10ERS5

Single Channel High-Frequency Pulser/Receiver

Daxsonics Ultrasound

Features:

- **± 100V Maximum Pulse Voltage (± 200V available as custom feature)**

- **User Adjustable Pulse Frequency Range:**
    - **4-65 MHz**

- **52 dB Typical Dynamic Range (noise floor to 1dB compression point)**

- **User Adjustable Amplification Range:**
    - **22-67 dB**

- **±670mV 3dB Compression Point**

Description:

The 10ERS5 is a high-bandwidth, low noise pulser/receiver for high frequency ultrasound imaging. The unit delivers single-cycle bipolar square pulses with user selectable pulse amplitudes ranging from ± 5V up to ± 100V in $5V_p$ intervals and user-selectable pulse frequencies from 4MHz up to 65MHz. The 10ERS5 may be externally trigged with a >2.0V pulse or triggers may be generated from an internal clock with pulse repetition frequency (PRF) ranging from 14KHz to 500 Hz.

A fixed gain low noise amplifier (noise figure <1.3 dB) is followed by second-stage variable gain amplifier that allows the user to configure receive amplification from 22dB to 67dB. Pulse parameters can be controlled through either a USB interface or from the instrument panel.
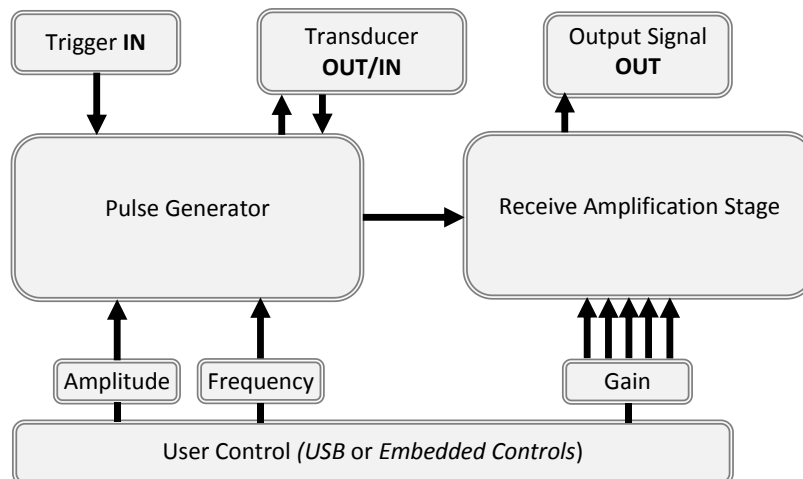
Operation Notes

Triggering

When the CLK setting is set to EXT the pulse generator is triggered from an external >2.0V trigger signal on the EXT line. This line is terminated in a 50Ω impedance. A pulse is generated 74 ns after the rising edge of the trigger signal.

If CLK is set to INT, then the 10ERS5 triggers itself using an internal clock. The pulse repetition period of this clock can be set by changing the value of PERIOD.

Pulser

The pulse amplitude is determined from the value of the AMP parameter. In SINGLE pulse mode the nominal pulse center frequency is set by the value of FREQ1.

The output impedance of the pulser is 5Ω, and there is a parallel 50 Ω termination to absorb reflections from the load. This makes the pulser receiver very versatile and able to drive a wide range of load impedances without causing electrical reflections that can degrade image quality. Transducers with impedances less than 20Ω should have at least three pulse lengths of 50Ω cable between the transducer and the 10ERS5 to avoid overloading the drive circuit. The 10ERS5 is not rated to tolerate a short circuit condition on the pulse outputs, and doing so may result in permanent damage.

Receiver

The amplification stage is connected to the output terminal of the pulser with circuitry to isolate the receive signal from the pulse electronics and to shield the amplification electronics from the high voltages associated with the pulse. The amplification stage isolation voltage limit is optimized for receive signals of 80mVpp or less. The receiver appears to the transducer as a nominal 50 Ω load on receive.

The amplifier consists of a low noise linear amplifier with 36 dB of gain followed by a variable gain amplifier (VGA) capable -14 dB to +31 dB gain. The GAIN setting sets the gain of the second stage. The amplified signal is delivered to the 'Out' terminal of the device which has nominal 50 ohm output impedance. Specific performance data relating to the characteristics of the amplification stage is shown in the 'Typical Performance Characteristics' section of this document.

USB Interface Control - Introduction

The 10ERS5 pulser receiver can be controlled via a USB interface that allows access to all the functions available on the main panel. This section describes the communications subsystem of the 10ERS5, the USB protocol, and the command set used to control the unit.

USB Interface Control - Architecture

USB communications are routed through a Future Device Technologies International (FTDI) FT232R USB-UART chip which translates USB commands into RS232 commands for communication with the internal microcontroller. FTDI provides free drivers for Windows, OSX and Linux that allow the operating system to communicate with the chip. Plugging the USB cable into a computer running Windows will cause the OS to auto-detect a new device and allow a device driver to be installed. Windows drivers for the chip are provided along with the 10ERS5 unit, and driver updates can be obtained from the FTDI website located at http://www.ftdichip.com/Drivers/.

FTDI provides two different device drivers. The Virtual Com Port driver (VCP) makes the USB-to-chip link appear to the operating system like a serial port that can be written to and read from using any virtual emulator supporting serial communications. Daxsonics recommends the excellent free and open-source terminal emulator Tera Term available from:

http://en.sourceforge.jp/projects/ttssh2/

Programmatic control of the 10ERS5 can be achieved using the VCP driver and the system's serial communications application programming interface (API). Both the WIN32 API and the .NET framework provide native support for serial communications. Examples of how to interface with the device using the VCP drivers are provided on the FTDI website.

An alternative means of controlling the 10ERS5 is through the FTDI D2XX driver. This driver provides an API that allows direct communication with the FT232R chip without the need to go through the operating system's serial communication API. The D2XX drivers are useful for controlling the 10ERS5 from within a program and avoids the 10ERS5 appearing as a standard COM port which can potentially cause issues for other programs accessing the COM port. Sample code showing how to use the D2XX API is available on the FTDI website.

USB Interface Control - Command Protocol

Daxsonics command protocol is based on the VISA command architecture standard. A command to the 10ERS5 consists of a colon, a command, a space and one or more arguments separated by commas. A command is followed by a carriage return ("\r"). The commands and arguments are case insensitive and only the first four letters of the command affect the outcome. For example, ":OUTPUT?" and ":outp?" would produce the same result.

Commands are either queries or instructions. Queries end in a question mark and contain no argument. When executed the 10ERS5 will reply with a response. For example, ":AMP?" is a query of the current amplitude setting and may, for instance, cause the 10ERS5 to return "10.0" indicating that the amplitude is $10.0V_{p-p}$.
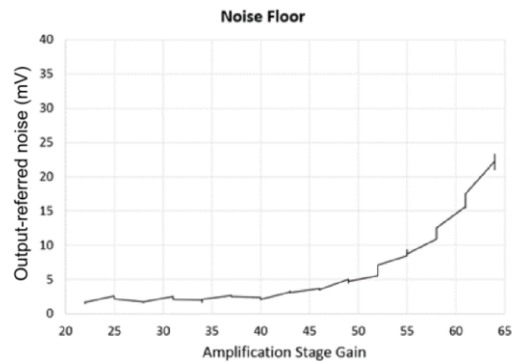
Instructions may contain one or more arguments and generally do not elicit a response, but instead cause the 10ERS5 unit to change its configuration. "AMP 10.0" sets the unit's voltage amplitude to $10.0V_{p-p}$, for instance.

USB Interface Control - Command set

The following are the commands that are recognized by the 10ERS5, along with a brief description of each.

Queries

:IDN*?	Returns a string identifying the unit and giving the revision number
:AMP?	Returns the nominal peak pulse amplitude in volts
:GAIN?	Returns the nominal receive gain in dB
:FREQ1?	Returns the current setting for pulse frequency in MHz
:PERIOD?	Returns the current pulse repetition period in microseconds
:CLK?	Returns the current CLK setting, either INT for internal clock or EXT for external clock
:STATUS?	Returns the current frequency, amplitude, period, gain, and clock setting separated by commas.

Instructions

:AMP	<voltage amplitude in volts>	Sets the pulse amplitude
:GAIN	<gain in dB>	Sets the nominal gain of the variable gain amplifier
:FREQ1	<freq in MHz>	Sets the pulse frequency
:LOCK		Disables the rotary knob on the front panel. The knob can only be re-enabled by issuing the USB instruction :UNLOCK or by power cycling the unit
:UNLOCK		If a :LOCK command had previously been issued this command re-enables the panel knob. If no :LOCK command had been issued then :UNLOCK does nothing.
:CLK	<EXT or INT>	Sets the clock to external or internal depending on the argument
:PERIOD	<pulse repetition period in μs>	Sets the pulse repetition period in microseconds

For instructions that take a quantitative argument, if the argument lies in between two setting values

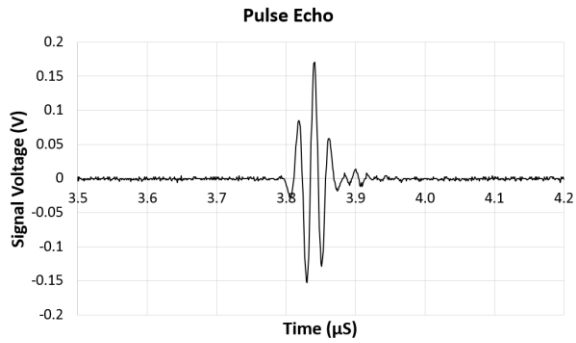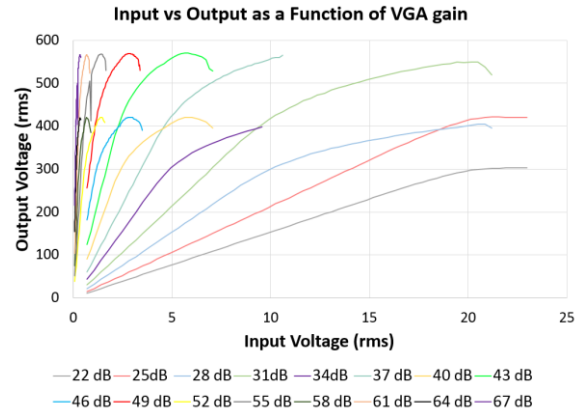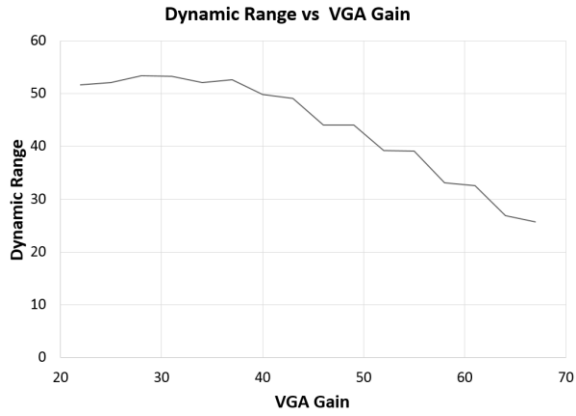the closest one will be selected. For instance, :FREQ1 44 will result in setting FREQ1 to 45 MHz which is closest setting to the argument. Settings outside the range of settings will result in the maximum or minimum setting being chosen so that :AMP 200 will result in an AMP setting of 100.

Typical Performance Characteristics:

Parameter			Pulse Parameters		
Parameter		Min	Typ	Max	Units
Trigger to Pulse Delay			74	90	nS
Pulse Rise Time			5.6		nS
Pulse Fall Time			5.2		nS
Pulse Voltage Limit			+/- 100		V
Voltage Adjust Increment			5		V
Pulse Frequency Range			4-65		MHz
Output Impedance			5	8	Ω
Trigger Input Impedance			50		Ω
Maximum safe pulsed load current			8		A

Parameter			Amplification Stage Parameters		
Parameter		Min	Typ	Max	Units
Dynamic Range		50	52		dB
Amplification Error (From VGA control value)			0.6	1	dB
Noise Floor @22dB gain			1.8		mV$_{rms}$
-3 dB Compression Point (at output)			±670		mV
-6 dB Compression Point (at output)			±1150		mV
Small-signal input impedance			50		Ω
Amplified signal output impedance			50		Ω

Amplifier Stage Frequency Response

Noise Floor

Dynamic Range vs VGA Gain

(y-axis: Dynamic Range; x-axis: VGA Gain)

Input vs Output as a Function of VGA gain

(y-axis: Output Voltage (rms); x-axis: Input Voltage (rms))

— 22 dB — 25dB — 28 dB — 31dB — 34dB — 37 dB — 40 dB — 43 dB
— 46 dB — 49 dB — 52 dB — 55 dB — 58 dB — 61 dB — 64 dB — 67 dB

Pulse Echo

(y-axis: Signal Voltage (V); x-axis: Time (µS))
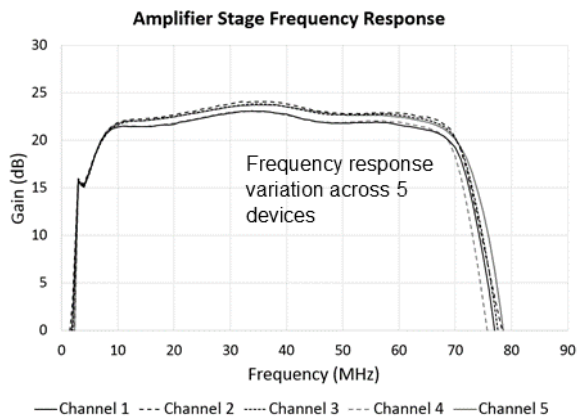
— Pulse Echo from a Lithium Niobate single element transducer off a Quartz flat in deionized water with 23 dB of inline attenuation. Gain of 22dB and pulse voltage of +/-20V

Agilent Technologies   Mon Feb 09 16:26:04 2015

1 2.50V/ 2   10.80s 5.00s/ Trig'd   ⚡ 1   75.7%

Agilent
Acquisition
Normal
4.00GSa/s

Channels
DC 50Ω 1.00:1
DC   1.00:1

More FFT Settings Menu |f(t) = FFT(Ch1)   FFT Sample Rate = 12.8GSa/s

Window   Span   Center   Auto Setup   Scale   Offset
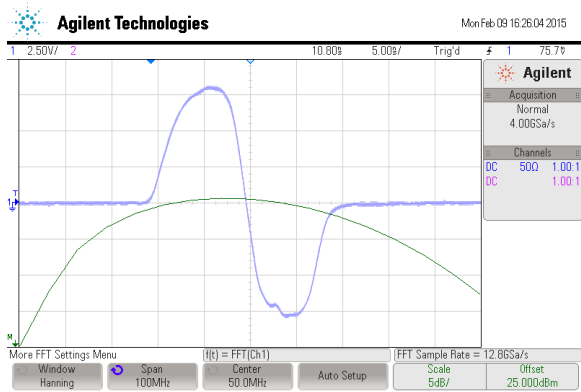Hanning   100MHz   50.0MHz   5dB/   25.000dBm

Figure 1 Typical pulse shape and spectrum (50 MHz, 75 Vp) into a 50 Ω load. The pulse is attenuated by 20 dB to enable measurement on the oscilloscope.