Kentech Instruments Ltd.

Cathode pulser

Unit 1 S/N J23-----

Version 1

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PLEASE READ THIS MANUAL CAREFULLY BEFORE USING THE SYSTEM.

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1. DISCLAIMER

This equipment contains high voltage power supplies. Although the current supply capacity is small, careless use could result in electric shock. It is assumed that this highly specialised equipment will only be used by qualified personnel.

Kentech Instruments Ltd. accept no responsibility for any electric shock or injury arising from use or misuse of this equipment. It is the responsibility of the user to exercise care and common sense with this highly versatile equipment.

2. ABBREVIATIONS

ADC or adc	Analogue to Digital Convertor
CPLD	Complex programmable logic device
CCD	Charge Coupled Device (camera)
cr	carriage return
DISC	Dim based X-Ray streak camera
DPCO	Double Pole Change Over
dv	desired value
EEPROM	Electrically programmable and erasable Read only memory, non-volatile
EHT or eht	Extra High Tension (high voltage)
EPLD	Electrically programmable logic device
EPROM	Electrically programmable read only memory, non-volatile
FET	Field Effect Transistor
FN	Foot Note
GXD	Gated X-ray Diagnostic
HDISC	Neutron hardened version of DISC
HSLOS	Neutron Hardened Single Line of Sight Imager, also called SLOS2.
hw	hardware
IBC	User's control system, also called UCS.
INT	Intensifier
lf	line feed
LFC	Large Format Camera, Gated X-ray Imager
LLNL	Lawrence Livermore National Laboratory
m	metres (meters US)
MAX	A phosphor and MCP combination
MCP	Micro Channel Plate
MCU	Main Control unit
mv	measured value
PCD	Photo Conductive Detector
PECL	Positive Emmitter Coupled Logic
PSU or psu	power supply unit
RAM	Random access memory, volatile.
RHIC	Radiation Hardened Instrument Controller
ro	read only
rw	read and write
SLOS2	Alternative name for HSLOS
SW	sweep
sw	software
UCS	Users Control System (to be provided by the user), also called IBC
W/E	Write Enable
wo	write only
w.r.t.	with respect to

3. INTRODUCTION

This manual describes the operation and use of the Cathode pulser. The pulser is based upon two standard pulser products and brings them together to make a flexible pulser offering a wide variety of pulse lengths and amplitudes. One pulser is based on FET technology which delivers pulse lengths in the range of a few ns to 200µs with voltages up to 100 volts into 12.5Ω (4 x 50Ω). The other pulser, based on avalanche transistor technology, delivers a fast nominally 1ns pulse with amplitude to 250 volts into 12.5 Ω. The required pulser is switched into the output with a high performance RF relay.

The system has some protection against large voltage transients appearing on the output as a result of issues with the load (normally a cathode floating at up to 90kV). In addition when the unit is powered down the RF relay connects the FET pulser to the load and also short circuits its output to ground to reduce the effect of any transients getting into the FET pulser. This is system is not full proof and could be overloaded by a serious cathode failure.

3.1 SPECIFICATIONS OF THE SYSTEM

Triggers	2 triggers, ON and OFF.
	OFF is only operational for the slower pulser.
Electrical trigger requirements	Differential PECL level with transition times < 5ns.
	Hi = 4.1V, Lo=3.3V
Outputs:	
4 identical outputs	
Fast pulse mode	~-290V to ~-160V, 1ns pulse
Slow pulse mode	~-120V to ~5V, 3ns to 200ns
	At lower voltage (~-100V) the minimum pulse width can be down to ~ 1.3ns
Monitor output	~1/40th. of the main output.
Sync. outputs	Edges corresponding to the ON and OFF triggers, 40mV.
Repetition rate	100Hz, maximum. A software limit of ~110 Hz is active.
Trigger delay	~32.5ns
Relative timing of fast and slow pulses	
	Nominally zero difference on the leading edge.
Power requirements	AC power 50 to 60 Hz, 110 to 240 VAC. at < 100W

Connectors, all on rear panel:

Trigger inputs x 2	Lemo PKG.00.302.CLLD35
Mating connector	Lemo FGG.00.302.CLAD35

(Note similar connectors from Raymo with the same part numbers are also suitable).

Sync. outputs x 2	SMA jack
Monitor output	SMA jack
Main outputs x 4	N type jack

Comms, all on rear panel:	
Ethernet	RJ45 socket
RS232	9 way Dsub with male pins
USB	Type B, for servicing only.

Power (Universal A.C. power)	IEC. Schurter 5200.0623.1 see

Controls, on rear panel:

Power switch

EEPROM write enable button

Indicators, all on front panel:

LEDs

Power

Slow pulser active

Fast Pulser active

ON triggered

OFF triggered

Slow pulser triggered (linked to OFF trigger only)

Fast pulser triggered

3.2 FUNCTIONALITY

The pulser has several modes of operation. These include the following:

1. Power modes
2. Pulser mode

4. OVERALL DESCRIPTION

4.1 MECHANICS OF THE ELECTRONICS PACKAGE

The electronics package consists of a 3U x 84HP (19 inch) rack unit nominally 400mm deep. All controls and connectors are on the rear panel. All indicators are on the front panel.

4.2 CONNECTIONS

Triggering is by way of two differential connections that use PECL signal levels. Internally these use Belden 9180 cable from the rear panel to the trigger circuit. The monitors and sync. outputs are all single sided signals on SMA connectors. The main outputs are N type. Communication is by way of Ethernet, RS232 or USB. Note that all 4 of the main outputs need to be terminated into 50Ω in order to avoid issues with reflections.

4.3 PRINCIPAL OF OPERATION

The pulse generator contains two pulsers, one for fast pulse of fixed length and a second for slower pulses with a variable length. The slow pulser uses two switches, one for ON and a second for OFF. The two trigger inputs deliver the respective ON and OFF triggers. For the fast pulser only the ON trigger is used.

Synchronisation pulses are available on the rear panel to indicate that the triggers have been received. In addition the software can interrogate and reset trigger latches.

Both pulsers have variable amplitude but the fast pulser amplitude is limited down to about 60% of the maximum amplitude. Going further degrades the pulse shape significantly. The slow pulser amplitude will go down to a few volts but becomes buried in the post pulse signal.

4.4 INITIAL POWER-UP

The unit will power up into the state determined by the data stored in the User EEPROM. The factory default is:

power mode = 0
pulser mode = 0
fast pulse amplitude = 0
slow pulse amplitude = 0
trigger enabled state = NOT enabled

The Save settings command, see on page 14 can overwrite these default settings to determine the power up state.

4.5 LATCHES

There are 4 trigger latches, ON, OFF, Fast Pulser and Slow pulser. The ON and OFF latches and the triggering system can all be operated with the pulsers inactive (in SAFE mode).

Note that the trigger inputs are differential PECL devices. They can pick up noise unless they are correctly terminated. The source for the triggers should hold the -ve input high and the +ve input low in the NON triggered state. If the inputs are left unterminated or incorrectly terminated they can cause the trigger latches in the trigger circuit to be set inadvertently. This can result in an inability to reset the latches as they are immediately triggered by noise again. Note that the trigger source needs to be powered up to deliver the High level to -ve input.

Powering up the fast pulser generates a triggered pulse and this will cause the fast triggered latch to be set and the fast pulser triggered LED to flash (blue). If the trigger latches are to be used then a power up command for the fast pulser should be followed with a clear latches command. Note that in Power Mode 0, the power to the fast pulser is kept on and changing the pulser mode to fast just flips the RF relay to select the pulser source that is coupled to the output. This does not generate a triggered pulse and the fast triggered latch will not be set.

4.6 SLOW PULSER OPERATION

The slow pulser uses two switches, one for ON and a second for OFF. These are separately triggered from the rear panel trigger inputs ON and OFF respectively. The relative timing of the ON and OFF edges delivered to the trigger inputs sets the pulse length. There is a small offset so that the two signal could be generated by a single pulse somewhat wider than the narrowest pulse the slow pulser can deliver (~1.2ns).

If the OFF pulse comes significantly before the ON pulse a fairly short positive going pulse can be generated. This is not an intended mode of operation but there is no hardware to prevent it.

The trigger detect signal from the Slow pulser is derived from the OFF trigger. If no OFF trigger is supplied the pulser will deliver its maximum pulse length, the trailing edge will be slow and the pulse will show significant droop towards the end of the pulse. The pulse is a lot longer than the 200ns specified. Also the “Slow pulser triggered” LED will not be illuminated.

5. SOFTWARE INTERFACE

5.1 VERSIONS AND REVISIONS

Revisions

0.0 24 AUGUST 2023 PK

5.2 CAUTIONS

1. No internal thermal shutdown, the temperature sensor should be regularly monitored. Temperatures over ~50°C should raise concern.

5.3 COMMAND LEVELS

In normal use only the level 1 commands specified below see 5.5 on page 10 are used. In order to access further commands the unit may put into “debug” mode and then level 2 commands and general Forth language commands can be used. Level 2 commands are required for changing the communication channel between Ethernet and RS232 and making other changes to the calibration data.

5.4 COMMAND ABBREVIATIONS

<p1> parameter 1

<pn> parameter n etc.

<sp> space

<term> carriage return

DEBUG MODE

Debug mode allows changing the communication interface between RS232 and Ethernet. It also allows changing of calibration data. When the unit boots up it will always be in NON debug mode i.e. Normal mode.

To switch the unit to debug mode type the command **+debug** <term>.

To return the unit to non debug mode, either reboot or type the command **-debug** <term>.

5.5 LEVEL 1 COMMANDS

Name	**Set Pulser Mode**
Explanation	Set the pulser into 1 of 4 modes
Format	**<p1><sp>!pulser_mode<term>**
parameter 1	p1 pulser mode 0 through 3
Response	ok<term>
Returned values	none

Notes:	<p1> = 0 = SAFE In SAFE mode the output of the pulser is shorted to ground by a relay. Although the outputs are not disconnected from the pulser circuits this does confer some protection from transients from electrical discharges in the load (gun). <p1> = 1 = INHIBIT No pulsers active, shorting relay energized. <p1> = 2 = FAST Fast pulser active, shorting relay energized. (Short Pulse active. ON trigger needed)" <p1> = 3 = SLOW Fast pulser active, shorting relay energized. Long Pulse active. ON and OFF trigger needed The factory default pulser mode is mode 0

Name	**Query pulser mode**
Explanation	Request which state the pulser is in
Format	**?pulser_mode<term>**
Response	?pulser_mode<sp><r1><sp><sp>ok<term>
Returned values	<r1> = pulser mode, see the command "set pulser mode" The factory default pulser mode is mode 0

Name	**Trigger input enable**
Explanation	Enable the trigger circuit
Format	**+trigger_enable<term>**
Response	+trigger_enable<sp><sp>ok<term>
Returned values	none
Notes:	This commands enables the ON trigger and OFF trigger inputs. OFF trigger is not used in FAST mode. The factory default state is triggers disabled.

Name	**Trigger disable**
Explanation	Disable the trigger inputs
Format	**-trigger_enable<sp><sp>ok<term>**
Returned values	none
Notes:	This commands disables the ON trigger and OFF trigger inputs. OFF trigger is not used in FAST mode. The factory default state is triggers disabled.

Name	**Query trigger state**
Explanation	Request the trigger state.
Format	**?trigger_enable<term>**
Response	?trigger_enable<sp><r1><sp><sp>ok<term>
Returned values	<r1> = 0 = FALSE = Off <r1> = -1 = TRUE = On The factory default state is triggers disabled.

Name	**Set power mode**
Explanation	Set the power mode

Format	**<p1><sp>!power_mode<term>**
Response	p1<sp>!power_mode<sp><sp>ok<term>
Returned values	none
Notes:	
	<p1> = 0 = Always Both pulsers always powered up in all pulser modes except in SAFE mode. Power to both pulsers is always off in SAFE mode <p1> = 1 = Active Active pulser power on only, other pulser power is off Having power to both pulsers continuously will minimise any timing drifts when changing between fast/slow/inhibit modes. Removing power from an inactive pulser will help lifetime and reduce power consumption. The factory default power mode is mode 0.

Name	**Query power mode**
Explanation	Request which power mode is in use.
Format	**?power_mode<term>**
Response	?power_mode<sp><r1><sp><sp>ok<term>
Returned value 1	<r1> = Power mode
Notes	For power modes see the command “Set power mode” The factory default power mode is mode 0.

Name	**Query the trigger latches**
Explanation	read the four trigger latches
Format	**?trigger_latches<term>**
Response	?trigger_latches<sp>< r1><sp><r2><sp><r3><sp><r4><sp><sp>ok<term>
Returned values	<r1> ON latch 0 = not set; -1 = set <r2> OFF latch 0 = not set; -1 = set <r3> Fast Pulse latch 0 = not set; -1 = set <r4> Slow Pulse latch 0 = not set; -1 = set

Name	**Reset trigger latches**
Explanation	Set all trigger latches to “not set”
Format	**0trigger_latches**
Response	0trigger_latches<sp><sp>ok<term>
Returned values	none
Note:	Turning on the power to the fast pulser will cause the fast pulser trigger latch to be set. This should be reset before testing for trigger pulses. Note that in power mode 0, activating the fast pulser does not turn on its power, as it will already be on. So activating the fast pulse in power mode 0, will not set the fast pulser trigger latch.

Name	**Restart the software**
Explanation	This restarts the software
Format	**Restart<term>**
Response	Restart<term>

Returned values	none

Name	**Fast pulse amplitude**
Explanation	Set the fast (short pulse) pulse amplitude
Format	**<p1><sp> !fast_amplitude<term>**
Parameter	<p1> = 0 through 4095 corresponding to a voltage of ~150 to 290 volts.
Response	<p1><sp>!fast_amplitude<sp><sp>ok<term>
Returned values	none
Notes	The output voltage is not very linear with respect to the set value There is not much change above 1300. The factory default fast pulse amplitude is 0.

Name	**Query fast pulse amplitude**
Explanation	Read the fast (short pulse) pulse amplitude
Format	**?fast_amplitude<term>**
Response	?fast_amplitude<sp><r1><sp><sp>ok<term>
Returned values	<r1> = fast pulse amplitude, 0 through 4095, corresponding to a voltage of ~150 to 290 volts. The factory default fast pulse amplitude is 0.

Name	**Slow pulse amplitude**
Explanation	Set the slow (long pulse) pulse amplitude
Format	**<p1><sp> !slow_amplitude<term>**
Parameter	<p1> = 0 through 4095 corresponding to a voltage of ~3.5 to 138 volts.
Response	<p1><sp>!slow_amplitude<sp><sp>ok<term>
Notes	The output voltage is fairly linear with respect to the set value. The factory default slow pulse amplitude is 0.

Name	**Query slow pulse amplitude**
Explanation	Read the slow (long pulse) pulse amplitude
Format	**?slow_amplitude<term>**
Response	?slow_amplitude<sp><r1><sp><sp>ok<term>
Returned value 1	<r1> = slow pulse amplitude, 0 through 4095, corresponding to a voltage of ~3.5 to 138 volts. The factory default slow pulse amplitude is 0.

Name	**Query diagnostics**
Explanation	read fast pulser stack voltages and trigger logic temperature
Format	**?diagnostics<term>**
Response	?diagnostics<sp><r1><sp><r2><sp>< r3><sp>< r4><sp><r5><sp><sp>ok<term>
Returned values	r1 = trigger stack voltage r2 = second stack voltage r3 = output stack voltage r4 = unassigned - will return 0. r5 = temperature of trigger unit in degrees Celsius.

Note:	Stacks will only have volts on them when the fast pulser is powered up. The output stack voltage will depend upon the fast pulse amplitude setting. Typical values for a maximum amplitude setting are: 1902 2238 2572 0 28 giving values of 1902V 2238V 2572V 0 28°C

Name	**Save settings**
Explanation	Saves current settings to EEPROM
Format	**user>eeprom<term>**
Response	<sp><sp>ok<term>
Returned value 1	none
Note:	The pulser will read the settings from eeprom after a reset or power up so the user can configure the start up settings and behaviour to suit the application. Parameters that are stored include: Power mode Pulser mode Fast pulser amplitude Slow pulser amplitude Trigger enabled state

5.6 LEVEL 2 COMMANDS

Level 2 commands are accessed by switching to debug mode. To switch to debug mode enter:

+debug <term>

In debug mode all the level 1 commands will work as before but in addition there are few other commands that will work and one can use standard Forth language commands, set up macros etc.

To exit debug mode either type:

-debug <term>

or cycle the power or use the **restart** command..

5.6.1 SWITCHING THE COMMUNICATIONS INTERFACE

To switch from ethernet to RS232 comms:

In debug mode enter the following:

0 use_ether? ! <term>

Hold down the black button on the rear of the unit, next to the ethernet port, and type:

ee!cal <term>

In practice the button only needs to be held down during execution, i.e. when the <term> character is hit.

Recycle the power.

To switch from ethernet to RS232 do the above but use -1 instead of zero as the parameter.

I.e. type:

-1 use_ether? ! <term>

To switch to the USB port repeatedly press the black button during power up.

5.6.2 ADJUSTING THE VOLTAGE LIMITS OF THE PULSERS

The amplitude of the pulsers is determined by the outputs of 12 bit ADCs. In practice much of this range is not usable, particularly for the fast pulser. Consequently the outputs of the ADCs are limited to a smaller range.

The input to the amplitude commands remains unchanged at 0 through 4095, but this is mapped into the restricted range of outputs.

If it is necessary to change these limits in order to access a slightly greater range or because the pulse shapes have been modified, then there are 4 variables that can be reset and saved to the calibration EEPROM.

The changes take place without saving to EEPROM but are volatile and the previous values will be read from EEPROM at boot up time.

A procedure for adjusting the values is as follows:

1. Switch the unit into debug mode with the **+debug** command.
2. Turn off the mapping by setting the limits to 0 and 4095 respectively for the particular pulser (fast or slow).

3. Adjust the amplitude using the normal command to find the new optimum higher and lower limits.
4. Set both the limit variables for that pulser.
5. Test to see that they work OK and then, if suitable, save to the calibration EEPROM.

The 4 variables are:

For the fast pulser :
f_maxamp
f_minamp

For the slow pulser
s_maxamp
s_minamp

Values are stored in the variable in the following manner:

4095 f_maxamp ! <term>
3000 f_minamp ! <term>
4095 s_maxamp ! <term>
600 s_minamp ! <term>

The "!" is the forth command for store.

The values can also be read with the folowing:

f_maxamp @ . <term>
f_minamp @ . <term>
s_maxamp @ . <term>
s_minamp @ . <term>

The "@" is the Forth command for fetch, the "." is the Forth command for Print. <term> = Carriage return as previously stated.

In order to save the new values to EEPROM, to make them non volatile, the values should be saved to the calibration EEPROM with :

ee!cal <term>

Note that the button on the rear panel of the pulser must be depressed before the <term> character is sent and released afterwards.

5.6.3 RESTORING THE FACTORY DEFAULT SETTINGS

The factory default settings is a set of settings that cannot be changed. The unit can be restored to the factory default settings in Debug mode with the command:

0cal <term>

This will set the unit to the default configuration but it will be volatile unless the settings are stored to EEPROM. This will require saving the calibration with **ee!cal** and also setting the user values with the command **user>eeprom**

Note that the factory defaults are not necessarily the same as the normal start up values as the calibration and user data overwrites it on boot up.

5.6.4 VALUES SET BY 0CAL

The **0cal** command sets the following values:

```
: 0cal ( -- )
anyold# Xcal !
1612271 serial# !
115200 RS232baud !
115200 USBbaud !
4 rate_delay !
true c_on_pol !
true c_off_pol !
10 c_flashtime !
true use_ether? !
4095 f_maxamp !
3000 f_minamp !
4095 s_maxamp !
600 s_minamp !
```

;

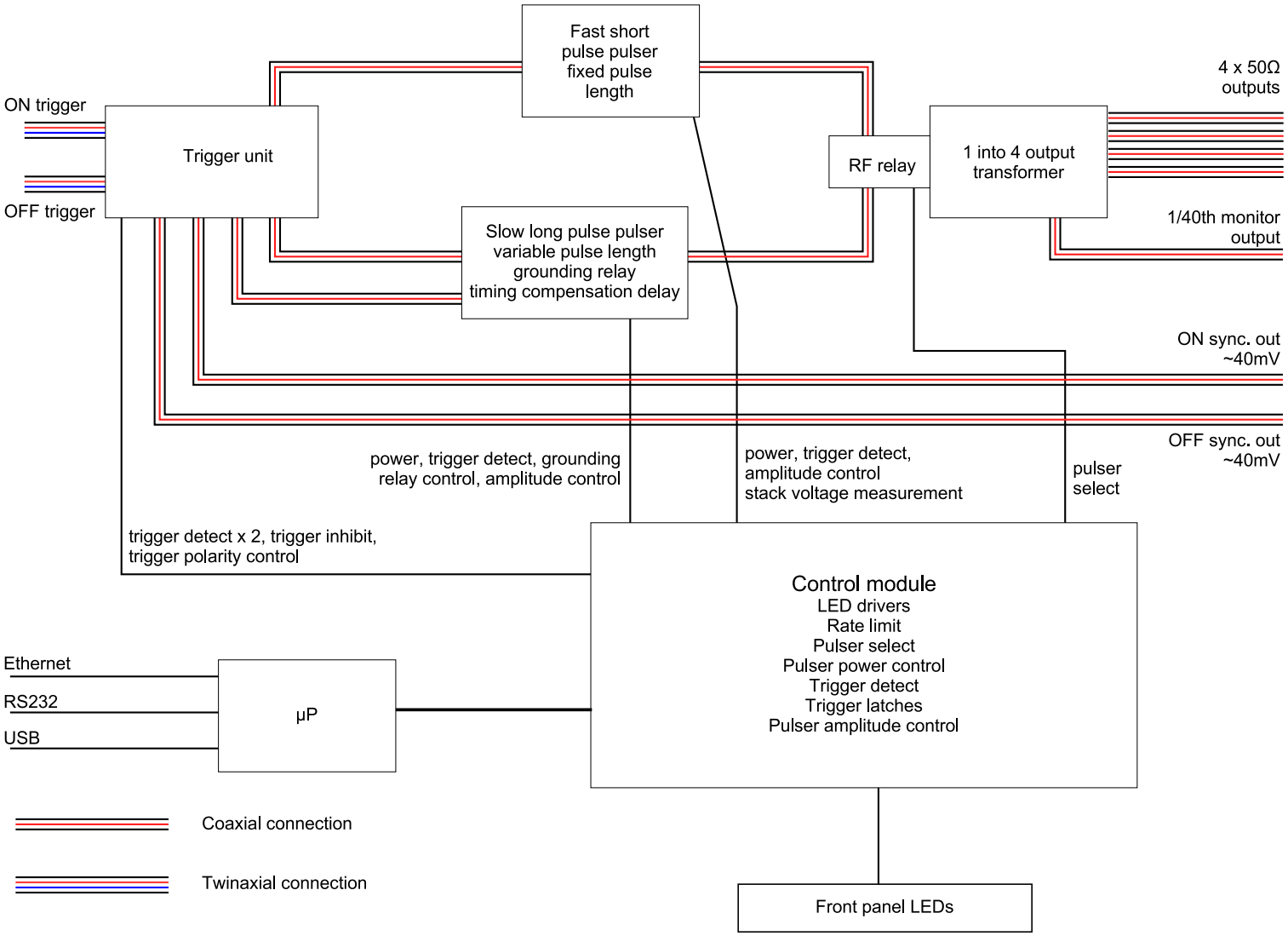
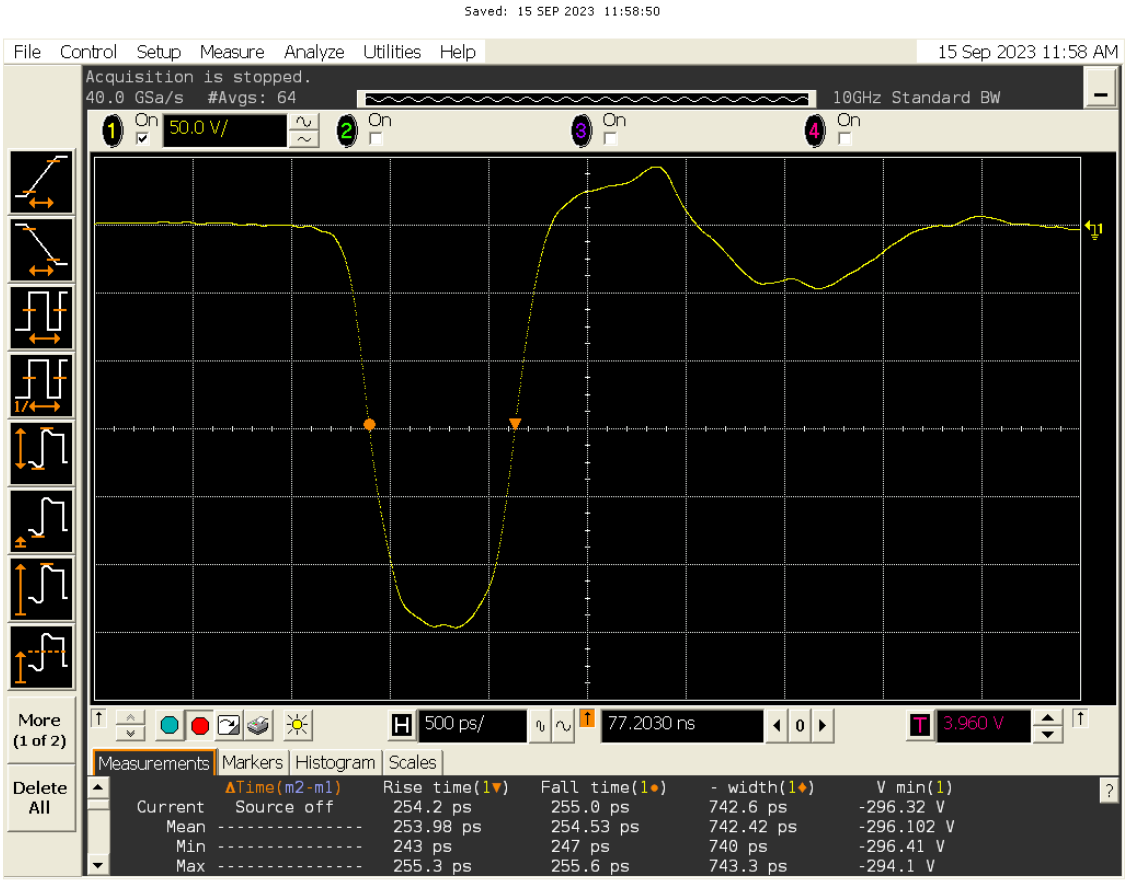


Figure 1 General layout of the pulser

6. WAVEFORMS



Acquisition
Sampling mode real time Normal
Memory depth automatic 202 pts
Sampling rate automatic Sampling rate 40.0 GSa/s
Averaging on # of averages 64 Interpolation on

Channel 1
Scale 50.0 V/ Offset -149.9 V Coupling DC Impedance 50 Ohms

Channel 4
Scale 10 mV/ Offset 4.000 V Coupling DC Impedance 50 Ohms

Time base
Scale 500 ps/ Position 77.2030 ns Reference center

Trigger
Mode edge Sweep triggered
Sensitivity low Holdoff time 100 ns
Source channel 4 Trigger level 3.9600 V Slope rising

Measure

	ΔTime(m2-m1)	Rise time(1▼)	Fall time(1●)	- width(1♦)	V min(1)
Current	Source off	254.2 ps	255.0 ps	742.6 ps	-296.32 V
Mean	----------	253.98 ps	254.53 ps	742.42 ps	-296.102 V
Min	----------	243 ps	247 ps	740 ps	-296.41 V
Max	----------	255.3 ps	255.6 ps	743.3 ps	-294.1 V
Range	----------	12.3 ps	8.5 ps	3.4 ps	2.29 V
Std Dev	----------	940 fs	940 fs	470 fs	184 mV
# of Meas	----------	524	524	524	524
Edge Dir		Rising	Falling		

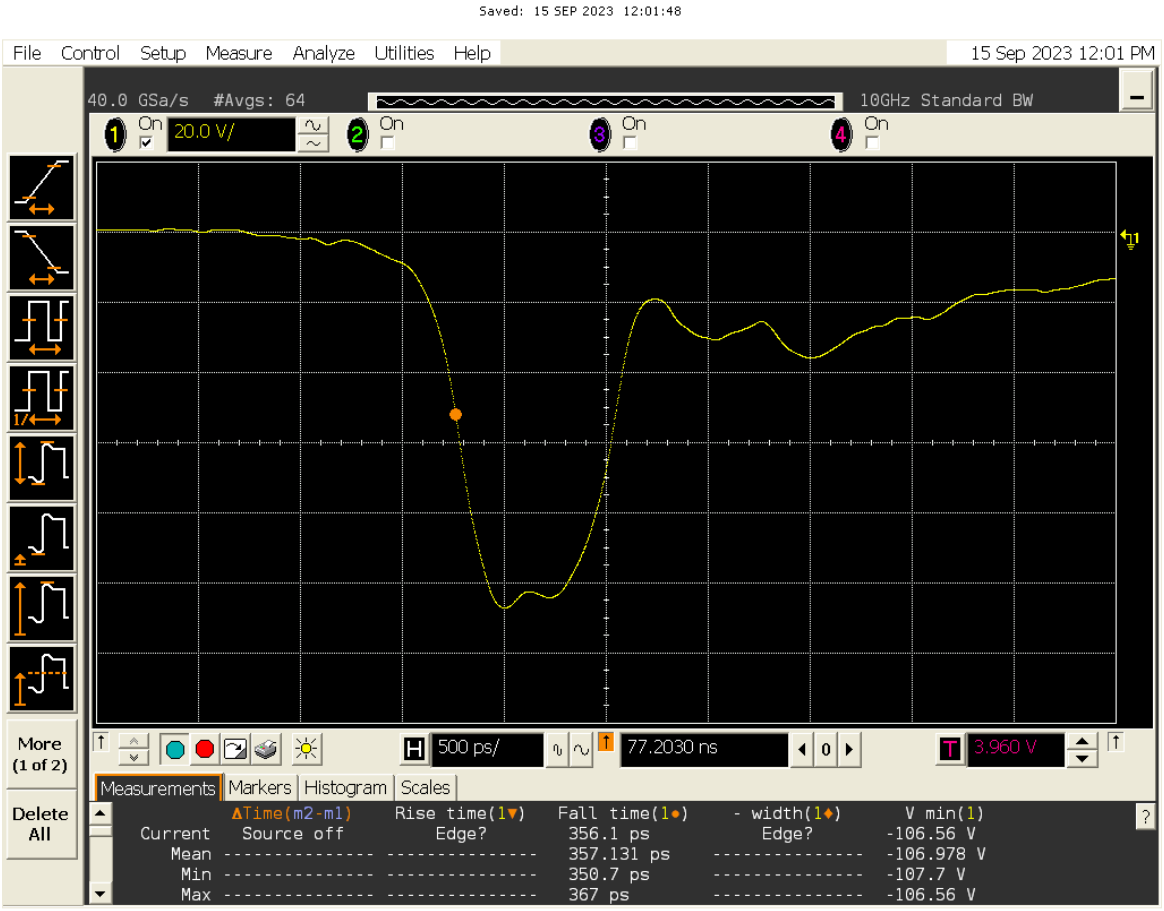
Marker

	ΔTime(m2-m1)	X	Y
Current	Source off	A——(m2) = ----------	----------
Mean	----------	B---(m1) = ----------	----------
Min	----------	Δ = ----------	----------
Max	----------	1/ΔX = ----------	
Range	----------		
Std Dev	----------		

Histogram
Axis horizontal Scale source channel 1
Ax Position 910.78 ps Bx Position -48.00 ps
Ay Position -70.6 V By Position -70.6 V
Scale type linear Size 4.0 div

		Mean	No data	Median	No data	Hits	No data
Y Scale	0 hits/	Std Dev	No data	Mode	No data	Peak	No data
Y Offset	0 hits	μ±1σ	No data	p-p	No data		
		μ±2σ	No data	Min	No data		
		μ±3σ	No data	Max	No data		

Figure 2 Fast pulse at maximum amplitude.
1 of 4 outputs



Acquisition Sampling mode real time Normal
Memory depth automatic 202 pts
Sampling rate automatic Sampling rate 40.0 GSa/s
Averaging on # of averages 64 Interpolation on

Channel 1 Scale 20.0 V/ Offset -59.5 V Coupling DC Impedance 50 Ohms

Channel 4 Scale 10 mV/ Offset 4.000 V Coupling DC Impedance 50 Ohms

Time base Scale 500 ps/ Position 77.2030 ns Reference center

Trigger Mode edge Sweep triggered
Sensitivity low Holdoff time 100 ns
Source channel 4 Trigger level 3.9600 V Slope rising

Measure

	ΔTime(m2-m1)	Rise time(1▼)	Fall time(1●)	- width(1♦)	V min(1)
Current	Source off	Edge?	356.1 ps	Edge?	-106.56 V
Mean	----------	----------	357.131 ps	----------	-106.978 V
Min	----------	----------	350.7 ps	----------	-107.7 V
Max	----------	----------	367 ps	----------	-106.56 V
Range	----------	----------	16.2 ps	----------	1.15 V
Std Dev	----------	----------	3.093 ps	----------	202.7 mV
# of Meas	----------	----------	1.068 k	----------	1.068 k
Edge Dir		----------	Falling		

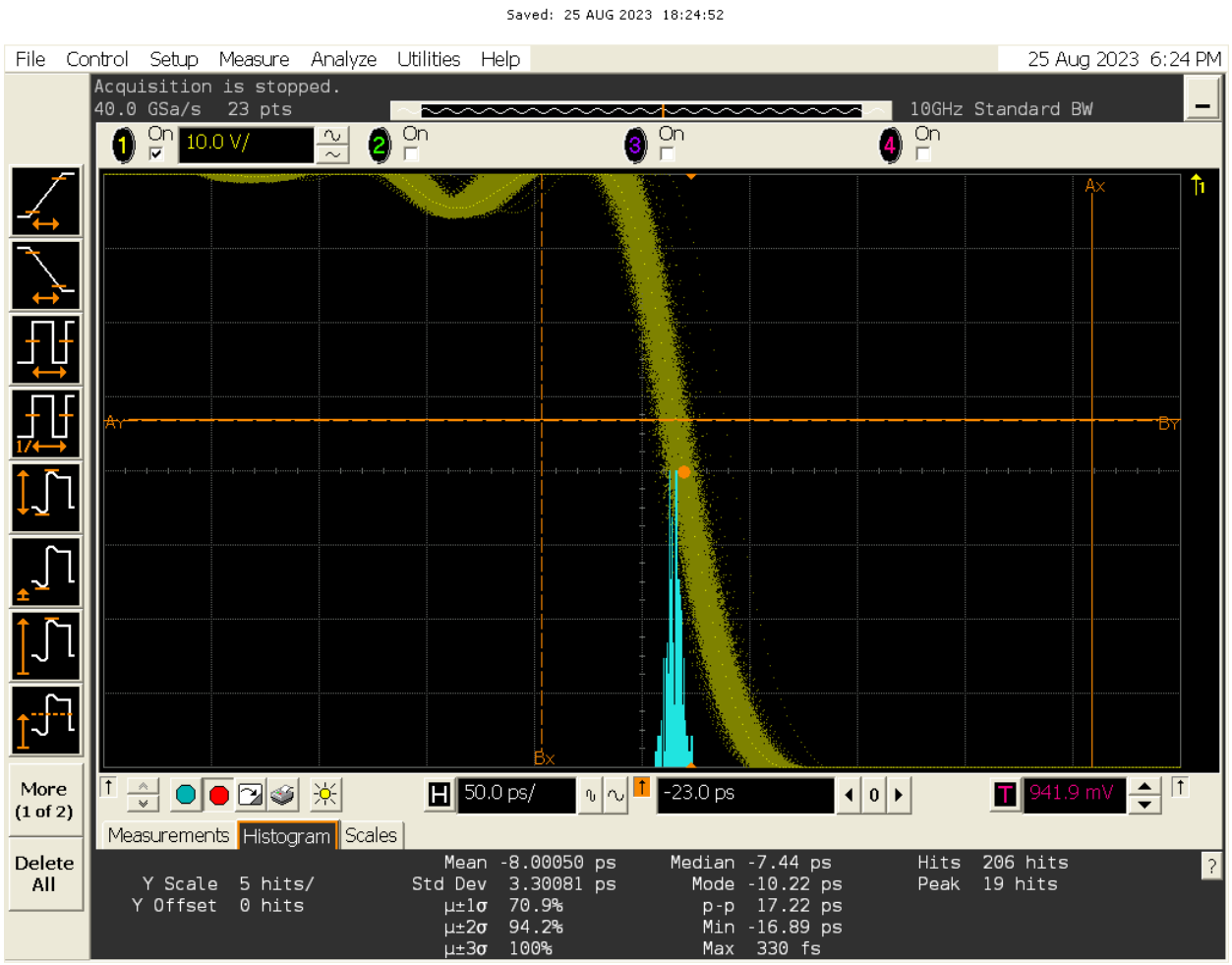
Marker

	ΔTime(m2-m1)		X	Y
Current	Source off	A——(m2) =	----------	----------
Mean	----------	B---(m1) =	----------	----------
Min	----------	Δ =	----------	----------
Max	----------	1/ΔX =	----------	
Range	----------			
Std Dev	----------			

Histogram Axis horizontal Scale source channel 1
Ax Position 910.78 ps Bx Position -48.00 ps
Ay Position -70.6 V By Position -70.6 V
Scale type linear Size 4.0 div

		Mean	No data	Median	No data	Hits	No data
Y Scale	0 hits/	Std Dev	No data	Mode	No data	Peak	No data
Y Offset	0 hits	μ±1σ	No data	p-p	No data		
		μ±2σ	No data	Min	No data		
		μ±3σ	No data	Max	No data		

Figure 3 Fast pulse at minimum amplitude.
1 of 4 outputs



Acquisition Sampling mode real time Normal
Memory depth automatic 23 pts
Sampling rate automatic Sampling rate 40.0 GSa/s
Averaging off Interpolation on

Channel 1 Scale 10.0 V/ Offset -132.9 V Coupling DC Impedance 50 Ohms

Channel 4 Scale 10 mV/ Offset 957 mV Coupling DC Impedance 50 Ohms

Time base Scale 50.0 ps/ Position -23.0 ps Reference center

Trigger Mode edge Sweep triggered
Sensitivity low Holdoff time 100 ns
Source channel 4 Trigger level 941.9 mV Slope rising

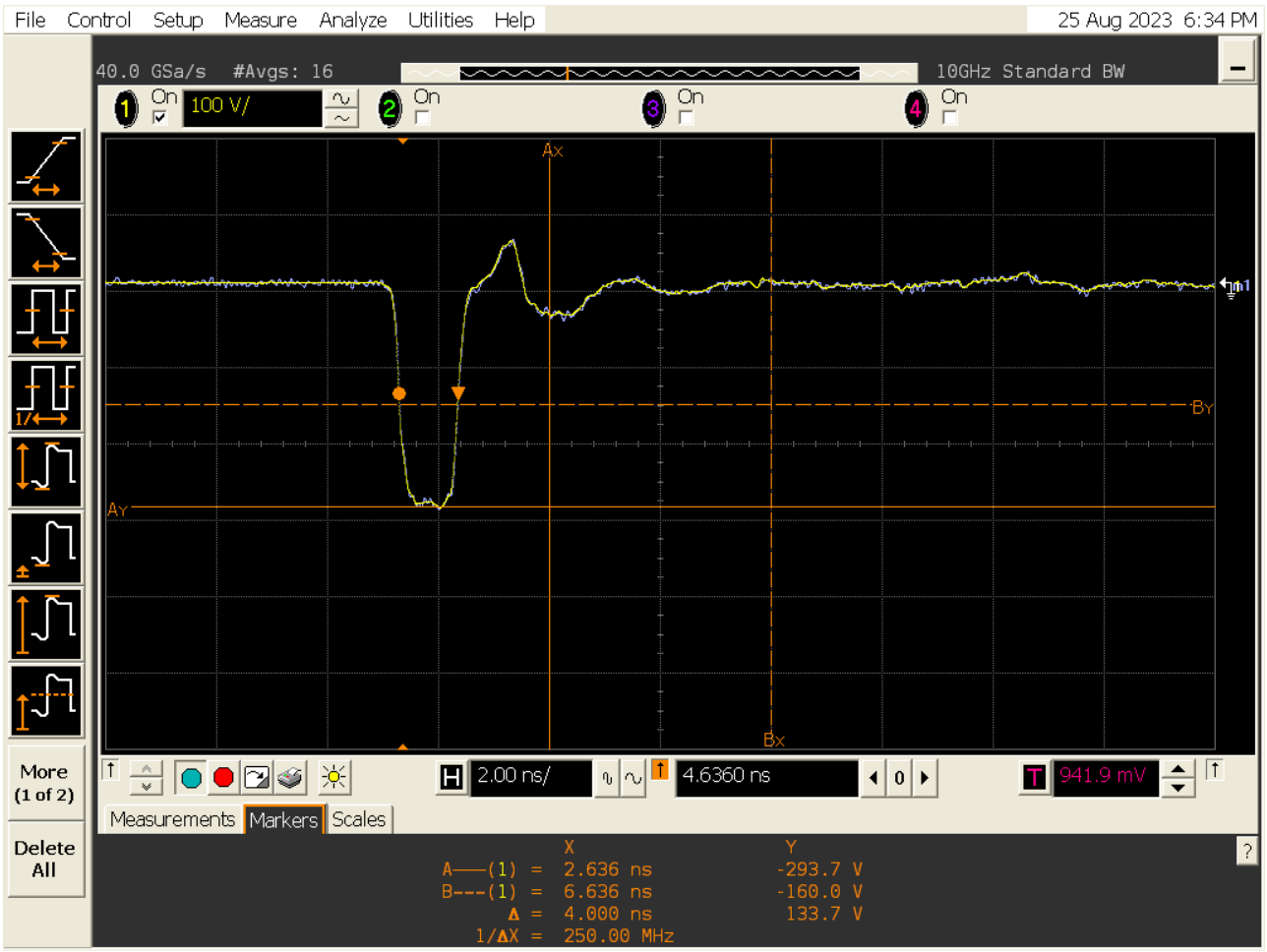
Measure

	Rise time(1▾)	Fall time(1▴)	- width(1◆)	V min(1)
Current	Edge?	49.74 ps	Edge?	≤-172.90 V
Mean	----------	48.1753 ps	----------	?-172.900 V
Min	----------	44.12 ps	----------	?-172.90 V
Max	----------	53.97 ps	----------	?-172.90 V
Range	----------	9.85 ps	----------	? 0.0 V
Std Dev	----------	1.9488 ps	----------	? 0.0 V
# of Meas	----------	1.924 k	----------	1.924 k
Edge Dir	----------	Falling		

Histogram Axis horizontal Scale source channel 1
Ax Position 185.89 ps Bx Position -69.67 ps
Ay Position -126.0 V By Position -126.1 V
Scale type linear Size 4.0 div

	Mean -8.00050 ps	Median -7.44 ps	Hits 206 hits	
Y Scale 5 hits/	Std Dev 3.30081 ps	Mode -10.22 ps	Peak 19 hits	
Y Offset 0 hits	µ±1σ 70.9%	p-p 17.22 ps		
	µ±2σ 94.2%	Min -16.89 ps		
	µ±3σ 100%	Max 330 fs		

Figure 4 Jitter of fast pulse at maximum amplitude ~3.4ps



Acquisition	Sampling mode real time Normal Memory depth automatic 1000 pts Sampling rate automatic Sampling rate 40.0 GSa/s Averaging on # of averages 16 Interpolation on
Channel 1	Scale 100 V/ Offset -211.4 V Coupling DC Impedance 50 Ohms
Channel 4	Scale 10 mV/ Offset 957 mV Coupling DC Impedance 50 Ohms
Time base	Scale 2.00 ns/ Position 4.6360 ns Reference center
Trigger	Mode edge Sweep triggered Sensitivity low Holdoff time 100 ns Source channel 4 Trigger level 941.9 mV Slope rising
Memory 1	Vertical scale 100 V/ Offset -211.400 V Horizontal scale 2.00 ns/ Position 4.6360000000000 ns

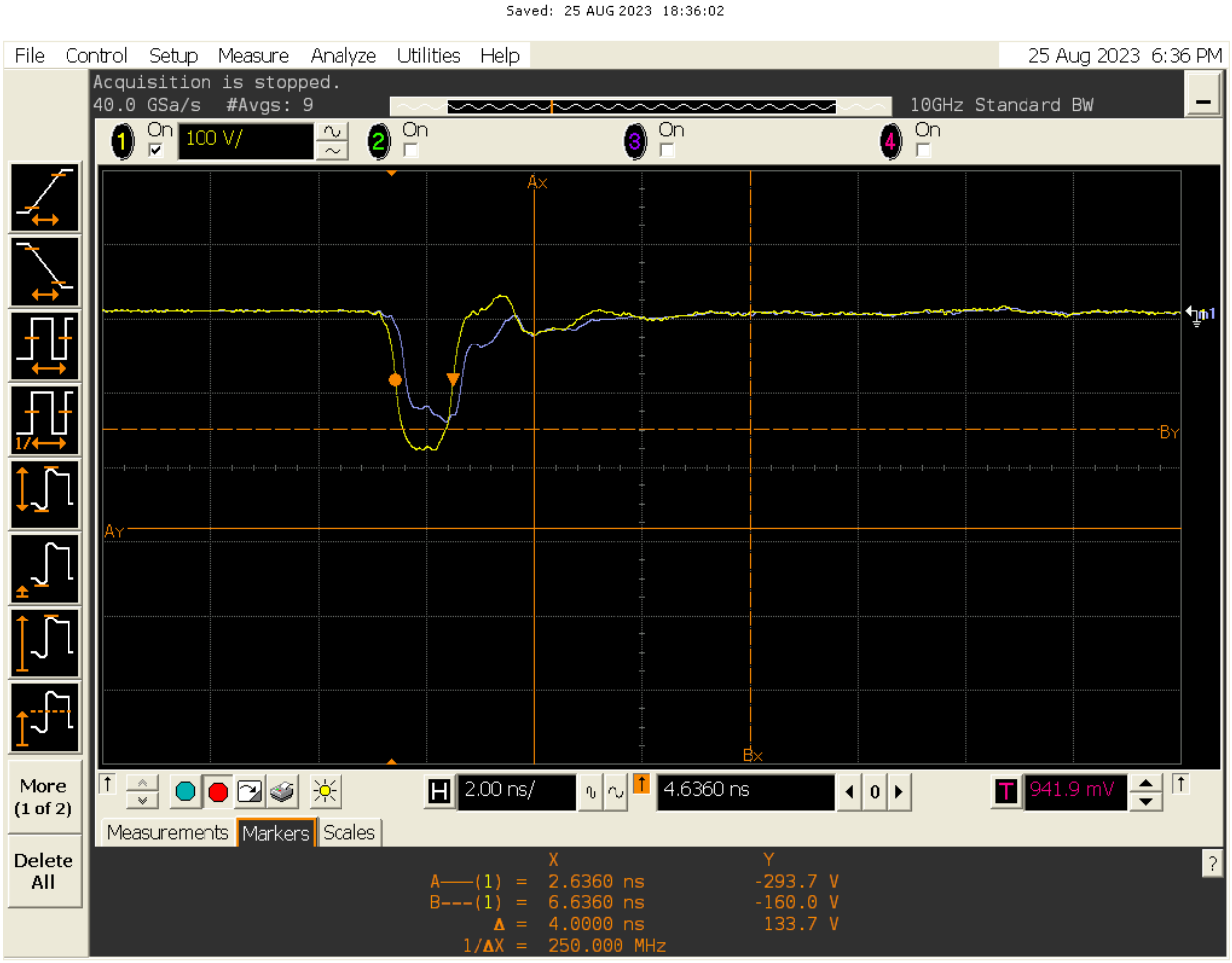
Measure

	Rise time(1▾)	Fall time(1▾)	- width(1◆)	V min(1)
Current	250.4 ps	246.9 ps	1.0705 ns	-294.35 V
Mean	247.29 ps	243.49 ps	1.07161 ns	-294.853 V
Min	244 ps	240 ps	1.0703 ns	-297.7 V
Max	252 ps	248 ps	1.074 ns	-293.93 V
Range	8 ps	8 ps	3.5 ps	3.82 V
Std Dev	1.88 ps	2.30 ps	820 fs	1.008 V
# of Meas	29	29	29	29
Edge Dir	Rising	Falling		

Marker

	V min(1)		X	Y
Current	Source off	A——(1) =	2.636 ns	-293.7 V
Mean	----------	B---(1) =	6.636 ns	-160.0 V
Min	----------	Δ =	4.000 ns	133.7 V
Max	----------	1/ΔX =	250.00 MHz	
Range	----------			
Std Dev	----------			

Figure 5 Superposition of fast pulse at maximum amplitude ant 100Hz and 1Hz. showing little difference. Data obtained with a longer pulse.



Acquisition Sampling mode real time Normal
Memory depth automatic 1000 pts
Sampling rate automatic Sampling rate 40.0 GSa/s
Averaging on # of averages 16 Interpolation on

Channel 1 Scale 100 V/ Offset -211.4 V Coupling DC Impedance 50 Ohms

Channel 4 Scale 10 mV/ Offset 957 mV Coupling DC Impedance 50 Ohms

Time base Scale 2.00 ns/ Position 4.6360 ns Reference center

Trigger Mode edge Sweep triggered
Sensitivity low Holdoff time 100 ns
Source channel 4 Trigger level 941.9 mV Slope rising

Memory 1 Vertical scale 100 V/ Offset -211.400 V
Horizontal scale 2.00 ns/ Position 4.6360000000000 ns

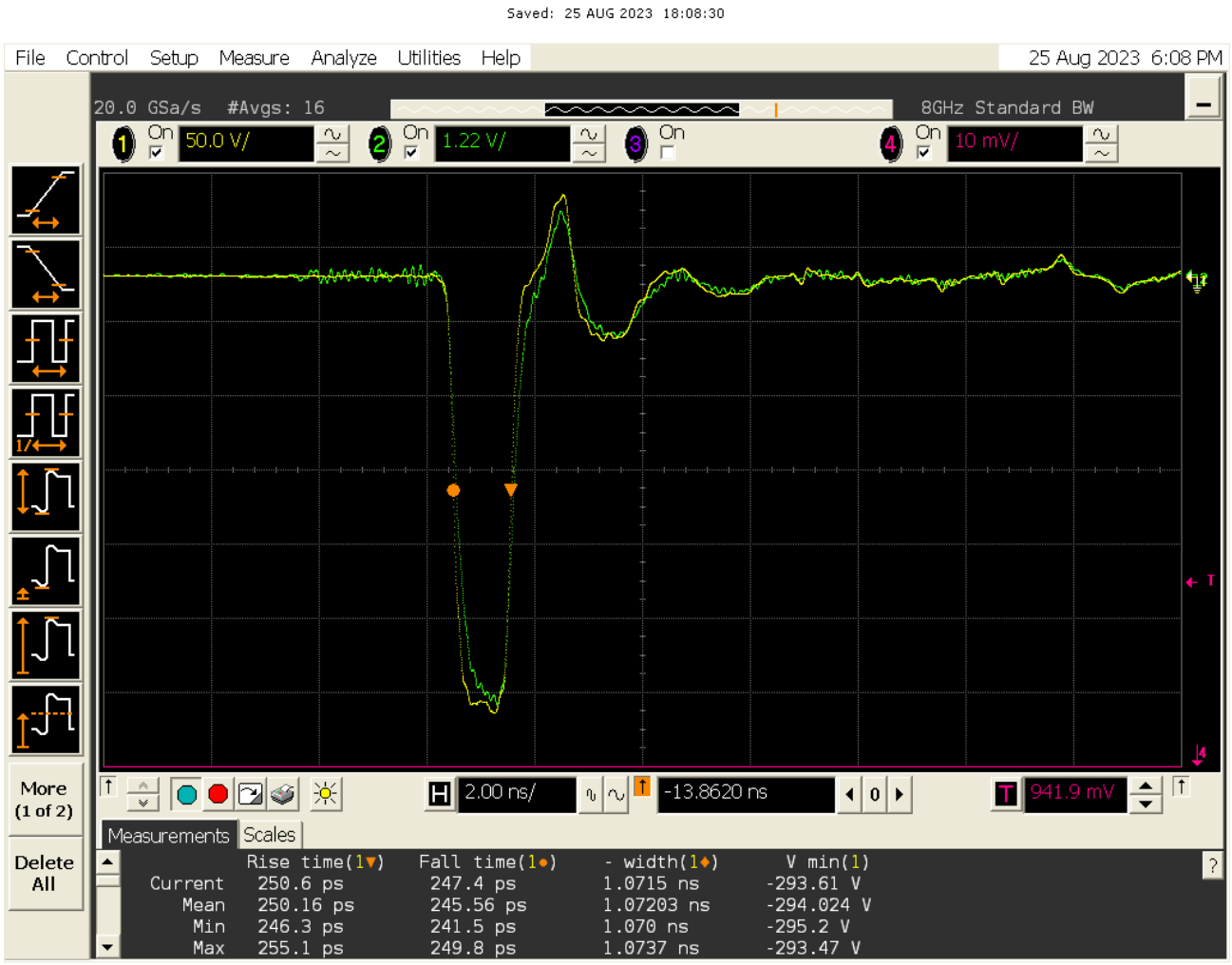
Measure

	Rise time(1▾)	Fall time(1▾)	- width(1◆)	V min(1)
Current	370 ps	357 ps	1.061 ns	-188.0 V
Mean	360 ps	345 ps	1.061 ns	-189.4 V
Min	326 ps	313 ps	1.052 ns	-193.3 V
Max	374 ps	357 ps	1.071 ns	-188.0 V
Range	48 ps	44 ps	19 ps	5.3 V
Std Dev	14 ps	14 ps	5 ps	1.9 V
# of Meas	9	9	9	9
Edge Dir	Rising	Falling		

Marker

	V min(1)		X	Y
Current	Source off	A——(1) =	2.6360 ns	-293.7 V
Mean	----------	B---(1) =	6.6360 ns	-160.0 V
Min	----------	Δ =	4.0000 ns	133.7 V
Max	----------	1/ΔX =	250.000 MHz	
Range	----------			
Std Dev	----------			

Figure 6 Below 10Hz, the reduced amplitude pulse shape looks better.
This is an artefact of the method of reducing the amplitude. data obtained with a longer pulse



Acquisition Sampling mode real time Normal
Memory depth automatic 1000 pts
Sampling rate automatic Sampling rate 20.0 GSa/s
Averaging on # of averages 16 Interpolation on

Channel 1 Scale 50.0 V/ Offset -130.0 V Coupling DC Impedance 50 Ohms

Channel 2 Scale 1.22 V/ Offset -3.205 V Coupling DC Impedance 50 Ohms

Channel 4 Scale 10 mV/ Offset 957 mV Coupling DC Impedance 50 Ohms

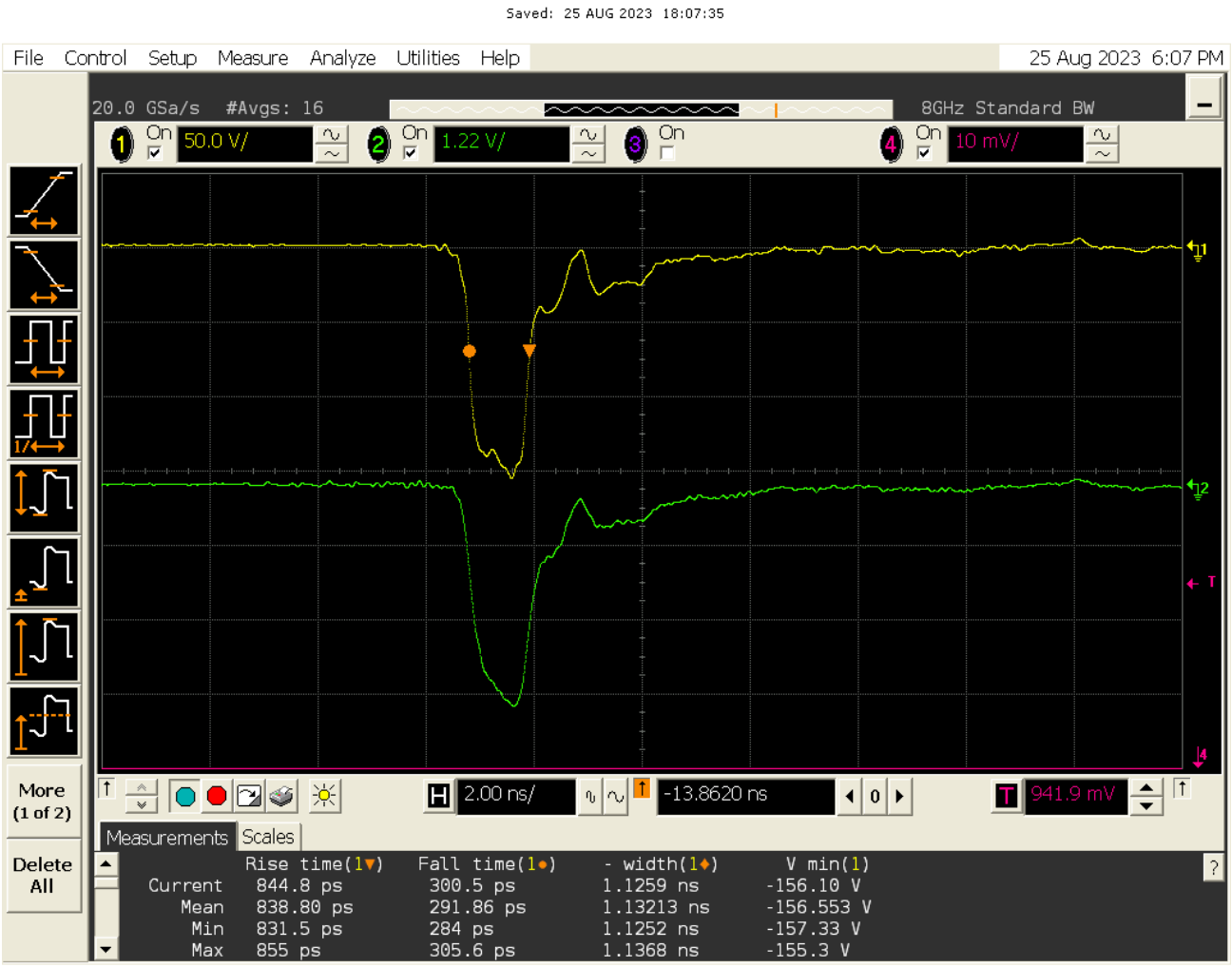
Time base Scale 2.00 ns/ Position -13.8620 ns Reference center

Trigger Mode edge Sweep triggered
Sensitivity low Holdoff time 100 ns
Source channel 4 Trigger level 941.9 mV Slope rising

Measure

	Rise time(1▼)	Fall time(1●)	- width(1◆)	V min(1)
Current	250.6 ps	247.4 ps	1.0715 ns	-293.61 V
Mean	250.16 ps	245.56 ps	1.07203 ns	-294.024 V
Min	246.3 ps	241.5 ps	1.070 ns	-295.2 V
Max	255.1 ps	249.8 ps	1.0737 ns	-293.47 V
Range	8.8 ps	8.3 ps	3.7 ps	1.69 V
Std Dev	1.40 ps	1.34 ps	550 fs	208 mV
# of Meas	925	925	925	925
Edge Dir	Rising	Falling		

Figure 7 Superposition of the main output (yellow) and the monitor output (green). showing the monitor performance and calibration [1.22:50 ~ 1/40]. Data obtained with a longer pulse.

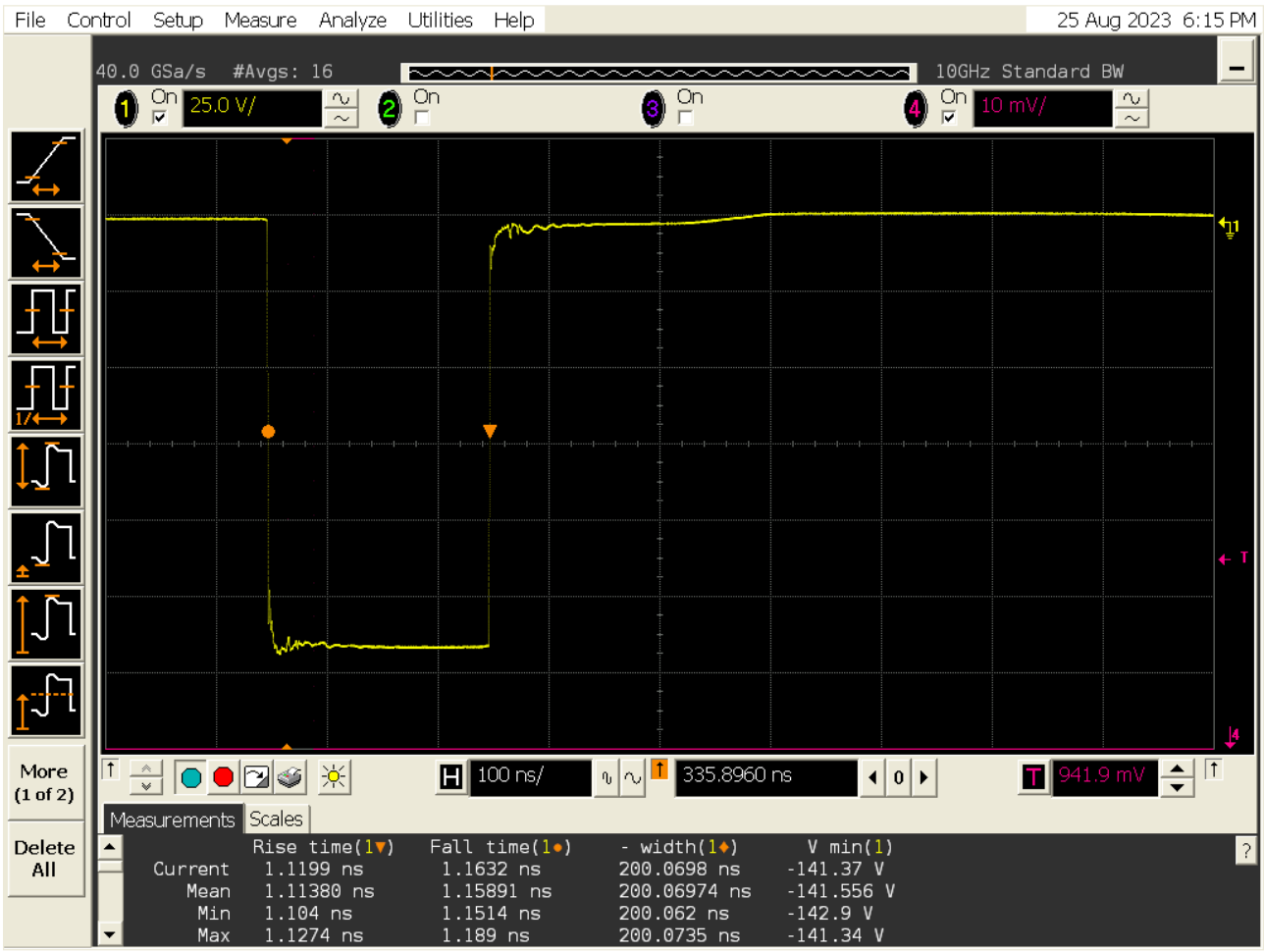


Acquisition	Sampling mode real time Normal Memory depth automatic 1000 pts Sampling rate automatic Sampling rate 20.0 GSa/s Averaging on # of averages 16 Interpolation on
Channel 1	Scale 50.0 V/ Offset -151.3 V Coupling DC Impedance 50 Ohms
Channel 2	Scale 1.22 V/ Offset 220 mV Coupling DC Impedance 50 Ohms
Channel 4	Scale 10 mV/ Offset 957 mV Coupling DC Impedance 50 Ohms
Time base	Scale 2.00 ns/ Position -13.8620 ns Reference center
Trigger	Mode edge Sweep triggered Sensitivity low Holdoff time 100 ns Source channel 4 Trigger level 941.9 mV Slope rising

Measure

	Rise time(1▼)	Fall time(1●)	- width(1◆)	V min(1)
Current	844.8 ps	300.5 ps	1.1259 ns	-156.10 V
Mean	838.80 ps	291.86 ps	1.13213 ns	-156.553 V
Min	831.5 ps	284 ps	1.1252 ns	-157.33 V
Max	855 ps	305.6 ps	1.1368 ns	-155.3 V
Range	24.0 ps	21.8 ps	11.6 ps	1.99 V
Std Dev	2.72 ps	4.66 ps	2.78 ps	321 mV
# of Meas	881	881	881	881
Edge Dir	Rising	Falling		

Figure 8 Fast pulse at low amplitude main output (yellow) and the monitor output (green). again showing the monitor performance and calibration [1.22:50 ~ 1/40] Data obtained with a longer pulse.



Acquisition Sampling mode real time Normal
Memory depth automatic 40002 pts
Sampling rate automatic Sampling rate 40.0 GSa/s
Averaging on # of averages 16 Interpolation on

Channel 1 Scale 25.0 V/ Offset -72.5 V Coupling DC Impedance 50 Ohms

Channel 4 Scale 10 mV/ Offset 957 mV Coupling DC Impedance 50 Ohms

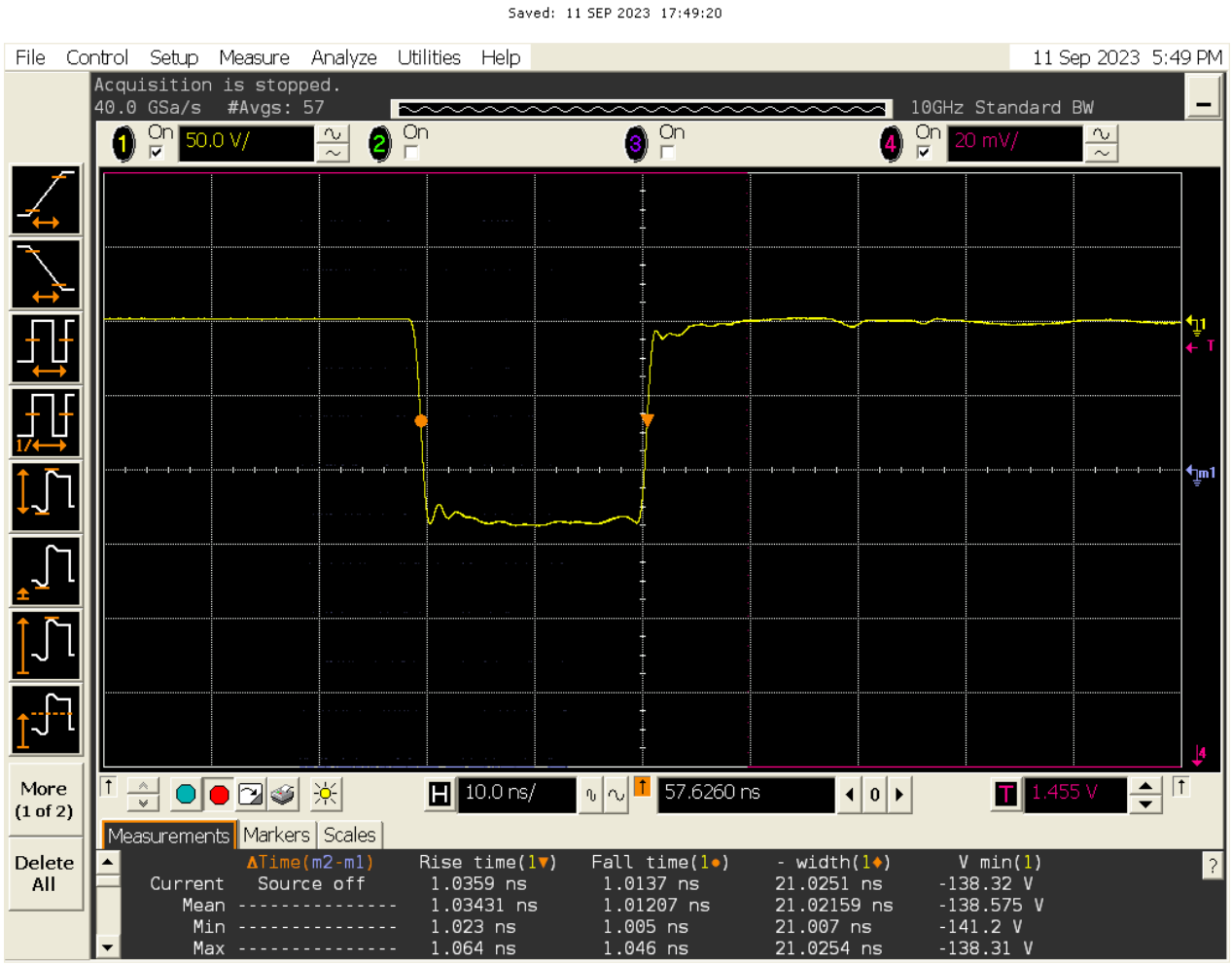
Time base Scale 100 ns/ Position 335.8960 ns Reference center

Trigger Mode edge Sweep triggered
Sensitivity low Holdoff time 100 ns
Source channel 4 Trigger level 941.9 mV Slope rising

Measure

	Rise time(1▼)	Fall time(1●)	- width(1◆)	V min(1)
Current	1.1130 ns	1.1602 ns	200.0675 ns	-141.45 V
Mean	1.11379 ns	1.15892 ns	200.06972 ns	-141.555 V
Min	1.104 ns	1.1514 ns	200.062 ns	-142.9 V
Max	1.1274 ns	1.189 ns	200.0735 ns	-141.34 V
Range	23.1 ps	37.4 ps	11.5 ps	1.57 V
Std Dev	5.32 ps	5.26 ps	2.25 ps	188 mV
# of Meas	107	107	107	107
Edge Dir	Rising	Falling		

Figure 9 Slow pulse at maximum amplitude and 200ns wide



Acquisition Sampling mode real time Normal
Memory depth automatic 4003 pts
Sampling rate automatic Sampling rate 40.0 GSa/s
Averaging on # of averages 64 Interpolation on

Channel 1 Scale 50.0 V/ Offset -100.8 V Coupling DC Impedance 50 Ohms

Channel 4 Scale 20 mV/ Offset 1.422 V Coupling DC Impedance 50 Ohms

Time base Scale 10.0 ns/ Position 57.6260 ns Reference center

Trigger Mode edge Sweep triggered
Sensitivity low Holdoff time 100 ns
Source channel 4 Trigger level 1.455 V Slope rising

Memory 1 Vertical scale 20.0 mV/ Offset 0.0 V
Horizontal scale 10.0 ns/ Position 57.626000000000 ns

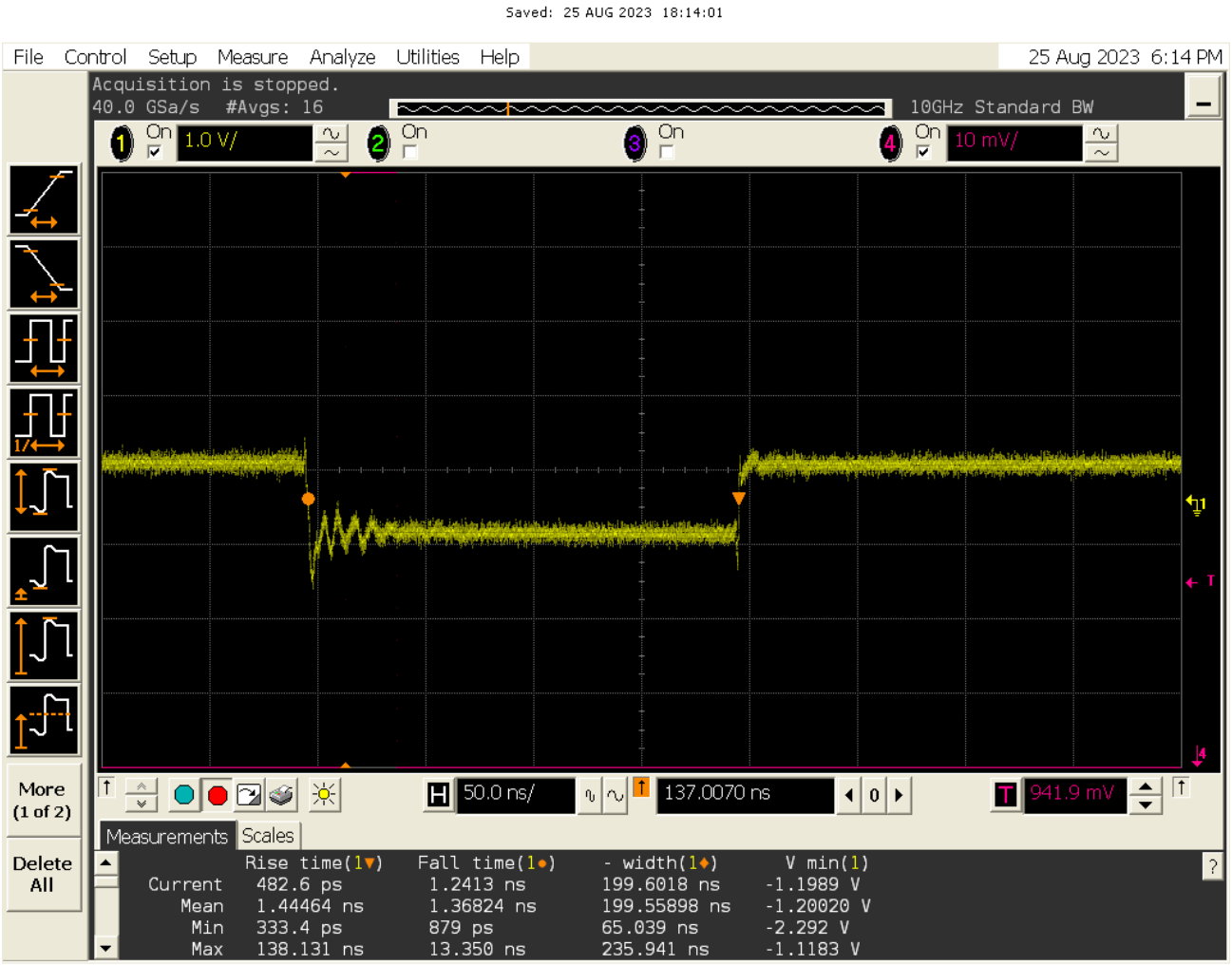
Measure

	ΔTime(m2-m1)	Rise time(1▼)	Fall time(1▼)	- width(1♦)	V min(1)
Current	Source off	1.0359 ns	1.0137 ns	21.0251 ns	-138.32 V
Mean	----------	1.03431 ns	1.01207 ns	21.02159 ns	-138.575 V
Min	----------	1.023 ns	1.005 ns	21.007 ns	-141.2 V
Max	----------	1.064 ns	1.046 ns	21.0254 ns	-138.31 V
Range	----------	41 ps	41 ps	18.2 ps	2.94 V
Std Dev	----------	5.60 ps	5.77 ps	3.74 ps	439 mV
# of Meas	----------	57	57	57	57
Edge Dir		Rising	Falling		

Marker

	ΔTime(m2-m1)	X	Y
Current	Source off	A——(m2) = ----------	----------
Mean	----------	B---(m1) = ----------	----------
Min	----------	Δ = ----------	----------
Max	----------	1/ΔX = ----------	
Range	----------		
Std Dev	----------		

Figure 10 Slow pulse at maximum amplitude and 20ns wide

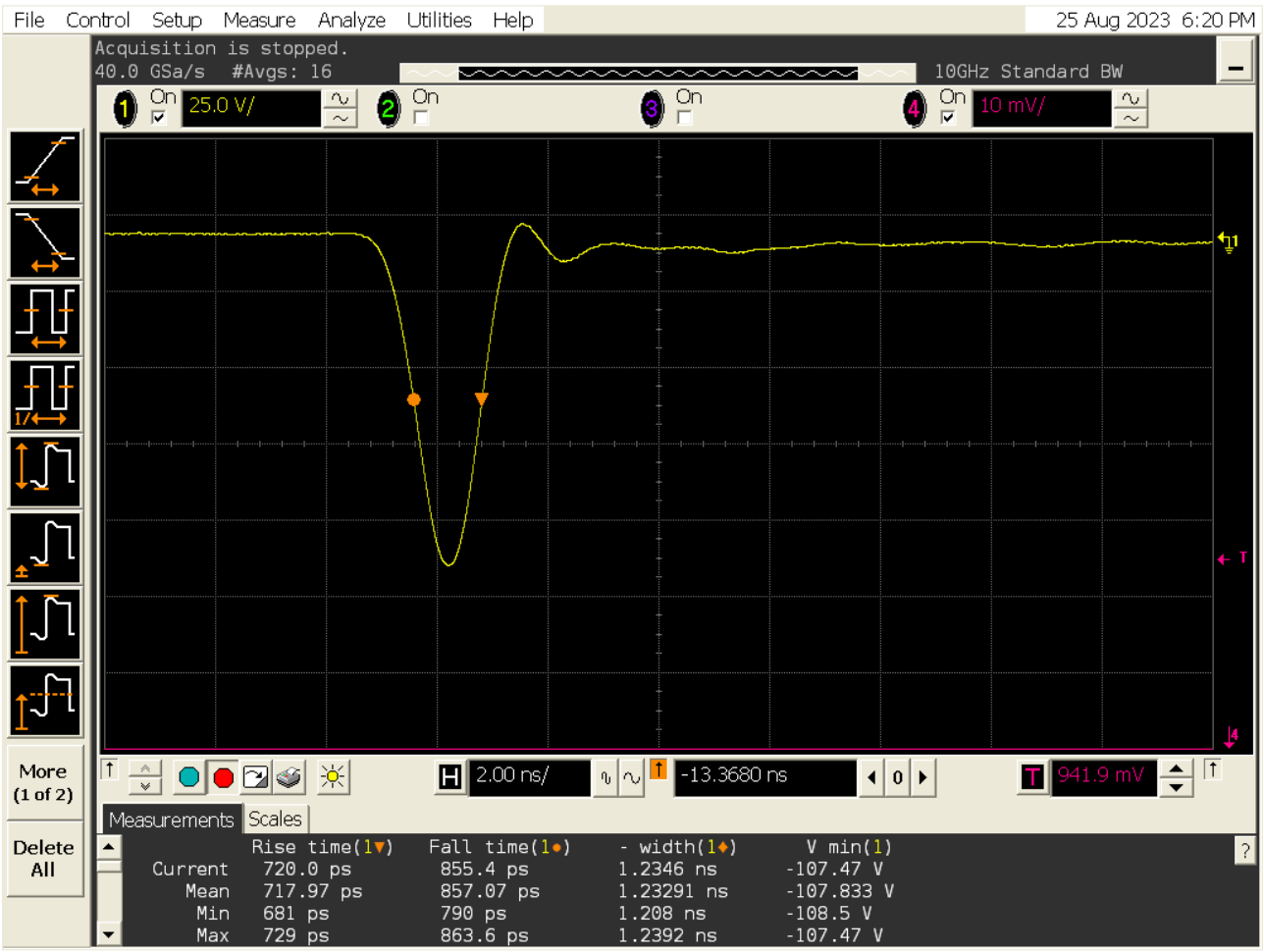


Acquisition	Sampling mode real time Normal Memory depth automatic 20003 pts Sampling rate automatic Sampling rate 40.0 GSa/s Averaging on # of averages 16 Interpolation on
Channel 1	Scale 1.0 V/ Offset 400 mV Coupling DC Impedance 50 Ohms
Channel 4	Scale 10 mV/ Offset 957 mV Coupling DC Impedance 50 Ohms
Time base	Scale 50.0 ns/ Position 137.0070 ns Reference center
Trigger	Mode edge Sweep triggered Sensitivity low Holdoff time 100 ns Source channel 4 Trigger level 941.9 mV Slope rising

Measure

	Rise time(1▼)	Fall time(1●)	- width(1♦)	V min(1)
Current	482.6 ps	1.2413 ns	199.6018 ns	-1.1989 V
Mean	1.44464 ns	1.36824 ns	199.55898 ns	-1.20020 V
Min	333.4 ps	879 ps	65.039 ns	-2.292 V
Max	138.131 ns	13.350 ns	235.941 ns	-1.1183 V
Range	137.7977 ns	12.471 ns	170.902 ns	1.1739 V
Std Dev	8.95961 ns	1.17166 ns	8.81053 ns	98.87 mV
# of Meas	256	256	256	256
Edge Dir	Rising	Falling		

Figure 11 Slow pulse at minimum amplitude and 200ns wide



Acquisition Sampling mode real time Normal
Memory depth automatic 1000 pts
Sampling rate automatic Sampling rate 40.0 GSa/s
Averaging on # of averages 16 Interpolation on

Channel 1 Scale 25.0 V/ Offset -67.7 V Coupling DC Impedance 50 Ohms

Channel 4 Scale 10 mV/ Offset 957 mV Coupling DC Impedance 50 Ohms

Time base Scale 2.00 ns/ Position -13.3680 ns Reference center

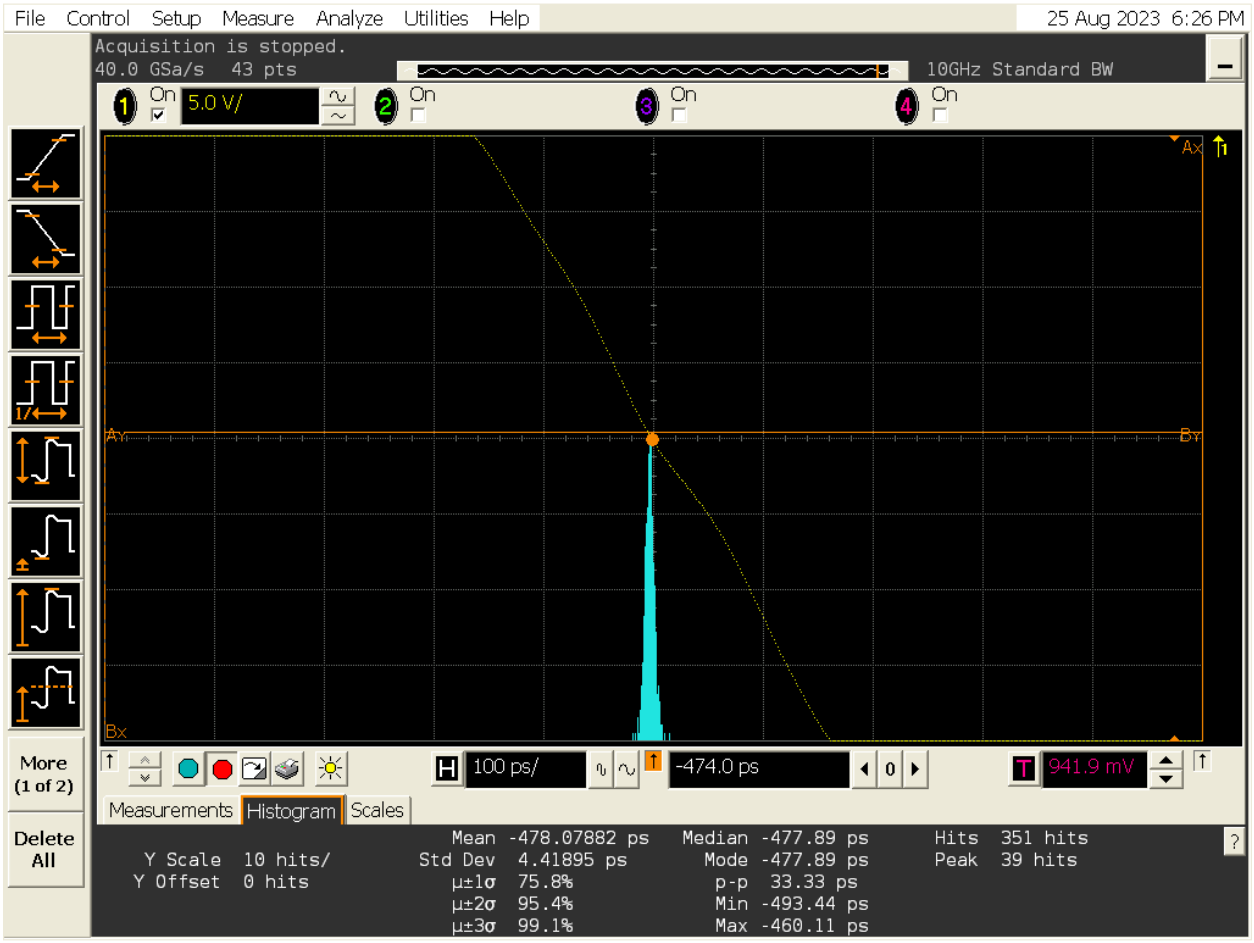
Trigger Mode edge Sweep triggered
Sensitivity low Holdoff time 100 ns
Source channel 4 Trigger level 941.9 mV Slope rising

Measure

	Rise time(1▼)	Fall time(1●)	- width(1◆)	V min(1)
Current	720.0 ps	855.4 ps	1.2346 ns	-107.47 V
Mean	717.97 ps	857.07 ps	1.23291 ns	-107.833 V
Min	681 ps	790 ps	1.208 ns	-108.5 V
Max	729 ps	863.6 ps	1.2392 ns	-107.47 V
Range	48 ps	73.2 ps	31.6 ps	1.07 V
Std Dev	6.17 ps	10.77 ps	3.82 ps	130 mV
# of Meas	113	113	113	113
Edge Dir	Rising	Falling		

Figure 12 Slow pulse at maximum amplitude and 1.24ns wide

Saved: 25 AUG 2023 18:26:40



Acquisition Sampling mode real time Normal
Memory depth automatic 43 pts
Sampling rate automatic Sampling rate 40.0 GSa/s
Averaging off Interpolation on

Channel 1 Scale 5.0 V/ Offset -60.4 V Coupling DC Impedance 50 Ohms

Channel 4 Scale 10 mV/ Offset 957 mV Coupling DC Impedance 50 Ohms

Time base Scale 100 ps/ Position -474.0 ps Reference center

Trigger Mode edge Sweep triggered
Sensitivity low Holdoff time 100 ns
Source channel 4 Trigger level 941.9 mV Slope rising

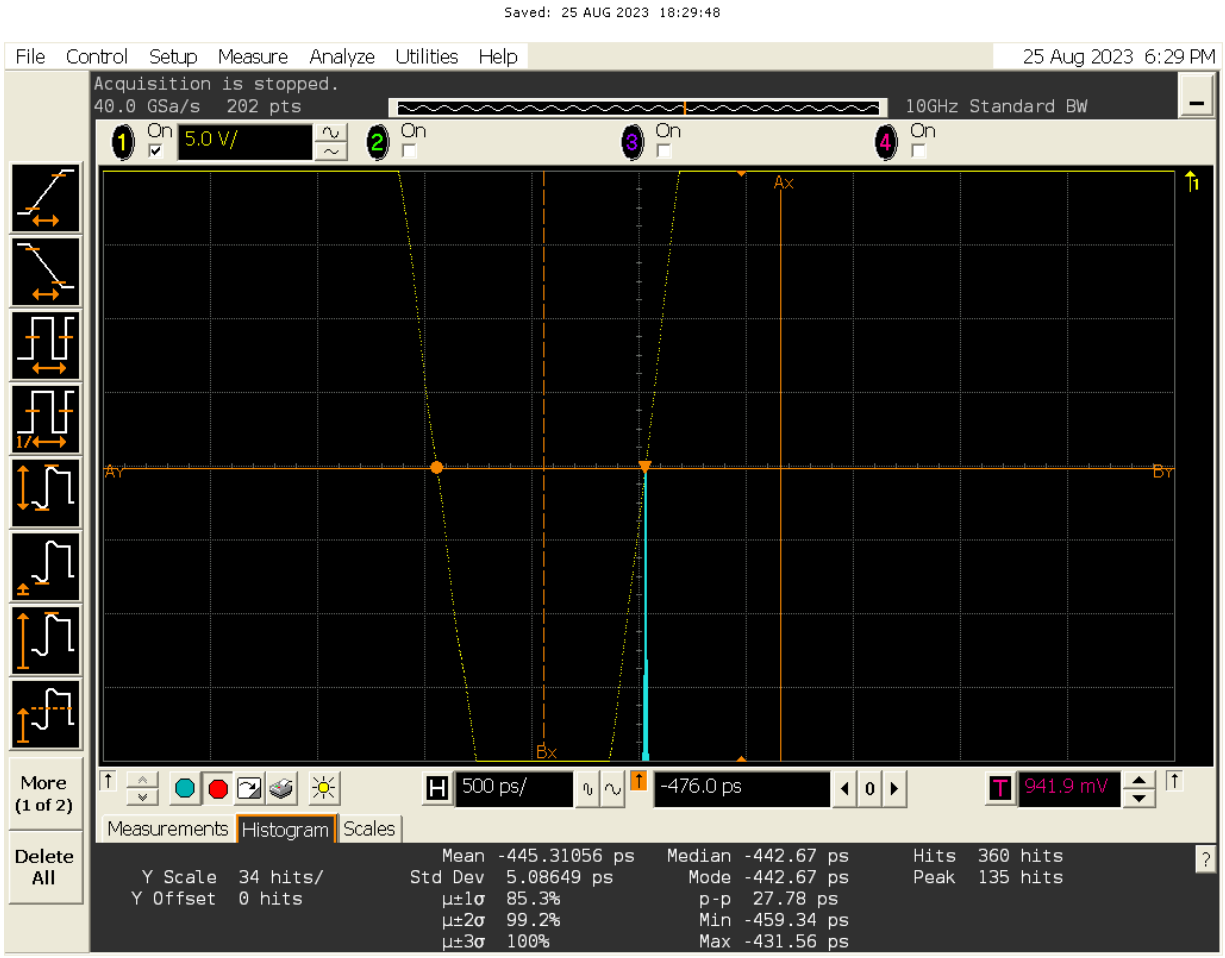
Measure

	Rise time(1▾)	Fall time(1▴)	- width(1◆)	V min(1)
Current	Edge?	266.58 ps	Edge?	≤-80.40 V
Mean	----------	267.605 ps	----------	?-80.400 V
Min	----------	252.52 ps	----------	?-80.40 V
Max	----------	279.71 ps	----------	?-80.40 V
Range	----------	27.19 ps	----------	? 0.0 V
Std Dev	----------	4.074 ps	----------	? 0.0 V
# of Meas	----------	797	----------	797
Edge Dir	----------	Falling		

Histogram Axis horizontal Scale source channel 1
Ax Position 185.89 ps Bx Position -1.58901 ns
Ay Position -60.0 V By Position -60.0 V
Scale type linear Size 4.0 div

Y Scale 10 hits/	Mean -478.07882 ps	Median -477.89 ps	Hits 351 hits
Y Offset 0 hits	Std Dev 4.41895 ps	Mode -477.89 ps	Peak 39 hits
	µ±1σ 75.8%	p-p 33.33 ps	
	µ±2σ 95.4%	Min -493.44 ps	
	µ±3σ 99.1%	Max -460.11 ps	

Figure 13 Slow pulse jitter ~ 4.4ps



Acquisition
Sampling mode real time Normal
Memory depth automatic 202 pts
Sampling rate automatic Sampling rate 40.0 GSa/s
Averaging off Interpolation on

Channel 1
Scale 5.0 V/ Offset -59.8 V Coupling DC Impedance 50 Ohms

Channel 4
Scale 10 mV/ Offset 957 mV Coupling DC Impedance 50 Ohms

Time base
Scale 500 ps/ Position -476.0 ps Reference center

Trigger
Mode edge Sweep triggered
Sensitivity low Holdoff time 100 ns
Source channel 4 Trigger level 941.9 mV Slope rising

Measure

	Rise time(1▾)	Fall time(1▾)	- width(1▸)	V min(1)
Current	265.56 ps	296.34 ps	973.16 ps	≤-79.80 V
Mean	277.434 ps	296.090 ps	967.479 ps	?-79.800 V
Min	259.70 ps	279.69 ps	925.55 ps	?-79.80 V
Max	296.69 ps	315.29 ps	1.00583 ns	?-79.80 V
Range	36.99 ps	35.60 ps	80.28 ps	? 0.0 V
Std Dev	5.520 ps	5.453 ps	12.204 ps	? 0.0 V
# of Meas	870	870	870	870
Edge Dir	Rising	Falling		

Histogram
Axis horizontal Scale source channel 1
Ax Position 185.89 ps Bx Position -919.16 ps
Ay Position -60.0 V By Position -60.0 V
Scale type linear Size 4.0 div

Y Scale 34 hits/	Mean -445.31056 ps	Median -442.67 ps	Hits 360 hits
Y Offset 0 hits	Std Dev 5.08649 ps	Mode -442.67 ps	Peak 135 hits
	µ±1σ 85.3%	p-p 27.78 ps	
	µ±2σ 99.2%	Min -459.34 ps	
	µ±3σ 100%	Max -431.56 ps	

Figure 14 Slow pulse off edge jitter ~ 5.1ps

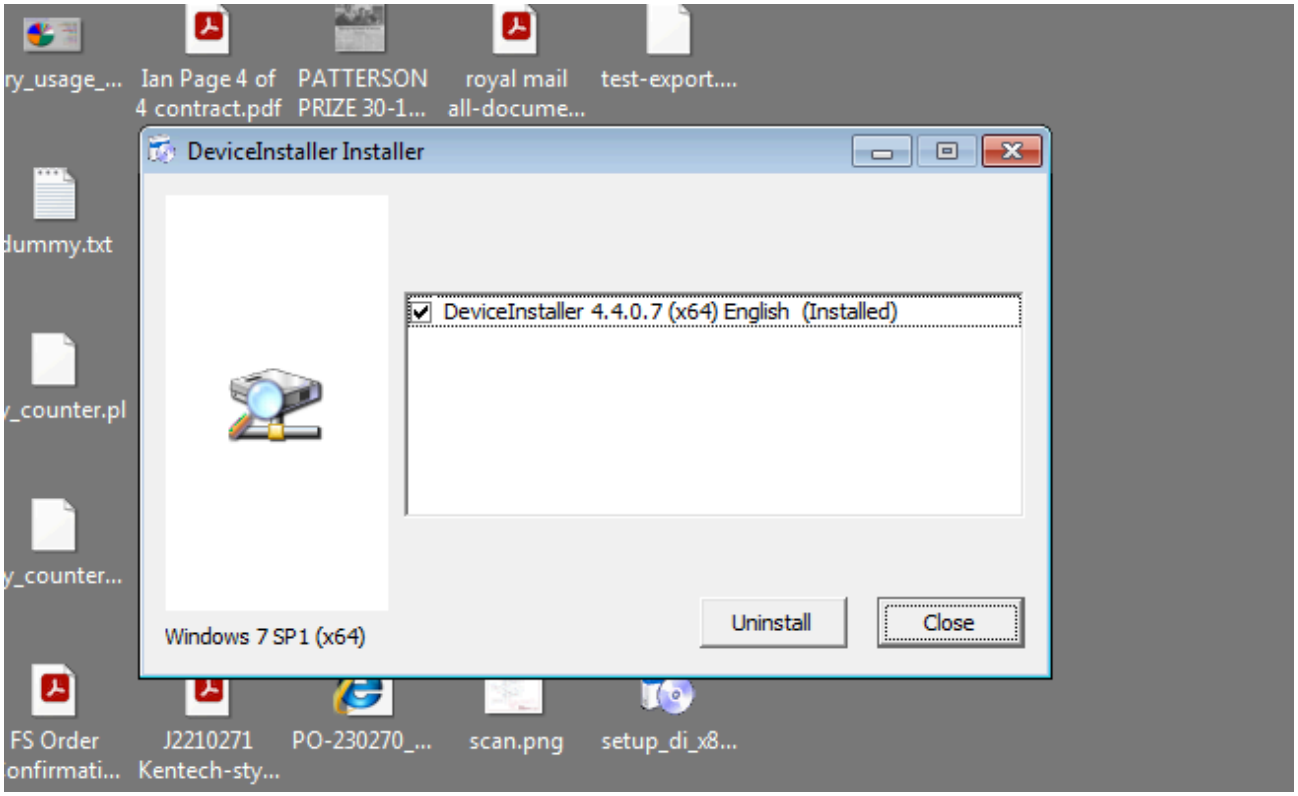
7. SETTING UP THE ETHERNET PORT

The ethernet port uses a Lantronix Xport device. This has been set up at the factory to use a DHCP server to acquire an IP address. If an alternative configuration is required this is easily done using software supplied by Lantronix. (A copy may be supplied with this manual). At the time of writing the latest version is 4.4.0.7

Install the software on a windows machine from the exe file supplied or downloaded from:

https://ltrxdev.atlassian.net/wiki/spaces/LTRXTS/pages/106070471/Latest+version+of+DeviceInstaller

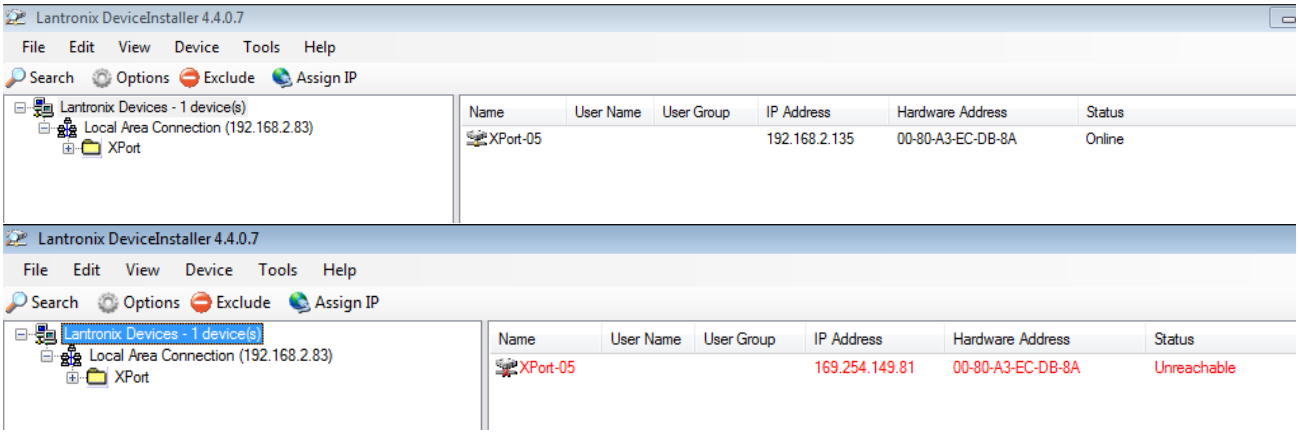
This will require a machine running Windows 7 or later. (We have not tried it on anything except Windows 7).



The Xport device (built into the Cathode pulser) needs to be powered up and connected to the same network as the Windows machine running the Lantronix software. Normally this network will have a router but it is not essential.

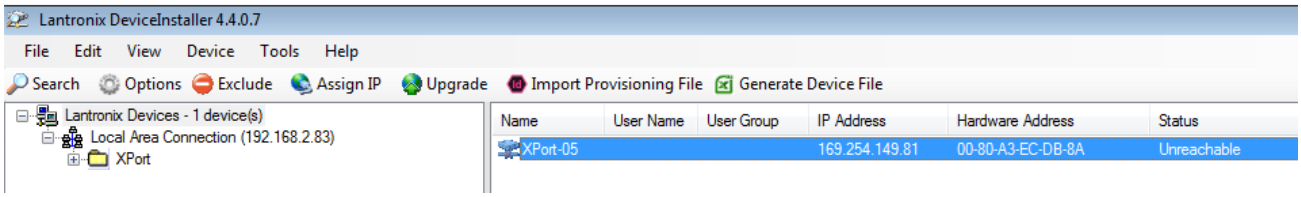
If the network has a DHCP server and the ethernet connection is present when the cathode pulser is powered up the lantronix Xport device will be assigned an IP address. If the unit is powered up before the Ethernet connection is made the Xport device will self assign an IP address of the form 169....

In either case the Lantronix device installer software can be launched and wil find the device. In the event that you might have other Lantronix devices on the same network, it is always worthwhile checking that the device installer reports the same MAC address as is printed on the cathode pulser..

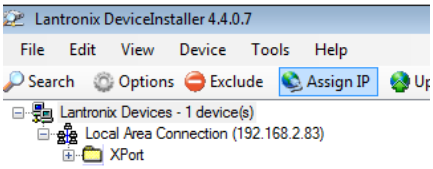


7.1 TO CHANGE THE IP ADDRESS CONFIGURATION

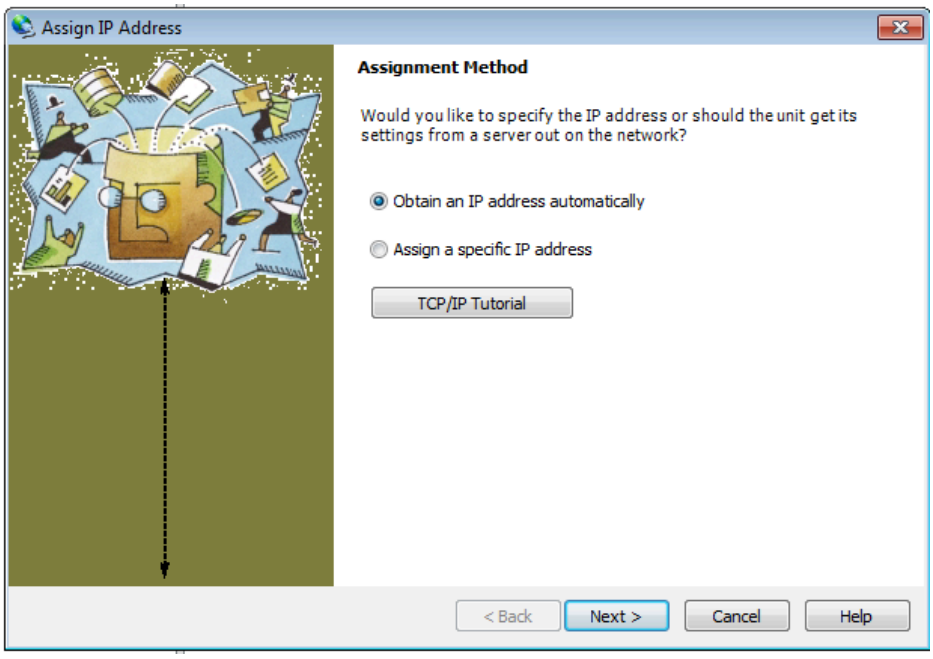
In order to change the IP address configuration single click on the found device in the right hand window to select it.



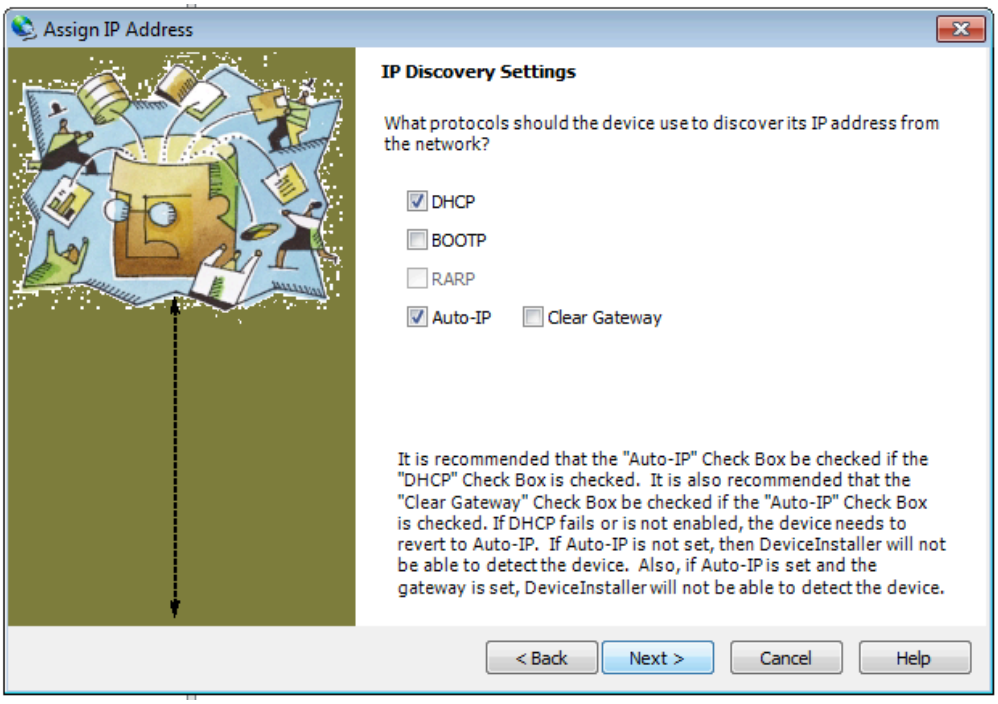
The click on Assign IP.



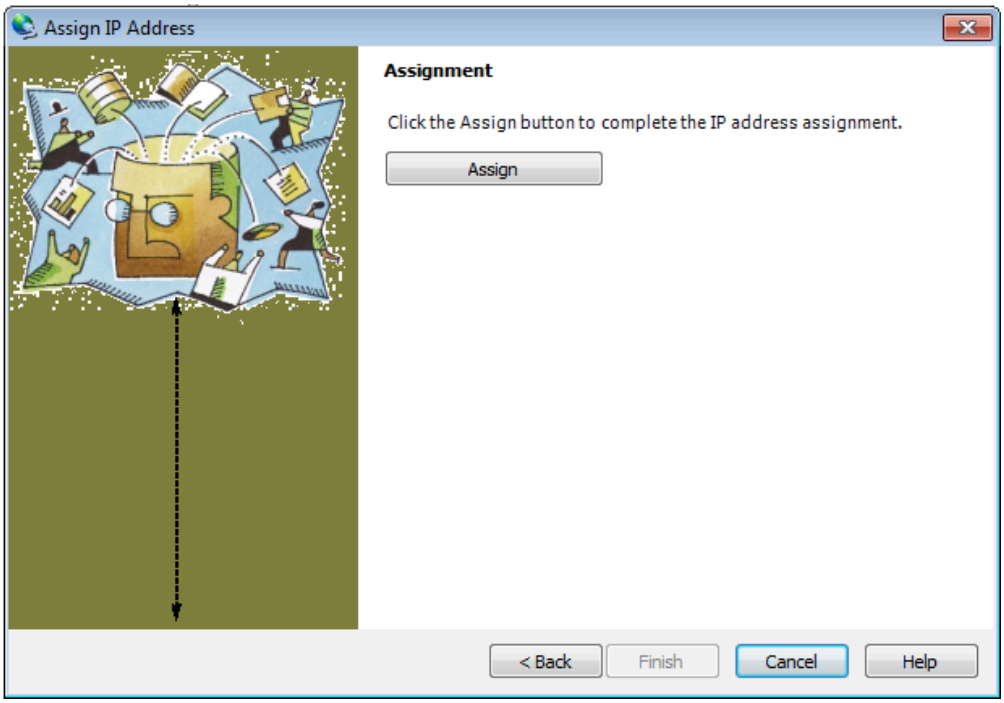
The following window will appear:



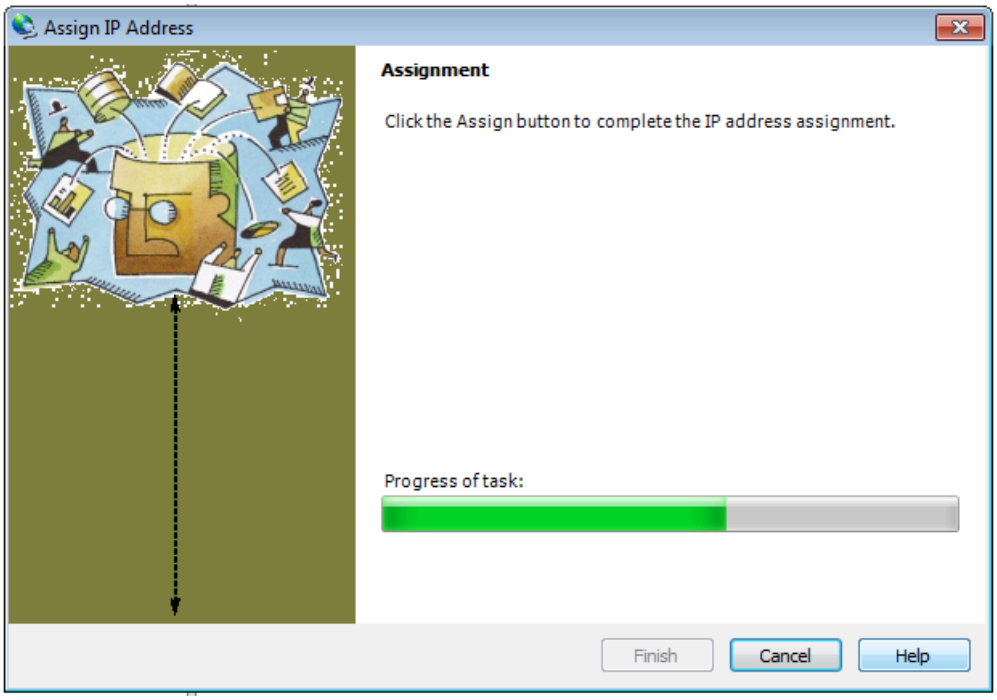
To use a DHCP server to assign the IP address, select Obtain IP address automatically. and then hit NEXT. The following window will appear:



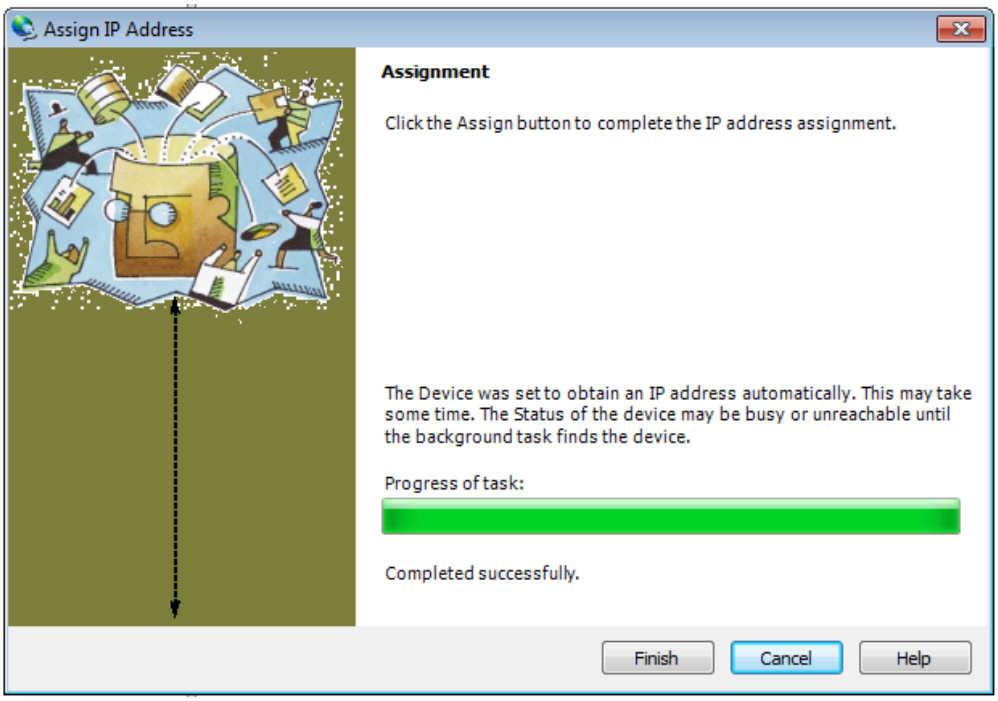
Check the box next to DHCP and hit NEXT: You will then see the window:



Hot ASSIGN and then you will see:

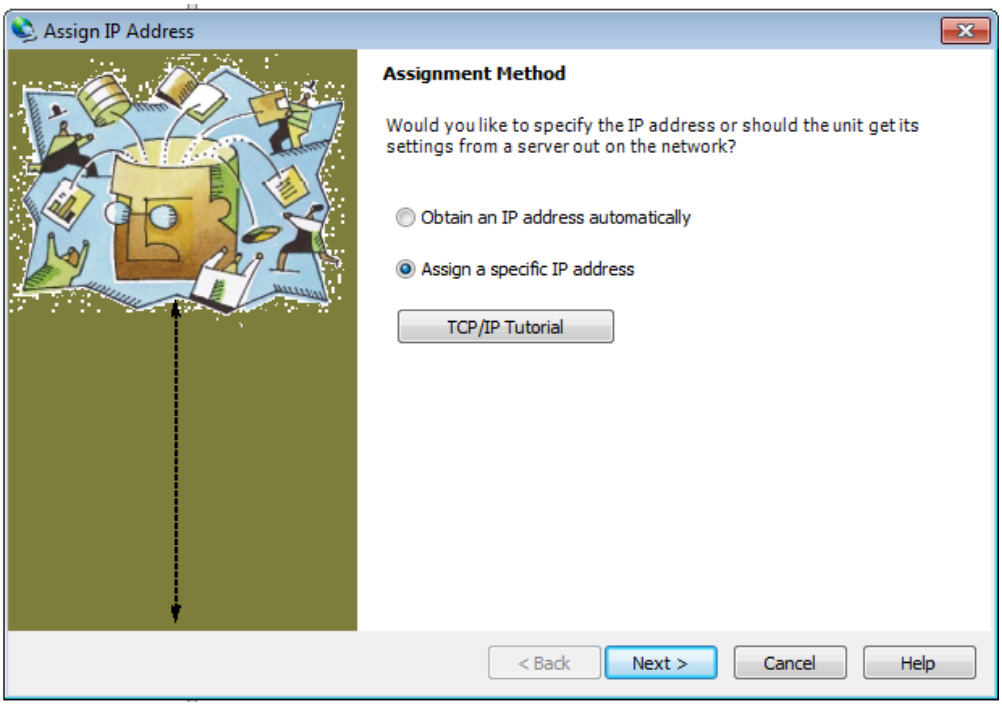


When the task has finished, hit FINISH.

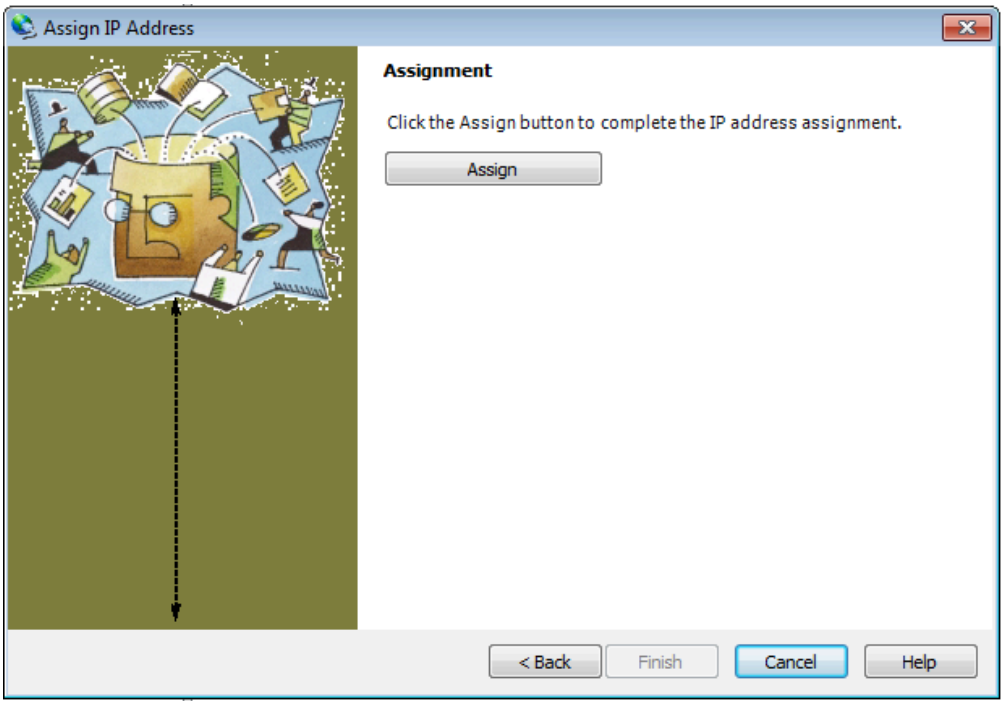


7.1.1 TO ASSIGN A SPECIFIC IP ADDRESS

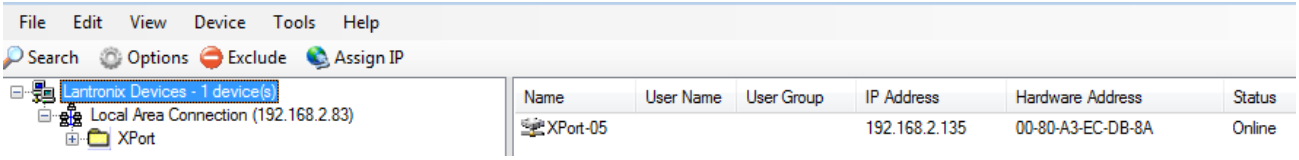
For a specific IP address at the window:



Select Assign a specific IP address and then hit NEXT. You wil see the window:



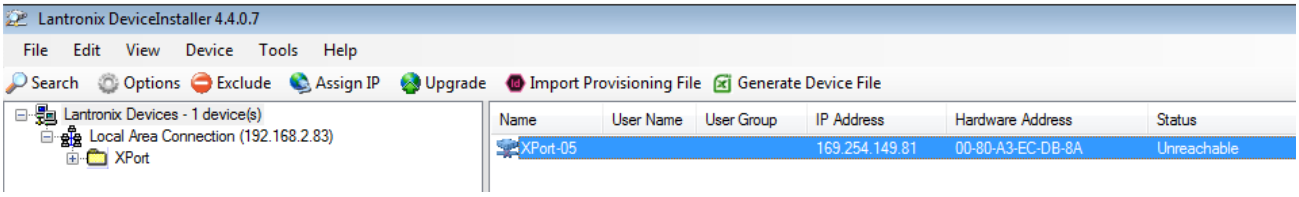
Hit ASSIGN a nd after the task is complete it wil return to the device selection window with the IP address set.



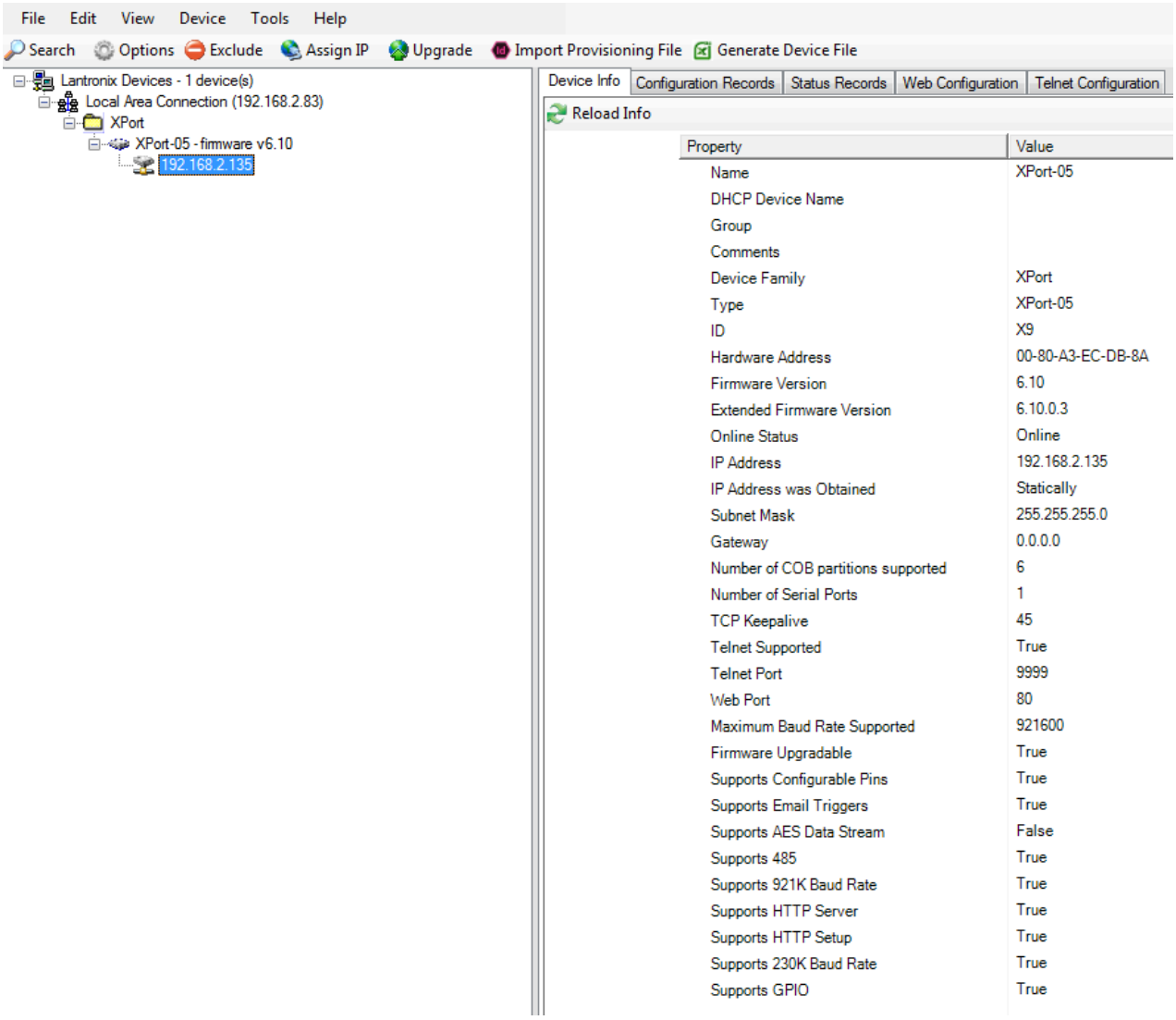
7.1.2 SETTING UP THE LOCAL PORT.

The local port settings are set at the factory and should not need changing. Here are instructions for setting up a new device should this ever be required. Two things need setting up, the communications protocol and the local port number.

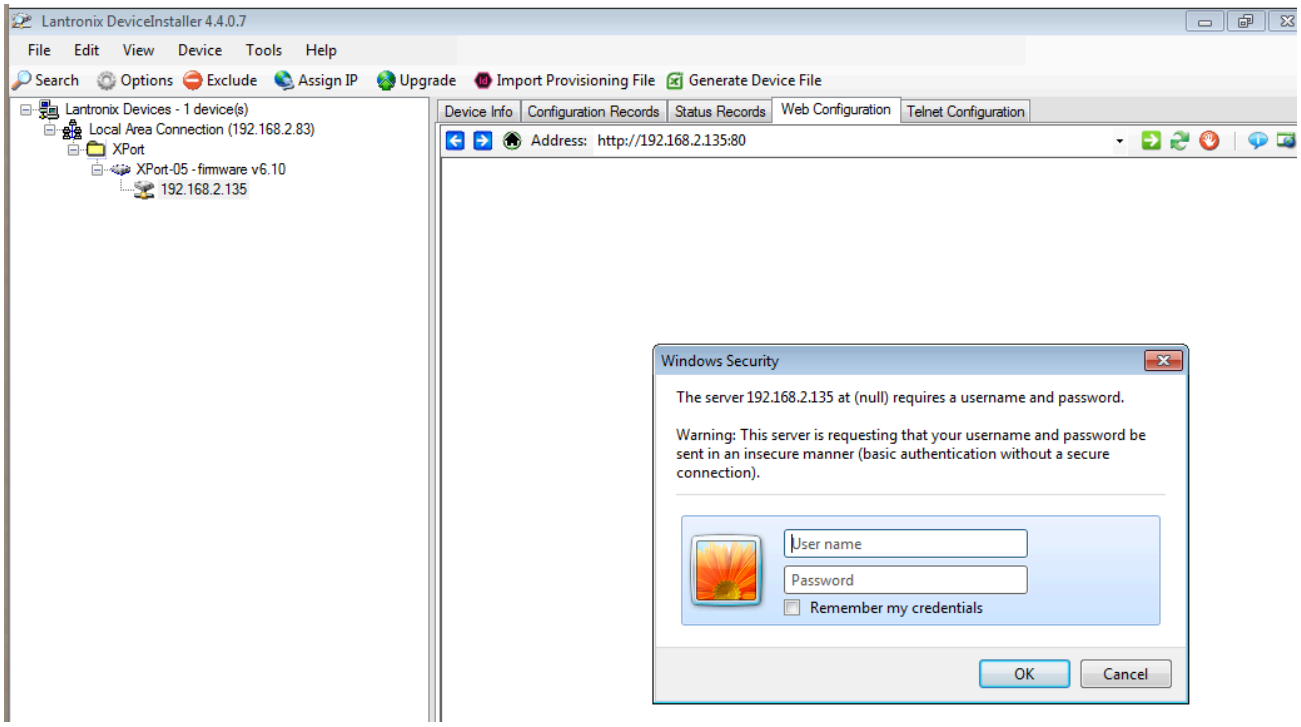
To set up the communications protocol double click the device in the right hand window of the screen:



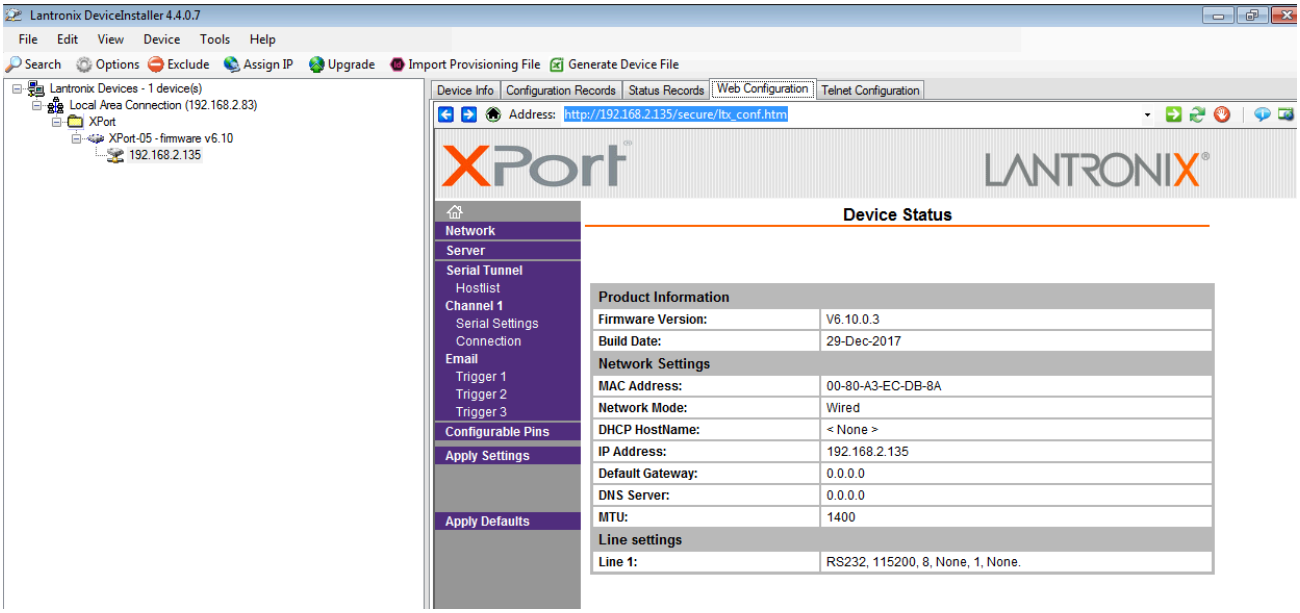
Then you will see:



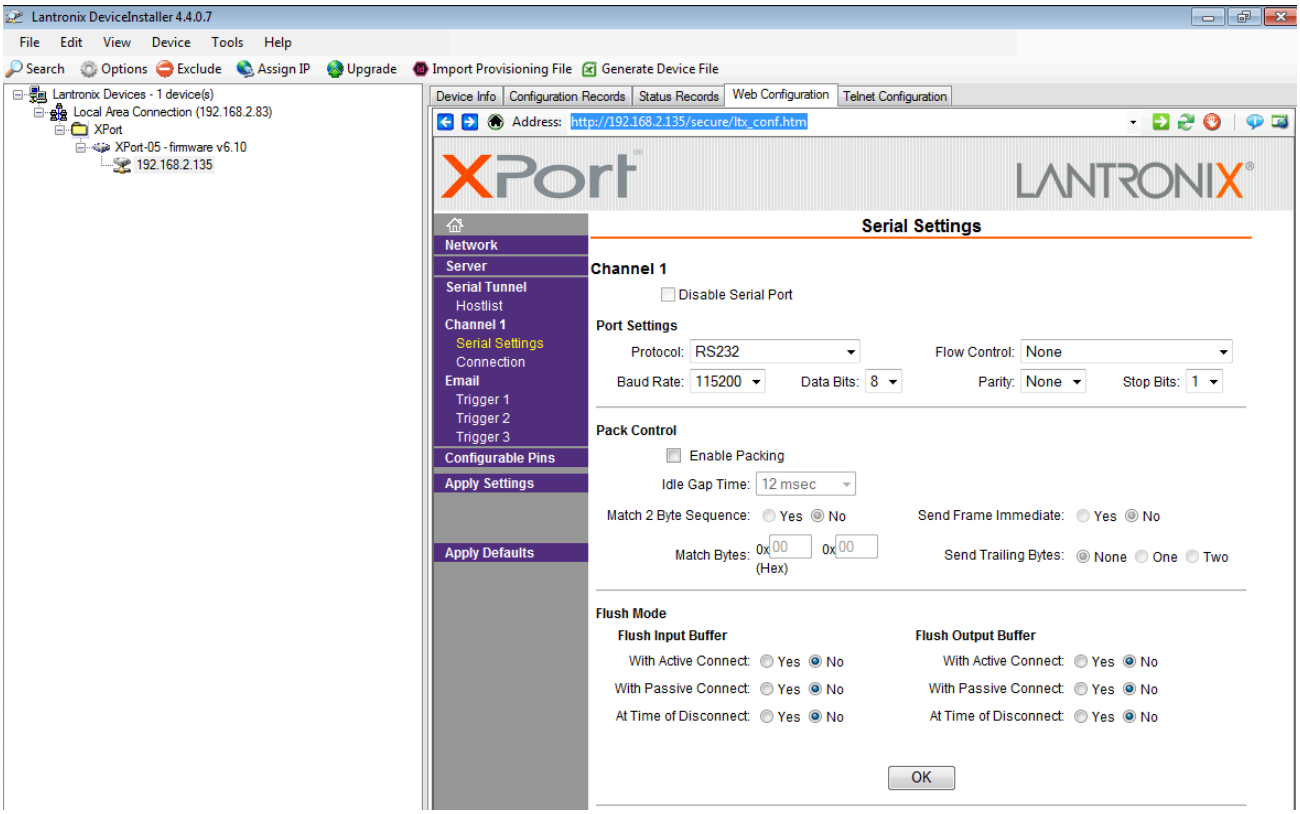
Next select WEB CONFIGURATION from the array of tabs at the top right.You will see:



Click on OK - do not fill in the screen. You will then see:

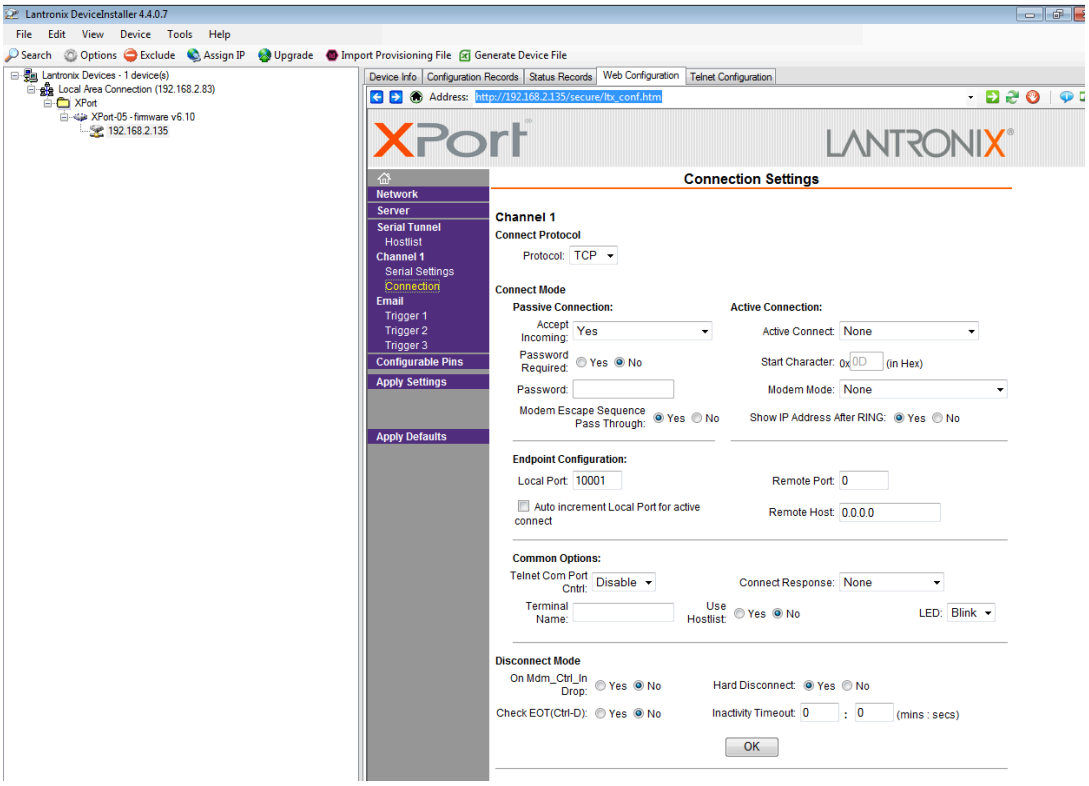


Click on SERIAL SETTINGS, you will then see:



If the settings are not as shown here, change them and then hit OK. This has set up the communications protocol.

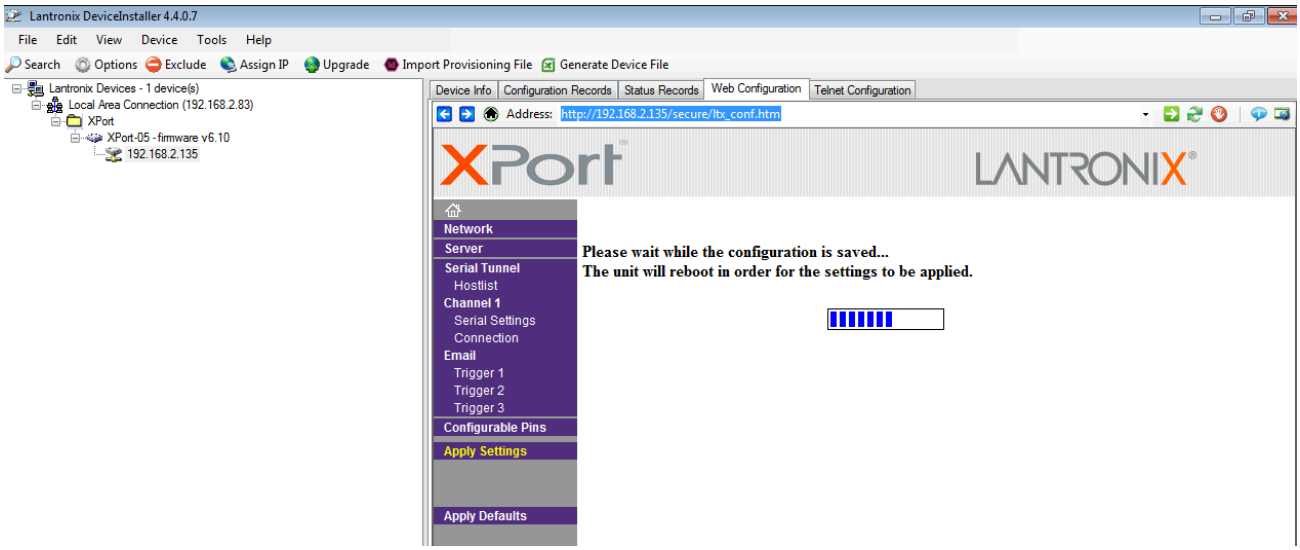
Then Hit Connection to set up the local port. You will see.



The settings should be as shown above - particularly the Local Port number should be 10001.

If you need to change it, do so and then hit OK.

If you have had to make any changes to the serial settings or the connection you must then hit APPLY SETTINGS The unit will reboot and apply the new settings:



When this has finished the ethernet port should now be set up. Quit the application to release the connection to another device.

8. IEC INLET DATA SHEET

IEC Appliance Inlet C14 with Filter, Fuseholder 1-pole

Snap-in mounting from front side
Type 5200, Fuseholder 1-pole with spare compartment
Snap-In Version

Screw-on from front side
Type 5200, Fuseholder 1-pole with spare compartment
Screw-On Version

C14

70° C

See below:
Approvals and Compliances

Description
- Panel mount :
  Snap-in or screw-on mounting front side
- 3 Functions :
  Appliance Inlet Protection class I , Fuseholder for fuse-links 5 x 20 mm 1-pole , Line filter in standard and medical version
- V-Lock notch standard
- Quick connect terminals 6.3 x 0.8 mm

Unique Selling Proposition
- Ultra-compact design
- Recessed faston connectors
- High quality filter case made of stainless steel
- Highly resistant since potted filter

Characteristics
- All single elements are already wired
- Plug removal necessary for fuse-link replacement
- For applications according IEC/UL 62368-1 we recommend variants with bleed resistor
  Standard and Medical Version, IEC 60939-2, UL 60939-3

Other versions on request
- Medical Version (M80)

References
Alternative: version without line filter 6200
Alternative: Standard version

Weblinks
pdf data sheet, html datasheet, General Product Information, Approvals, Distributor-Stock-Check, Accessories, Detailed request for product

Technical Data

Ratings IEC	1 - 10 A @ Ta 40 °C / 250 VAC; 50 Hz
Ratings UL/CSA	1 - 10 A @ Ta 40 °C / 250 VAC; 60 Hz
Leakage Current	standard < 0.5 mA (250 V / 60 Hz) medical < 5 µA (250 V / 60 Hz)
Dielectric Strength	> 1.7 kVDC between L-N > 2.7 kVDC between L/N-PE Test voltage (2 sec)
Allowable Operation Temperature	-25 °C to 85 °C
Climatic Category	25/085/21 acc. to IEC 60068-1
IP-Protection	front side IP40 acc. to IEC 60529
Protection Class	Suitable for appliances with protection class I acc. to IEC 61140
Terminal	Quick connect terminals 6.3 x 0.8 mm
Panel Thickness S	Screw: max 8 mm Mounting screw torque max 0.5 Nm Snap-in: 0.8 mm to 3 mm
Material	Thermoplastic, black, UL 94V-0

Appliance inlet/-outlet	C14 acc. to IEC 60320-1, UL 60320-1, CSA C22.2 no. 60320-1 (for cold conditions) pin-temperature 70 °C, 10 A, Protection Class I
Fuseholder	1-pole, Shocksafe category PC2 acc. to IEC 60127-6, for fuse-links 5 x 20 mm
Rated Power Acceptance @ Ta 23 °C	5 x 20: 2 W (1 pole)
Power Acceptance @ Ta > 23°C	Admissible power acceptance at higher ambient temperature see derating curves
Line Filter	Standard and Medical Version, IEC 60939-2, UL 60939-3, CSA C22.2 no. 8 Technical Details
MTBF	> 2'300'000 h acc. to MIL-HB-217 F

Approvals and Compliances

Detailed information on product approvals, code requirements, usage instructions and detailed test conditions can be looked up in Details about Approvals

SCHURTER products are designed for use in industrial environments. They have approvals from independent testing bodies according to national and international standards. Products with specific characteristics and requirements such as required in the automotive sector according to IATF 16949, medical technology according to ISO 13485 or in the aerospace industry can be offered exclusively with customer-specific, individual agreements by SCHURTER.

Approvals

The approval mark is used by the testing authorities to certify compliance with the safety requirements placed on electronic products.

Approval Reference Type: 5200

Approval Logo	Certificates	Certification Body	Description
	VDE Approvals	VDE	Certificate Number: 101307
	UL Approvals	UL	UR File Number: E495089
	CQC Approvals	CQC	CQC Certificate Number: CQC18001210262

Product standards

Product standards that are referenced

Organization	Design	Standard	Description
	Designed according to	IEC 60320-1	Appliance couplers for household and similar general purposes
	Designed according to	IEC 60939-2	Passive filters for suppressing electromagnetic interference
	Designed according to	IEC 60127-6	Miniature fuses. Part 6. Fuse-holders for miniature fuse-links
	Designed according to	UL 60320-1	Standard for Attachment Plugs and Receptacles
	Designed according to	UL 60939-3	Electromagnetic interference filters
	Designed according to	CSA C22.2 no. 60320-1	General Use Receptacles, Attachment Plugs, and Similar Wiring Devices
	Designed according to	CSA C22.2 no. 8	Electromagnetic interference (EMI) filters

Application standards

Application standards where the product can be used

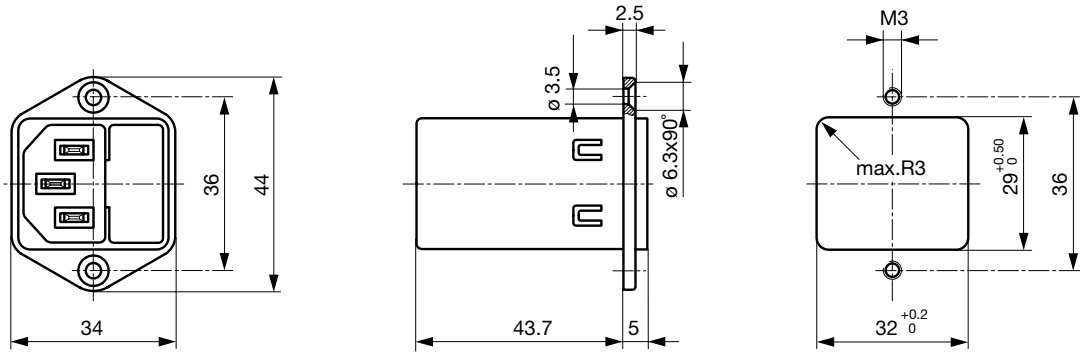
Organization	Design	Standard	Description
	Suitable for applications acc.	IEC/UL 62368-1	Audio/video, information and communication technology equipment - Part 1: Safety requirements
	Suitable for applications acc.	IEC 60601-1	Medical electrical equipment - Part 1: General requirements for basic safety and essential performance
	Suitable for applications acc.	IEC 60335-1	Safety of electrical appliances for household and similar purposes. Meets the requirements for appliances in unattended use. This includes the enhanced requirements of glow wire tests acc. to IEC 60695-2-11 or -12 & -13.

Compliances

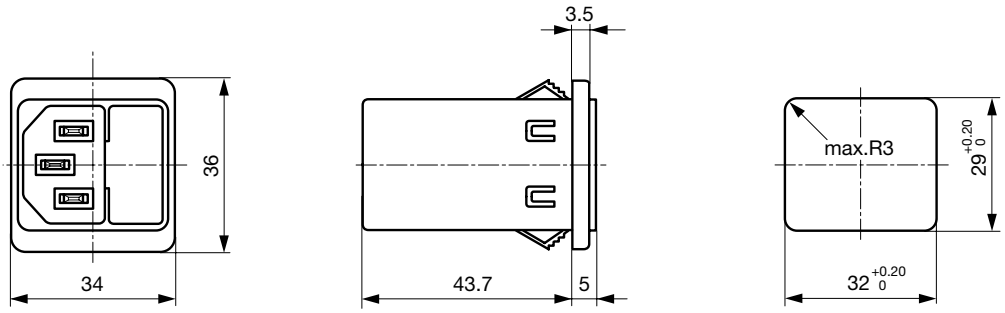
The product complies with following Guide Lines

Identification	Details	Initiator	Description
CE	CE declaration of conformity	SCHURTER AG	The CE marking declares that the product complies with the applicable requirements laid down in the harmonisation of Community legislation on its affixing in accordance with EU Regulation 765/2008.
UK CA	UKCA declaration of conformity	SCHURTER AG	The UKCA marking declares that the product complies with the applicable requirements laid down in the British Amendment of Regulation (EC) 765/2008.
RoHS	RoHS	SCHURTER AG	Directive RoHS 2011/65/EU, Amendment (EU) 2015/863
	China RoHS	SCHURTER AG	The law SJ / T 11363-2006 (China RoHS) has been in force since 1 March 2007. It is similar to the EU directive RoHS.
REACH	REACH	SCHURTER AG	On 1 June 2007, Regulation (EC) No 1907/2006 on the Registration, Evaluation, Authorization and Restriction of Chemicals 1 (abbreviated as "REACH") entered into force.
V-Lock		SCHURTER AG	V-Lock system are based on a matching plug-dose combination. The connector is equipped with a notch intended for use with the latching cordset. The cord latching system prevents against accidental removal of the cordset.
	White Paper Glow wire test	SCHURTER AG	Meets the requirements of IEC 60335-1 for appliances in unattended use. This includes the enhanced requirements of glow wire tests acc. to IEC 60695-2-11 or -12 &-13.
	Medical Equipment	SCHURTER AG	Suitable for use in medical equipment according to IEC/UL 60601-1 (1 MOOP, 1 MOPP)

Dimension [mm]
Screw-on mounting type 5200



Snap-in mounting type 5200

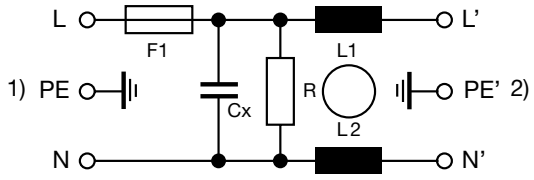


Technical Data of Filter-Components

Rated Current [A]	Filter-Type	Inductances L [mH]	Capacitance CX [nF]	Capacitance CY [nF]	R [MΩ]
1	Standard version	2 x 11	47	2.2	-
2	Standard version	2 x 4	47	2.2	-
4	Standard version	2 x 1.6	47	2.2	-
6	Standard version	2 x 0.7	47	2.2	-
8	Standard version	2 x 0.6	47	2.2	-
10	Standard version	2 x 0.4	47	2.2	-
1	Medical Version (M5)	2 x 11	47	-	1
2	Medical Version (M5)	2 x 4	47	-	1
4	Medical Version (M5)	2 x 1.6	47	-	1
6	Medical Version (M5)	2 x 0.7	47	-	1
8	Medical Version (M5)	2 x 0.6	47	-	1
10	Medical Version (M5)	2 x 0.4	47	-	1
10	Standard and Medical Version	2 x 11	47	2.2	1

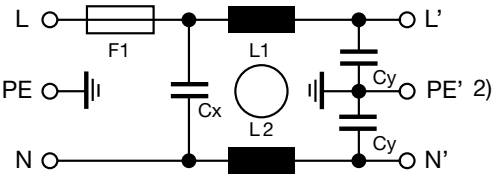
Diagrams

5200 Medical Version (M5)



1) Line
2) Load

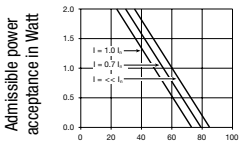
5200 Standard Version



1) Line
2) Load

Derating Curves

1-pole

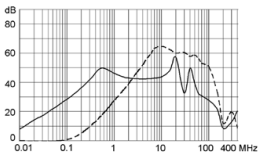


Attenuation Loss

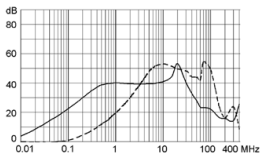
- - - - 50Ω differential mode _____ 50Ω common mode

Standard version

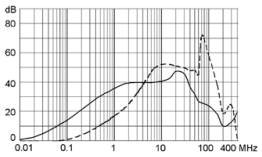
2 A



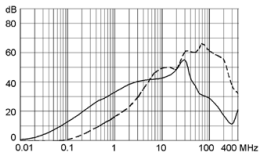
4 A



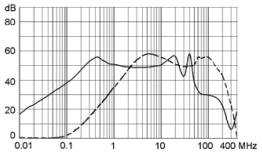
6 A



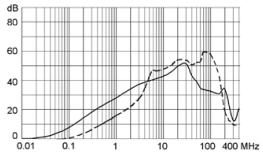
8 A



1 A

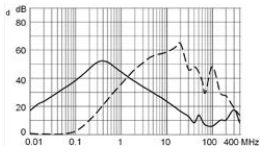


10 A

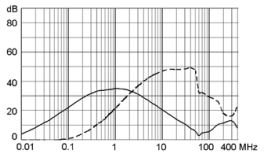


Medical version (M5)

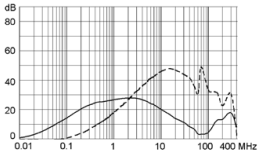
1 A



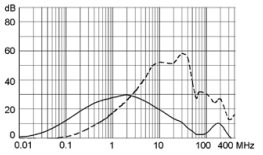
4 A



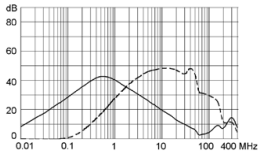
6 A



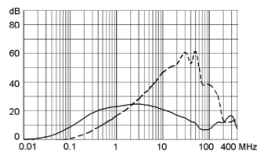
8 A



2 A



10 A



All Variants

Rated Current [A]	Filter-Type	Panel mounting	Fuseholder	Order Number	
1	Standard version	Snap-in	1-pole	5200.0143.1	▮
2	Standard version	Snap-in	1-pole	5200.0243.1	▮
4	Standard version	Snap-in	1-pole	5200.0443.1	▮
6	Standard version	Snap-in	1-pole	5200.0643.1	▮
8	Standard version	Snap-in	1-pole	5200.0843.1	
10	Standard version	Snap-in	1-pole	5200.1043.1	▮
1	Standard version	Screw	1-pole	5200.0123.1	▮
2	Standard version	Screw	1-pole	5200.0223.1	▮
4	Standard version	Screw	1-pole	5200.0423.1	▮
6	Standard version	Screw	1-pole	5200.0623.1	▮
8	Standard version	Screw	1-pole	5200.0823.1	
10	Standard version	Screw	1-pole	5200.1023.1	▮
1	Medical Version (M5)	Snap-in	1-pole	5200.0143.3	
2	Medical Version (M5)	Snap-in	1-pole	5200.0243.3	
4	Medical Version (M5)	Snap-in	1-pole	5200.0443.3	
6	Medical Version (M5)	Snap-in	1-pole	5200.0643.3	
8	Medical Version (M5)	Snap-in	1-pole	5200.0843.3	
10	Medical Version (M5)	Snap-in	1-pole	5200.1043.3	
1	Medical Version (M5)	Screw	1-pole	5200.0123.3	
2	Medical Version (M5)	Screw	1-pole	5200.0223.3	
4	Medical Version (M5)	Screw	1-pole	5200.0423.3	
6	Medical Version (M5)	Screw	1-pole	5200.0623.3	▮
8	Medical Version (M5)	Screw	1-pole	5200.0823.3	
10	Medical Version (M5)	Screw	1-pole	5200.1023.3	

▮ Most Popular.

Availability for all products can be searched real-time:https://www.schurter.com/en/Stock-Check/Stock-Check-SCHURTER

Packaging unit 10 Pcs

Accessories

	Description	
	Assorted_Covers Rear Cover	
		0859.0047
	RC320 Rear Cover for Power Entry Module	
	Cord_retaining_kits Cord retaining strain relief	
	Countersunk, B	4700.0002

Mating Outlets/Connectors

	Category / Description	
	Appliance Outlet Overview complete	
	4787, Mounting: Screw-on mounting, Appliance Outlet: IEC Solder terminals, 10 A, Suitable for appliances with protection class I	4787
	4788, Mounting: Snap-in version, Appliance Outlet: IEC Solder / Quick Connect, 10 A, Suitable for appliances with protection class I	4788
	IEC Appliance Outlet F or H, Screw-on Mounting, Front Side, Solder, PCB or Quick-connect Terminal	5091
	Connector Overview complete	
	4782 Mounting: Power Cord, 3 x 1 mm² / 3 x 18 AWG, Cable, Connector: IEC C13	4782
	4785 Mounting: Power Cord, 3 x 1 mm² / 3 x 18 AWG, Cable, Connector: IEC C13	4785
	4300-06 Mounting: Power Cord, 3 x 1 mm² / 3 x 18 AWG, Cable, Connector: IEC C13	4300-06
	4781 Mounting: Power Cord, Cable, Connector: IEC C15	4781
	4784 Mounting: Power Cord, 3 x 1 mm² / 3 x 18 AWG, Cable, Connector: IEC C15	4784

Mating Outlets/Connectors shuttered

	Connector Overview complete	
	4783 Mounting: Power Cord, 3 x 1 mm² / 3 x 18 AWG, Cable, Connector: IEC C13	4783

15.08.2023