DPR300 Pulser/Receiver

Operator Manual

August 2001

JSR Ultrasonics

Technical Support

There are no user serviceable parts in the DPR300. DPR300 units should be returned to the manufacturer for any repair.

Contact Information

The answers to most questions regarding the use of the DPR300 Pulser/Receiver are contained in this manual. Please use this as your first source for information. If, in this manual, you cannot find an answer to a question, please contact JSR Ultrasonics technical support at:

Voice: +1 716 264 0480
Fax: +1 716 264 9642
E-mail: sales@jsrultrasonics.com

Please have the following information available when contacting Technical Support:

1) Instrument model number.
2) Instrument serial number.
3) The specific nature of the problem.

Technical support is available Monday through Friday from 8:00AM to 5:00PM EST.

Warranty Agreement

Hardware Limited Warranty

JSR Ultrasonics, Inc. warrants that its instruments will be free from defects in materials and workmanship for a period of one year from the date of purchase. JSR will, at its option, repair or replace any of its products that prove to be defective during the warranty period without charge for parts and labor.

To obtain service under this warranty, the Customer must ship the defective product to JSR with the shipping charges prepaid. The Customer will be responsible for packaging the defective product, preferably in the original packaging materials.

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Section 1

General Description

Description

The DPR300 is a general-purpose ultrasonic pulser/receiver that can be configured for a wide range of uses. In addition to describing available DPR300 features and options, this manual indicates the differences between the available DPR300 configurations.

The DPR300 can be configured during manufacture as a pulser/receiver with manual-only control, PC control, or simultaneous manual and PC control. For DPR300 units populated with both front panel and remote PC controls, the instrument responds to both sets of controls, and each instrument function will be set to the value most recently received from the front panel or remote command.

The DPR300 receiver is available in 35MHz and 50MHz bandwidths, and the DPR300 pulser is available in 475V and 900V amplitude ranges. *Users should familiarize themselves with the operational limits of DPR300 pulsers that have the 900V option installed by reading about the PRF command in Section 6 of this manual.*

In a typical DPR300 application, the DPR300 pulser produces a high voltage electrical excitation pulse and applies this pulse to the instrument's T/R connector. An ultrasonic transducer connected to the T/R connector via a length of 50 Ω coaxial cable is then employed to convert the electrical energy of the excitation pulse into an ultrasonic pulse that is propagated into a test material or medium. Four energy levels, sixteen amplitude levels, and two pulser-impedance values offered by the DPR300 enable the user to adjust the characteristics of the excitation pulse to the specific transducer employed. Sixteen discrete damping levels in the DPR300 allow the transducer response to be adjusted over a wide damping range.

With the DPR300 configured for pulse-echo mode operation, acoustic echoes reflected from interfaces or defects within the test material are converted by the transducer into electrical signals that are presented to the T/R connector of the DPR300. The low-noise DPR300 receiver amplifies these electrical signals, and the signals then pass through adjustable high pass and low pass filters. The DPR300 receiver gain is adjustable between -13 dB and 66 dB, and there are six high pass and six low pass filter settings for band-limiting the receiver frequency response. The amplified and filtered signals are available on the instrument's Receiver Output connector.

The DPR300 may also be used in transmission mode operation wherein a separate receiving transducer is used to detect acoustic pulses that have propagated through a test material or medium. This second transducer is connected to the DPR300 receiver Through connector, and the received signals are processed as described above for pulse-echo mode operation.

The DPR300 allows external equipment such as A/D digitizer boards or oscilloscopes to be synchronized to the pulser operation. To facilitate this, a synchronization pulse applied to the Trig/Sync. connector can be employed to trigger the pulser when the instrument is in external trigger mode. Alternatively, when the DPR300 is configured for internal-trigger mode, a short pulse is output on the Trig/Sync. connector simultaneous with the generation of the excitation pulse. All connectors on the DPR300 are BNC-type with the exception of the computer interface connectors.

Physical

The DPR300 ultrasonic pulser/receiver is a complete instrument on a stand-alone enclosure. The enclosure dimensions are 12” deep, 8.25” wide, and 3.5” high.

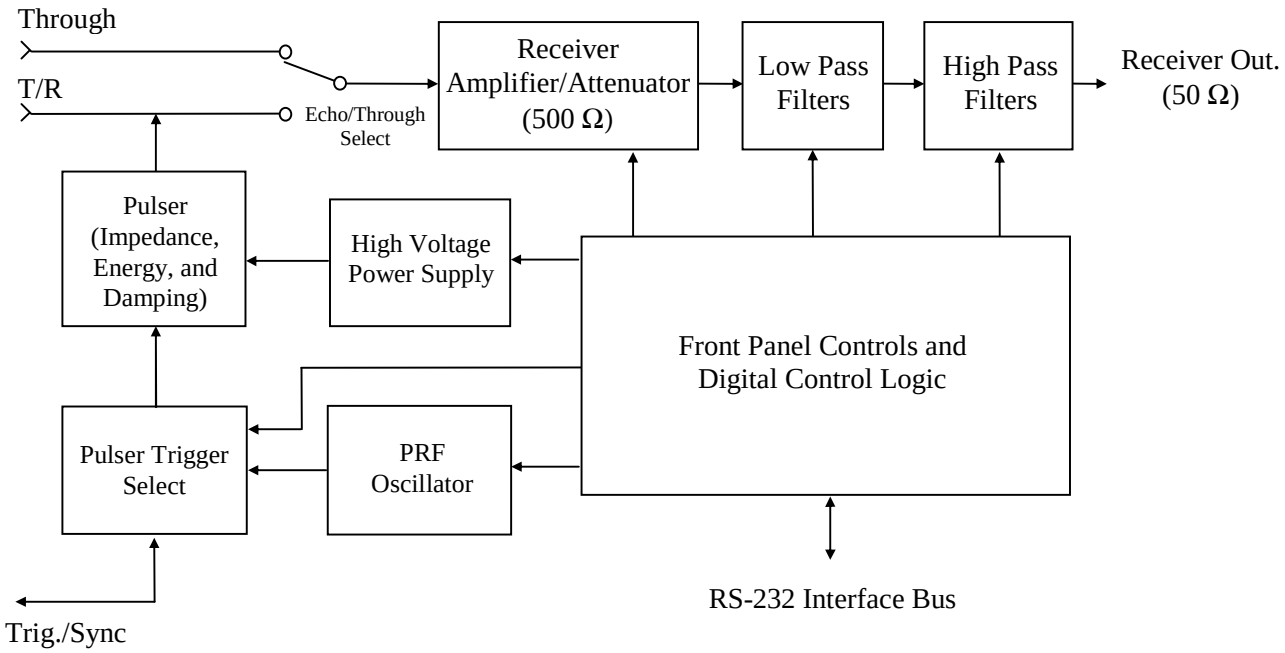
Section 2

Theory of Operation

DPR300 Subsystems and Their Functions

The DPR300 pulser/receiver is composed of the functional blocks shown in the figure below. These functional blocks include the front panel and remote control hardware, high voltage power supply, pulser, pulser trigger select, PRF oscillator, receiver amplifier, receiver low pass filters, receiver high pass filters, and the RS-232 interface for instruments with the remote PC control option. Instrument control software resides in the remote computer and controls the instrument via the RS-232 serial-interface bus.

DPR300 System Block Diagram



Instrument Control Software

Control software enables a user to remotely control the DPR300 from a PC for instruments with the remote PC control option. In addition to the control program

provided with the DPR300, information is provided in this manual for users that wish to develop custom instrument control programs.

Manual Controls, Digital Control Logic, and RS-232 Interface

The remote control interface and control logic enables the control of the DPR300 from software running on the host computer. Communication is via an RS-232 interface such as the COM1 or COM2 ports on the remote computer. Front panel controls enable manual control of instruments with the manual control option.

High Voltage Power Supply

The precision-regulated high-voltage supply provides power to the pulser. Precise voltage regulation allows the DPR300 pulser to maintain constant pulse amplitude regardless of changes in either the pulse repetition rate or other instrument controls. The voltage may be adjusted from 100V to 475V or from 100V to 900V depending on the pulser voltage option installed.

Pulser (Impedance / Energy / Damping)

The pulser generates an excitation pulse upon receiving a trigger event from a selected source. There are four energy and two impedance values, and the single Energy and Impedance control adjusts the pulse energy and the pulser impedance.

The damping control allows the damping impedance at the pulser output to be set to one of sixteen discrete values.

Pulser Trigger Control

This control selects between the internal PRF oscillator or an external source applied to the Trig/Sync. connector as trigger sources for the DPR300 pulser.

PRF Oscillator

The internal PRF oscillator generates repetitive trigger pulses for the pulser subsystem under the control of the PRF control.

Receiver Amplifier

Controls the amplification or attenuation of signals processed by the DPR300 receiver. The receiver gain can be varied from -13 dB to +66 dB. The DPR300 receiver has an input impedance of 500 ohms and is available in both 35MHz and 50MHz bandwidths.

Low Pass Filters

These filters are available for reducing the bandwidth of the DPR300 receiver. High frequency bandwidth limiting can be used to improve the signal to noise ratio for applications that do not require the full receiver bandwidth. Six low pass filter settings are available in the DPR300, and the exact filter cutoff frequencies depend upon the receiver bandwidth selected..

High Pass Filters

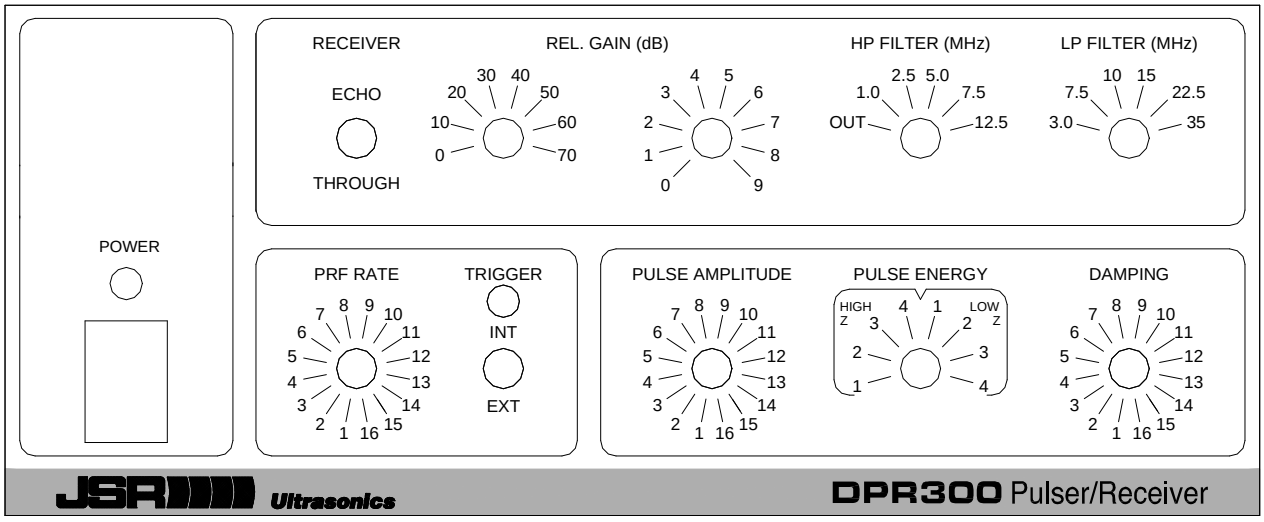
These filters are available for eliminating undesirable low frequency energy from the DPR300 receiver signal. High pass filtering can be used as a means of providing faster receiver recovery from strong signals such as the excitation pulse or strong interface echoes. Six high pass filter settings are available in the DPR300.

Section 3

Controls, Indicators, and Connectors

In this section, the DPR300 ultrasonic pulser/receiver controls, indicators, and connectors are described. The main power switch, power indicator LED, and pulse indicator LED are common to all DPR300. The remaining controls apply only to DPR300 instruments with manual controls. The diagram below shows the locations of the DPR300 front panel controls.

DPR300 Front Panel



Main Power Switch

A push button switch for turning on/off power to the DPR300.

Power Indicator LED (Power)

An amber-colored LED that lights to indicate that power is applied to the DPR300. This LED can also be made to blink at a controlled rate by the 'Blink' command described in Section 6.

Pulse Indicator LED (Pulse)

This is a red LED indicator that illuminates when the DPR300 pulser is firing.

PRF Control

A rotary switch that selects the frequency at which the pulser fires when internal trigger operation is selected. The PRF values range from 100 Hz to 5 kHz.

Int / Ext Switch

A toggle switch that selects between internal trigger (PRF) and external trigger sources for the pulser.

Echo / Through Switch

A toggle switch that connects the receiver input to the T/R BNC connector or Through BNC connector for Pulse/Echo or Through mode operation respectively.

Rel. Gain Controls

These controls are a pair of rotary switches that set the receiver gain. The receiver gain will be the value indicated by the switches minus 13 dB.

HP Filter Control

This control is a rotary switch that sets the receiver high-pass filter to the value indicated.

LP Filter Control

This control is a rotary switch that sets the receiver low-pass filter to the value indicated.

Pulse Amplitude Control

This control is a rotary switch that sets the amplitude of the excitation pulse generated by the pulser. The amplitude is adjustable between 100V and 475V or 100V and 900V depending on the pulser option installed.

Pulse Energy and Pulser Impedance Control

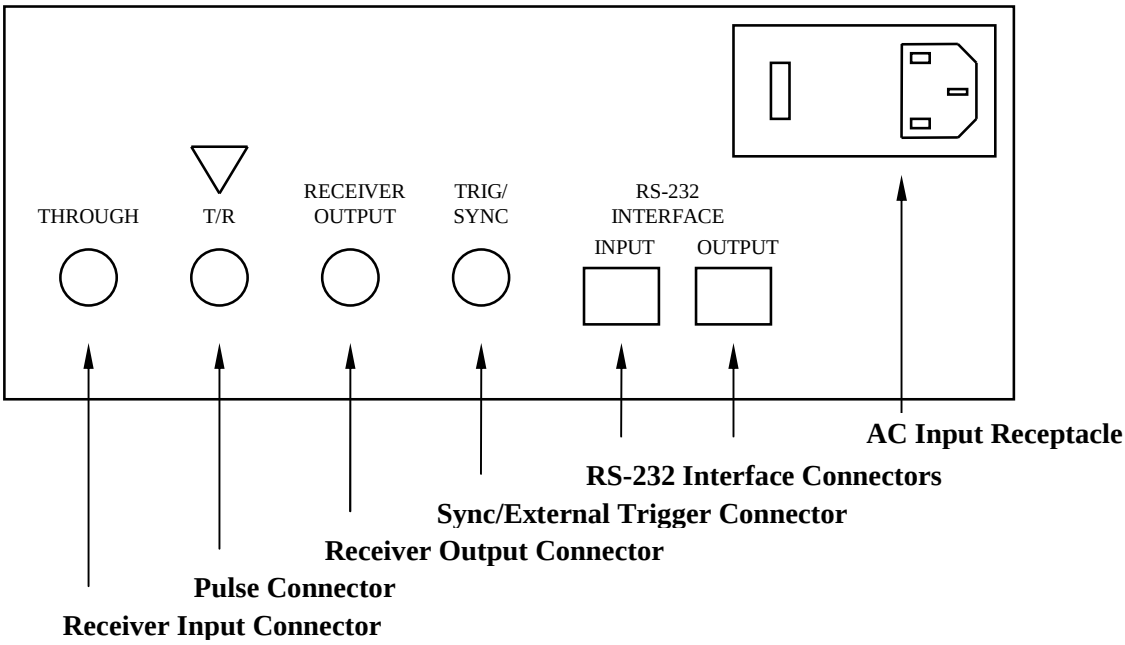
This control is a rotary switch that sets the energy of the excitation pulse generated by the pulser, and the pulser impedance. This switch combines the pulser energy and pulser impedance functions. The High Z impedance range provides for better transducer damping while the Low Z impedance range provides for better signal strength.

Damping Control

This control is a rotary switch that adjusts the damping applied to the transducer.

The diagram below shows the positions of the connectors on the DPR300 rear panel.

DPR300 Rear Panel Connectors



Receiver Input Connector (Through)

This connector is a BNC receptacle for use in connecting receiving transducers to the DPR300 receiver during through-transmission mode operation.

T/R Pulse Connector

A BNC receptacle for connecting to a transmit/receive (T/R) transducer during pulse-echo mode operation, or to a transmitting transducer during through-transmission mode operation.

Receiver Output Connector (Receiver Output)

This connector is a BNC receptacle on which the output signal from the DPR300 receiver is available. This output signal line should be terminated with a 50 Ω load.

Trig / Sync Connector

This connector provides a positive polarity sync pulse signal that can be used to trigger an oscilloscope or other signal monitoring/recording instrument when the DPR300 internal oscillator is used to trigger the pulser. In this mode, the signal line should be terminated with a 50 Ω load.
If the DPR300 pulser is operated in external trigger mode, then the Trig / Sync connector is used for receiving a positive going 3V to 5 V external trigger pulse. Triggering of the pulser will occur synchronously with the rising edge of the trigger pulse.

When triggering the DPR300 pulser from an external source, it is important to ensure that the pulse repetition frequency does not exceed limits defined later in this text.

RS-232 Interface Connectors

These connectors are a pair of RJ45 receptacles through which computer control of the DPR300 is effected on units with the remote PC control option installed. An RS-232 serial-interface port on the control computer is connected to the Input RJ45 receptacle using the eight-conductor reversing RJ45 cable and the DB-9 to RJ45 adapter supplied with the DPR300. When control of other DPR300 instruments is desired, they may be added in a daisy-chain fashion by connecting a reversing RJ45 cable from the RS-232 Output connector on one instrument to the RS-232 Input connector of the next instrument.

AC Input Receptacle

This receptacle is standard power receptacle with fuses. Any supply voltage from 100VAC to 240VAC at 50 Hz or 60 Hz may be applied.

Section 4

Instrument Setup

This section describes requirements for the control computer and the setup procedure for the DPR300.

System Components

The following system components should be present in your shipment:

- DPR300 Pulser/Receiver
- DB-9 to RJ45 Adapter (for DPR300 units with remote control function)
- RJ45 Serial Interface Cable (for DPR300 units with remote control function)
- Power Cord
- DPR300 Instruction Manual
- DPR300 software control program.

Mains Disconnect

The power cord is the mains disconnect device. Position the DPR300 such that the instrument can be easily disconnected from the main power supply when needed.

Earth Ground

Earth ground is connected to the instrument through the power cord.

Computer Requirements

DPR300 units with the remote control option can be controlled by a PC or compatible computer with an available COM1, COM2, or RS-232 serial port.

System Configuration

1. Locate the power receptacle on the rear of the DPR300.
2. Verify that the fuse values are correct. Pull the fuses out of the power receptacle and verify that they both have value .20A. Slide the proper fuses into the power receptacle and snap the cover closed.
3. For DPR300 units with the computer control option:
    a) Plug the RS-232 to RJ-45 adapter into the COM1, COM2, or RS-232 serial port on the computer that will be used to control the DPR300.

   b) Plug one end of the RJ45 serial interface cable into the DB-9 to RJ45 adapter. Plug the other end of the cable into the DPR300 rear connector labeled RS-232 Input.

4. Plug the power cord into the power receptacle on the rear of the DPR300, and plug the other end into a power outlet of the correct voltage.
5. Turn on power to the DPR300 with the front panel power switch.
6. Control the DPR300 using either:
   a) Manual front-panel controls, or
   b) The software control program installed and running on a PC or control computer.

Section 5

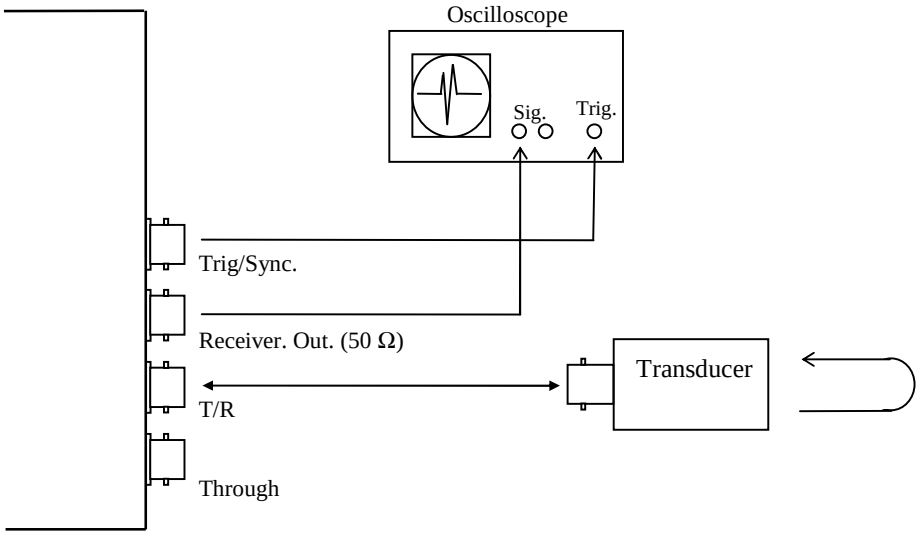
Operation

Pulse-Echo Mode Operation

In the pulse-echo mode of operation, a single transducer is used for both pulse generation and echo receiving. To configure the DPR300 for pulse-echo mode operation, the transmit/receive transducer is connected to the rear panel BNC connector labeled T/R, typically via a short length of 50Ω coaxial cable.

The DPR300 pulse-echo mode configuration is shown in the following figure.

Pulse-Echo Mode Operation

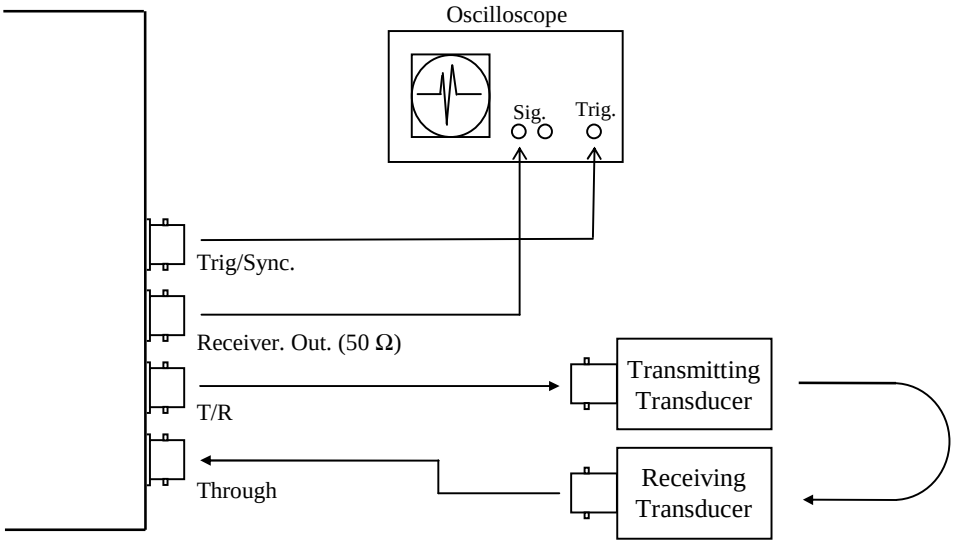


Transmission Mode Operation

For transmission mode operation, separate transmitting and receiving transducers are employed. The transmitting transducer is connected to the DPR300 T/R connector and the receiving transducer is connected to the Through BNC connector.

The DPR300 transmission mode configuration is shown in the next figure.

Transmission Mode Operation



Operating the DPR300

The following sequence of steps describes a typical operating session with the DPR300.

1. Connect a transmit/receive transducer or separate transmit and receive transducers to the DPR300 as explained above. For contact applications, use a suitable acoustic couplant between the transducer(s) and the sample that is to be tested.
2. Connect the DPR300 BNC connector labeled Receiver Output to the input of an oscilloscope or waveform digitizer via a length of 50Ω coaxial cable. The monitoring oscilloscope or digitizer should have a 50Ω input impedance. If the device input has a high impedance, then a shunt 50 Ω terminator should be added to the input.
3. If a computer is used to control the DPR300, use the supplied software to initialize and control the instrument from a PC or other computer. Otherwise use the front panel controls to control the instrument.
4. Set the pulse trigger control to INT if the DPR300 pulser is to be triggered by the internal PRF oscillator, and connect the DPR300 Trig/Sync connector to the external trigger input of the monitoring oscilloscope. If the DPR300 pulser is to be triggered from an external source such as the synchronization signal of a waveform digitizer, then set the pulse trigger control to EXT and connect both the DPR300 Trig/Sync connector and the external trigger input of the oscilloscope to the source of the external trigger signal. The coaxial cable from the trigger source may be connected to more than one high-impedance load (such as the trigger input of the oscilloscope) but the final connection on the end of the coax cable should be to

the DPR300 Trig/Sync connector. The input impedance of the DPR300 Trig/Sync connector is 50 Ω, which serves to properly terminate the trigger signal on the coaxial cable.

5. Using the control software or manual front-panel controls, the instrument may be configured for the operation desired. The red Pulse indicator located on the DPR300 front panel should illuminate when the pulser is firing. Once the pulser is firing, the pulse amplitude (voltage), energy, and damping may be adjusted to match the transducer requirements. In addition, the pulse repetition frequency (PRF) should be adjusted such that all echoes from any previous excitation pulses have subsided before a new excitation pulse is generated.
6. Adjust the gain control to obtain a signal level between ± .2 and ± .5 Volts peak into a 50 Ω load at the SIG OUT connector.
7. Adjust the high and low pass filter cutoff frequencies as necessary. High pass filters can be used to speed amplifier recovery from the main excitation pulse or large interface echoes. For the low pass filter, the cutoff frequency can be reduced in order to improve the signal to noise ratio in low frequency applications.

Section 6

Remote Operation of the DPR300

This section describes the DPR300 communications interface and the various commands used to configure and control the instrument. Using this information, a user can develop custom software applications may be developed for controlling one or more DPR300 instruments that have the remote control interface option.

DPR300 units that possess both a front panel control option and a remote PC control interface will respond to both sets of controls with each instrument function taking the function value last received from either the front panel or remote PC. The front panel controls in these instruments may be individually disabled using the 'm' mode command described in this section such that the associated function will only respond to remote PC commands. Otherwise, when a front panel control is changed, the instrument will send a confirmation of the function change to the remote PC as described herein. This confirmation message function may be disabled using the 'c' configure command.

DPR300 Remote Operation Overview

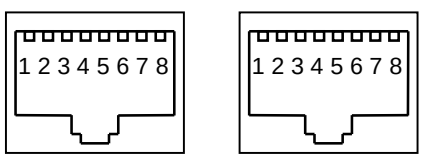
Communication between the control computer and DPR300 is via an RS-232 interface using the COM1 or other RS-232 serial port on a control computer. Commands are issued by the control computer and consist of a sequence of bytes transmitted via the RS-232 interface to the DPR300.

Multiple DPR300 instruments may be connected in a daisy-chain fashion to the serial port on the control computer. A command sent by the computer will be received by all instruments in the daisy chain, and acted upon by only the addressed instrument(s). If a DPR300 in the daisy chain is turned off, it will not impede communication between the computer and other instruments.

Up to 255 instruments may be connected to the serial port. All instruments may be controlled independently through the assignment of individual addresses.

COM Port Configuration

The RS-232 serial port on the control computer should be configured to 4800 baud with 1 start bit, 8 data bits, one stop bit, and no parity. An adapter is supplied to convert the DB-9 serial port connector on a PC to an RJ45 receptacle. An RJ45 reversing eight-conductor cable is then used to connect from the serial port to the RS-232 input connector on the DPR300. The pin assignment of the DPR300 rear panel RS-232 interface connectors is shown below.



Pin	Input	Output
1	RXD	TXD
4	Gnd	Gnd
5	Gnd	Gnd
8	TXD	RXD
2,3,6,7	No connection	

Command Protocol

A DPR300 command consists of a sequence of 5 or more bytes transmitted via the serial port to the instrument. This byte sequence includes the address of the individual instrument to be controlled, the length of the command byte sequence, one or more data bytes, and a stop byte. A single dummy data byte is sent with commands that do not require any accompanying data. The generic command byte sequence is as follows:

Byte 1: Address of instrument to be controlled.
Byte 2: Number of data bytes minus one that follow byte 3 and precede the stop byte.
Byte 3: Command byte that identifies the specific command being sent.
Byte 4: First data byte (for some commands this will be a dummy byte)
Byte 5: Second data byte, if any.
Byte N: Stop byte

The DPR300 must synchronize to the command byte sequence in order to interpret the command bytes properly. To provide for automatic synchronization, the time interval between any two sequential bytes received by the DPR300 must not exceed 50 mSec. If a delay exceeding 50 mSec occurs, the RS-232 receiver logic of the DPR300 will reset and the next received byte will be interpreted as Byte 1 of a new command. Following a minimum of 50 mSec of inactivity on the serial port, all instruments connected to that port will reset their RS-232 receivers. Instrument control software must thus ensure that intervals between transmitted bytes do not exceed 50 mSec during the transmission of a command to a DPR300.

Command Types

Commands sent to the DPR300 may be grouped into the following three categories:

1) Configuration of the instrument and system
2) Function control to alter instrument function values
3) Queries to determine the current value of instrument functions

These categories and their associated commands are described below.

Configuration

A maximum of 255 individually addressed DPR300 instruments may be connected in a daisy chain fashion on a single serial port. No other equipment such as modems or printers may be connected to the same serial port. Each instrument may be assigned a unique nonzero address between 1 and 255. Once assigned, the instruments retain their addresses in nonvolatile memory. Instrument addresses may be reassigned at any time. Instruments should be assigned unique addresses, but this is not a requirement. If multiple instruments are assigned identical addresses, they will act upon received commands properly but their simultaneous responses via the serial port may interfere and be garbled.

Commands are received simultaneously by all instruments connected to the bus, and the value of the address byte in the command determines which instrument(s) will act upon the command. A means of easily assigning unique addresses to instruments is required, especially for multi-instrument systems in which the addresses of instruments may not be known and may not be unique when a system is first assembled. There are four configuration commands that allow a user to assign a unique address to each instrument. These commands, described below, employ the ASCII values of the characters D, A, I, and E as their command byte values.

D Command

The D command is a command used to initiate address assignment. This command is composed of the following byte sequence:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	
0x00	0x00	0x44	0x00	0x00	Note: 0x44 is the ASCII value for 'D'

All instruments respond to the Byte 1 address value of 0x00 and the Byte 3 command value of 0x44 (ASCII value for D) regardless of their current address assignments. The D command causes all active instruments to enter into 'address assignment mode', a mode in which they will remain until receiving an E command which is described later. Instruments act upon the D command by breaking the RS-232 connection to the next instrument on the daisy chain. Thus, following the D command, the first instrument in the daisy chain will continue to receive commands from the computer but will not relay these commands to the second instrument. Likewise, the second instrument will have isolated itself from the third instrument, and so forth along the daisy chain. After issuing a D command, communication is isolated to just the computer and the first instrument on the daisy chain.

Following the D command, the I, A, and E commands may be issued to request information, assign an address, and to exit from 'address assignment mode' and reestablish the serial link to the next instrument respectively. These commands are described below.

I Command

The I command may be sent following the D command in order to request information from an instrument. In addition to the requested information, the instrument will return its current address value. The I command is composed of the following byte sequence:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	
0x00	0x00	0x49	Value	0x00	Note: 0x49 is the ASCII value for 'I'

The Byte 4 value, described below, indicates the type of information requested. The instrument responds by returning a byte sequence to the control computer that includes its current address assignment as the first byte in the response string. This response sequence is identical to the instrument's response to the 'i' command described later in the query section. (Note that while servicing this command, the pulser in the instrument may not respond to some trigger events.)

In the response string, the first byte of the response is the instrument's current address. The second byte states the number of bytes to follow, beginning with Byte 3. The third byte is 0x69, the ASCII value for I, which indicates that the DPR300 is responding to an I command. There are several I commands to which the instrument will respond which differ only in the value assigned to Byte 4. These commands are listed below together with the associated responses made by the instrument:

1) Byte 4 = 0x00. The instrument type is returned as shown below.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9
Address	0x07	0x69	0x44	0x50	0x52	0x33	0x35	0x47
		I	D	P	R	3	0	0

2) Byte 4 = 0x01. The instrument serial number is returned as shown below.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9
Address	0x07	0x69	value	value	value	value	value	value
		I	#	#	#	#	#	#

where Bytes 4-8 are the ASCII values corresponding to the characters of the serial number, e.g. DA1234.

3) Byte 4 = 0x02. The instrument firmware and hardware revisions are returned.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
Address	0x03	0x69	value	value
		I	Firm Rev.	Hard Rev.

where Byte 4 is the ASCII value corresponding to the instrument firmware revision, e.g. ‘C’, and Byte 5 is the ASCII value corresponding to the instrument hardware revision, e.g. ‘D’.

4) Byte 4 = 0x03. The hardware serial number of the DPR300 circuit board is returned.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9
Address	0x07	0x69	value	value	value	value	value	value
		I	hh	hh	hh	hh	hh	hh

Byte 4 through Byte 9 are, respectively, the MSB to LSB digits of the serial number. Each byte is decoded by converting both its upper and lower nibble to their corresponding hexadecimal value, and the complete serial number is thus composed of twelve hexadecimal values. The hardware serial number differs from the instrument serial number in that the hardware number pertains only to the main internal circuit board of the DPR300 while the instrument number applies to the entire instrument. For purposes of instrument identification, the instrument serial number should be used.

5) Byte 4 = 0x04. The bandwidth of the DPR300 receiver is returned.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
Address	0x03	0x69	value	value

Byte 4 and Byte 5 are ASCII characters that identify the bandwidth of the receiver, e.g. 35.

6) Byte 4 = 0x05. The maximum value of the excitation pulse amplitude is returned.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
Address	0x04	0x69	value	value	value

Byte 4 through Byte 6 are ASCII characters that identify the maximum pulse amplitude available from the pulser in volts, e.g. 475

7) Byte 4 = 0x06. The receiver High-Pass filter cutoff frequencies are returned.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	….	Byte 19
Address	0x11	0x69	value	value		value

Byte 4 through Byte 19 are ASCII values that comprise a comma separated list of the DPR300 receiver high-pass filter values expressed in MHz., e.g. 1,2.5,5,7.5,12.5

8) Byte 4 = 0x07. The receiver Low-Pass filter cutoff frequencies are returned.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	….	Byte 19
Address	0x11	0x69	value	value		value

Byte 4 through Byte 19 are ASCII values that comprise a comma separated list of the DPR300 receiver low-pass filter values expressed in MHz., e.g. 3,7.5,10,15,22.5

9) Byte 4 = 0x08. The pulser energy capacitor values are returned.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	….	Byte 20
Address	0x12	0x69	value	value		value

Byte 4 through Byte 20 are ASCII values that comprise a comma separated list of the DPR300 pulser energy capacitor values expressed in pico-farads, e.g. 310,620,1350,2700

10) Byte 4 = 0x09. The front panel hardware and firmware revisions are returned. This command may be employed to distinguish whether or not a DPR300 has the manual control option installed.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
Address	0x03	0x69	value	value

Byte 4 and Byte 5 are integer values representing the firmware and hardware revisions of the front panel board, respectively. If the DPR300 does not have the manual control option, Byte 4 and Byte 5 both have value 0xFF.

11) Byte 4 = 0x0A. The gain range of the instrument is returned.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	….	Byte 10
Address	0x08	0x69	value	value		value

Byte 4 through Byte 10 are ASCII values that comprise a comma separated list of the DPR300 minimum and maximum gain values expressed in dB, e.g. –13,+66

Once the current address of an instrument has been established using the I command, a new address may be assigned with the A command, if desired. Alternatively, the E command may be issued to skip to the next instrument in the daisy chain.

A Command

To assign an address to an instrument, the following command would be issued at any time following the D command but before an E command is issued:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	
0x00	0x00	0x41	Address	0x00	Note: 0x41 is the ASCII value for 'A'

where 'Address' is a value between 0x01 and 0xFF to be assigned to the instrument. An address value of 0x00 is not valid and will be ignored by the instrument. The A and I commands may be repeated for an individual instrument prior to the issuance of an E command. Thus, the instrument may be queried with the I command to determine its address, then assigned a new address with the A command, and queried again with the I command to verify the new address.

Instruments should be assigned unique addresses. If two instruments receive identical address assignments, both will respond to the same commands, but communication conflicts will result when both attempt to reply to the computer with a confirmation that a command was acted upon.

Once the desired address is set for one instrument in the daisy chain, the process can be repeated for the next instrument in the chain. The E command causes the address assignment process to step to the next instrument in the chain.

E Command

Following the D command which causes an instrument to enter 'address assignment mode', the instrument must receive an E command to exit from this mode. When it exits from this mode, the instrument reestablishes the RS-232 connection to the next instrument in the daisy chain. The E command consists of the following byte sequence:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	
0x00	0x00	0x45	Address	0x00	Note: 0x45 is the ASCII value for 'E'

An instrument that has received an E command will ignore subsequent A and I commands. The next instrument on the daisy chain, having not received the E command, will still be in 'address assignment mode', however, and will respond to A and I commands. After an address is assigned to an instrument, an E command may be used to reestablish the serial link to the next instrument in the daisy chain, and this process repeats until each instrument in the daisy chain has been assigned an address. Following the issuance of an E command to the last instrument on the daisy chain, the instruments are ready for normal usage involving queries and function commands as described below in the Function Control and Queries sections.

Example of address assignment process for a multiple instrument system.

Issue 'D' command	All instruments enter 'address assignment mode' and disable communication to next instrument on the daisy chain.
Issue 'I' command	First instrument responds with current address.
Issue 'A' command, if desired	New address is accepted by first instrument and saved into nonvolatile memory.
Issue 'I' command	First instrument responds with new address.

Issue ‘E’ command	First instrument exits from ‘address assignment mode’ and enables serial link to second instrument.
Issue ‘I’, ‘A’, ‘E’ commands	Assign an address to the second instrument and enable the serial link to the third instrument.
Issue ‘I’, ‘A’, ‘E’ commands	Repeat for each remaining instrument on the daisy chain.

Function Control

Several commands are used to configure the operation of a DPR300. After a command has been acted upon, the DPR300 sends a confirming response. Commands for controlling instrument functions typically consist of the following byte sequence:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
Address	0x00	Command	Value	0x00

‘Address’ is the address of the instrument to be controlled, ‘Command’ is an ASCII value that determines the instrument function to be controlled, and ‘Value’ is the new value to be assigned to the function. For details on the meaning of each control, please refer to Section 2 of this manual. The Byte 3 and Byte 4 values for the various DPR300 commands are described below.

Note that if a command is sent with a Byte 4 value that exceeds the maximum value allowed for that command, the value defaults to the maximum value. The exception to this rule is the pulser voltage command where the value will default to the minimum value.

[b] Blink Command

This command sets the blink rate of the power LED. To invoke this command, set Byte 3 and Byte 4 to the values given below.

Byte 3 = 0x62 ASCII value for ‘b’.
Byte 4 = 100-255 100 = Blink Slowly, … 254 = Blink Rapidly, 255 = LED fully on.

[c] Configure Command

This command configures the DPR300. To invoke this command, set Byte 3 and Byte 4 to the values given below.

Byte 3 = 0x63 ASCII value for ‘c’.
Byte 4 = 0x00 to 0x03

If Byte 4 bit 0 is set to 0, a 5kHz limit will be applied to ext. triggering of the DPR300 pulser. Trigger pulses that exceed this rate will be ignored. Set bit 0 to 1 to disable this feature.

If Byte 4 bit1 is set to 0, automatic update messages will be sent to the remote PC to confirm front panel control changes. Set bit 1 to 1 to disable this feature.

[d] Damping Command

This command sets the damping impedance value for the pulser. To invoke this command, set Byte 3 and Byte 4 to the values given below:

Byte 3 = 0x64 ASCII value for 'd'
Byte 4 = 0-15 The damping impedance, in Ohms, for Byte 4 values from 0 - 15 are, 1000, 333, 200, 143, 111, 91, 77, 67, 58, 52, 47, 43, 40, 37, 34, and 32 respectively.

[e] Energy Command

This command sets the energy value for the pulser. To invoke this command, set Byte 3 and Byte 4 to the values given below. . See also the PRF command regarding allowable limits to the pulser firing rate for DPR300 units with the 900V pulser voltage option installed.

Byte 3 = 0x65 ASCII value for 'e'
Byte 4 = 0-3 Sets pulse energy level (0 - 3) => (min, .. , max)

The energy contained in a pulse is a function of both the 0 - 3 pulse energy control value and the 0 - 15 pulser voltage control value. Expressed as a function, the pulse energy is:

Pulse Energy (Joules) = $L*(100 + 25*V)^2$ for 475V pulsers
Pulse Energy (Joules) = $L*(100 + 53.3*V)^2$ for 900V pulsers

where the value of L for the corresponding pulse energy control values (0,1,2,3) is, respectively, (155×10^{-12}, 310×10^{-12}, 675×10^{-12}, 1350×10^{-12}), and V is the pulse voltage function value, (0,..,15). For example, for a 475V pulser with the maximum energy control value of 3 and V = 15, the pulse energy equals .3046 mJ

[g] Gain Command

This command sets the receiver gain. To invoke this command, set Byte 3 and Byte 4 to the values given below:

Byte 3 = 0x67 ASCII value for 'g'
Byte 4 = 0-79 Sets gain in 1 dB steps (0 - 79) => (-13, .. , 66) dB

[h] High Pass Filter Command

This command controls the receiver high pass filter. To invoke this command, set Byte 3 and Byte 4 to the values given below:

Byte 3 = 0x68 ASCII value for 'h'
Byte 4 = 0-5 Sets high pass filter (0 - 5) => (DC, 1, 2.5, 5, 7.5, 12.5) MHz.

[l] Low Pass Filter Command

This command controls the receiver low pass filter. To invoke this command, set Byte 3 and Byte 4 to the values given below:

Byte 3 = 0x6C ASCII value for 'l'
Byte 4 = 0-5 Sets low pass filter (0 - 5) => (3, 7.5, 10, 15, 22.5, 35) for 35 MHz
(0 - 5) => (5, 10, 15, 22.5, 35, 50) for 50 MHz.

[m] Mode Command

This command selects which functions should respond to front panel control. In other words, manual controls can either be totally or selectively disabled in DPR300 units that

possess both a manual front panel and remote PC control options. Two data bytes are required for the mode command and thus the mode command consists of the following byte sequence:

Byte1	Byte2	Byte3	Byte4	Byte5	Byte6
Address	0x01	0x6D	Value	Value	0x00

The Byte 4 and Byte 5 bit values correspond to the following DPR300 functions:

Byte 4 bits0 - 5 Unassigned
bit6 - Pulser impedance
bit7 - Pulser voltage

Byte 5 bit0 - Echo/Through receiver source
bit1 - Int/Ext trigger source for pulser
bit2 - PRF (Internal trigger pulse repetition frequency)
bit3 - Pulser energy
bit4 - Receiver low pass filter
bit5 - Receiver high pass filter
bit6 - Receiver gain
bit7 - Pulser damping

When a mode bit is set to value 1, the corresponding function will respond to the front panel controls. When the bit is set to value 0, the function will not respond to the front panel. Any combination of front panel controls may be enabled or disabled. To enable all front panel controls, set the mode byte values to 0xFF.

[o] Pulser On/Off Command

The pulser on/off command enables/disables the pulser from firing and enables/disables the pulser voltage supply. When the pulser is disabled and then enabled, a short recovery period of 500 mSec is necessary to allow the pulser voltage supply to stabilize. For fastest power supply recovery, the pulser should not be fired during this recovery period. To invoke this command, set Byte 3 and Byte 4 to the values given below:

Byte 3 = 0x6F ASCII value for ‘o’
Byte 4 = 0,1 Disable/enable pulser (0,1) => (Disable, Enable)

There is no Pulser on/off switch on the front panel. Thus, the ‘o’ command is unaffected by the mode command described above. The ‘o’ command can be used to disable the pulser even if the mode command has configured all instrument functions to be controlled by the front panel.

[p] PRF Command

This command selects the pulse repetition frequency (PRF) of the pulser when internal triggering is selected. To invoke this command, set Byte 3 and Byte 4 to the values given below:

Byte 3 = 0x70 ASCII value for ‘p’

Byte 4 = 0-15 Values in Hz. corresponding to the PRF function values (index) from 0 - 15 are, respectively, 100, 200, 400, 600, 800, 1000, 1250, 1500, 1750, 2000, 2500, 3000, 3500, 4000, 4500, and 5000. This semi-logarithmic sequence provides greater precision in the pulser firing rate at lower frequencies.

DPR300 instruments with the 900V pulser option automatically limit the PRF when the instrument is operating in internal-trigger mode so as to protect the pulser against excess power dissipation. The applied PRF limit depends upon the pulser voltage and energy settings. The following table expresses the recommended maximum PRF index as a function of the pulser voltage index and the pulser energy index.

		Pulser Voltage Index															
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Energy Index	0	15	15	15	15	15	15	15	15	15	15	15	15	15	15	12	11
	1	15	15	15	15	15	15	15	15	15	15	15	15	15	13	11	9
	2	15	15	15	15	15	15	15	15	15	13	12	11	10	9	8	7
	3	15	15	15	15	15	15	13	12	10	9	8	7	6	5	4	4

Maximum Recommended PRF Value vs. Energy Value and Pulser Voltage Value for DPR300 Units with the 900V Pulse Voltage Option

When a DPR300 instrument with a 900V pulser option is operated in internal-trigger mode, the above PRF limits will always be applied as the Energy and Voltage values are adjusted. However, for such instruments operated in external-trigger mode, the average rate of pulser firing must not exceed the rate specified in the table above. For example, if the energy function is set to value 3 and the pulser voltage is set to value 12, then the PRF index limit is 6. This corresponds to a firing rate of 1250 Hz, and the average rate of trigger pulses sent to the pulser should not exceed this value.

[r] Receiver Command

This command selects between Pulse-Echo and Through mode operation for the receiver. To invoke this command, set Byte 3 and Byte 4 to the values given below:

Byte 3 = 0x72 ASCII value for ‘r’
Byte 4 = 0,1 Sets Receiver to Echo/Through (0,1) => (Echo, Through)

[t] Trigger Command

This command selects between internal and external triggering of the pulser. To invoke this command, set Byte 3 and Byte 4 to the values given below:

Byte 3 = 0x74 ASCII value for ‘t’
Byte 4 = 0,1 Sets Int/Ext trigger source (0,1) => (Internal, External)

[v] Voltage Command

This command selects the pulser voltage. To invoke this command, set Byte 3 and Byte 4 to the values given below. See also the PRF command regarding allowable limits to the pulser firing rate for DPR300 units with the 900V pulser voltage option installed.

Byte 3 = 0x76	ASCII value for 'v'
Byte 4 = 0-15	The pulser voltage supply values in Volts corresponding to the pulser voltage function values from 0 - 15 are, respectively 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, 350, 375, 400, 425, 450, and 475. Each step increments the pulser supply voltage by 25 volts. For DPR300 units with the 900V pulser option, the voltages corresponding to the function values 0 - 15 are, respectively, 100, 153, 207, 260, 313, 367, 420, 473, 527, 580, 633, 687, 740, 793, 847, and 900.

[z] Impedance Command

This command selects between low and high pulser impedance values. To invoke this command, set Byte 3 and Byte 4 to the values given below:

Byte 3 = 0x7A	ASCII value for 'z'
Byte 4 = 0,1	Sets pulser impedance (0,1) => (max, min) Ohms.

Response to Commands

Following the issuance of a command, the addressed instrument will confirm that the command has been implemented by responding with the byte sequence shown below:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
Address	0x04	Command	Value	FP Value	Indicator

where 'Address' is the instrument address. Byte 2 describes the number of bytes that follow starting with Byte 3 (four bytes in the above example). 'Command' is the byte value of the received command, Byte 4 is the data byte received with the command and Byte 5 is the current value of the associated front panel control. Indicator Byte 6 has value 0x00 or 0x01 if the instrument function was last set to the Byte 4 or Byte 5 value respectively.

Exceptions to the format described above are as follows:

1) For the 'm' mode command response, Byte 2 has value 0x03 and Byte 6 is eliminated. Byte 4 and Byte 5 are the mode byte values.
2) For the 'b' blink command response, Byte 2 has value 0x03 and Byte 6 is eliminated. Byte 5 has value 0xFF since the LED is fully on for manual control.
3) For the 'c' Configure command, Byte 2 has value 0x03 and Byte 6 is eliminated. Byte 4 is the configuration byte, and Byte 5 has value 0x00.
4) For the 'o' pulser on/off command response, Byte 4 indicates whether the pulser is enabled or disabled by remote control with values 0x00/0x01 indicating disabled/enabled respectively. Byte 5 is given the same value as Byte 4 since there is no front panel control for enabling or disabling the pulser.

The responses above are produced regardless of whether a function is altered by a front panel control or a remote command from a computer. The 'c' Configuration command may be issued to disable such responses from being produced by adjustments made to front panel controls.

Queries

The function commands described above control instrument functions. Queries, on the other hand, are requests for information regarding the instrument or an instrument function, and the value of a function is not altered by a query. Query commands consist of the byte sequence shown below:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
Address	0x00	Query	0x00	0x00

where 'Address' is the address of the instrument to be queried, and 'Query' describes what information is desired. The query character is equal to the logical OR of 0x80 with the command character of the function to be queried. For example, to query a DPR300 for its gain value which is controlled by the 'g' command, the query byte value would be 0x80 OR 0x67 = 0xE7, where 0x67 is the ASCII value for 'g', the gain command character. A list of the query byte values used for requesting the current value of an instrument function is given below:

Command	Query Value	Associated Command
0x62 'b'	0xE2	blink LED
0x63 'c'	0xE3	configure
0x64 'd'	0xE4	damping
0x65 'e'	0xE5	pulse energy
0x67 'g'	0xE7	gain
0x68 'h'	0xE8	high pass filter
------ 'i'	0xE9	inquire[1]
0x6C 'l'	0xEC	low pass filter
0x6D 'm'	0xED	mode
0x6F 'o'	0xEF	pulser en/dis
0x70 'p'	0xF0	PRF
0x72 'r'	0xF2	receiver
------ 's'	0xF3	status[2]
0x74 't'	0xF4	int/ext trigger
0x76 'v'	0xF6	pulser voltage supply
0x7A 'z'	0xFA	pulser impedance

Following the issuance of a query command, the addressed instrument will respond with the following byte sequence:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
Address	0x04	Query	Value	FP Value	Indicator

'Address' is the instrument address, Byte 2 describes the number of bytes that follow counting from Byte 3. 'Query' is the value of the received Query byte minus 0x80, and 'Value' is the current remote controlled value of the function referenced by the query byte. Byte 5 is the value

of the front panel control associated with that function. Indicator Byte 6 has value 0x00 or 0x01 if the instrument function was last set to the Byte 4 or Byte 5 value respectively.

Note 1: The inquiry or 'i' query has no related function command. This query requests information regarding the instrument. Byte 4 selects the type of information desired. With the exception of the Byte 1, the instrument address, the response to this query is identical to that described for the I command. Please refer to the Configuration I command at the beginning of this section for details.

Note 2: The status or 's' query, which has no corresponding function command, requests the current instrument status. The response to this query is as follows:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
Address	0x03	0x44	value	0x00	0x00

where 'Address' is the address of the instrument, Bytes 3 is the ASCII code for 's', and bytes 4 and 5 are the status bytes. At present, the bit values of bytes 4 and 5 have the following meanings:

Byte 4, bit 0: When the value of this bit is 1, this indicates that the instrument has received at least one remote PC command since power was applied. It is zero otherwise.

Byte 4, bits 1-7: Reserved for future assignment.
Byte 5, all bits: Reserved for future assignment.
Byte 6, all bits: Reserved for future assignment.

Appendix A

DPR300 Specifications

Pulser

Pulse Type	Negative spike pulse.
High Voltage Supply	100V to 475V or 100V to 900V, Precision regulated. Sixteen discrete voltage selections are available over the range in equal increments.
Initial Transition (Fall Time)	<5 ns (10-90%) typical for 475V pulsers.
Pulse Amplitude	-475V or –900V peak. Amplitude depends on Energy, Impedance, Damping control settings, and pulser type.
Pulse Energy	1.55 μJoules minimum, 304 μJoules maximum for 475V pulsers. Dependent upon energy and voltage setting.
Pulse Duration	Typically 10-70 ns FWHM for 50 Ω load. Function of the Energy, Impedance, and Damping controls.
Damping	16 Damping values: 24.6, 26.3, 28.1, 30.3, 32.7, 35.7, 39.2, 43.5, 48.7, 55.6, 64.5, 76.9, 95.2, 125, 182, and 333 Ω.
Mode	Pulse-echo or through transmission.
Through Mode Isolation	Typically 80 dB at 10 MHz.
Pulser Repetition Rate	Internal: 100 Hz - 5 kHz for 475V pulsers. Limits apply for 900V pulsers. External: 0 - 5 kHz for 475V pulsers. Limits apply for 900V pulsers.
Sync Output	Maximum +5 V, t_r < 30 ns, t_w = 50 ns. min. TTL and CMOS compatible. Minimum value of load impedance is 50 Ω.
Pulse Trigger Source	Selectable by computer between internal oscillator and external source.
External Trigger Input	3 - 5 V positive going pulse. Triggering will occur synchronously with leading edge of trigger signal. TTL and CMOS compatible.

Receiver

Gain	-13 to 66 dB in 1 dB steps controlled by the host computer.
Phase	0^o (noninverting)
Input Impedance	500 Ω (through transmission)
Bandwidth	.001 - 35 MHz (-3 dB) or .001 – 50 MHz (-3 dB)
High Pass Filter	DC, 1, 2.5, 5, 7.5, and 12.5 MHz.
Low Pass Filter	3.0, 7.5, 10, 15, 22.5 (35 MHz BW) or 5, 10, 15, 22.5, 35 (50 MHz BW)
Receiver Noise	Typically 49 μV peak-peak input referred (measured at 60 dB gain, 35 MHz bandwidth). Typically 59 μV peak-peak input referred (measured at 60 dB gain, 35 MHz bandwidth).
Output Impedance	50 Ω
Output Voltage	±.5 V into 50 Ω

PC or Compatible Control Computer

Interface	Bi-directional communication via RS-232 serial port using RJ45 type 8-conductor cable.
Software	Windows based control program, Windows 98/95 and NT .dll's and LabVIEW .vi and C language drivers provided.

Environmental Conditions

Operating Temperature	0 to 50 ^{O}C
Operating Humidity	0 to 80% RH non-condensing

Miscellaneous

Power	10 W
Dimensions	3.9" High, 8.5" Wide, 12.25" Deep
Weight	5.0 lbs (2.3 Kg)
Operating Temperature	0 to 50 ^{o}C

Notes: Specifications typical at 25 ^{o} C