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Proteus Series Performance Verification Manual

Rev. 1.6

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Document Revision History

Revision	Date	Description	Author
1.6	04-Feb-2026	• 2 Test Plan — Added figures and corrections.	Jonathan Netzer
1.5	10-Dec-2025	• 2.6.1 Coarse Delay Between Channels — Changed in "Test Procedure" from ns to points, and added a note. • Table 2-10 Sinewave Harmonics Test — Added a note for "Reading Limits".	Shivani Chouksey Jakob Apelblat
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1.0	15-Oct-2019	• Original version.	Yaron Pohoriles

Acronyms & Abbreviations

Acronym	Description
µs or us	Microseconds
ADC	Analog to Digital Converter
AM	Amplitude Modulation
ASIC	Application-Specific Integrated Circuit
ATE	Automatic Test Equipment
AWG	Arbitrary Waveform Generators
AWT	Arbitrary Waveform Transceiver
BNC	Bayonet Neill–Concelm (coax connector)
BW	Bandwidth
CW	Carrier Wave
DAC	Digital to Analog Converter
dBc	dB/carrier. The power ratio of a signal to a carrier signal, expressed in decibels
dBm	Decibel-Milliwatts. E.g., 0 dBm equals 1.0 mW.
DDC	Digital Down-Converter
DHCP	Dynamic Host Configuration Protocol
DSO	Digital Storage Oscilloscope
DUC	Digital Up-Converter
ENoB	Effective Number of Bits
ESD	Electrostatic Discharge
EVM	Error Vector Magnitude
FPGA	Field-Programmable Gate Arrays

Acronym	Description
GHz	Gigahertz
GPIB	General Purpose Interface Bus
GS/s	Giga Samples per Second
GUI	Graphical User Interface
HP	Horizontal Pitch (PXIe module horizontal width, 1 HP = 5.08mm)
Hz	Hertz
IF	Intermediate Frequency
I/O	Input / Output
IP	Internet Protocol
IQ	In-phase Quadrature
IVI	Interchangeable Virtual Instrument
JSON	JavaScript Object Notation
kHz	Kilohertz
LCD	Liquid Crystal Display
LO	Local Oscillator
MAC	Media Access Control (address)
MDR	Mini D Ribbon (connector)
MHz	Megahertz
MIMO	Multiple-Input Multiple-Output
ms	Milliseconds
NCO	Numerically Controlled Oscillator
ns	Nanoseconds
PC	Personal Computer
PCAP	Projected Capacitive Touch Panel
PCB	Printed Circuit Board
PCI	Peripheral Component Interconnect
PRBS	Pseudorandom Binary Sequence
PRI	Pulse Repetition Interval
PXI	PCI eXtension for Instrumentation
PXIe	PCI Express eXtension for Instrumentation
QC	Quantum Computing
Qubits	Quantum bits
RADAR	Radio Detection And Ranging
R&D	Research & Development
RF	Radio Frequency
RT-DSO	Real-Time Digital Oscilloscope
s	Seconds
SA	Spectrum Analyzer
SCPI	Standard Commands for Programmable Instruments
SFDR	Spurious Free Dynamic Range
SFP	Software Front Panel
SMA	Subminiature version A connector
SMP	Subminiature Push-on connector

Acronym	Description
SPI	Serial Peripheral Interface
SRAM	Static Random-Access Memory
TFT	Thin Film Transistor
T&M	Test and Measurement
TPS	Test Program Sets
UART	Universal Asynchronous Receiver-Transmitter
USB	Universal Serial Bus
VCP	Virtual COM Port
Vdc	Volts, Direct Current
V p-p	Volts, Peak-to-Peak
VSA	Vector Signal Analyzer
VSG	Vector Signal Generator
WDS	Wave Design Studio

Contents

Figures

Tables

1 Introduction

This document describes the specifications and performance verification tests necessary for validating the Proteus Series AWG (Arbitrary Waveform Generators).

Figure 1-1 Proteus Benchtop P25812B

Figure 1-2 Proteus Desktop P25812D

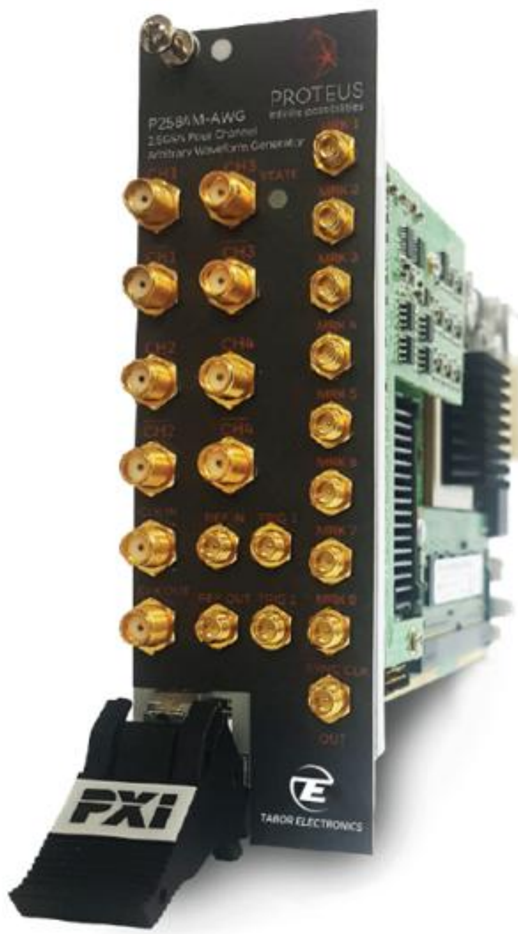


Figure 1-3 Proteus Model P2584M

Caution!
The procedures described in this section are for use only by qualified service personnel. Do not remove instrument covers as it may affect product characteristics and temperature.

Caution!
Always perform performance tests in a static safe workstation.

1.1 Proteus Series Devices

The tables below list the validated Proteus devices. The validation also includes all the applicable device options.

Table 1-1 Validated Proteus Benchtop Devices

Model	Description
P1282B	1.25 GS/s, 16 bit, 1 GS memory, 2 channels, 4 markers, benchtop RF AWG
P1284B	1.25 GS/s, 16 bit, 1 GS memory, 4 channels, 4 markers, benchtop RF AWG

Model	Description
P1288B	1.25 GS/s, 16 bit, 2 GS memory, 8 channels 8 markers, benchtop RF AWG
P12812B	1.25 GS/s, 16 bit, 2 GS memory, 12 channels 12 markers, benchtop RF AWG
P2582B	2.5 GS/s, 16 bit, 2 GS memory, 2 channels, 8 markers, benchtop RF AWG
P2584B	2.5 GS/s, 16 bit, 2 GS memory, 4 channels, 8 markers, benchtop RF AWG
P2588B	2.5 GS/s, 16 bit, 2 GS memory, 8 channels 16 markers, benchtop RF AWG
P25812B	2.5 GS/s, 16 bit, 2 GS memory, 12 channels, 24 markers, benchtop RF AWG
P9082B	9 GS/s, 16 bit, 4 GS memory, 2 channels, 8 markers, benchtop RF AWG
P9084B	9 GS/s, 16 bit, 4 GS memory, 4 channels, 16 markers, benchtop RF AWG
P9086B	9 GS/s, 16 bit, 4 GS memory, 6 channels, 24 markers, benchtop RF AWG
P9482B	9 GS/s, 16 bit, 8 GS memory, 2 channels, 8 markers, benchtop RF AWG
P9484B	9 GS/s, 16 bit, 8 GS memory, 4 channels, 8 markers, benchtop RF AWG
P9488B	9 GS/s, 16 bit, 8 GS memory, 8 channels, 16 markers, benchtop RF AWG
P94812B	9 GS/s, 16 bit, 8 GS memory, 12 channels, 24 markers, benchtop RF AWG

Table 1-2 Validated Proteus Desktop Devices

Model	Description
P1282D	1.25 GS/s, 16 bit, 1 GS memory, 2 channels, 4 markers, desktop RF AWG
P1284D	1.25 GS/s, 16 bit, 1 GS memory, 4 channels, 4 markers, desktop RF AWG
P1288D	1.25 GS/s, 16 bit, 2 GS memory, 8 channels, 8 markers, desktop RF AWG
P12812D	1.25 GS/s, 16 bit, 2 GS memory, 12 channels, 12 markers, desktop RF AWG
P2582D	2.5 GS/s, 16 bit, 2 GS memory, 2 channels, 8 markers, desktop RF AWG
P2584D	2.5 GS/s, 16 bit, 2 GS memory, 4 channels, 8 markers, desktop RF AWG
P2588D	2.5 GS/s, 16 bit, 2 GS memory, 8 channels 16 markers, desktop RF AWG
P25812D	2.5 GS/s, 16 bit, 2 GS memory, 12 channels, 24 markers, desktop RF AWG
P9082D	9 GS/s, 16 bit, 4 GS memory, 2 channels, 8 markers, desktop RF AWG
P9084D	9 GS/s, 16 bit, 4 GS memory, 4 channels, 16 markers, desktop RF AWG
P9086D	9 GS/s, 16 bit, 4 GS memory, 6 channels, 24 markers, desktop RF AWG
P9482D	9 GS/s 16 bit, 8 GS memory, 2 channels, 8 markers, desktop RF AWG
P9484D	9 GS/s 16 bit, 8 GS memory, 4 channels, 8 markers, desktop RF AWG
P9488D	9GS/s 16 bit, 8 GS memory, 8 channels, 16 markers, desktop RF AWG
P94812D	9 GS/s 16 bit, 8 GS memory, 12 channels, 24 markers, desktop RF AWG

Table 1-3 Validated Proteus Module Devices

Model	Description
P1282M	1.25 GS/s, 16 bit, 1 GS memory, 2 channels, 4 markers, module RF AWG
P1284M	1.25 GS/s, 16 bit, 1 GS memory, 4 channels, 4 markers, module RF AWG
P2582M	2.5 GS/s, 16 bit, 2 GS memory, 2 channels, 8 markers, module RF AWG
P2584M	2.5 GS/s, 16 bit, 2 GS memory, 4 channels, 8 markers, module RF AWG
P9082M	9 GS/s, 8 bit, 4 GS memory, 2 channels, 8 markers, module RF AWG
P9482M	9 GS/s, 16 bit, 8 GS memory, 2 channels, 8 markers, module RF AWG

P9484M	9 GS/s, 16 bit, 8 GS memory, 4 channels, 8 markers, module RF AWG

1.2 Qualification Procedure

The following specifications and performance verification tests verifies that the Proteus Series device is working according to specifications.

1.3 Environmental Conditions

Tests should be performed under laboratory conditions having an ambient temperature of 25°C, ±5°C and at relative humidity of less than 80%. If the instrument has been subjected to conditions outside these ranges, allow at least one additional hour for the instrument to stabilize before beginning the tests.

1.4 Warm-up Period

Most equipment is subject to a small amount of drift when it is first turned on. To ensure accuracy, turn on the power to the Proteus and allow it to warm-up for at least 30 minutes before beginning the tests.

1.5 Initial Instrument Setting

To avoid confusion as to which initial setting is to be used for each test, it is required that the instrument be reset to factory default values prior to each test. To reset the Proteus to factory defaults refer to the "Wave Design Studio User Manual" section Reset.

1.6 Recommended Test Equipment

Recommended test equipment for troubleshooting, calibration and performance checking are listed below. Test instruments other than those listed may be used only if their specifications equal or exceed the required characteristics.

Table 1-4 Recommended Test Equipment

Equipment	Model No.	Manufacturer
Oscilloscope	MSOS404A	Keysight
Digital Multimeter	34460A	Keysight
Signal Generator	LS1291D (or any 9 GHz)	Tabor
Counter	53132A	Keysight
Function Generator	WS8102	Tabor
Spectrum Analyzer	FSV 13.6GHz	R&S

1.7 Test Procedures

Use the following procedures to check the Proteus against the specifications. A complete set of specifications is listed in the Proteus user manual. The following paragraphs show how to set up the instrument for the test, what the specifications for the tested function are, and what acceptable limits for the test are. If the instrument fails to perform within the specified limits, the instrument must be calibrated or tested to find the source of the problem. Please contact support@tabor.co.il.

1.8 Default Setup

Refer to the “Proteus Programming Manual” section “Instrument Commands”.

1.9 Related Documentation

- Proteus Programming Manual
- Wave Design Studio User Manual
- Proteus Benchtop/Desktop/Portable/Rackmount User Manual

2 Test Plan

Note that the following test plan applies to a 9GS/s, four-channel unit with an AWT (digitizer) option. Some of these tests may not be applicable to the unit under test. Please make sure to verify which options are installed on the unit under test. In all tests make sure to terminate the inverted output of each analog channel with a 50 Ω termination.

2.1 Frequency Accuracy

This tests the accuracy of the generator using internal and external oscillator references. Each pair of channels 1&2, 3&4 share the same clock, and therefore the accuracy is tested on each pair of channels using channel 1 and channel 3. In the case of a dual channel unit use only channel 1.

2.1.1 Internal Reference CH1&CH3

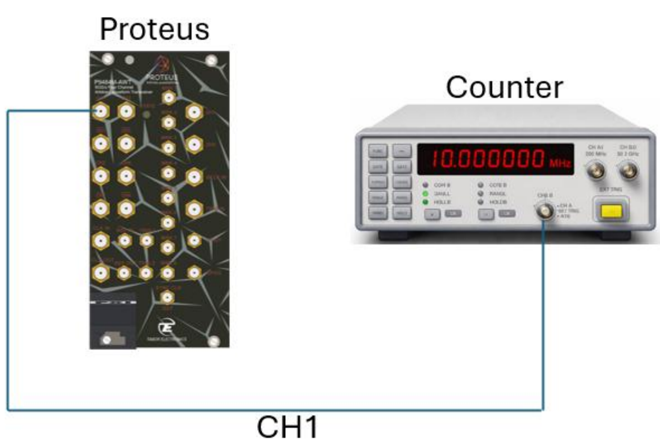


Figure 2-1 Internal Reference Test Setup

Equipment:
Counter

Preparation:

1. Configure the counter as follows:
   a. Termination: 50Ω, DC coupled. Frequency measurement.
2. Connect the Proteus channel 1 output to the counter input channel 1.
3. Configure the Proteus, channel 1 as follows:
   a. Waveform: 6400 points 64 square wave cycles.
   b. Amplitude: 0.5V.
   c. Output: On.
   d. Sample clock: As specified in the table below.

Test Procedure:
Perform frequency accuracy tests for CH1 and CH3 according to the table below.

Table 2-1 Frequency Accuracy

Clock Setting	Output Frequency	Error Limits	Counter Reading	Pass	Fail
1.0 GS/s	10 MHz	±10 Hz			
1.15 GS/s	11.5 MHz	±11.5 Hz			
1.25GS/s	12.5 MHz	±12.5 Hz			
1.50 GS/s	15 MHz	±15 Hz			
2.00 GS/s	20 MHz	±20 Hz			
2.4 GS/s	24 MHz	±24 Hz			
2.50 GS/s	25 MHz	±25 Hz			
5.00 GS/s	50 MHz	±50 Hz			
7.50 GS/s	75 MHz	±75 Hz			
9.00 GS/s	90 MHz	±90 Hz			

2.1.2 External 100 MHz Reference CH1&CH3

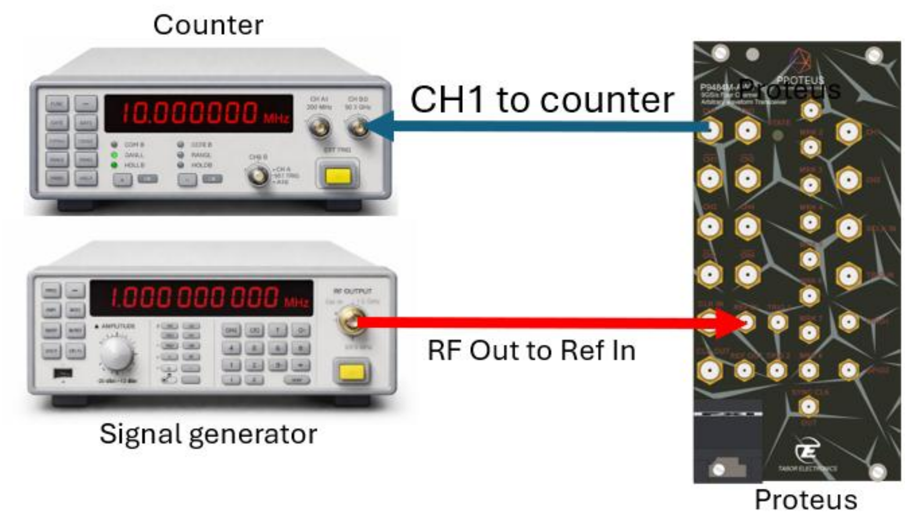


Figure 2-2 External Reference Test Setup

Equipment:
Signal generator (at least 1ppm), counter.

Preparation:

1. Connect the Proteus channel 1 normal output to the counter input channel 1.
2. Configure the signal generator to output 100MHz, 5 dBm signal
3. Configure the Proteus channel 1 as follows:
   a. Ref Clock Source: External.
   b. Waveform: 6400 points 64 square wave cycles.
   c. Output: On.
   d. Sample clock: As specified in the table below.

Test Procedure

Perform frequency accuracy tests for CH1 and CH3 according to the table below.

Table 2-2 Frequency Accuracy Using External Reference Counter Test

Clock Setting	Output Frequency	Error Limit	Counter Reading	Pass	Fail
1.25GS/s	12.5 MHz	±12.5 Hz			
2.50 GS/s	25 MHz	±25 Hz			
9 GS/s	90 MHz	±90 Hz			

2.1.3 External Sample Clock CH1&CH3 and Sample Clock Output

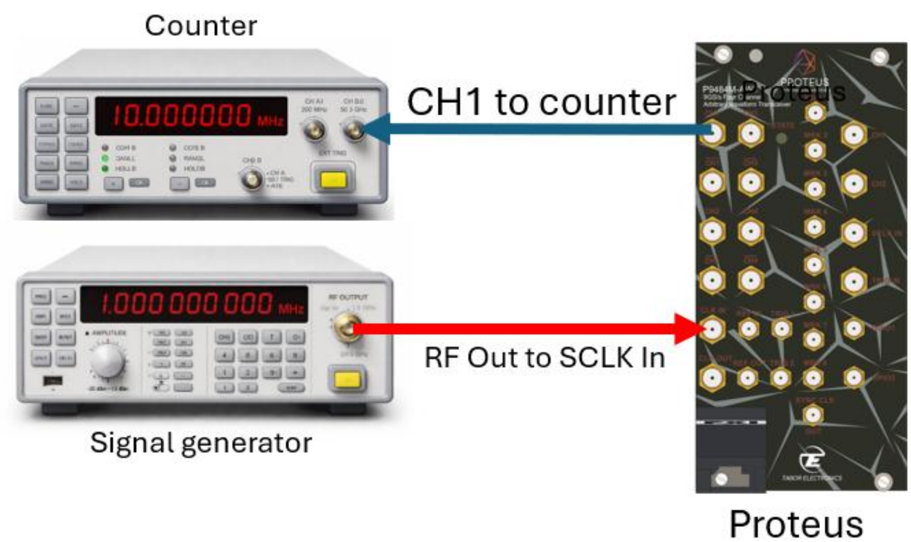


Figure 2-3 External SCLK Setup

Equipment:

Signal generator (at least 1ppm), counter.

Preparation:

1. Configure the counter as follows:
   a. Function: Frequency
   b. Gate Time: 1 ms
2. Connect the signal generator output to the Proteus external SCLK input.
3. Configure the signal generator as follows:
   a. Amplitude: 0 dBm
   b. Frequency: As required by the test
4. Configure the Proteus channel 1 as follows:
   a. Function: Arbitrary
   b. Waveform: 6400 points 64 square wave cycles
   c. CH1 SCLK: EXT
   d. Ext SCLK Freq: As required by the test

e. CH1 Output: On

Test Procedure

Perform frequency accuracy, external sample clock tests according to the table below.

Table 2-3 Frequency Accuracy Using External Sample Clock

Signal Generator Setting	Counter Reading Limits	Counter Reading	Pass	Fail
1.0 GS/s	10 MHz, ±50 Hz			
1.15 GS/s	11.5 MHz, ±57.5 Hz			
1.25GS/s	12.5 MHz, ±62.5 Hz			
1.50 GHz	15 MHz, ±75 Hz			
2.00 GHz	20 MHz, ±100 Hz			
2.50 GHz	25 MHz, ±125 Hz			
5.00 GHz	50 MHz, ±250 Hz			
7.50 GHz	75 MHz, ±375 Hz			
9.00 GHz	90 MHz, ±450 Hz			

Test Procedure

Connect the sample clock output to the counter input (or spectrum analyzer if counter does not reach 9 GHz) and perform sample clock output tests according to the table below.

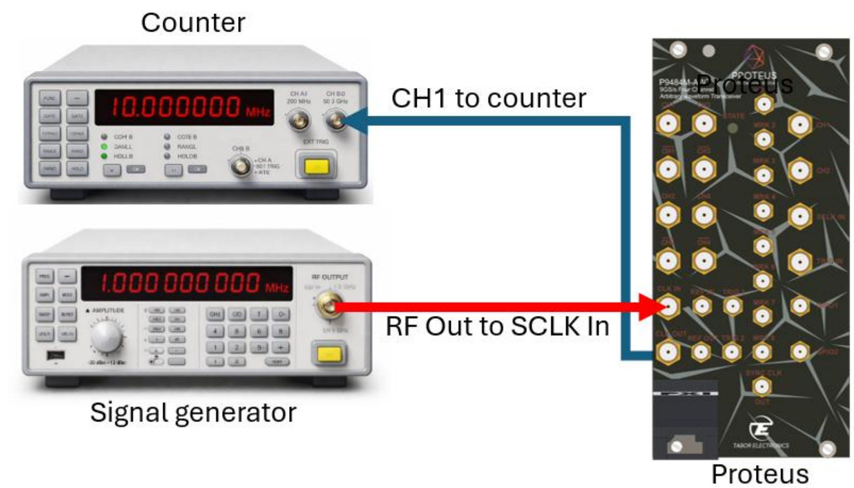


Figure 2-4 SCLK OUT Test Setup

Table 2-4 Sample Clock Output Accuracy test

Proteus Clock Setting	Proteus Sample Clock Output Frequency	Error Limits	Counter Reading	Pass	Fail
1 GS/s	1 GHz	±5 kHz			
2 GS/s	2 GHz	±10 kHz			
9 GS/s	9 GHz	±45 kHz			

2.2 Amplitude Accuracy

This tests the accuracy of the output amplifier and attenuators. Each channel has its own set of amplifiers and attenuators, and therefore the accuracy is tested on each channel separately.

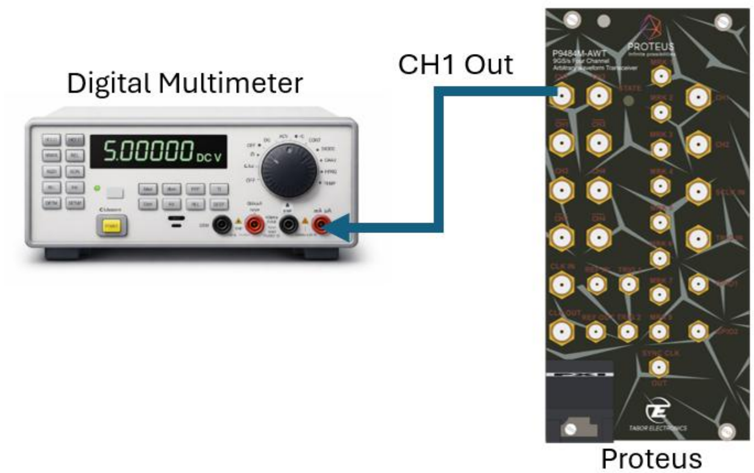


Figure 2-5 Amplitude Accuracy Test Setup

Equipment:
DMM with a 50Ω termination.

Figure 2-6 50 Ohm Termination to DMM

Preparation:

1. Configure the DMM as follows:
   a. Function: ACV
   b. Range: As required by the test
2. Connect the Proteus channel outputs to the DMM input
3. Configure the Proteus as follows:
   a. Waveform: 124,992 points sine wave
   b. Sample clock: 1.25 GS/s
   c. Outputs: On
   d. Amplitude: As specified in the table below.

Test Procedure

4. Perform amplitude accuracy tests on all channels according to the table below.

Table 2-5 Amplitude Accuracy

Amplitude Setting	Error Limits	DMM Reading	Pass	Fail
1.2 V	424.26 mV, ±14.72 mV			
1.0 V	353.55 mV, ±12.6 mV			
0.5 V	176.78 mV, ±7.3 mV			
0.25 V	88.39 mV, ±4.65 mV			
0.1 V	35.36 mV, ±3.063 mV			
0.05 V	17.68 mV, ±2.53 mV			

Table 2-6 Amplitude Accuracy for Direct Option

Amplitude Setting	Error Limits	DMM Reading	Pass	Fail
0.5 V	176.78 mV, ±7.3 mV			
0.4 V	141.4 mV,6.2mV			
0.3 V	106.07 mV, ±5.2 mV			
0.25 V	88.39 mV, ±4.65 mV			
0.1 V	35.36 mV, ±3.063 mV			
0.05 V	17.68 mV, ±2.53 mV			

2.3 Offset Accuracy

This tests the accuracy of the DC offset. Each channel has its own set of offset generators, and therefore the accuracy is tested on each channel separately. This is not applicable for AC couple units (Direct Output option)

Equipment:

DMM

Preparation:

1. Configure the DMM as follows:
    a. Function: DCV
    b. Range: As required by the test
2. Connect the Proteus outputs to the DMM input
3. Configure the Proteus as follows:
    a. Waveform: 1248 points sine wave
    b. Sample clock: 1.25 GS/s
    c. Amplitude: 100 mVpp
    d. Outputs: On
    e. Offset: As specified in the table below.

Test Procedure

Perform the offset accuracy tests on all channels according to the table below.

Table 2-7 Offset Accuracy

Offset Setting	Error Limits	DMM Reading	Pass	Fail
+500 mV	0.5 V, ±31 mV			
+250 mV	250 mV, ±23.5 mV			
0 V	0 V, ±15 mV			
-250 mV	-250 mV, ±23.5 mV			
-500 mV	-0.5 V, ±31 mV			

2.4 Square Wave Characteristics

This tests the characteristics of the square waveform. It includes transition times, aberrations and skew between channels. Each channel has its own set of amplifiers and attenuators, and therefore the characteristics are tested on each channel separately.

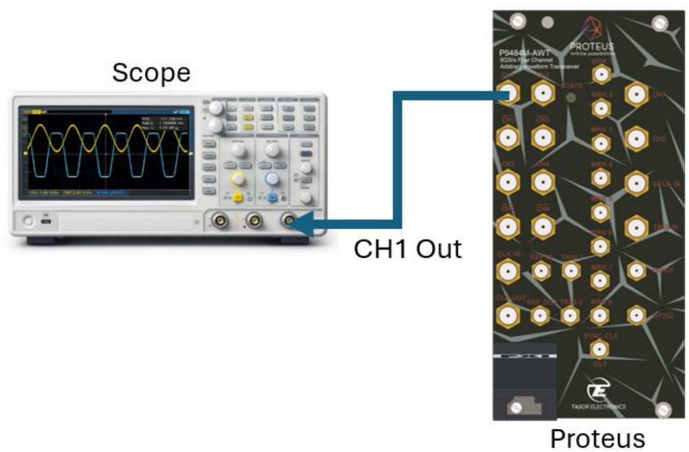


Figure 2-7 Square Wave Characteristics Test Setup

Equipment:
Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   a. Setup: As required for the test. See image below
2. Connect Proteus outputs to the oscilloscope input
3. Configure the Proteus as follows:
   a. Waveform: 1,248 points square wave
   b. Sample clock: 1.25 GS/s
   c. Amplitude: 0.5 V
   d. Outputs: On

Figure 2-8 Scope Setup: 1 ns/Division, 100 mV/Division

Test Procedure

4. Perform square wave characteristics tests on all channels according to the table below.

Table 2-8 Square Wave Characteristics, DC Option

Parameter Tested	Error Limits	Oscilloscope Reading	Pass	Fail
Rise/Fall Time (20%-80%)	<130 ps			
Overshoot	<5%			

Table 2-9 Square Wave Characteristics, Direct Option

Parameter Tested	Error Limits	Oscilloscope Reading	Pass	Fail
Rise/Fall Time (20%-80%)	<60 ps			
Overshoot	<8%			

2.5 Sinewave Characteristics

This tests the characteristics of the sine waveform. It includes distortions, spectral purity, spurs and flatness. Each channel has its own set of amplifiers and attenuators, and therefore the characteristics are tested on each channel separately.

2.5.1 Sinewave Harmonics

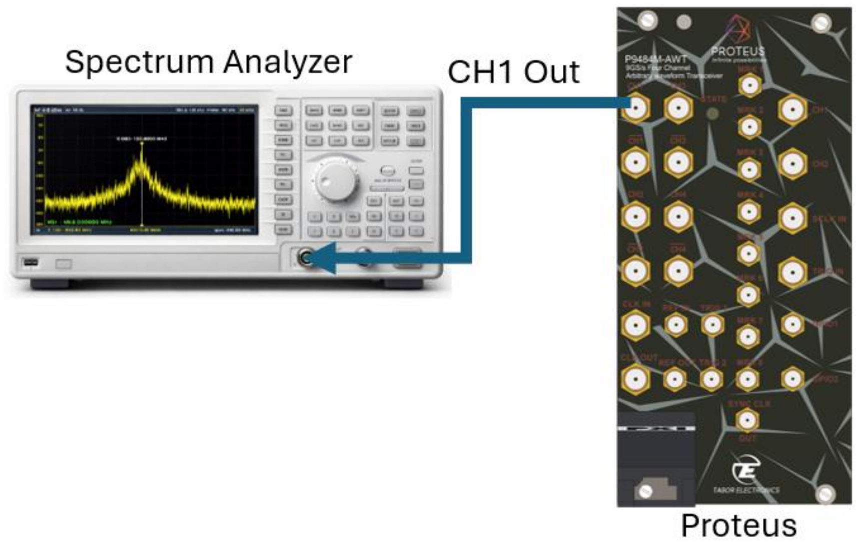


Figure 2-9 Harmonics Test Setup

Equipment:
Spectrum analyzer, balun adapter.

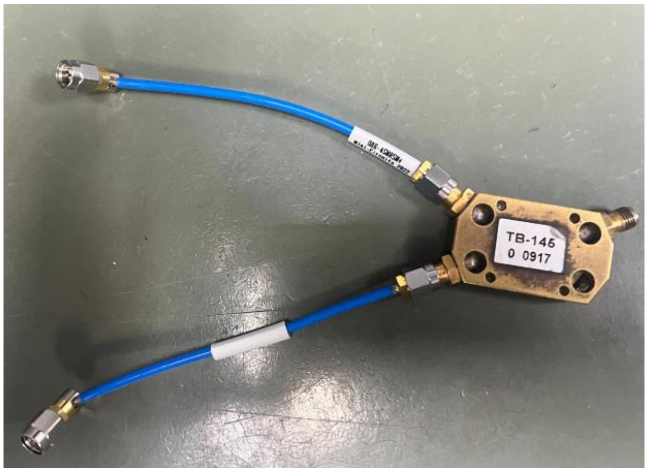


Figure 2-10 Balun Adapter

Preparation:

1. Using the balun connect the Proteus outputs to the spectrum analyzer input.
2. Configure the Proteus as follows:
   a. Amplitude: 500 mV
   b. Outputs: On
   c. Sample Clock: As required for the test
   d. Waveform1: 1600 points, 121 cycles of sine wave
   e. Waveform2: 1600 points, 242 cycles of sine wave

f. Waveform3: 1600 points, 380 cycles of sine wave

Test Procedure

3. Perform sinewave spectral purity tests according to the table below. Set the spectrum analyzer as shown below or use built in harmonics measurement. Specification for Harmonics are measured as follows
   a. Output frequency < 200MHz measured span DC to 2GHz
   b. Output frequency >200MHz measured @ DC to 4.5GHz

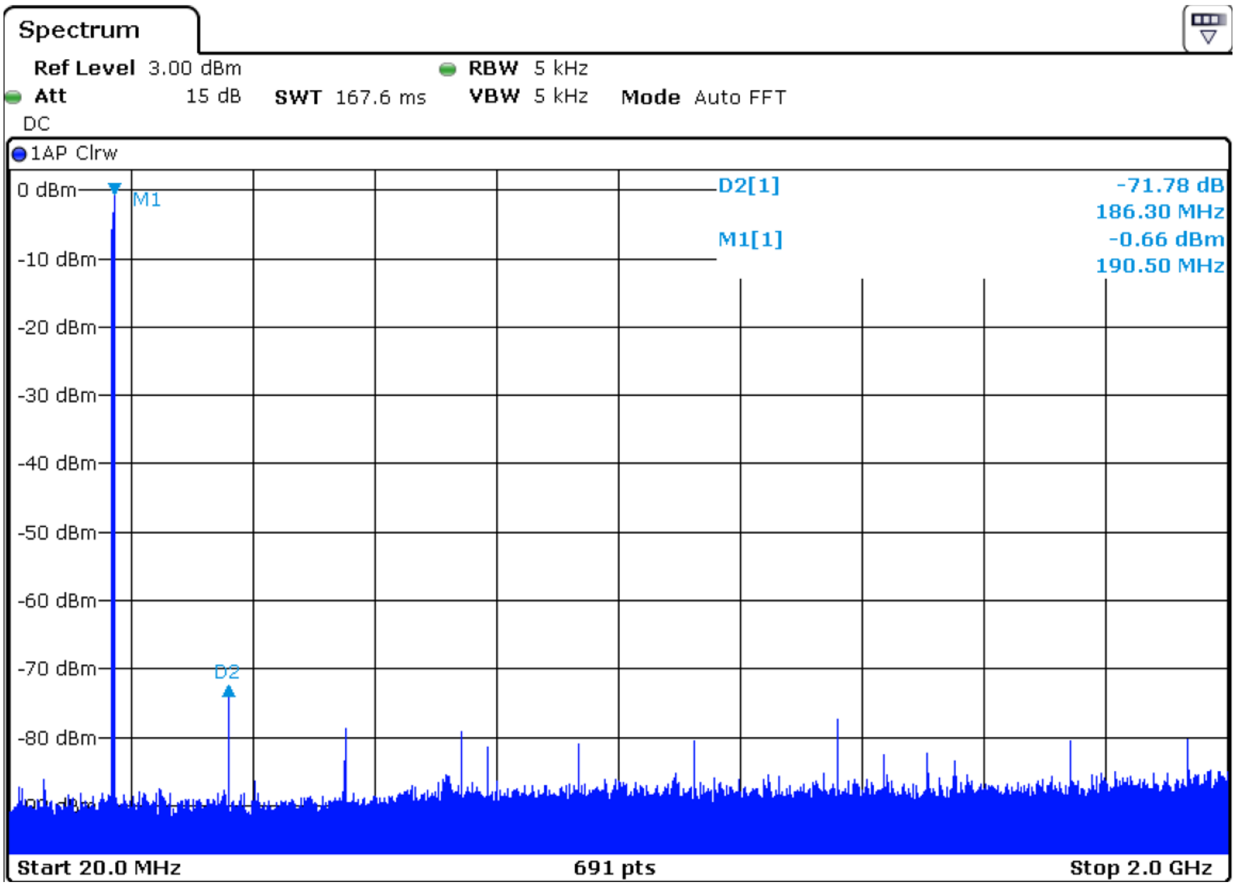


Figure 2-11 Spectrum Analyzer Measurement For Harmonics Test

Table 2-10 Sinewave Harmonics Test

Sample Clock	Waveform	Output Frequency	Reading Limits[1]	Harmonics Results	Pass	Fail
1.25 GS/s	Waveform1	94.53125 MHz	-70 dBc			
1.25 GS/s	Waveform2	189.0625 MHz	-70 dBc			
1.25 GS/s	Waveform3	296.875 MHz	-60 dBc			
2.5 GS/s	Waveform1	189.0625 MHz	-70 dBc			
2.5 GS/s	Waveform2	378.125 MHz	-60 dBc			
2.5 GS/s	Waveform3	593.75 MHz	-60 dBc			
9 GS/s	Waveform1	680.625 MHz	-60 dBc			
9 GS/s	Waveform2	1361.257 MHz	-60 dBc			

9 GS/s	Waveform3	2137.5 MHz	-50 dBc			

[1] Tolerance is 5 dBc.

2.5.2 Sinewave Spurious

Equipment:

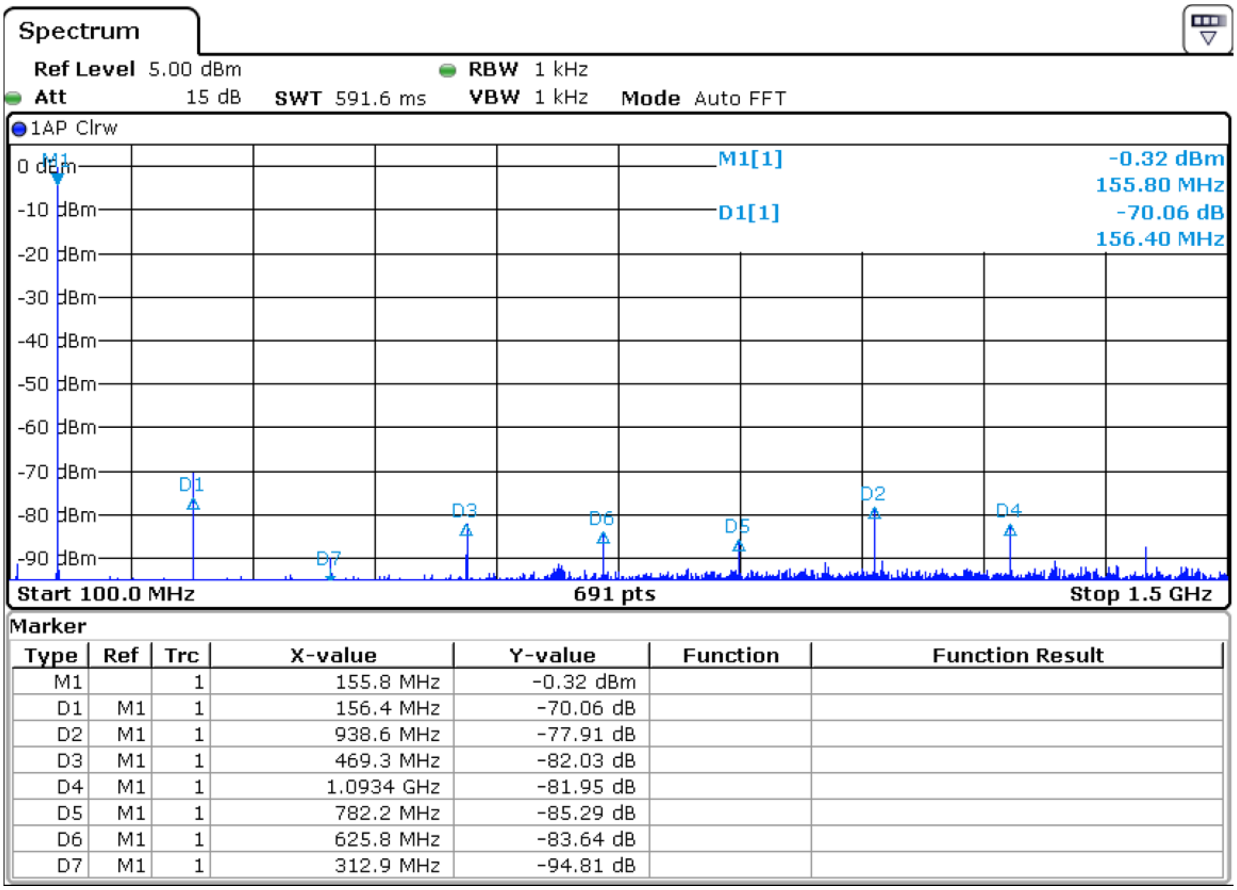
Spectrum analyzer same as shown in Figure 2-9 Harmonics Test Setup.

Preparation:

1. Connect the Proteus outputs to the spectrum analyzer input.
2. Configure the Proteus as follows:
   a. Amplitude: 0.5 V
   b. Outputs: On
   c. Sample Clock: As required for the test
   d. Waveform1: 1600 points, 100 cycles of sine wave
   e. Waveform2: 1600 points, 200 cycles of sine wave
   f. Waveform3: 1600 points, 400 cycles of sine wave

Test Procedure

1. Perform sinewave spectral purity tests according to the table below. Set the spectrum analyzer for harmonics measurement. Search for any signal that is not a harmonic. Specification for spurious are measured as follows:
   a. Output frequency < 500MHz measured span DC to 1.5GHz
   b. Output frequency >500MHz measured @ DC to 4.5GHz



Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	155.8 MHz	-0.32 dBm		
D1	M1	1	156.4 MHz	-70.06 dB		
D2	M1	1	938.6 MHz	-77.91 dB		
D3	M1	1	469.3 MHz	-82.03 dB		
D4	M1	1	1.0934 GHz	-81.95 dB		
D5	M1	1	782.2 MHz	-85.29 dB		
D6	M1	1	625.8 MHz	-83.64 dB		
D7	M1	1	312.9 MHz	-94.81 dB		

Figure 2-12 Spectrum Analyzer setup for Spurious test

Table 2-11 Sinewave Spurious Test

Sample Clock	Waveform	Output Frequency	Reading Limits[1]	Worst Spur Result	Pass	Fail
1.25 GS/s	Waveform1	78.125 MHz	-80 dBc			
1.25 GS/s	Waveform2	156.25 MHz	-80 dBc			
1.25 GS/s	Waveform3	312.5 MHz	-80 dBc			
2.5 GS/s	Waveform1	156.25 MHz	-80 dBc			
2.5 GS/s	Waveform2	312.5 MHz	-80 dBc			
2.5 GS/s	Waveform3	625 MHz	-70 dBc			
9 GS/s	Waveform1	562.5 MHz	-70 dBc			
9 GS/s	Waveform2	1125 MHz	-70 dBc			
9 GS/s	Waveform3	2250 MHz	-70 dBc			

Table 2-12 Sinewave Spurious Test for Direct Option

Sample Clock	Waveform	Output Frequency	Reading Limits[1]	Worst Spur Result	Pass	Fail
1.25 GS/s	Waveform1	78.125 MHz	-85 dBc			
1.25 GS/s	Waveform2	156.25 MHz	-85 dBc			

Sample Clock	Waveform	Output Frequency	Reading Limits[1]	Worst Spur Result	Pass	Fail
1.25 GS/s	Waveform3	312.5 MHz	-85 dBc			
2.5 GS/s	Waveform1	156.25 MHz	-85 dBc			
2.5 GS/s	Waveform2	312.5 MHz	-85 dBc			
2.5 GS/s	Waveform3	625 MHz	-75 dBc			
9 GS/s	Waveform1	562.5 MHz	-75 dBc			
9 GS/s	Waveform2	1125 MHz	-75 dBc			
9 GS/s	Waveform3	2250 MHz	-75 dBc			

2.6 Inter-Channel Propagation Characteristics

This tests the offset and skew characteristics between the two channels.

2.6.1 Coarse Delay Between Channels

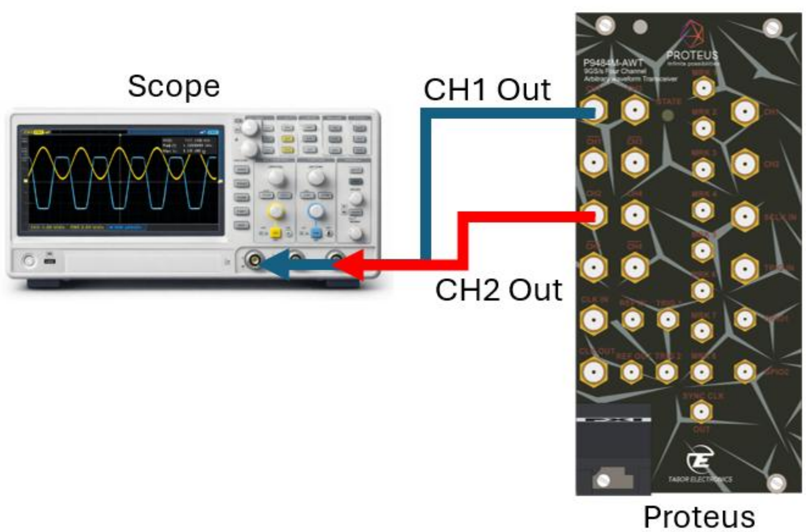


Figure 2-13 Coarse Delay Test Setup

Equipment:
Oscilloscope

Preparation:

1. Configure the oscilloscope as required for the test, see below. Make sure to calibrate the cables. This can usually be done using the scope internal probe calibration procedure.

Figure 2-14 Scope Setup for Coarse Delay Test

2. Connect the Proteus outputs to the oscilloscope inputs
3. Configure the Proteus as follows:
   a. Waveform: 1024 points Square wave
   b. SCLK: 1.25 / 2.5 / 9 GS/s
   c. Amplitude: 0.5 V
   d. Outputs: On
   e. Offset: 0 points

Test Procedure

4. Measure the initial offset between all channels. Verify that is less than ±50 ps.

Table 2-13 Refence measurement result

Sampling rate (SCLK)	Test Results	Pass	Fail
1.25 GS/s			
2.5 GS/s			
9 GS/s			

5. Change CH2 -> offset to 64 points and verify offset reading between CH2 to CH1 on the oscilloscope is 64/32/8 points ±50 ps (with respect to used SCLK).

Table 2-14 CH2 to CH1 offset results

Sampling rate (SCLK)	Test Results	Pass	Fail
1.25 GS/s			
2.5 GS/s			

Sampling rate (SCLK)	Test Results	Pass	Fail
9 GS/s			

6. Change CH3 -> offset to 128 points and verify offset reading between CH3 to CH1 on the oscilloscope is 128/64/16 points ±50 ps.

Table 2-15 CH3 to CH1 offset results

Sampling rate (SCLK)	Test Results	Pass	Fail
1.25 GS/s			
2.5 GS/s			
9 GS/s			

7. Change CH4 offset to 256 points and verify offset reading between CH4 to CH1 on the oscilloscope is 256/128/32 points ±50 ps.

Table 2-16 CH4 to CH1 offset results

Sampling rate (SCLK)	Test Results	Pass	Fail
1.25 GS/s			
2.5 GS/s			
9 GS/s			

8. Change CH4 -offset to 0 points.
9. Change CH1 offset to 64 points and verify offset reading between CH1 to CH4 on the oscilloscope is 64/32/8 points ±50 ps.

Table 2-17 CH1 to CH4 offset results

Sampling rate (SCLK)	Test Results	Pass	Fail
1.25 GS/s			
2.5 GS/s			
9 GS/s			

Note

The delay time will vary according to sample rate.

2.6.2 Fine Delay Between Channels

Note

This test is not applicable for 2 channels models.

Equipment:

Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   a. Setup: As required for the test

2. Connect the Proteus CH1 and CH3 outputs to the oscilloscope inputs
3. Configure the Proteus as follows:
   a. Function: Arbitrary
   b. Waveform: 1024 points square wave
   c. SCLK: 1.25 / 2.5 / 9 GS/s
   d. Amplitude: 1 V
   e. Outputs: On
   f. Skew: 0 ns

Test Procedure

4. Measure the skew between the channels. It should be less than 50 ps. Record this value as reference for the next steps (T_0).

Test Results	Pass	Fail

5. Change CH1 -> Skew to 1 ns and verify skew reading is 1 ns + $T_0 \pm 150$ ps.

Test Results	Pass	Fail

6. Change CH1 skew to 0 ns.
7. Change the CH1 skew to -1 ns and verify that the skew reading on the oscilloscope is -1 ns + T_0 ± 150 ps.

Test Results	Pass	Fail

2.7 Run Mode Tests

This tests the operation of the various run modes. There are three run modes: Continuous, Triggered and Gated. These tests do not challenge the individual inputs but only tests the operation of the standard functions in all three modes. Additional tests will be carried out on individual trigger inputs and on other instrument functions.

2.7.1 Triggered Run Mode Test

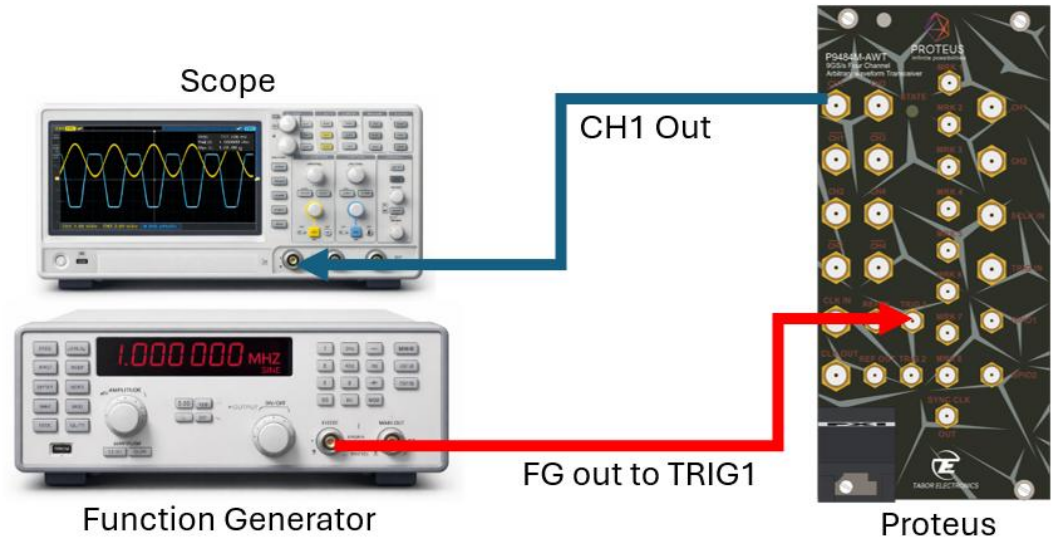


Figure 2-15 Triggered Run Mode Test Setup

Equipment:
Oscilloscope, function generator, counter.

Preparation:

1. Configure the oscilloscope as follows:
   a. Setup: Time – 500 ns/division, Amplitude – 100 mV per division
2. Configure the function generator as follows:
   a. Frequency: 1 MHz
   b. Amplitude: 2 V
   c. Offset: 0 V
3. Connect the Proteus outputs to the oscilloscope inputs.
4. Connect the function generator to the Proteus trigger1 input.
5. Configure the Proteus as follows:
   a. Outputs: On
   b. Waveform: 192 points Sine wave
   c. SCLK: 1.92 GS/s
   d. Run Mode: Triggered
   e. Trigger Source: Trigger1
   f. Trigger Count: 1

Test Procedure

6. Verify that there is no signal at the Proteus outputs. Trigger the function generator to generate a single trigger and verify that the Proteus generates a single 1 MHz sine waveform every time you trigger it.

Test Results	Pass	Fail

7. Modify the Proteus trigger source to setting trigger2.
8. Connect the function generator to the Proteus trigger2 input.
9. Trigger the function generator to generate a single trigger and verify that the Proteus generates a single 1 MHz sine waveform every time you trigger it.

Test Results	Pass	Fail

Figure 2-16 Expected Output For Trigger Test

10. Modify the Proteus trigger source to setting BUS and remove the function generator cable from the trigger input.
11. Connect the Proteus output to the counter input.

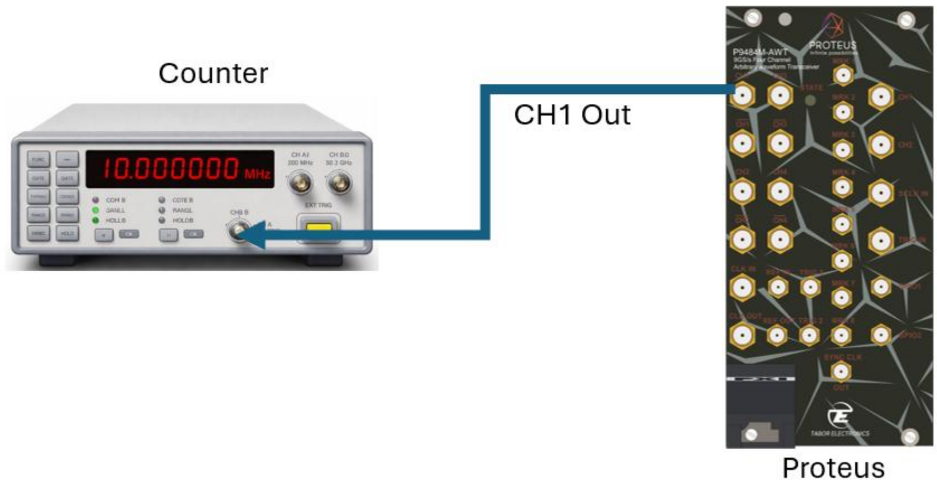


Figure 2-17 Trigger Test Setup for BUS Trigger

12. Program the counter to totalize measurements.
13. Generate 10 events of *trg from remote and verify that the counter reading is 10.

Test Results	Pass	Fail

2.8 Trigger Input Tests

This tests the operation of the individual trigger inputs. The Proteus can accept trigger signals from a number of sources: 2 front panel trigger input, internal trigger generator and remote trigger commands from a host computer. The characteristics of these inputs are checked using the following tests.

2.8.1 Trigger Input Level Test

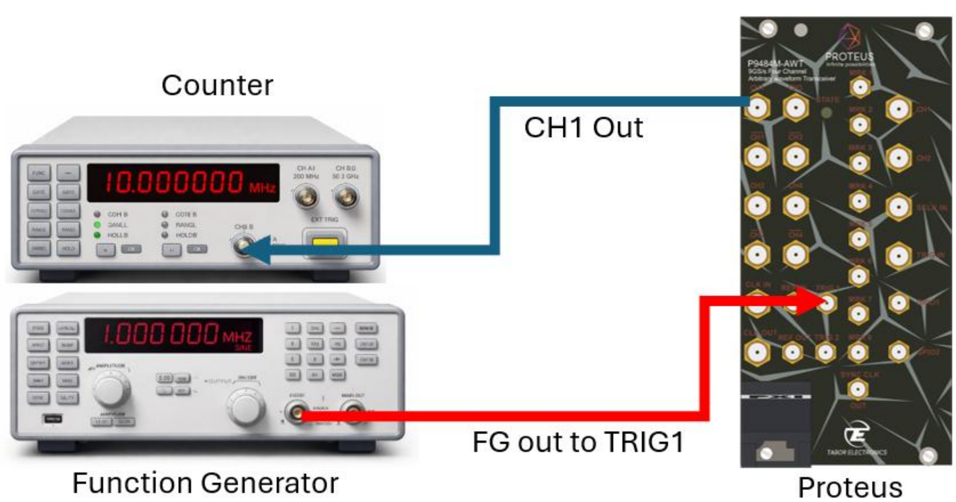


Figure 2-18 Trigger Input Level Test Setup

Equipment:
Function generator, counter.

Preparation:

1. Configure the counter to period measurements.
2. Configure the function generator as follows:
   a. Frequency: 100 kHz
   b. Amplitude: 0.2 V
   c. Offset: As specified by the test
   d. Waveform: Square
3. Connect the function generator output to the Proteus trigger input.
4. Connect the Proteus outputs to the counter input channel 1.
5. Configure the Proteus as follows:
   a. Outputs: On
   b. Waveform: 1024 points Sine wave
   c. SCLK: 1.024 GS/s
   d. Run Mode: Trigger
   e. Trigger count: 1
   f. Trigger Source: Trigger1
   g. Trigger Level: As specified by the test
   h. Trigger Slope: As specified by the test

Test Procedure

6. Check the trigger level and slope operation according to the table below. Note that the accuracy of the measurement is directly related to the accuracy of the function generator.

Table 2-18 Trigger1 Input Characteristics

Trigger Level	Trigger Slope	Counter Reading	Pass	Fail
-5 V	Positive	10 μs ±10 ns		
-5 V	Negative	10 μs ±10 ns		
-2.5 V	Positive	10 μs ±10 ns		
-2.5 V	Negative	10 μs ±10 ns		
2.5 V	Positive	10 μs ±10 ns		
2.5 V	Negative	10μs ±10 ns		
5 V	Positive	10 μs ±10 ns		
5 V	Negative	10 μs ±10 ns		

7. Modify the Proteus trigger source to trigger2.
8. Continue with the trigger level and trigger slope tests according to the table below.

Table 2-19 Trigger2 Input Characteristics

Trigger Level	Trigger Slope	Counter Reading	Pass	Fail
-5 V	Positive	10 µs ±10 ns		
-5 V	Negative	10 µs ±10 ns		
-2.5 V	Positive	10 µs ±10 ns		
-2.5 V	Negative	10 µs ±10 ns		
2.5 V	Positive	10 µs ±10 ns		
2.5 V	Negative	10 µs ±10 ns		
5 V	Positive	10 µs ±10 ns		
5 V	Negative	10 µs ±10 ns		

9. Modify the function generator frequency setting to 1Hz.
10. Configure the counter to totalize measurements.
11. Modify the Proteus count field as shown in the table below and continue with the counted burst tests according to the table below.

Table 2-20 Trigger Input Counted Burst Checks

Trigger Count	Counter/Timer Reading	Pass	Fail
2	Counts multiples of 2		
10,000	Counts multiples of 10,000		
1,000,000	Counts multiples of 1,000,000		

2.8.2 Trigger Jitter Test

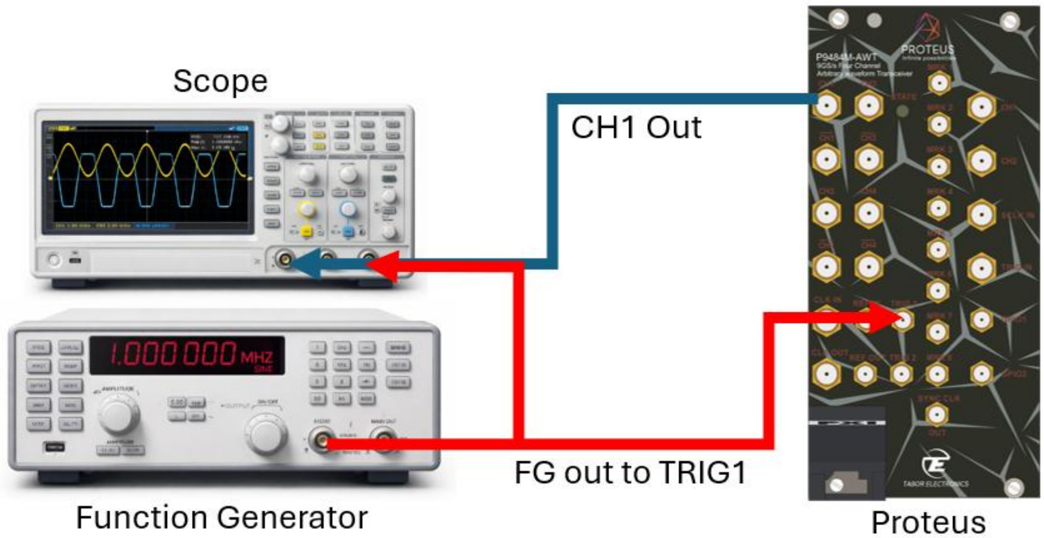


Figure 2-19 Trigger Jitter Test Setup

Equipment:

Function generator, oscilloscope.

Preparation:

1. Configure the oscilloscope as required by the test.

Figure 2-20 Trigger Jitter Test Expected Result and Scope Setup

2. Configure the function generator as follows:
   a. Frequency: 100 kHz
   b. Amplitude: 2 Vpp
   c. Offset: 1 V
   d. Waveform: Square
3. Connect the function generator output via a “T” connector to the Proteus trigger input and to the scope input channel 1.
4. Connect the Proteus outputs to the scope input channel 2.
5. Configure the Proteus as follows:
   a. Outputs: On
   b. Waveform: 1024 points square wave
   c. SCLK: Maximum 1.25 / 2.5 / 9 GS/s
   d. Run Mode: Trigger
   e. Trigger count: 1
   f. Trigger Source: As specified by the test
   g. Trigger Level: 1 V

Test Procedure

6. Check the trigger jitter operation according to the table below.

Table 2-21 Trigger Input Test

Trigger Source	Reading Limits			Scope Reading	Pass	Fail
	1.25GS/s	2.5GS/s	9GS/s			
Trigger1	6.4 ns, ±50 ps	3.2 ns, ±50 ps	3.55 ns, ±50 ps			
Trigger2	6.4 ns, ±50 ps	3.2 ns, ±50 ps	3.55 ns, ±50 ps			

7. Configure the Proteus as follows:
   a. Low Jitter: On
   b. Check the trigger jitter operation according to the table below.

Table 2-22 Trigger Input Low Jitter Test

Trigger Source	Reading Limits			Scope Reading	Pass	Fail
	1.25GS/s	2.5GS/s	9GS/s			
Trigger1	814 ps, ±80ps	427 ps, ±40ps	187 ps, ±20ps			
Trigger2	814 ps, ±80ps	427 ps, ±40ps	187 ps, ±20ps			

2.9 Marker Output Characteristics

This tests the operation of the markers. There are two markers for each channel and these are programmed as part of the waveform data. The markers can be programmed to have variable length, delay and amplitude and each can be skewed in reference to one another in increments of 5 ps. The function of the markers is tested in this section. Perform the following tests if you suspect that the markers do not perform as expected.

2.9.1 Marker Amplitude, Offset and Transition Checks

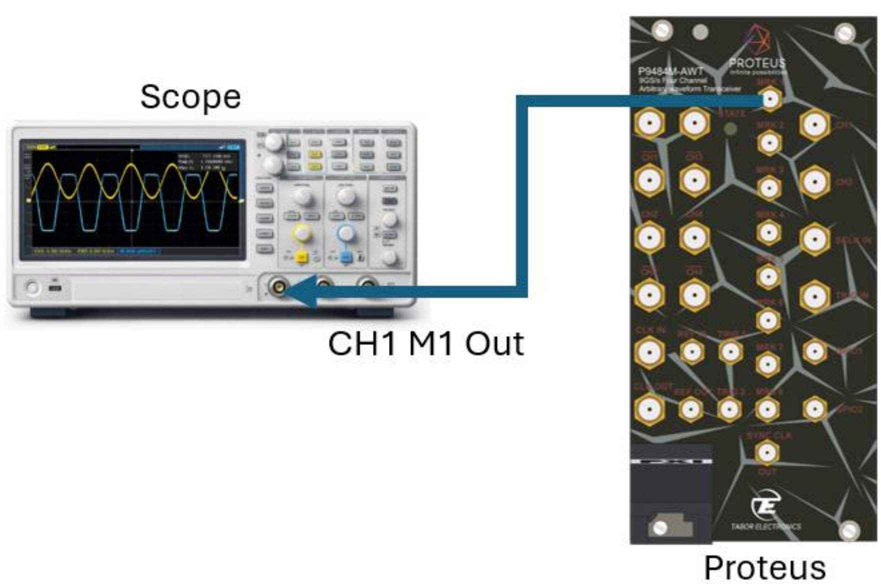


Figure 2-21 Marker Amplitude, Offset and Transition Test Setup

Equipment:
Oscilloscope.

Preparation:

1. Configure the oscilloscope as follows:
   a. Setup: As required for the test

Figure 2-22 Marker Amplitude and Offset Result

2. Connect the Proteus marker outputs to the oscilloscope inputs.
3. Configure the Proteus as follows:
   a. Outputs: On
   b. Markers: On
   c. Function: Arbitrary
   d. SCLK: 1 GS/s
   e. Waveform: 100000 points square wave with all markers

Test Procedure

4. Check all markers levels according to the table below.
5. Repeat this test for all markers output.

Table 2-23 Marker Levels Tests

Amplitude Setting	Offset Setting	Amplitude Error Limits	Offset Error Limits	Amplitude Reading	Offset Reading	Pass	Fail
1.2 Vpp	0 V	1.2Vpp, ±84 mVpp	0 V,				

Amplitude Setting	Offset Setting	Amplitude Error Limits	Offset Error Limits	Amplitude Reading	Offset Reading	Pass	Fail
			±27 mV				
0.85 Vpp	0 V	0.85Vpp, ±59.5 mVpp	0 V, ±23.5mV				
0.3 Vpp	0.2 V	0.3Vpp, ±21 mVpp	0.2 V, ±24 mV				
0.3 Vpp	0.5 V	0.3Vpp, ±21 mVpp	0.5 V, ±33mV				

6. Configure the marker amplitude to 1 Vpp with 0 V offset.
7. Check the transition time according to the table below. Note the transition time is specified for 20 -80% threshold measurement.

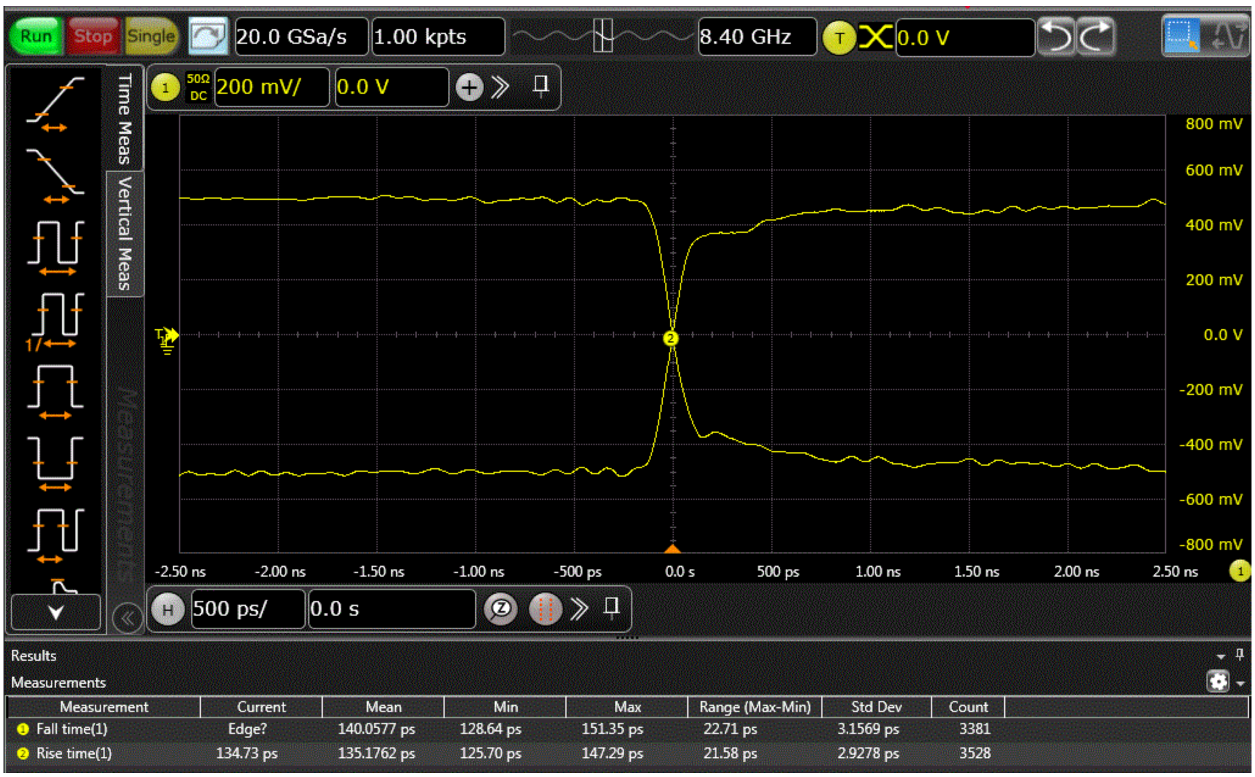


Figure 2-23 Marker Transition Expected Result

Table 2-24 Marker Transition Tests

Test	Reading Limits	Scope Reading	Pass	Fail
Rise Time	200 ps			
Fall Time	200 ps			

2.9.2 Marker Fine Delay

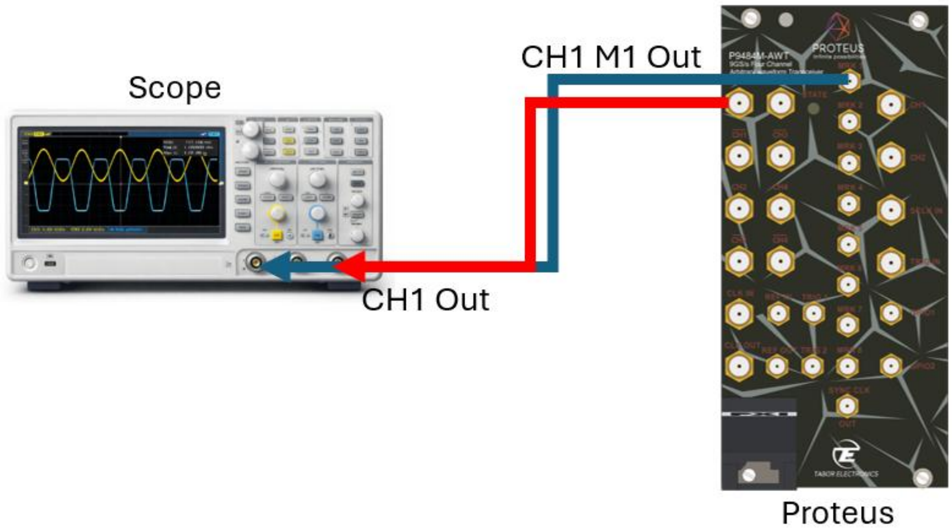


Figure 2-24 Marker Fine and Coarse Delay Test Setup

Equipment:
Oscilloscope

Preparation:

Configure the oscilloscope as required by the test. Measure the delay between channel 1 and channel 2 of the scope using the delta time measurements.

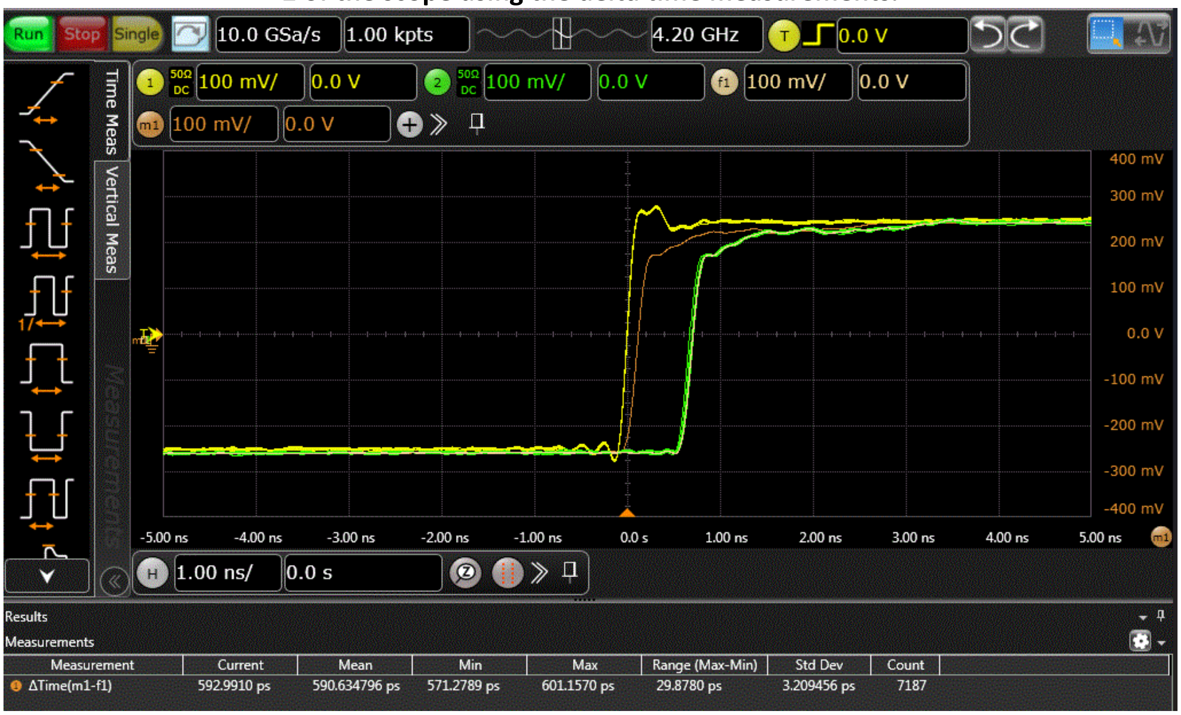


Figure 2-25 Marker Fine Delay Expected Output

1. Connect Proteus' main channel 1 output to the oscilloscope input channel 1.
2. Connect the Proteus channel 1 marker 1 output to the oscilloscope channel 2.
3. Configure the Proteus as follows:
   a. Outputs: On
   b. Markers: On
   c. Delay: As required by the tests
   d. Function: Arbitrary
   e. SCLK: 1 GS/s
   f. Waveform: 1024 points square wave with all markers

Test Procedure

4. Check the marker delay according to the table below. The delay is related to the channel output. Note and record the initial delay with the Proteus marker delay set to 0. Always add the initial delay value to the actual result. Typically, the initial marker delay is less than 1 ns.
5. Repeat this test for all marker outputs.

Table 2-25 Marker Delay Tests

Delay Setting	Error Limits	Oscilloscope Reading	Pass	Fail
0	Reference			
600 ps	Ref + 600 ps, ±100 ps			

-600 ps	Ref -600 ps, ±100 ps			

2.9.3 Marker Coarse Delay

Equipment:

Oscilloscope, see figure below.

Preparation:

1. Configure the oscilloscope as required by the test.

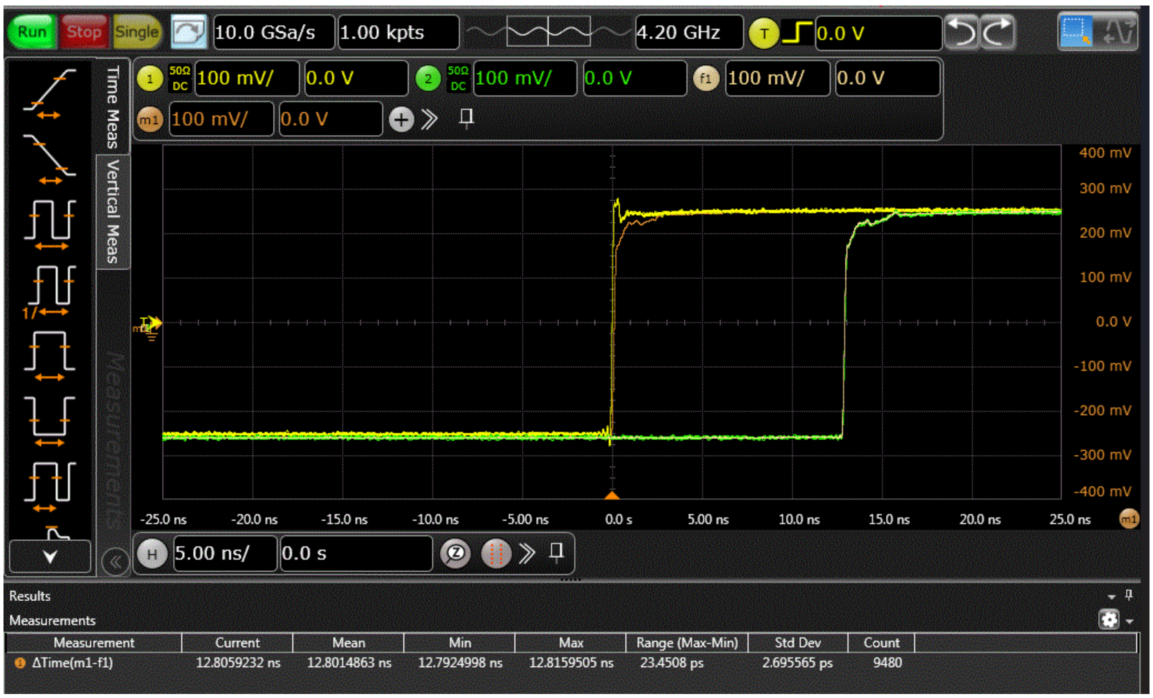


Figure 2-26 Marker Coarse Delay Expected Result and Scope Setup

2. Connect the Proteus main output to the oscilloscope channel 1.
3. Connect the marker outputs to the oscilloscope channel 2.
4. Configure the Proteus as follows:
   a. Function: Arbitrary
   b. SCLK: 1.25 / 2.5 / 9GS/s
   c. Waveform: 10240 points square with all markers
   d. Outputs: On
   e. Markers: On
   f. Marker Position: As required by the tests

Test Procedure

5. Check the marker position according to the table below. The position is related to the channel output. Note that there is a constant delay between the outputs and the markers that must be considered as part of the accuracy limits. The position in reference to the output waveform is programmed in units of sample clock periods (or waveform points).

6. Note and record the marker position with the Proteus marker position set to 0 points. Always add the initial delay value to the actual result. Typically, the initial marker position delay is less than 3.5 ns.
7. Repeat this test for all marker outputs.

Table 2-26 Channel 1 Marker Position Tests

Position Setting	Error Limits			Oscilloscope Reading	Pass	Fail
	1.25GS/s unit	2.5GS/s unit	9GS/s unit			
0	Reference	Reference	Reference			
28	Ref+22.4 ns, ±6.4 ns					
-28	Ref-22.4 ns, ±6.4 ns					
32		Ref+12.8 ns,±3.2ns				
-32		Ref-12.8 ns,±3.2ns				
128			Ref+14.222ns,±0.889ns			
-128			Ref-14.222ns,±0.889ns			

2.10 Digitizer Amplitude Accuracy

Amplitude accuracy check tests the accuracy of the input amplifier. Each channel has its own set of amplifiers, and therefore the accuracy is tested on each channel separately.

2.10.1 Amplitude Accuracy

Equipment:
Function Generator

Preparation:
1. Configure the function generator as follows:
   a. Frequency: 10 kHz
   b. Amplitude: As required by the test
2. Connect the function generator output to the digitizer input
3. Configure the Proteus digitizer as follows:
   a. Channel State: Enable
   b. Digitizer Freq: 2.4 GS/s
   c. Frame Size: 2,400,000
   d. Trigger: CPU

Test Procedure

4. Perform digitizer amplitude accuracy tests on all channels according to the table below.
5. Sample the waveform and calculate the average amplitude of 10 captured cycles.

Table 2-27 Amplitude Accuracy

Function Generator Amplitude Setting	Error Limits	Calculated Amplitude	Pass	Fail
0.2 Vpp	0.2 Vpp, ± 10 mV			
0.35 Vpp	0.35 Vpp, ± 17.5 mV			
0.45 Vpp	0.45 Vpp, ± 22.5 mV			

2.11 Digitizer Offset Accuracy

This tests the accuracy of the input offset. Each channel has its own set of offset, and therefore the accuracy is tested on each channel separately.

2.11.1 Offset Accuracy

Equipment:

Function Generator

Preparation:

1. Configure the function generator as follows:
   a. Frequency: 10 MHz
   b. Amplitude: 0.1 Vpp
   c. Offset: As required by the test
2. Connect the function generator outputs to the Proteus digitizer input
3. Configure the Proteus digitizer as follows:
   a. Channel State: Enable
   b. Digitizer Freq: 2.4 GS/s
   c. Frame Size: 2,400,000
   d. Trigger: CPU
   e. Offset: As required by the test

Test Procedure

4. Perform digitizer offset accuracy tests according to the table below.
5. Sample the waveform and calculate the average offset.

Table 2-28 Offset Accuracy

Function Generator and Digitizer Offset Setting	Error Limits	Calculate offset	Pass	Fail
+1 V				
+0.5 V				
0 V				
-0.5 V				
-1 V				

2.12 Digitizer Trigger Inputs Tests

This tests the operation of the individual trigger inputs. The Proteus digitizer can accept trigger signals from several sources: Front panel trigger inputs, internal trigger generator and remote trigger commands from a host computer.

2.12.1 Trigger Input Slope Test

Equipment:
Function generator

Preparation:

1. Configure the function generator as follows:
    a. Frequency: 100 kHz
    b. CH1 Amplitude: 3 V
    c. CH2 Amplitude: 0.5 V
    d. CH1 Offset: As specified by the test.
    e. CH1 Waveform: Square
    f. CH2 Waveform: Sine
    g. CH1 Output: ON
    h. CH2 Output: ON
2. Connect the function generator CH2 output to the digitizer input
3. Connect the function generator CH1 output to the digitizer trigger input
4. Configure the Proteus digitizer as follows:
    a. Channel State: Enable
    b. Trigger source: Ext
    c. Trigger Slope: As specified by the test.

Test Procedure

5. Check the trigger level and slope operation according to the table below. Verify that the digitizer sample full sine cycle for positive and half cycle for negative.

Table 2-29 Trigger Input Slope Test

Trigger Slope	Pass	Fail
Positive		
Negative		

2.12.2 Trigger Input Level Test

Equipment:
Function generator

Preparation:

1. Configure the function generator as follows:
    a. Frequency: 100 kHz
    b. CH1 Amplitude: 0.1 V
    c. CH2 Amplitude: 0.5 V
    d. CH1 Offset: As specified by the test

e. CH1 Waveform: Square
f. CH2 Waveform: Sine
g. CH1 Output: ON
h. CH2 Output: ON
2. Connect the function generator CH2 output to the digitizer input
3. Connect the function generator CH1 output to the digitizer trigger input
4. Configure the Proteus digitizer as follows:
   a. Channel State: Enable 125,000 points sine wav
   b. Trigger source: Ext
   c. Trigger Level: As specified by the test

Test Procedure

5. Check the trigger level and slope operation according to the table below.
6. Adjust the function generator CH1 offset from 0V to the trigger level 1 and then to trigger level 2 as specified by the test. Verify that the digitizer trigger each within the error limit.

Table 2-30 Trigger Input Levels Test

Trigger Level 1	Trigger Level 2	Error Limits	Pass	Fail
-5 V		10 µs		
-5 V		10 µs		
-2.5 V		10 µs		
-2.5 V		10 µs		
2.5 V		10 µs		
2.5 V		10µs		
5 V		10 µs		
5 V		10 µs		

2.13 Digitizer Frequency Accuracy

Frequency accuracy tests the accuracy of the digitizer using internal and external clocks. Channels 1 and 2 share the same clock, and therefore the accuracy is tested on channel 1 only.

2.13.1 Frequency Accuracy, Internal Clock

Equipment:
Function generator, counter

Preparation:

1. Configure the counter as follows:
   a. Termination: 50Ω, DC coupled
2. Connect the Proteus channel 1 output to the counter input channel 1
3. Connect the function generator outputs to the Proteus digitizer input
4. Configure the function generator as follows:
   a. Frequency: 1 MHz
   b. Amplitude: 0.5 Vpp
   c. Burst count: 1e6

5. Configure the Proteus digitizer, channel 1 as follows:
   a. Channel State: Enable 125,000 points sine wav
   b. Trigger: Self
   c. Segment: 1e9 points

Test Procedure:

6. Perform frequency accuracy tests according to the table below.
7. Trigger the function generator to generate 1e6 cycles, sample it with the digitizer.
8. Download and generate the sampled segment with the Proteus generator and count the number of cycles it generates and calculate the digitizer clock.

$$\text{Digitizer Clock} = \frac{(\text{memory length})}{(\#\text{ of Counted cycles}) * (1 \text{ cycles period})}$$

Table 2-31 Frequency Accuracy

Counter Reading	Calculated Digitizer Clock	Error Limits	Pass	Fail
		2 GS/s±4 kHz		

2.13.2 Frequency Accuracy, External Clock

Equipment:

Function generator, counter, signal generator

Preparation:

1. Configure the counter as follows:
   a. Termination: 50Ω, DC coupled
2. Connect the Proteus channel 1 output to the counter input channel 1
3. Connect the signal generator output to the digitizer sample clock input
4. Connect the function generator outputs to the Proteus digitizer input
5. Configure the signal generator as follows:
   a. Frequency: 2 GHz
   b. Power: 5dBm
6. Configure the function generator as follows:
   a. Frequency: 1 MHz
   b. Amplitude: 0.5 Vpp
   c. Burst count: 1e6
7. Configure the Proteus digitizer, channel 1 as follows:
   a. Sample Clock: External
   b. Channel State: Enable 125,000 points sine wav
   c. Trigger: Self
   d. Segment: 1e9 points

Test Procedure:

8. Perform frequency accuracy tests according to the table below.
9. Trigger the function generator to generate 1e6 cycles, sample it with the digitizer.
10. Download and generate the sampled segment with the Proteus generator and count the number of cycles it generates and calculate the digitizer clock.

$$\text{Digitizer Clock} = \frac{(\text{memory length})}{(\#\ \text{of Counted cycles}) * (1\ \text{cycles period})}$$

Table 2-32 Frequency Accuracy Using External Reference Counter Test

Counter Reading	Calculated Digitizer Clock	Error Limits	Pass	Fail
		2 GS/s±4 kHz		