the full output from the pulser.

4. Adjust the receiver gain. (GAIN, menu page 3)

For optimal linearity and performance, the gain of the receiver should be adjusted such that the output level is 1 V peak to peak when terminated into 50 Ω. Please note that only the feature(s) of interest in the received signal should be in the range. When you are doing pulse-echo measurements, the receiver output will be saturated and over 1 V peak to peak during the burst.

When you are looking for return signals, it helps to increase the gain by 10 – 20 dB if you do not see anything at first. Once you have found your signals of interest, set the receiver gain to the correct level before you begin any data acquisition or digitizing.

5. Adjust the receiver filters (HP and LP, menu page 4)

   If you need to work at higher gains, you can improve your signal to noise ratio by lowering the low pass filter setting.

   If you are doing pulse-echo measurements, you can make some improvements to the recovery time of the receiver by increasing the high pass filter setting.

When first getting started with a new transducer-sample combination, some experimentation will be required to optimize the settings of the instrument, and several iterations of combinations of the above steps may be required. Once you have found settings that are satisfactory, these can be saved in the internal memory. Please see *"Section 2: System Operation"* subheading *"Saving programs"* for more details.

Using the instrument in Amplifier Mode

The RPR-4000 may be used as an amplifier by connecting an arbitrary waveform generator to the rear panel inputs.

1. Apply the RF signal to be amplified to the "CW" input on the rear panel. The signal must not exceed 1V P/P.

2. Apply a positive TTL gate to the "AMP GATE INPUT" which goes positive (+5V) at the beginning of the burst and goes to zero volts at the end of the burst.

Care must be taken to avoid applying the wrong polarity gate as this will effect the output duty cycle and may cause damage to the unit.

3. Set the frequency setting on the front console to 00.000000 Hz.
   Set the trigger setting to "EXT".
4. Enable the high voltage power supply (rocker switch, front panel)

Duty cycle must be limited to 1% by the user. Allowing higher duty cycle may cause damage to the unit.

An "external excessive duty cycle" limiter has been added to protect it from inadvertently operating at an excessive duty cycle with external signals applied via the rear panel connectors. When an excessive duty cycle has been applied, a resettable thermal fuse shuts off the 24V power supply that feeds the power MOSFET drivers. When this happens, a red LED on the rear panel will light up.

Turn the unit power off for a period of 3 to 5 minutes to allow the thermal fuse to cool. Reset the external signal generator such that the duty cycle is 1% or less.

When the unit power is restored the LED should be off, if not, remove power long enough to allow additional cooling.

NOTE: If RPR-4000 frequency setting is set to 00.000000Hz and no external gate is applied for a period of time (approximately 20 minutes) the displayed peak detector voltage will gradually drift to a level which will result in an Over Voltage condition and will be indicated by a beeping sound and message on the front panel display. This condition will not harm the instrument, but the operator should be aware. If this condition occurs, it can be terminated by entering a frequency setting with trigger set to INT. or by cycling system power.

2 System Operation

This section provides a complete description of the instrument settings and adjustments available to the user. These settings are accessed via the front panel console. For information on controlling the instrument remotely, please see *Section 3: Remote Programming*.

Front panel console

The operator's console was designed to give the operator quick and easy access to system parameter settings. The display is a 4 line by 20 character LCD display with LED backlighting to provide a sharp, easy-to-read data presentation. Available keys include 0 thru 9 for entering numerical data, Up, Down, Left & Right arrow keys for changing alpha data fields and selecting numerical data field character positions, the Enter key for accepting the data field settings and the Menu key for selecting 1 of 5 menu pages. A view of the keypad display is shown in Figure 2.1.

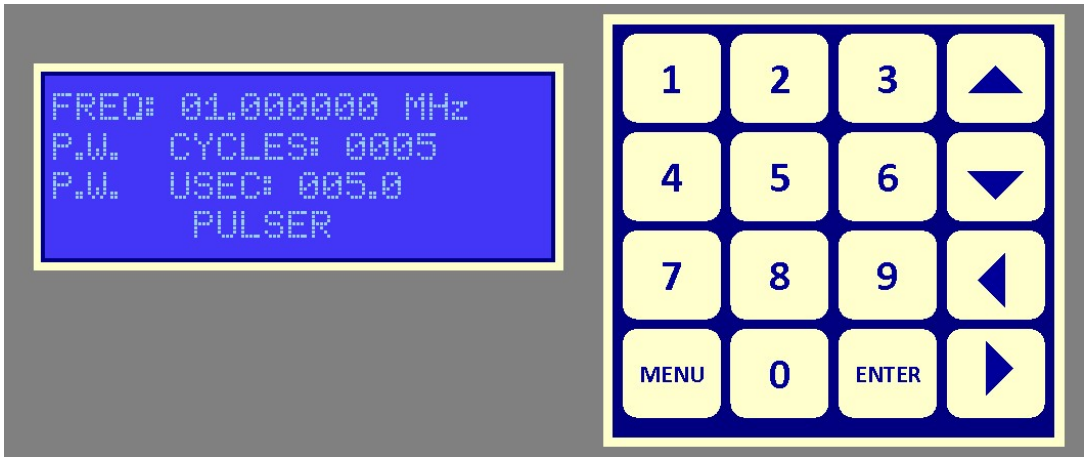


Figure 2.1: The keypad display console for manually controlling the RPR-4000.

Navigating the menu

Parameters for the pulser-receiver are stored in 5 pages. To cycle to the next page, press the MENU key. Table 2.1 lists the Table of contents for the pages of the menu.

Table 2.1: Table of contents for the RPR-4000 control menu

Page	Contents
1-2	Pulser settings – frequency, pulse width, output level control
3	Receiver settings – input channel, gain, filter selection
4	Trigger settings – trigger source and repetition rate
5	Program settings – loading and saving parameters

To cycle through the parameters on a page, press the enter key.

NOTE If a change has been entered into a data field without pressing the ENTER key the next menu page cannot be accessed. This prevents the operator from continuing without completing an entry.

Changing alpha parameters

Data fields containing alpha information may be changed by first selecting the data field with the ENTER key and then selecting the desired setting using the UP ARROW key only. When an alpha data field is selected, the operator is notified by an UP ARROW (^) located on the bottom right side of the display; see Figure 2.2. The (^) character indicates that the selected data field is an alpha data field and can be changed by using the UP arrow key only. When the desired setting is displayed press the ENTER key to accept and execute the setting.

Figure 2.2: A (^) character in the lower right corner of the display indicates that the current control is an alpha type data field. Use the UP ARROW key to change these parameters. Press ENTER when you are done.

Changing numeric parameters

NOTE If a change is outside the acceptable limits of the system, the display will show the following message “ILLEGAL COMMAND”.

Entering data into numeric data fields can be accomplished using 1 of 2 methods.

NOTE When either method has been used to initially enter data, that method **must** be used to complete the data field entry.

Manual Entry: Data can be entered using the numeric keys 0 thru 9 beginning with the left most position in the data field. The first numeric entry will be displayed and the remainder of the data field will be filled with zeros. When the entry has been completed press the ENTER key to accept and execute the setting. Pressing the ENTER key again will advance the cursor to the next data field.

If a mistake was made on entering data or the operator has changed his/her mind, before the ENTER key is depressed the data field may be cleared by pressing the LEFTARROW key and entering new data.

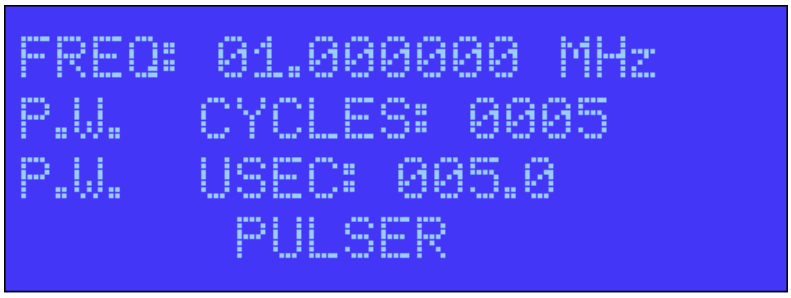
Position Select: Data may be entered by first selecting a position within the data field using the LEFT and RIGHT ARROW keys. The position selected may then be set to the desired setting by pressing the UP ARROW (increase) or DOWN ARROW (decrease) keys**. Each depression of the UP or DOWN ARROW keys will take immediate effect in a numeric data field.**

NOTE Arrow keys can not be used to change the RR (repetition rate) setting.

Upon completion of the entry press the ENTER key to terminate data entry. A second depression of the ENTER key will advance the cursor to the next data field.

NOTE Using this mode of data entry does not clear the data field when the first character is entered. Only the selected position is changed.

Page 1 – Pulser settings (1/2)



Label	Parameter	Data range	Units	Data Type
FREQ	Pulse frequency	00.030000 to 21.999999	MHZ	Numeric
PW CYCLES	Pulse width	0000 to 4444		Numeric
PW USEC	Pulse width	000.0 to 200.0	USEC	Numeric

FREQ Pulse Frequency

The acceptable frequency range is 30 kHz to 22 MHz (Data range from 00.030000 to 21.999999). The internal synthesizer output can be disabled by entering 00.000000.

PW CYCLES / PW USEC Pulse width (# cycles or time)

The pulse width may be entered in increments of time or number of cycles.

If entered as time the pulse width will be limited so as to yield a maximum duty cycle of 1%. The number of cycles for the time specified will be calculated and displayed which may include part of a cycle.

Entering a setting over 200 µs will generate the error 'ILLEGAL COMMAND'.

The minimum pulse width corresponds to 1 cycle at 22 MHz, or about 4.5 ns. However, the frequency at which you can generate a clean 1 cycle pulse of RF depends upon your model of RPR-4000 and the load that you are driving.

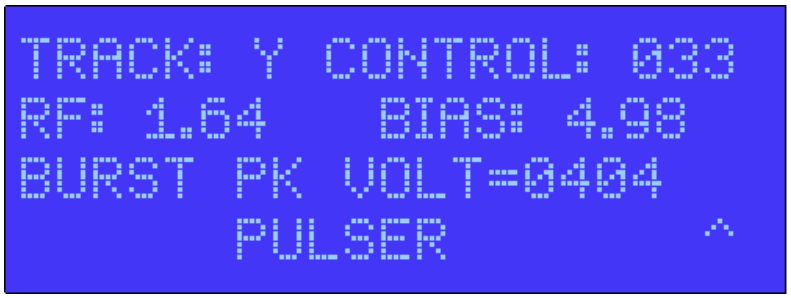
If the setting entered exceeds 1% duty cycle, the pulse width will be limited to the maximum number of cycles while maintaining 1% duty cycle.

If entered as cycles the total time for the specified number of cycles will also be calculated and displayed.

If the setting entered exceeds 1% duty cycle the pulse width will be limited to the maximum number of cycles while maintaining 1% duty cycle.

The message 'MAX DUTY CYCLE' will be displayed.

Page 2 – Pulser settings (2/2)



Label	Parameter	Data range	Units	Data type
TRACK	Control Tracking	Y, N		Alpha
CONTROL	Level control	Control	0 to 100	Numeric
RF	RF control voltage	0 to 4.99	V	Numeric
BIAS	Bias control voltage	0 to 4.99	V	Numeric
BURST PK VOLT	Peak burst voltage			

Tracking TRACK

Allows the operator to manually select the RF Gain and Bias Level settings or allow the CONTROL function to automatically calculate the RF and Bias.

If TRACK is set to Y(es) then the RF Gain and BIAS Level will be calculated by the control module. Anytime the CONTROL setting is changed the RF and BIAS will be recalculated and displayed. With TRACK set to Y(es) the operator cannot access the RF and BIAS data fields on the display.

If TRACK is set to N (o) the RF Gain and BIAS Level may be entered by the operator but must remain within acceptable limits. Any setting not within the system's acceptable limits will be rejected and the following message will appear on the display: "ILLEGAL COMMAND".

With TRACK set to N (o) the operator can access the RF and BIAS data fields on the display but cannot access the CONTROL data field.

Level Control CONTROL

When TRACK is set to Y, this parameter allows the operator to smoothly change the output level of the gated amplifier. The parameter varies from 0 to 100, but does not track exactly with output amplitude.

When TRACK is set to N, then the CONTROL field is not accessible to the operator. The operator can directly control the RF gain and the bias level of the gated amplifier using the controls RF and BIAS.

RF control voltage RF

This field is only accessible when TRACK is set to N. This control allows the operator to change the RF gain in the low power sections of the RF amplifier.

BIAS control voltage BIAS

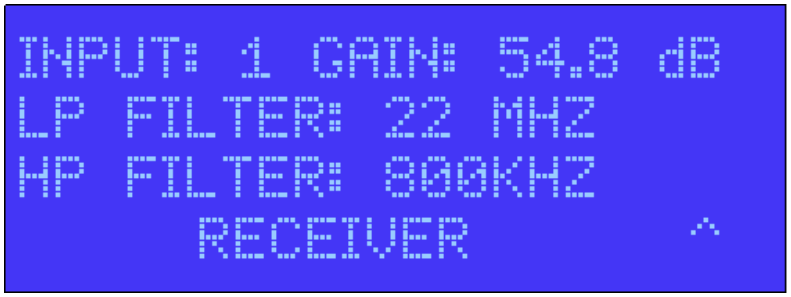
This field is only accessible when TRACK is set to N. This control allows the operator to change the RF gain in the low power sections of the RF amplifier.

NOTE The controls RF and BIAS allow the user to make adjustments to the gain and class of operation (A, AB, B etc.) of the gated amplifier. For guidance on using these controls contact RITEC.

Burst Peak Voltage BURST PEAK VOLT

Displays the burst peak voltage. This readout is meant to be only an indication of the voltage level, not a precise measurement.

Page 3 – Receiver settings



Label	Parameter	Data range	Units	Data type
INPUT	Receiver input channel	1,2, or A		alpha
GAIN	Receiver gain	20.0 to 99.9	dB	numeric
LP FILTER	Low pass filter	8 values		alpha
HP FILTER	High pass filter	8 values		alpha

Receiver input channel INPUT

Input must be selected using the UP ARROW key. When Input 1 or 2 is selected the corresponding gain will also be displayed. When Input A is selected the GAIN data field will go blank. In this mode Inputs 1 and 2 will be alternately selected based on the current repetition rate (RR) and will use the current gain settings. The GAIN data field is not accessible when A is selected.

Receiver gain GAIN

Gain setting range is 20 to 99.9 dB. Gain is set in increments of 0.4 dB starting at 20 dB. If the selected setting entered is not a 0.4dB increment the unit will round down to the closest 0.4 dB setting which will then be displayed.

NOTE: Channels 1 and 2 can be set to have different gains.

Low/High Pass Filter LP / HP FILTER

These are also alpha data fields. Eight settings are available for both the high and low filter settings and are assigned at the factory based on customer requirements. Both high and low filter settings apply to both channels 1 and 2 therefore filter settings for inputs 1 and 2 will always be the same.

NOTE: **When making adjustments to the filter, you must press ENTER in order for the new filter to be switched in**. It is common, when setting up the instrument and viewing received signal on an oscilloscope, to view the affect of changing filters on the viewed signals. You must press ENTER after changing the filter to see any affect.

Page 4 – Trigger settings

Label	Parameter	Data range	Units	Data type
TRIG	Trigger source	INT, EXT, or XPC		alpha
RR	Repetition rate	See <TBL>	Hz	numeric

Trigger source TRIG

The trigger input setting provides 3 trigger sources:

INT: The trigger pulse is provided by the internal rep rate generator with settings defined in Table 1 in Section IV. Trigger signal is brought out to the connector labeled 'TRIGGER OUTPUT' on the rear panel of the unit.

EXT: The unit is triggered by an external trigger generator provided by the user. is provided on the rear panel of the RPR-4000. This must be a TTL compatible signal.

NOTE: An external trigger pulse is required at least once every 15 minutes. If the unit is allowed to sit in the standby mode for more than approximately 20 minutes the beeper will sound and an O.V. (over-voltage) message will be displayed even though an over-voltage condition does not exist.

XPC: The trigger pulse is provided via the RS232 serial port using the following command: 'CT:<CR>'. One trigger will be generated for each command entered. See *Section 3: Remote Programming* for more information.

Repetition rate RR

Table 3.2 lists the different repetition rates provided. If a setting other than those listed is entered the unit will select and display the closest setting below the entered value (e.g., an entry of 390 Hz will result in a repetition rate of 250 Hz.)

If a rep. rate setting is entered which would result in a burst width exceeding 1% duty cycle the unit will recalculate the burst width based on the new rep rate and display the new P.W. in cycles and μs (USEC). The message 'MAX DUTY CYCLE' will be displayed.

NOTE: Arrow keys cannot be used to change the RR setting. The desired RR setting must be entered in using the numeric key pad. For example, to change the repetition rate to 50 Hz, you must press ENTER 0 0 0 5 0 0 0 ENTER. See Table 2.1 for the available repetition rates from the internal signal generator.

Table 2.1: Available repetition rate settings

10000.000	01000.000	00100.000	00010.000	00001.000	00000.100
08000.000	00800.000	00080.000	00008.000	00000.800	00000.080
05000.000	00500.000	00050.000	00005.000	00000.500	
04000.000	00400.000	00040.000	00004.000	00000.400	
02500.000	00250.000	00025.000	00002.500	00000.250	
02000.000	00200.000	00020.000	00002.000	00000.200	
01600.000	00160.000	00016.000	00001.600	00000.160	
01200.000	00125.000	00012.000	00001.250	00000.125	

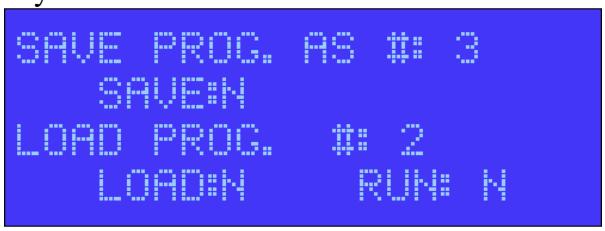
Page 5 – Program settings

Label	Parameter	Data range	Data type
SAVE PROG. AS #	Slot to save settings in	0 to 9	numeric
SAVE	Save command	Y, N	alpha
LOAD PROG. AS #	Slot to load settings from	0 to 9	numeric
LOAD	Load command	Y, N	alpha
RUN	Run command	Y, N	alpha

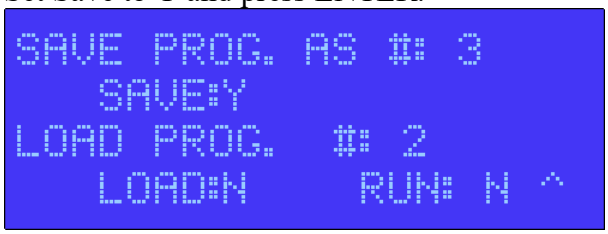
Once you have entered in the various settings for the pulser and the receiver, you can save these settings to internal, non-volatile memory.

To save your settings

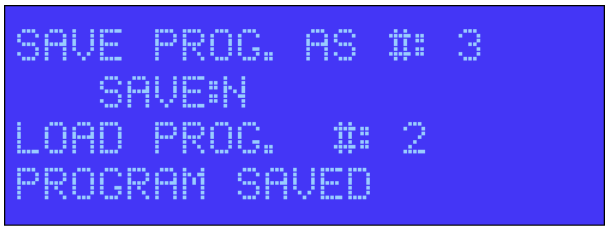
Enter the desired program number in the field “SAVE PROG. AS #:’ and press the enter key



Set Save to Y and press ENTER.

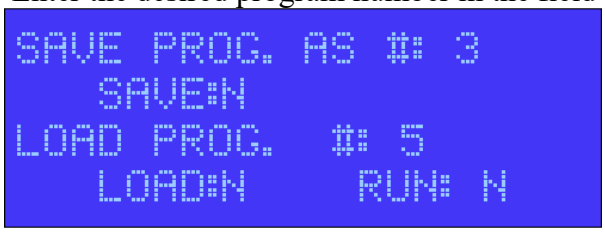


The message ‘PROGRAM SAVED’ will flash on the bottom line of the display, and the SAVE setting will change back to ‘N’.

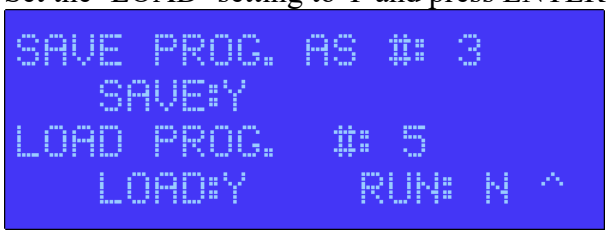


To load previously saved settings

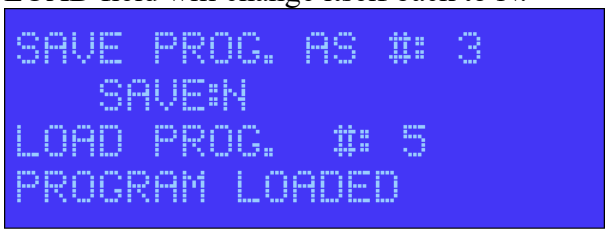
Enter the desired program number in the field “LOAD PROG. #:’ and press enter.



Set the ‘LOAD’ setting to Y and press ENTER



The bottom line of the display should flash ‘PROGRAM LOADED’. After this, the LOAD field will change itself back to N.



At this point, all of the settings have been loaded and will be displayed on the menus. However, the settings will not take affect until the program is RUN. To Run the program and make the settings take affect, select change RUN to Y and press enter.

3 Remote Programming

The RPR-4000 can be programmed remotely by a control computer using the RS-232 interface.

Setting up the Remote Interface

RS-232 configuration

Table 3.1 lists the data format settings for the RS-232 communication link. The RPR-4000 is configured as a DCE.

Table 3.1: Settings for the RS-232 communications link.

Baud rate	57600
Data bits	8
Stop bit	1
Parity	NONE
Flow control	Hardware CTS/RTS

Connector pin-outs

The connector on the rear panel labeled "REMOTE COMM. RS-232" is a standard DB-9 female connector. Table 3.2 gives the required connections for the communication cable.

Table 3.2: Wiring diagram for the communications cable between the RPR-4000 and the control system.

Computer / controller (DTE) 9 pin FEMALE to mate with typical serial port			RPR-4000 (DCE) 9 pin MALE to mate to rear panel connector	
PIN	signal	flow	signal	PIN
2	RX	<<<<<<	TX	2
3	TX	>>>>>>	RX	3
7	RTS	>>>>>>		7
8		<<<<<<	CTS	8
5	GND	<><><>	GND	5

Starting up

When power is applied to the RPR-4000, the instrument settings are transmitted from the serial port followed by “READY” which indicates that the instrument is ready for use. Figure 3.2 shows an example output received from the RPR-4000 after power on.

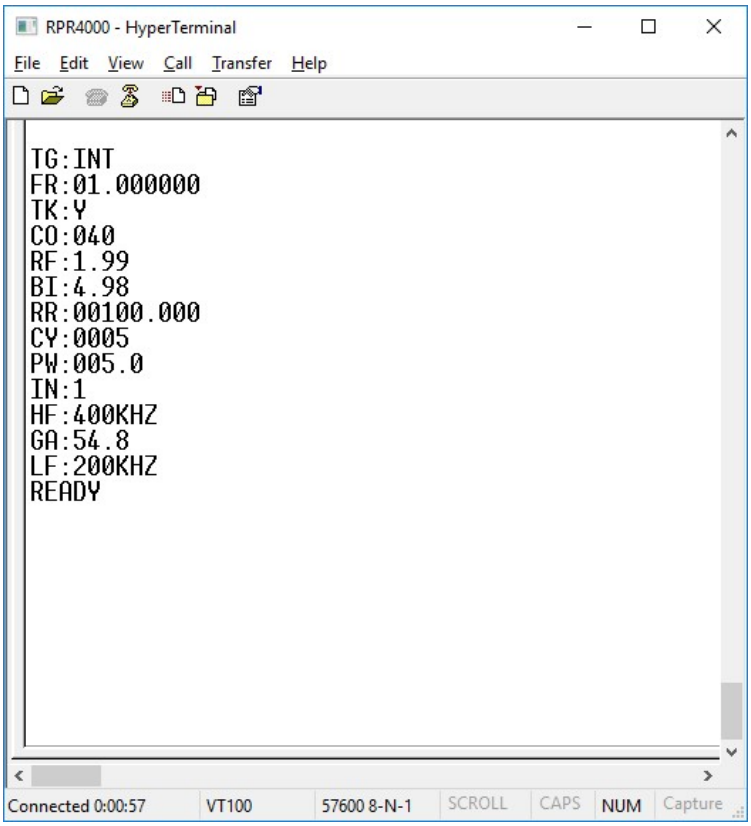


Figure 3.2: Example serial output of the RPR-4000 after being powered on.

External commands or text files can be sent to the RPR-4000 using a variety of terminal programs. The screen shot shown in Fig. 3.2 was taken from the program called HyperTerminal.

All commands will be echoed back to the external computer, which indicates that the command has been received by the pulser or receiver and implemented.

When a command has been issued, the keypad display will be changed to the menu that contains the item being changed.

When an instrument setting is changed on the local keypad, the results are both displayed on the local LCD and echoed at the serial port.

Command Reference

Syntax

All commands are case sensitive and end with a carriage return, which is indicated by the string '<CR>' in this manual.

Commands with a variable data range will only function correctly when the correct number of characters is sent. For example the command

CY:1<CR> will return the result 'ILLEGAL COMMAND'
CY:0001<CR> will successfully set the number of cycles to 1.

Pulser commands

Parameter	*Command*	*Data range*	*Units*	*Query*	*Echo*
Frequency	FR:xx.xxxxxx<CR>	00.000000 to 21.999999	MHZ	FR:?<CR>	FR:xx.xxxxxx<CR>
Pulse width (# of cycles)	CY:xxxx<CR>	0000 to 4444	CYCLES	CY:?<CR>	FR:xxxx<CR>
Pulse width (time)	PW:xxx.x<CR>	000.0 to 200.0	USEC	PW:?<CR>	PW:xxx.x<CR>
Tracking	TK:x<CR>	Y or N		TK:?<CR>	TK:x<CR>
Level Control	CO:xxx<CR>	000 to 100		CO:?<CR>	CO:xxx<CR>
RF control voltage	RF:x.xx<CR>	0.00 to 4.99	V	RF:?<CR>	RF:x.xx<CR>
BIAS control voltage	BI:x.xx<CR>	0.00 to 4.99	V	BI:?<CR>	BI:x.xx<CR>
Burst voltage query			V	BV:?<CR>	BV:xxxx<CR>

Receiver commands

Parameter	*Command*	*Data range*	*Units*	*Query*	*Echo*
Input select	IN:x<CR>	1,2, A		IN:?<CR>	IN:x<CR>
Receiver gain	GA:xx.x<CR>	20.0 to 99.9	dB	GA:?<CR>	GA:xx.x<CR>
High pass filter	HF:n<CR>	1,2,3,4,5,6, 7, or 8		HF:?<CR>	HF:<hpf-id><CR>
Low pass filter	LF:n<CR>	1,2,3,4,5,6, 7, or 8		LF:?<CR>	LF:<lpf-id><CR>

Trigger and repetition rate commands

Parameter	*Command*	*Data range*	*Units*	*Query*	*Echo*
Trigger source	TG:x<CR>	I,E, or C		TG:?<CR>	{ INT | EXT|XPC}<CR> INT for internal EXT for external XPC for remote
Repetition rate	RR:xxxxx.xxx<CR>	See Table 3.2	HZ	RR:?<CR>	RR:xxxxx.xxx<CR>
Trigger remotely	CT:<CR>				CT:<CR>

Table 3.2 Allowable repetition rate settings

10000.000	01000.000	00100.000	00010.000	00001.000	00000.100
08000.000	00800.000	00080.000	00008.000	00000.800	00000.080
05000.000	00500.000	00050.000	00005.000	00000.500	
04000.000	00400.000	00040.000	00004.000	00000.400	
02500.000	00250.000	00025.000	00002.500	00000.250	
02000.000	00200.000	00020.000	00002.000	00000.200	
01600.000	00160.000	00016.000	00001.600	00000.160	
01200.000	00125.000	00012.000	00001.250	00000.125	

Operating modes and keypad management

Parameter	*Command*	*Query*	*Echo*
Query mode		MO:?<CR>	'UPDATE MODE' or 'PASSTHRU MODE'
Set to UPDATE mode	UP:<CR>		'UPDATE MODE' followed by all settings
Set to PASSTHROUGH mode	PS:<CR>		'PASSTHRU MODE' <CR>
Lock local keypad	KL:<CR>		KL:<CR>
Unlock local keypad	KU:<CR>		KU:<CR>
Query keypad status		KS:?<CR>	{ KL | KU}:<CR> KL for locked KU for unlocked

Loading and Saving programs

Parameter	*Command*	*Data range*	*Echo*
Save program	SP:n<CR>	0 to 9	PROGRAM SAVED<CR>
Load program	LP:n<CR>	0 to 9	PROGRAM LOADED<CR>
Run program	RN:n<CR>		

Control Modes

The RPR-4000 can be operated in two control modes, pass-through mode and update mode. More information on these operating modes is presented below.

Update Mode

This is the default mode of operation for the RPR-4000 system. The main control module accepts commands from either the local keypad or the remote RS-232 interface. The main control module interprets the commands, updates the local display, and then sends the appropriate commands to either the pulser or receiver module.

NOTE The maximum number of commands per second in Update Mode is 20.

Passthrough Mode

Operating in the "Passthrough Mode" enables the RPR-4000 to receive commands at a rate of 50 commands per second vs. 20 commands per second in the "Update Mode". This is due to the fact that the operator's console is not updated in the Passthrough Mode. Updating the operator's console involves the verification, calculation and passing of commands as well as updating the display. By eliminating these steps, the command response rate can be increased.

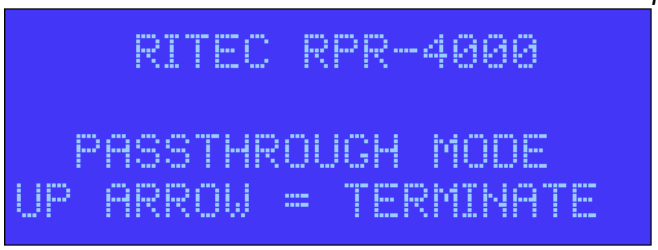
NOTE When changing from Passthrough back to Update, all commands issued during Passthrough Mode will be lost. As soon as the UPDATE command is issued the current console settings will be reloaded and sent to the pulser and receiver and take immediate effect.

When operating in the PASSTHROUGH MODE there will be no echo of settings to the remote console. In this mode the pulse width will not be recalculated with a change in frequency or cycle settings. It will remain at the setting entered: P.W. WIDTH.

In PASSTHROUGH MODE, only the CO command is available for controlling the amplifier output level. Do not send RF or BI commands.

A typical use of the PASSTHROUGH MODE would be frequency sweeping when trying to detect resonance. A text file containing a series of frequency settings or data field settings can be downloaded to the RPR-4000 and sequentially executed. For more information, see the next heading *"Sending multiple commands"*.

To activate PASSTHROUGH MODE, send the command "PS:<CR>" via the RS-232 communication link. You should see the following message on the local LCD display:



To exit pass through mode, either send the command UP:<CR> via RS-232 communication link or press the up arrow key on the local keypad

Upon exiting PASSTHROUGH mode, the local display will revert to the first menu, and the last settings used during UPDATE mode will be reloaded into the pulser and receiver.

NOTE The maximum number of commands per second in Passthrough Mode is 50.

Sending multiple commands

A sequence of commands can be sent to the RPR-4000 by transferring a text file via the serial port. The file must be a text file only.

NOTE When transferring the file, the lines must be sent with an appropriate delay in order to stay below the limits of 20 commands per second for UPDATE MODE and 50 commands per second for PASSTHROUGH MODE.

4 Troubleshooting & Maintenance

This section contains information to help the operator troubleshoot the instrument and interpret its error messages. Some limited information on maintenance of the instrument is also provided.

Control Module Error Messages

These messages are displayed on the local keypad display and echoed to the serial communications port.

'ILLEGAL COMMAND'

One of the following events leads to this message:

- A command was issued with incorrect syntax.
- A command did not conform to the specified command format.
- A command setting is not within acceptable limits.

If this happens when using the local keypad display, then double check your entry and verify that the entered data is within the accepted range. Consult *"Section 2: System operation*" for more information.

If this happens when using the remote RS-232 interface:

- Verify that the command arguments are within bounds. Consult *"Section 2: System Operation"* for more information.

- Check your command syntax. Commands are case sensitive and require a carriage return at the end of each command. Consult *"Section 3: Remote programming"* for more information.

- Verify that commands are not being sent too quickly in rapid succession. The maximum command rate is 20 commands per second for Update Mode and 50 for Passthrough mode.

'PUL. COMM. ERR' and 'REC. COMM. ERR'

The internal communications link between the control module and the pulser or receiver module has been broken or is corrupt. Cycling the AC power may reset this condition.

If this condition continues to appear, do not use the unit and contact RITEC or your authorized representative.

'O.T. DEC DUTY CYCLE'

The High Voltage power supply is in an over-temperature condition, the HV power has been turned off and the alarm turned on. The operator must **decrease** the duty cycle. If doing so does not enable the HV power supply a cooling off period will be required. The alarm will be turned off when the duty cycle has been decreased and the temperature is within acceptable limits.

'O.C. DEC DUTY CYCLE'

An over-current event has occurred. The High Voltage power supply is in an over-current condition, the HV power has been turned off and the alarm turned on.

The operator must decrease the burst duty cycle. If doing so does not enable the HV power supply a cooling off period will be required.

The alarm will be turned off when the duty cycle has been decreased and the high voltage power supply current draw is within acceptable limits.

The operator has 3 ways of decreasing the duty cycle:

- Reduce the number of burst cycles (P.W. CYCLES)
- Reduce the burst width in µs (P.W. USEC)
- Reduce the repetition rate(RR)

'O.V. SET RF/BI'

An over voltage event has occurred on the RF pulser output, and the burst peak voltage has exceeded the programmed limit. The burst voltage was automatically decreased and the alarm turned on.

The operator must readjust the RF and/or Bias settings if Tracking is not in effect.

The alarm will be turned off when the RF or Bias settings are within acceptable limits.

‘O.V. RESET CONTROL’

An over voltage event has occurred on the RF pulser output. The burst voltage level has exceeded the programmed limit. The burst voltage was automatically decreased.

The operator must re-enter the CONTROL setting.

The audio alarm will be turned off when the CONTROL setting is within acceptable limits.

Front panel LCD corruption

The problem

The front panel display is showing unreadable characters and/or gibberish.

Required action

Use the following procedure to reset the LCD display.

1. Turn unit AC line power off (rocker switch on rear panel)
2. Press and hold the LEFT ARROW key on the keypad while turning power on.
3. When the data appears on the display, release the LEFT ARROW key.
4. Press and release the ENTER key.

This procedure will also reset the displayed settings; it will be necessary to re-enter all used settings.

Amplifier Mode Over Duty Cycle

The problem

When using the RPR-4000 in external amplifier mode, the pulse output is no longer present, and the RED LED on the rear panel is lit.

Required action

An over duty cycle event has occurred. When using the pulser is amplifier mode, it is very important that you stay within the duty cycle limits of your instrument.

1. Turn off the HV power switch (rocker switch, front panel.)

2. Wait 15 minutes for the unit to cool down.

3. While the unit is cooling down, use and oscilloscope to view your RF and Gate signal; verify that you are within the duty cycle limits for your unit.

4. Once you have made the necessary changes to your input signals, reconnect them and turn the HV power switch back on.

Replacing the HV Fuse

The problem

No high power RF pulse output; when the high voltage power supply is enabled (front panel rocker switch) the high voltage fuse holder (rear panel) glows orange.

Required action

The high voltage power supply fuse must be changed.

It is strongly recommended that that user determine if the instrument settings were responsible for the fuse blow event.

1. Turn off the HV power switch (rocker switch, front panel)
2. Turn off the AC power switch (rocker switch, rear panel)
3. Wait 5 minutes for any remaining high voltage to dissipate.
4. Replace the fuse.
5. Once you have made the necessary changes to your input signals, reconnect them and turn the HV power switch back on.

Replacement fuses must be of the same type and rating as specified in this manual to maintain protection.

FOR 400W (-HD) and standard 8 kW models:
USE ONLY GBB-8-R replacement fuses when replacing the HV fuse

For High Power 15kW or Very High Power 20kW units:
USE ONLY GBB-10-R replacement fuses when replacing the HV fuse

Replacing the Line Fuse

The problem

The unit will not turn on.

Required action

The line fuse must be changed.

It is strongly recommended that that user determine if the instrument settings were responsible for the fuse blow event.

The RPR-4000 has an auto switching AC mains input. Acceptable inputs are 95-125VAC ±5% and 195-250VAC ±5% at 300VA. Always connect the RPR-4000 to a properly grounded source using the supplied line cord. Failure to properly ground this instrument could result in injury.

Replacement fuses must be of the same type and rating as specified in this manual to maintain protection:

For AC Input voltages of 95-125VAC
USE ONLY 5A 250V replacement fuses, Glass, Slow Blow 5mmX20mm

For AC Input voltages of 195-250VAC
USE ONLY 2.5A 250V replacement fuses, Glass, Slow Blow 5mmX20mm

.

Routine Maintenance

There are no user serviceable parts inside the instrument. Please contact RITEC or an authorized representative for service.

Cleaning the instrument

The instrument enclosure can be cleaned by using a damp cloth with mild detergent. The cloth should be damp but not dripping. Do not spray liquid directly onto the product. Avoid using either organic solvents or cleaners containing abrasives.

Before cleaning the instrument, disconnect from the AC line power. Failure to do so could result in personal injury or damage to the product.

5 Appendices

A. Caution for Transducers

Exercise care when using the RPR-4000 with transducers, especially for the first time.

The high voltage and high duty cycle available from the RPR-4000 may make it necessary to use modified or custom transducers. Experience has shown that transducers with built in resonating inductors are most prone to failure because of either overheating of the inductor or voltage breakdown.

Special transducers with at least a voltage rating of 1000 volts peak for the 8kW version, 1300 volts peak for the 15kW version and 1500 volts peak for the 20kW version are required if operation at full output power is desired. In addition, if impedance matching techniques are employed then voltages present at the transducer may be even higher. During the development and evaluation of tests and measurements with new transducers, careful monitoring of the excitation signal **at the transducer** is required.

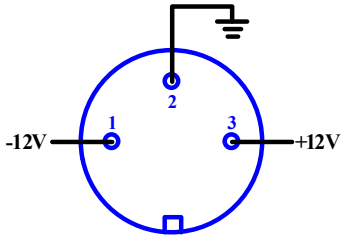
During use at higher duty cycles, a method of removing heat from the transducer body may be necessary. For some transducers, excessive heat may cause the material to permanently lose its ability to generate ultrasound.

B. Power Supply Output Connector

There is an auxiliary power connector located on the rear panel of the RPR-4000 to power peripherals such as a preamplifier. For safety reasons, the connector on the instrument is female.

All Ritec peripherals are powered via a seven pin connector. When ordering RITEC peripherals, please indicate that you will be powering them from an RPR-4000. This will insure the Ritec power peripheral will be set up to work properly with your instrument and be supplied with the proper peripheral power cord. In the case of the RPR-4000 the proper peripheral power cord will be a three pin male to seven pin female cord.

The female connector on the rear panel is shown below. Outputs available are -12V @ 100 mA on pin one, +12V @ 100 mA on pin three. Pin two is tied to earth ground.



C. Warranty and Disclaimer Statement

All RITEC instruments are warranted against defects in material and workmanship for a period of one year after date of shipment. RITEC agrees to repair or replace any assembly or component found to be defective after normal use during this period. RITEC's obligation under this warranty is limited solely to repairing any such instrument which, in RITEC's sole opinion, proves to be defective within the scope of the warranty when returned to the factory. Transportation to the factory is to be prepaid by the purchaser. Shipment should not be made without prior authorization by RITEC.

This warranty does not apply to any products repaired or altered by persons not authorized by RITEC, or not in accordance with instructions furnished by RITEC. If the instrument is defective as a result of misuse, improper repair, or abnormal conditions or operations, repairs will be billed at cost.

RITEC assumes no responsibility for its product being used in a hazardous or dangerous manner either alone or in conjunction with other equipment. High voltage used in some instruments may be dangerous if misused. Special disclaimers apply to these instruments. RITEC assumes no liability for secondary charges or consequential damages and, in any event, RITEC's liability for breach of warranty under any contract or otherwise shall not exceed the purchase price of the specific instrument shipped and against which a claim is made.

Any recommendations made by RITEC for use of its products are based upon tests believed to be reliable, but RITEC makes no warranty of the results to be obtained. This warranty is in lieu of all other warranties, expressed or implied, and no representative or person is authorized to represent or assume for RITEC any liability in conjunction with the sale of our products other than set forth herein.

This warranty covers only items manufactured by RITEC. It specifically excludes all items sold by RITEC which were manufactured by other companies. All of these items are subject to their original individual manufacturer's warranty. Any claims for defective merchandise should be made to the original manufacturer for these items.