Tektronix MDO Demo 1 Board

Instruction Manual

www.tektronix.com

071-2924-00

Tektronix

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Preface

The MDO Demo 1 board provides signals that you can use to show key features of Tektronix MDO4000 Series oscilloscopes.

Compliance Information

Environmental Considerations

This section provides information about the environmental impact of the product.

Product End-of-Life Handling

Observe the following guidelines when recycling an instrument or component:

Equipment recycling. Production of this equipment required the extraction and use of natural resources. The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. In order to avoid release of such substances into the environment and to reduce the use of natural resources, we encourage you to recycle this product in an appropriate manner that will ensure that most of the materials are reused or recycled appropriately.

This symbol indicates that this product complies with the applicable European Union requirements according to Directives 2002/96/EC and 2006/66/EC on waste electrical and electronic equipment (WEEE) and batteries. For information about recycling options, check the Support/Service section of the Tektronix Web site (www.tektronix.com).

Restriction of Hazardous Substances

This product has been classified as Monitoring and Control equipment, and is outside the scope of the 2002/95/EC RoHS Directive.

Preventing Electrostatic Damage

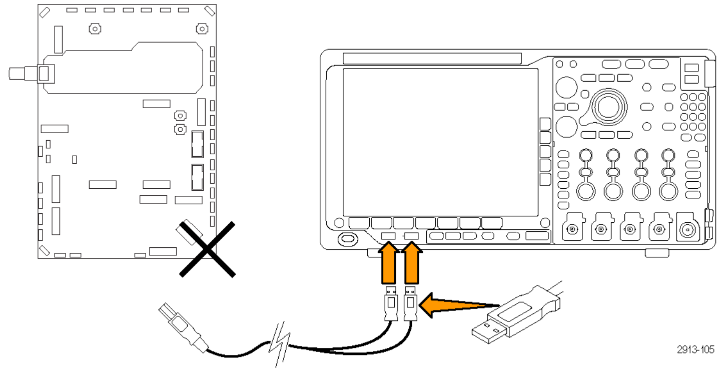
Electrostatic discharge (ESD) can damage components on the demo board. To prevent ESD:

- Do not touch exposed components or connector pins unless you are using ESD protective measures, such as wearing an antistatic wrist strap.
- Handle the demo board as little as possible.
- Do not slide the demo board over any surface.
- Transport and store the demo board in a static-protected bag or container.

Installation

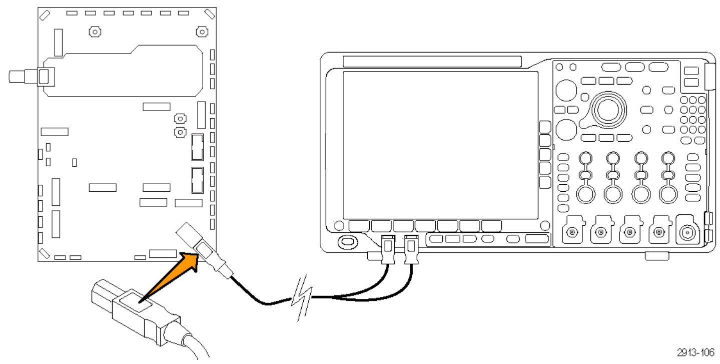
1. Plug the dual USB A connectors from one end of the "T" USB cable, which comes with your board, into two USB ports of a PC or an oscilloscope. Do this before plugging the single USB B connector from the other end of the USB cable into the MDO Demo 1 board.

   You need to attach both USB A connectors to provide adequate power to the demo board.

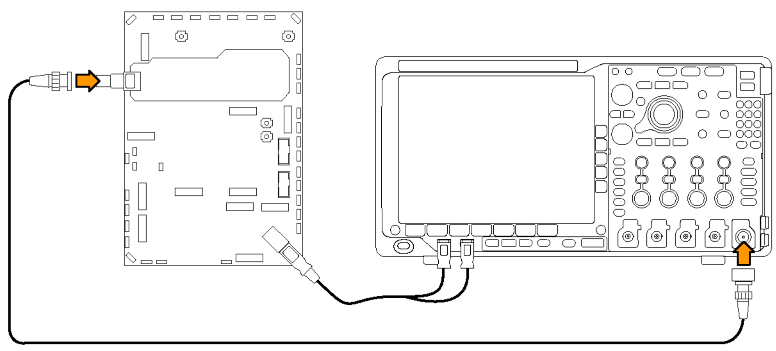


2. Plug the single B connector from the other end of the USB cable into the demo board. Two green and one red LEDs on the board turn on and remain steady when you apply adequate power to the board.

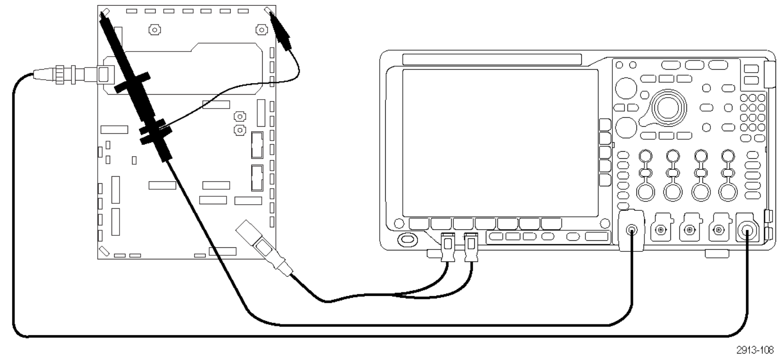
   If you plug the single B connector to the demo board when there is just one of the two USB A connectors attached to the PC or oscilloscope, you may cause an over-current (>500 mA) condition. This can generate an error message.



3. Connect the MDO4000 Series oscilloscope RF input to the MDO Demo 1 Board RF output using the N-to-BNC Adapter (103–0045–00) and a 50 Ω coax BNC cable.



4. Connect one or more analog probes, if desired, from the MDO4000 Series oscilloscope to the desired connector or connectors on the Demo 1 Board.



***NOTE.** The Tektronix MDO Demo 1 board requires approximately 0.75 A to operate.*

***NOTE.** The purpose of the USB cable is to provide power to the demo board. No communication occurs over the USB cable.*

All available signals (except for single-shot) are present on their connectors when you apply power to the demo board.

Push the **RESET** button immediately after connecting power.

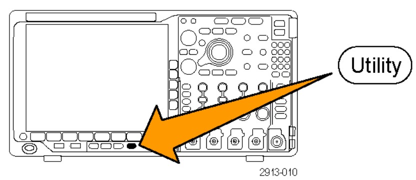
Operation

The MDO4000 Series oscilloscope has six setups of product demonstrations, all of which utilize the MDO 1 Demo Board. Use these setups for the:

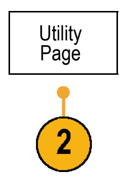
- Multiple peaks demo
- Spectrogram demo
- VCO/PLL Turn On demo
- ASK Modulation demo
- Frequency Hop demo
- Capture Bandwidth demo

To use these setups and see related demo instructions, do the following:

1. Push the front-panel **Utility** button of your MSO4000 Series oscilloscope.



2. Push **Utility Page**



3. Turn multipurpose knob **a** and select **Demo**.

Demo

4. Push the desired demo from the bottom-bezel menu.

   Follow the probe setup instructions for the related demo that now appear on the screen.

Utility Page Demo	Multiple Peaks	Spectro-gram	VCO/PLL Turn On	ASK Modulation	Frequency Hop	Capture Bandwidth

5. Push **Recall Demo Setup** from the side menu to automatically setup the oscilloscope optimally for the demo.
6. Push the button marked **Mode** on the MDO Demo 1 Board as many times as needed to light up the red LED on the board corresponding to the demo you wish to run.

The board does the following, depending on the mode selected:

CW (Continuous Wave) Demo

The RF output connector generates a CW signal at 2.4 GHz.

The red LED labeled “CW” at grid location B11 turns on.

NOTE. *There is no corresponding demo setup in the oscilloscope for this mode.*

Multiple Peaks Demo

The RF output connector generates an array of frequencies, which are centered around 2.4 GHz, to show the ability of the MDO4000 Series oscilloscopes to dynamically mark each peak in the frequency domain with its exact frequency and amplitude.

The red LED labeled “Multiple Peaks” at grid location B11 turns on.

Spectrogram Demo

The RF output connector generates an array of frequencies, which are centered around 2.4 GHz and are both amplitude and frequency modulated, to show the value of the Spectrogram function on slowly changing RF phenomena.

The red LED labeled “Spectrogram” at grid location B11 turns on.

VCO/PLL Turn On Demo

The RF output connector, VCO-1 Enable loop, and PLL-1 Voltage loop, and the SPI, CLK, SPO_SS_1, and SPO_MOSI square pin connectors generate signals that show the interaction between the control signals and the latency of the RF output turning on and tuning to the desired frequency. Use this mode with the **VCO-1 On/Off** push button, which toggles the state of the VCO-1 on and off.

The red LED labeled “VCO/PLL-1 Turn On” at grid B11 turns on.

ASK Modulation Demo

The RF output connector generates an RF signal, which is centered at 2.4 GH,z and is amplitude-modulated by a control signal that turns the RF output on and off. View the control signal and a trigger signal by connecting analog channels to the ASK_MOD probe loop and the Trigger loop.

The red LED labeled “ASK Modulation” at grid B12 turns on.

Frequency Hop Demo

The RF output connector generates three frequency steps. These are centered at 2.4 GHz and step up and down 3 MHz from the CF (center frequency). By using the built-in RF Frequency versus Time function of the MDO4000 Series oscilloscopes, you can see the frequency hop represented as a real-time waveform in the time domain.

The red LED labeled “Frequency Hop” at grid B12 turns on.

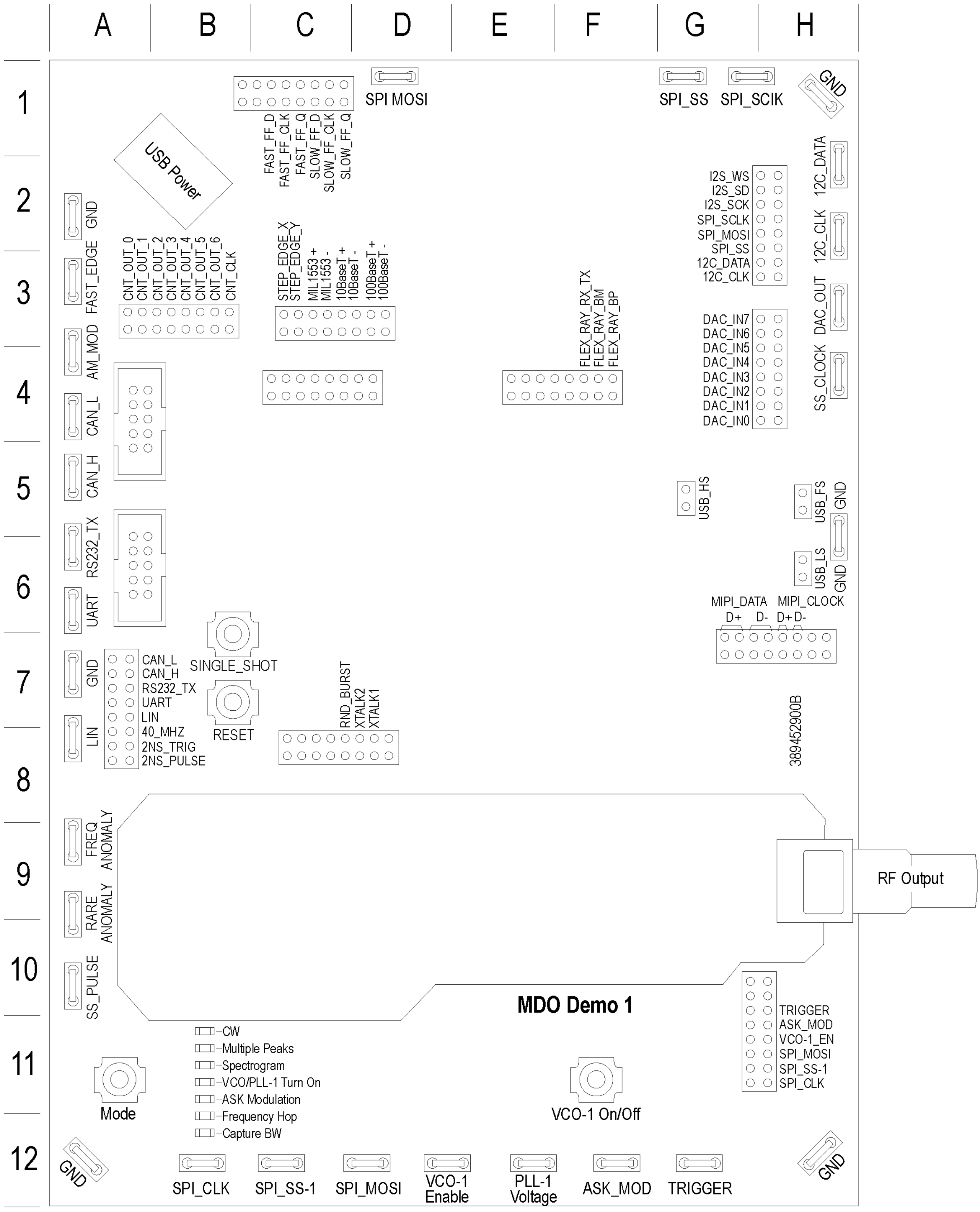
Capture BW Demo

The RF output connector generates both a 2.4 GHz signal and a 900 MHz signal simultaneously to show the broad frequency capture capability.

The red LED labeled “Capture BW” at grid B12 turns on.

Signal Descriptions

The following diagram includes a grid to help you locate signal outputs. To find a particular signal output on the board, look up the connector grid location in the following *Signal Descriptions* section and use the grid location information to find the signal on the demo board.


A
B
C
D
E
F
G
H
1
2
3
4
5
6
7
8
9
10
11
12
SPI MOSI
SPI_SS
SPI_SCIK
GND
USB Power
FAST_FF_D
FAST_FF_CLK
FAST_FF_Q
SLOW_FF_D
SLOW_FF_CLK
SLOW_FF_Q
GND
FAST_EDGE
CNT_OUT_0
CNT_OUT_1
CNT_OUT_2
CNT_OUT_3
CNT_OUT_4
CNT_OUT_5
CNT_OUT_6
CNT_CLK
STEP_EDGE_X
STEP_EDGE_Y
MIL1553 +
MIL1553 -
10BaseT +
10BaseT -
100BaseT +
100BaseT -
I2S_WS
I2S_SD
I2S_SCK
SPI_SCLK
SPI_MOSI
SPI_SS
12C_DATA
12C_CLK
12C_DATA
12C_CLK
DAC_OUT
SS_CLOCK
FLEX_RAY_RX_TX
FLEX_RAY_BM
FLEX_RAY_BP
DAC_IN7
DAC_IN6
DAC_IN5
DAC_IN4
DAC_IN3
DAC_IN2
DAC_IN1
DAC_IN0
AM_MOD
CAN_L
CAN_H
USB_HS
USB_FS
GND
USB_LS
GND
RS232_TX
UART
MIPI_DATA
MIPI_CLOCK
D+
D-
D+
D-
GND
CAN_L
CAN_H
RS232_TX
UART
LIN
40_MHZ
2NS_TRIG
2NS_PULSE
SINGLE_SHOT
RESET
RND_BURST
XTALK2
XTALK1
LIN
389452900B
FREQ ANOMALY
RARE ANOMALY
RF Output
SS_PULSE
MDO Demo 1
TRIGGER
ASK_MOD
VCO-1_EN
SPI_MOSI
SPI_SS-1
SPI_CLK
CW
Multiple Peaks
Spectrogram
VCO/PLL-1 Turn On
ASK Modulation
Frequency Hop
Capture BW
Mode
VCO-1 On/Off
GND
SPI_CLK
SPI_SS-1
SPI_MOSI
VCO-1 Enable
PLL-1 Voltage
ASK_MOD
TRIGGER
GND
2924-002

2 ns Pulse

Board label: 2NS_PULSE
Grid location: A8

Description: This signal is a 2 ns to 3 ns, 2.5 V pulse at a 3.3 ms repetition rate. Use this signal to show the minimum pulse width capture specification of an instrument digital acquisition system.

2 ns Pulse Trigger

Board label: 2NS_TRIG
Grid location: A8

Description: This is the trigger edge signal for the 2 ns pulse. A falling edge on this signal occurs approximately 5 ns before the 2 ns pulse.

40 MHz

Board label: 40_MHZ
Grid location: A8

Description: This is a 40 MHz square wave signal.

AM Modulation

Board label: AM_MOD
Grid location: A4

Description: This is a 1.25 MHz carrier amplitude signal modulated by a 1.25 kHz sine wave signal.

The AM Mod signal is centered around ground.

Set the oscilloscope trigger level to either the top or bottom of the waveform to stabilize it on the display.

ASK_MOD

Board label: ASK_MOD
Grid location: F12, H11

Description: This is a digital modulation signal that is used to amplitude modulate the RF output when the board is in the ASK Modulation demo mode. When it is high, the RF is on. When it is low, the RF is off

CAN Bus

Board label: CAN_H, CAN_L
Grid location: A4, A5, A7

Description: These are the CAN (Controller Area Network) bus signals between two CAN transceivers.

The bit rate of the data packet is 500 kbps.

Counter Clock

Board label: CNT_CLK
Grid location: B3

Description: This is the 1.25 MHz clock signal for the 7-bit Counter Output described next.

Counter Output Bits

Board label: CNT_OUT_0: CNT_OUT_6
Grid location: A3, B3

Description: These are the 7-bits of the binary counter. The LSB is CNT_OUT_0. It runs at 625 KHz, which is half of the counter input clock.

The Counter Output Bits and the Counter Clock signals are on eight adjacent sets of header pins for easy connection to a digital probe.

Crosstalk

Board label: XTALK1, XTALK2
Grid location: D8

Description: These two signals have significant crosstalk between them. Use them to show MagniVu.

DAC Input, Parallel

Board label: DAC_IN0, DAC_IN1, DAC_IN2, DAC_IN3, DAC_IN4, DAC_IN5, DAC_IN6, DAC_IN7
Grid location: H3, H4

Description: These signals are the input to the DAC. These are also the 8-bit parallel output signals of the port expander in the middle of the mixed signal chain. The sine wave data from the SPI bus is converted to 8 parallel bits to drive the DAC. DAC_IN0 is the LSB. (See Figure 1.)

See the SPI Bus description for packet details.

DAC Output

Board label: DAC_OUT
Grid location: H3

Description: This is the output of the DAC at the end of the mixed signal chain. The DAC is driven from the port expander. The DAC output is a sine wave. Since the output is not filtered, the digitizing levels are present in the output waveform. (See Figure 1.)

The resulting DAC voltage is a sine wave with an amplitude 0 to 3 volts, and a period of 31 ms.

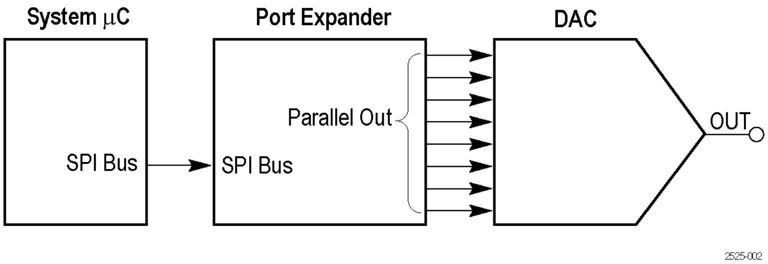


Figure 1: Mixed signal chain block diagram

Ethernet Bus

Board label: 10BaseT+, 10BaseT-, 100BaseT+, 100BaseT-
Grid location: C3, D3

Description: These signals generate representative and compliant Ethernet traffic, but the board will not recognize or communicate with any externally connected hardware. The following Ethernet Serial Bus signals are driven as differential pairs:

- The 10Base-T signal pair communicates at a 10 Mbit/s data rate.
- The 100Base-TX signal pair communicates at 100 Mbit/s.

Fast Edge

Board label: FAST_EDGE
Grid location: A3

Description: This is a 156 kHz, capacitively-coupled pulse signal with a 1.5 ns rise and fall time.

Fast FF Clock

Board label: FAST_FF_CLK
Grid location: C1

Description: This is the 1.25 MHz clock input signal to a fairly fast flip-flop. The pulse width of this clock signal varies slowly.

Fast FF Data

Board label: FAST_FF_D
Grid location: C1

Description: This is the 1.25 MHz data input signal to a fairly fast flip-flop that is asynchronous to the clock input.

Fast FF Q Output

Board label: FAST_FF_Q
Grid location: C1

Description: This is the Q output signal of the fairly fast flip-flop. This signal shows metastable behavior infrequently.

FlexRay

Board label: FLEXRAY_BP, FLEXRAY_BM, FLEXRAY_RX/TX
Grid location: F4

Description: These FlexRay signals consist of the following test points:

- FlexRay_BP, the positive half of a differential FlexRay bus
- FlexRay_BM, the negative half of a differential FlexRay bus
- FlexRay_Rx/Tx, the single-ended logic signal between the controller and the transceiver

The data rate is at 10 Mb/s. The swing is 0 to 3.3 V. Tri-state is at 1.65 V (BP and BM only). There are 15 individual 198-bit long frames.

Frequent Anomaly

Board label: FREQ_ANOMALY
Grid location: A9

Description: There are two frequently occurring anomalies in this pulse train.

A half height runt signal occurs approximately every 104.8 ms. Use a Runt trigger to isolate the signal.

A 25 ns (narrow) pulse appears approximately every 104.8 ms. Use a Pulse Width trigger to isolate the signal.

The pulse train is a repeating group of three pulses. The three pulses are 100 ns, 200 ns, and 100 ns wide, with a 100 ns low between. The group repeats at a 1.6 μs rate.

The anomaly is a group of four pulses. The four pulses are 100 ns, 50 ns (narrow), 100 ns (runt), and 100 ns wide, with a 100 ns low between, except for a 50 ns low before the runt.

I²C Bus

Board label: I2C_CLK, I2C_DATA
Grid location: H2, H3

Description: These are the I²C (Inter-IC Communication) bus signals between the µC and a serial EEPROM.

There are several different types of data packets.

The clock rate is a 200 kHz, 0 to 5 volt signal.

I2S (Inter-IC Sound) Bus

Board label: I2S_SCK, I2S_WS, I2S_SD
Grid location: H2

Description: This is an I2S (Inter-IC sound) serial bus.

The clock rate is 2.5 MHz.

LIN Bus

Board label: LIN
Grid location: A8

Description: This is the LIN (Local Interconnect Network) bus signal between two LIN transceivers.

The bus speed is 19.2 kbaud. It contains a mix of version 1.x and 2.x frames.

MIL-STD-1553

Board label: MIL1553+, MIL1553-
Grid location: C3

Description: These signals are representative of MIL-STD-1553 bus protocol traffic for a serial, differential pair running at 1 MHz. Messages consist of one or more 16-bit words, where each word is preceded by a 3 µs sync pulse and followed by an odd parity bit.

MIPI_DATA, MIPI_CLOCK

Board label: MIPI_DATA, MIPI_CLOCK
Grid location: H7

Description: These signals are representative of MIPI D-PHY bus protocol traffic for a serial differential pair running at 500 Mb/s.

Mode Button

Board label: Mode
Grid location: A11

Description: Push this button to choose which of the seven alternative signals to send out of the RF output connector. Your current choice is identified by which of the seven related red LEDs is lighted.

PLL-1 Voltage

Board label: Voltage
Grid location: E12

Description: This signal is the voltage on the first PLL/VCO in the RF section of the board. It typically operates at 2.4 GHz.

Random Burst

Board label: RND_BURST
Grid location: C8

Description: This signal produces bursts of 100 ns wide logic pulses every 6.6 ms. The pattern is a pseudo-random bit sequence that repeats every 128 bursts and has a 6.32 μs duration.

Rare Anomaly

Board label: RARE_ANOM
Grid location: A10

Description: The two less-frequent anomalies in this pulse train can show up on high waveform capture rate oscilloscopes.

A half-height runt signal occurs approximately every 838.8 ms. Use a Runt trigger to isolate the signal.

A 25 ns (narrow) pulse appears in approximately 838.8 ms. Use a Pulse Width trigger to isolate the signal.

The pulse train is a repeating group of three pulses. The three pulses are 100 ns, 200 ns, and 100 ns wide, with a 100 ns low between each pulse. The group repeats at a 1.6 μs rate.

The anomaly is a group of four pulses. The four pulses are 50 ns, 25 ns (narrow), 100 ns (runt), and 100 ns wide, with a 100 ns low between each pulse, except for a 25 ns low before the narrow pulse.

Reset Button

Board label: RESET
Grid location: B7

Description: Push this button to start all generated signals from a common point.

RF Output

Board label: None
Grid location: H9

Description: Use the RF output from this connector in the seven different RF demos controlled by the **Mode** button. Directly connect this output to the RF input of the MDO4000 Series oscilloscope.

RS232 UART, Transmit

Board label: UART, RS232_TX
Grid location: A6, A7

Description: The UART signal is the noninverted logic level input to the RS-232 UART from the µC. The inverted transmit signal (TX) is the RS-232 voltage level serial bus signal.

The decoded data packets display the ASCII string “Tektronix, Enabling Innovation”.

There are no matching receive or data flow control signals.

The baud rate is 9600. The data format is 1 start bit, and 8 data bits with no parity.

Single Shot Button

Board label: SINGLE SHOT
Grid location: B7

Description: Push this button to initiate a 200 ns pulse on the Single Shot Pulse (**SS_PULSE**) signal connector.

Single Shot Pulse

Board label: SS_PULSE
Grid location: A10

Description: This is a 200 ns wide positive pulse that is initiated by the **SINGLE SHOT** push button (grid location B7). The demo board provides one pulse per button push.

Slow FF Clock

Board label: SLOW_FF_CLK
Grid location: C1

Description: This is the 1.25 MHz clock input signal to a slow flip-flop.

Slow FF Data

Board label: SLOW_FF_D
Grid location: C1

Description: This is the 1.25 MHz data input signal to a slow flip-flop, which is asynchronous to the clock input.

Slow FF Q Output

Board label: SLOW_FF_Q
Grid location: C1

Description: This is the Q output signal of the slow flip-flop. This signal shows metastable behavior frequently.

SPI Bus

Board label: SPI_SCLK, SPI_SS, SPI_MOSI
Grid location: D1, G1, H1, H2, H3

Description: These are the SPI (Serial Peripheral Interface) serial bus signals. (See Figure 1.)

The SPI bus works as follows:

- SCLK rising edge clock
- Active Low SS
- Active High MOSI data

This is the beginning of the mixed signal chain. See the descriptions of these signals: DAC Input, Parallel and DAC Output.

Packets occur approximately every 500 µs. The SPI packet contents are transferred to the Parallel DAC Input bus at the end of the packet. The Parallel DAC Input bus then changes the voltage output of the DAC.

The resulting DAC output is a sine wave with an amplitude 0 to 3 volts, and a period of 31 ms.

The clock rate is a 200 kHz, 0 to 5 volt signal.

SPI Bus (for RF)

Board label: SPI_CLK, SPI_SS-1, SPI_MOSI-1
Grid location: B12, C12, D12, H11

Description: These are the SPI (Serial Peripheral Interface) serial bus signals. (See Figure 1.)

The SPI bus works as follows:

- SCLK rising edge clock
- Active Low SS
- Active High MOSI data

This SPI bus is the control bus for several different parts that control the RF output in the RF based demonstrations.

Spread Spectrum Clock

Board label: SS_CLOCK
Grid location: H4

Description: This is a nominally 98.5 MHz spread spectrum clock with triangular modulation. Use it for demonstrating timing measurement trends over time.

Step Edge X, Step Edge Y

Board label: STEP_EDGE_X, STEP_EDGE_Y
Grid location: C3

Description: These identical step edge (rising edge) signals, when used together, let you show different probe loading effects. Connect two different probes simultaneously, with one on Step Edge X and the other on Step Edge Y, and compare the rise times from each probe for these identical signals.

For example, if you put a low input capacitance probe, like the Tektronix TPP1000, on one of these signals and an alternative, higher input capacitance probe, like the Tektronix P6139A, on the other signal, capture the waveforms on an oscilloscope and then overlay the two captured signals, the waveform from the lower input capacitance TPP1000 will show a faster rise time.

TRIGGER

Board label: TRIGGER
Grid location: G12, H11

Description: This signal acts as a trigger reference for the ASK Modulation, Frequency Hop, and Capture BW demonstrations. It provides a short positive pulse at the start of the event of interest.

USB Bus

Board label: USB_LS, USB_FS, USB_HS
Grid location: G5, H5, H6

Description: Universal Serial Bus signals, defined by USB 2.0 and driven as differential pairs:

- The USB_LS signal represents the Low Speed USB standard, with data running at 1.5 Mbit/s.
- The USB_FS signal represents the Full Speed USB standard, with data running at 12 Mbit/s.
- The USB_HS signal represents the High Speed USB standard, with data running at 480 Mbits/s.

VCO-1 Enable

Board label: VCO-1 Enable
Grid location: E12, H11

Description: This is a digital control signal that transitions from low to high to turn on VCO-1 (2.4 GHz).

VCO-1 On/Off Button

Board label: VCO-1 On/Off
Grid location: F11

Description: Push this button to toggle VCO-1 on or off. Use this in the VCO/PLL demonstration to turn the VCO off and then back on to capture its start-up sequence.