10.5. Renishaw Resolute™ Absolute Rotary Encoder DB9 Signals Oscilloscope Captures

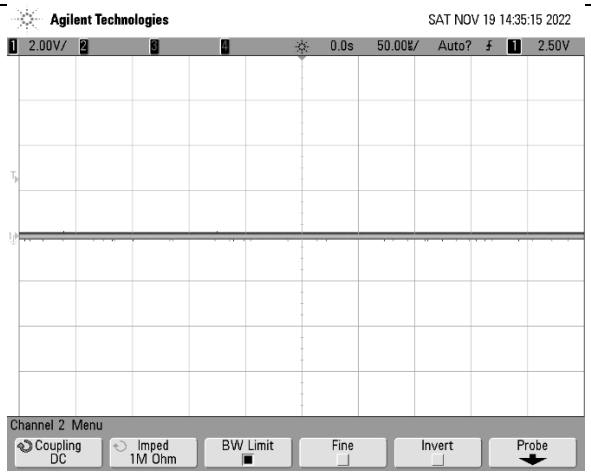
This section contains oscilloscope captures at the Renishaw Resolute absolute rotary encoder DB9 connector pins while connected to the E201-9S USB Interface [35].

The Renishaw Resolute absolute rotary encoder DB9 connector is then moved from the E201-9S USB Interface [35] to a Texas Instruments THVD1551DGKR [34] to transform the differential Clock (MA+ and MA-) and Data (SLO+ and SLO-) signals from the encoder to the single ended Clock (CLK) and Data signals on the Speedgoat. A second set of oscilloscope captures are taken at the Renishaw Resolute absolute rotary encoder DB9 connector pins while connected to the Texas Instruments THVD1551DGKR [34] and the Speedgoat.

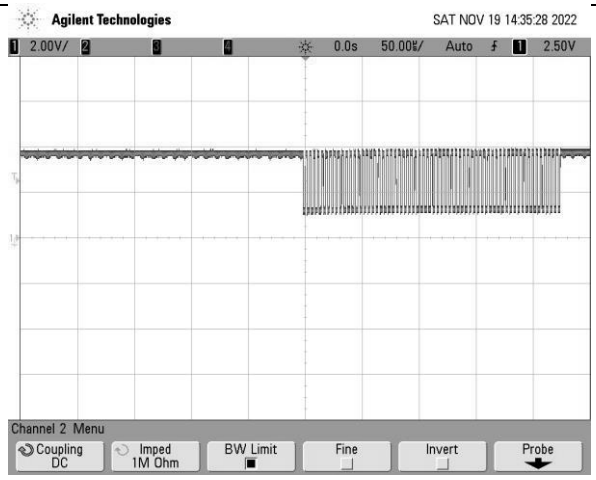
10.5.1. Renishaw Resolute absolute rotary encoder DB9 connector pins while connected to the E201-9S USB Interface (known good / working)

All oscilloscope captures are taken single-ended with respect to DB9 connector pin 9 (0V).

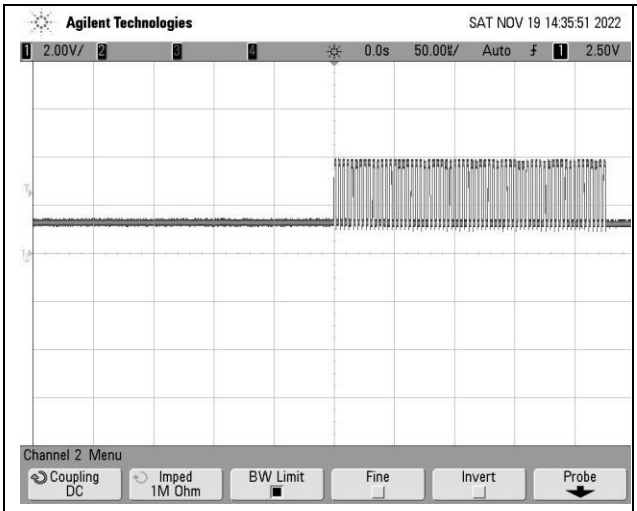
MA+ frequency: 281.69 kHz
MA+ period: 3.55 µs
MA+ frame duration: ~224 µs (~64 MA+ rising edges)



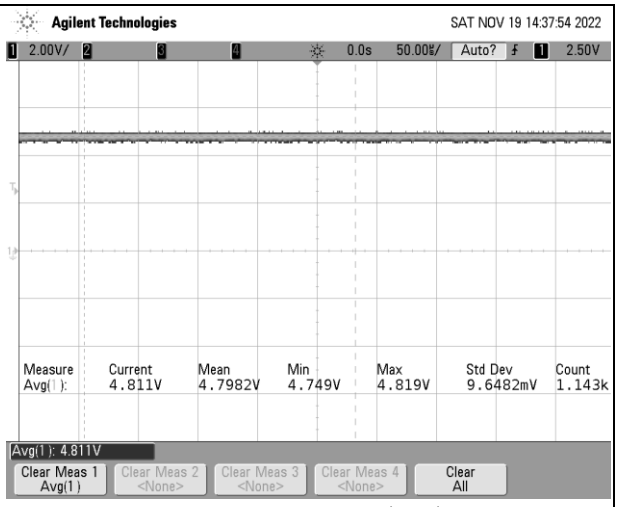
DB9 Connector Pin 1 (Inner Shield).
Shows pin 1 is 0 V (clean).



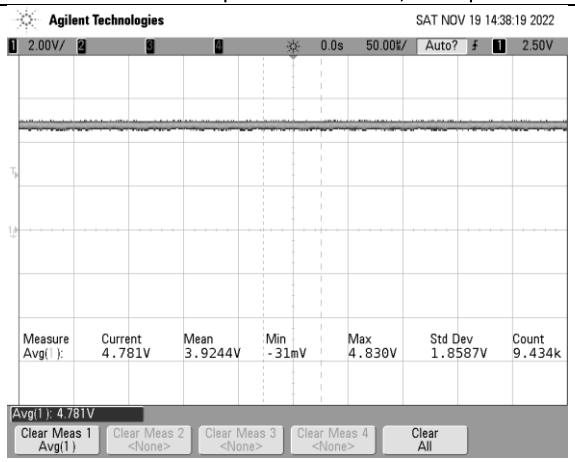
DB9 Connector Pin 2 (MA+).
Shows MA+ Vhigh ≈ 3.75 V, Vlow ≈ 1.25 V.
Idle state is high, 64 MA+ rising edges.



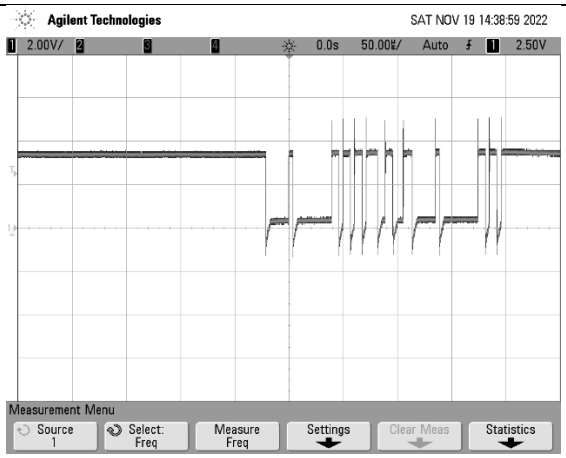
DB9 Connector Pin 3 (MA-).
Shows MA- is complement of MA+, as expected.



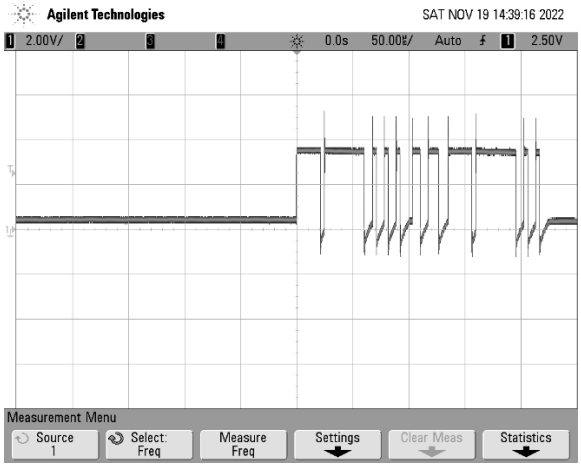
DB9 Connector Pin 4 (+5V).
Shows +5V supply is 4.8 Vdc and clean.



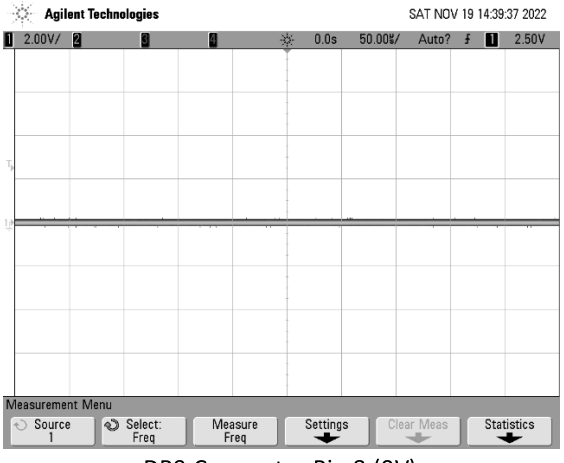
DB9 Connector Pin 5 (+5V).
Shows +5V supply is on both pins 4 and 5.
Shows +5V supply is 4.8 Vdc and clean.



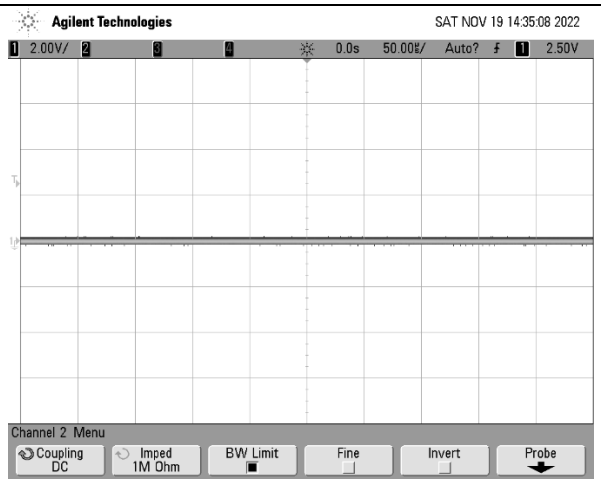
DB9 Connector Pin 6 (SLO+)
Shows SLO+ Vhigh ≈ 3.5 V, Vlow ≈ 0.35 V.
Idle state is high, responds to MA+ rising edges.



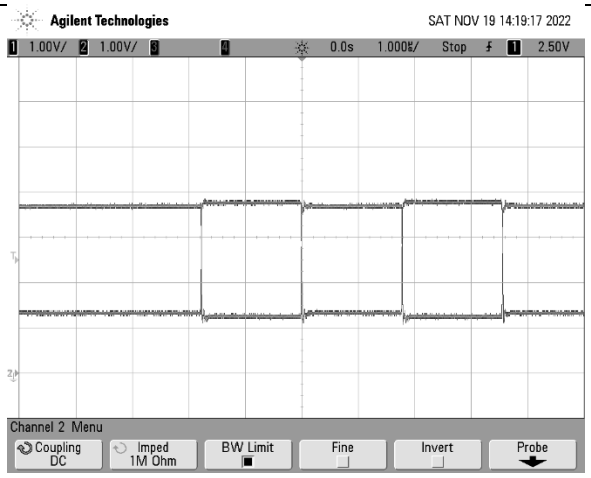
DB9 Connector Pin 7 (SLO-).
Shows SLO- is complement of SLO+, as expected.



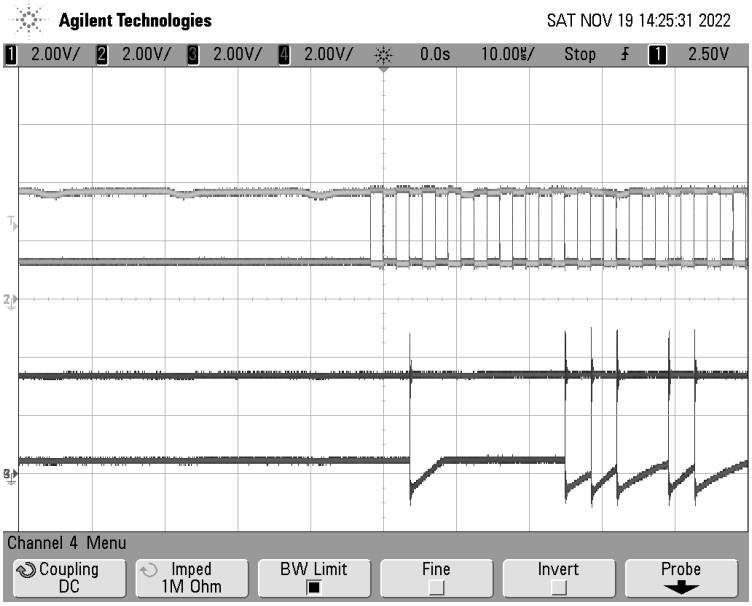
DB9 Connector Pin 8 (0V).
Shows pin 8 is 0 V (clean).



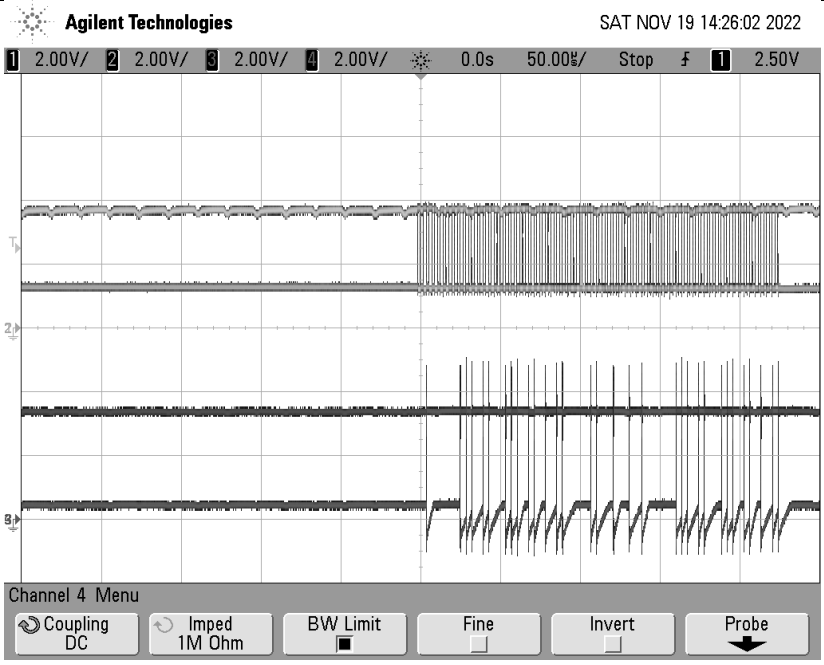
DB9 Connector Pin 9 (0V).
Shows pin 9 is 0 V (clean).



MA+ and MA- on same oscilloscope capture.
Vhigh ≈ 3.75 V, Vlow ≈ 1.25 V



MA+, MA- (top) and SLO+, SLO- (bottom) on same oscilloscope capture.

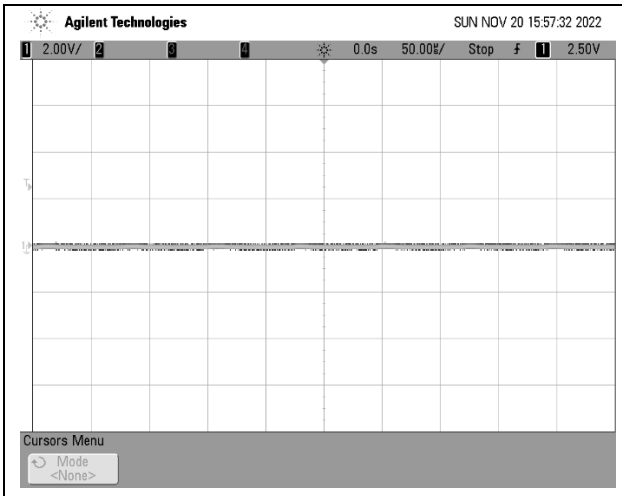


MA+, MA- (top) and SLO+, SLO- (bottom) on same oscilloscope capture.

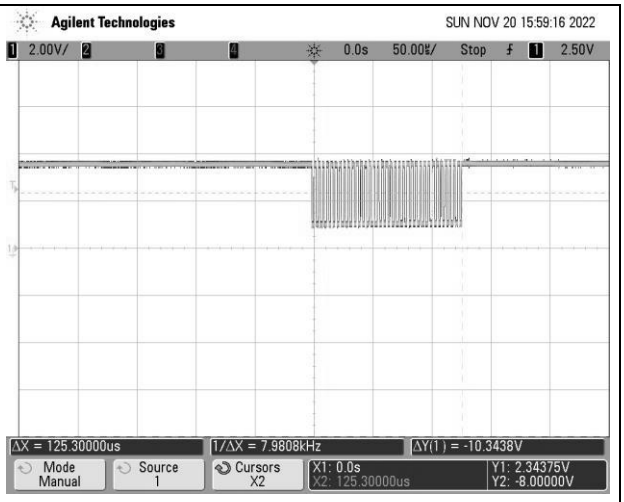
10.5.2. Renishaw Resolute absolute rotary encoder DB9 connector pins while connected to Texas Instruments THVD1551DGKR and the Speedgoat

All oscilloscope captures are taken single-ended with respect to DB9 connector pin 9 (0V).

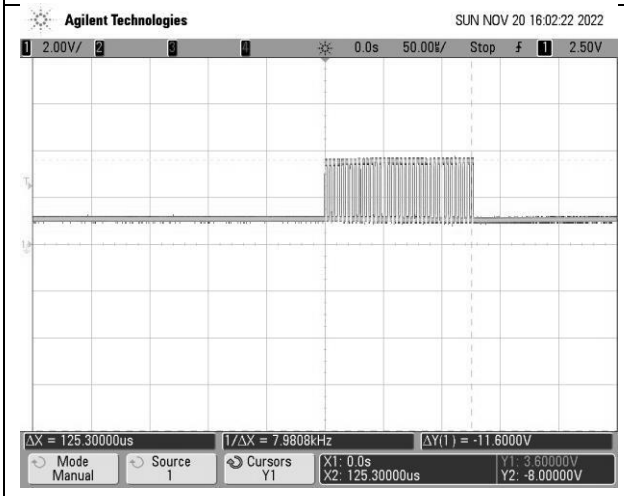
MA+ frequency: 280.11 kHz
MA+ period: 3.57 µs
MA+ frame duration: ~125.3 µs (~35 MA+ rising edges)



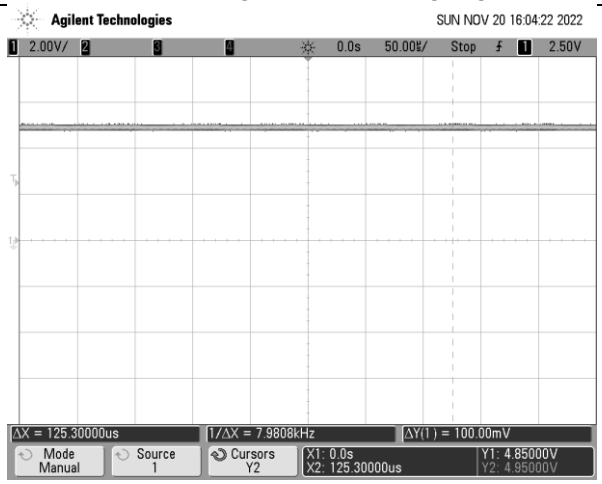
DB9 Connector Pin 1 (Inner Shield).
Shows pin 1 is 0 V (clean).



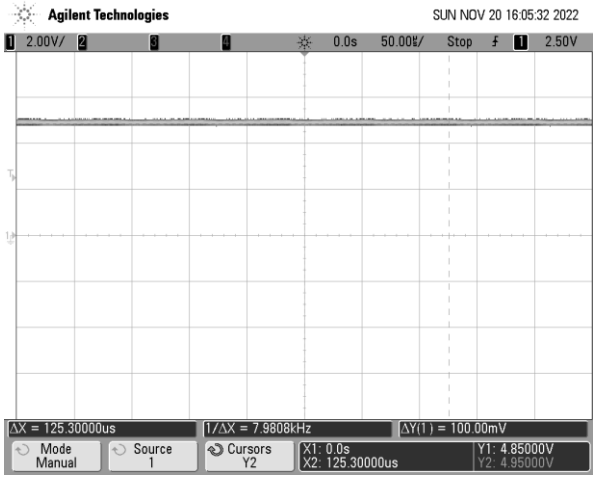
DB9 Connector Pin 2 (MA+).
Shows MA+ Vhigh ≈ 3.60 V, Vlow ≈ 1.03 V.
Idle state is high, ~35 MA+ rising edges.



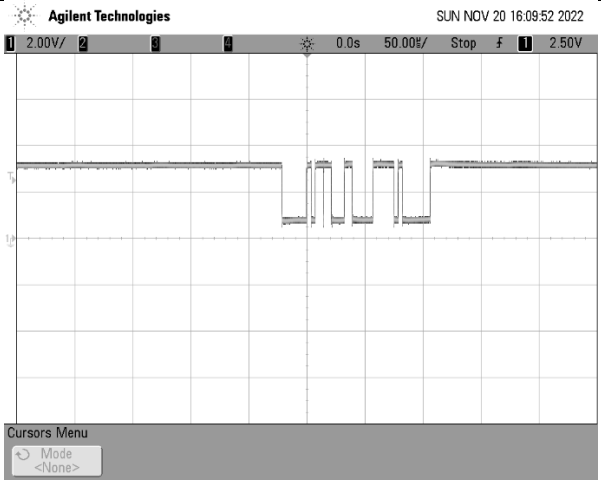
DB9 Connector Pin 3 (MA-).
Shows MA- is complement of MA+, as expected.



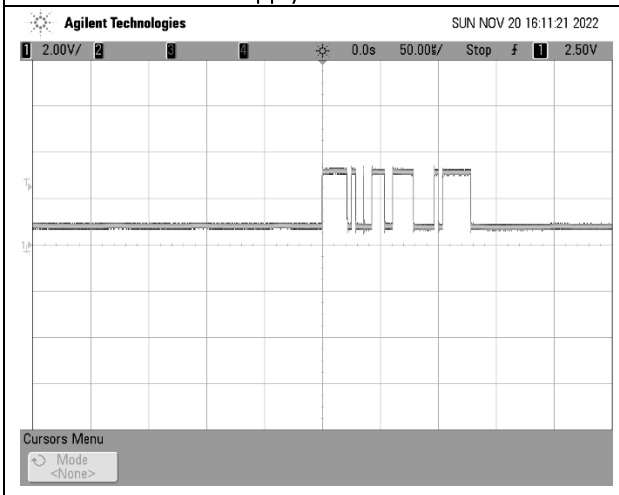
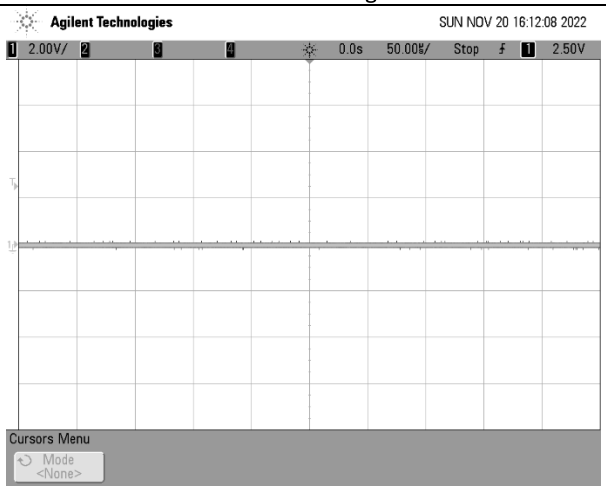
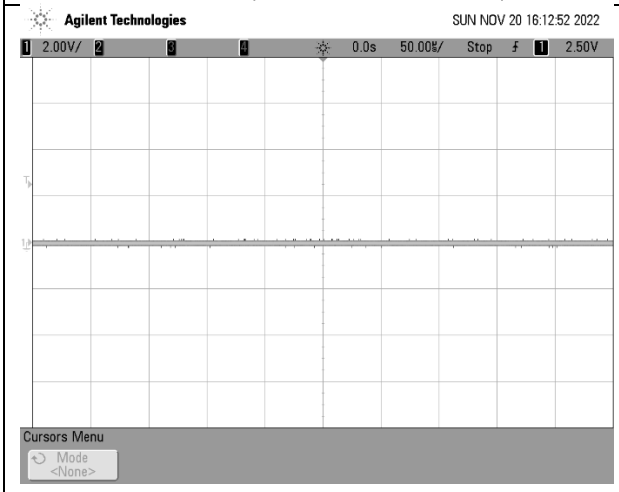
DB9 Connector Pin 4 (+5V).
Shows +5V supply is on both pins 4 and 5.
Shows +5V supply is 4.9 Vdc and clean.

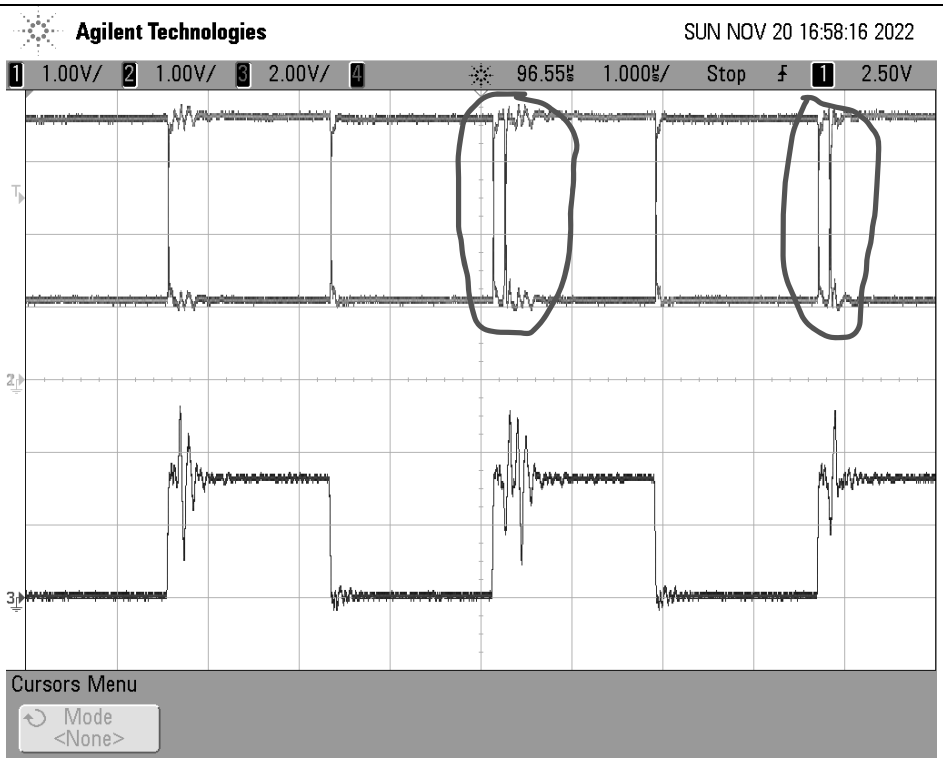


DB9 Connector Pin 5 (+5V).
Shows +5V supply is on both pins 4 and 5.

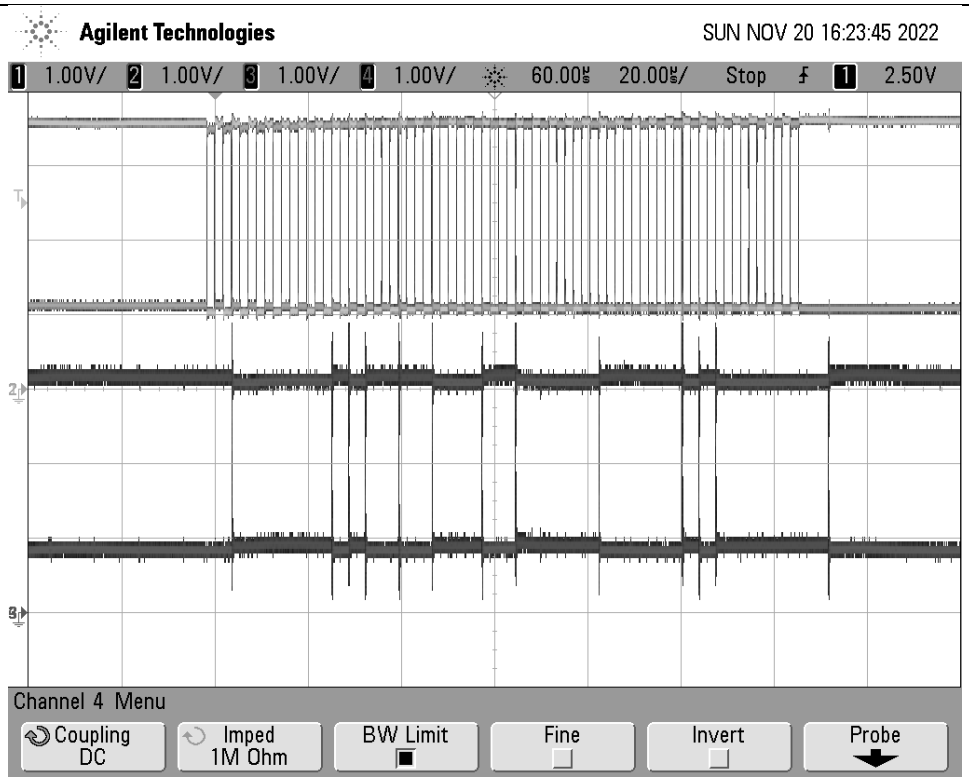


DB9 Connector Pin 6 (SLO+).
Shows SLO+ Vhigh ≈ 3.2 V, Vlow ≈ 0.8 V.

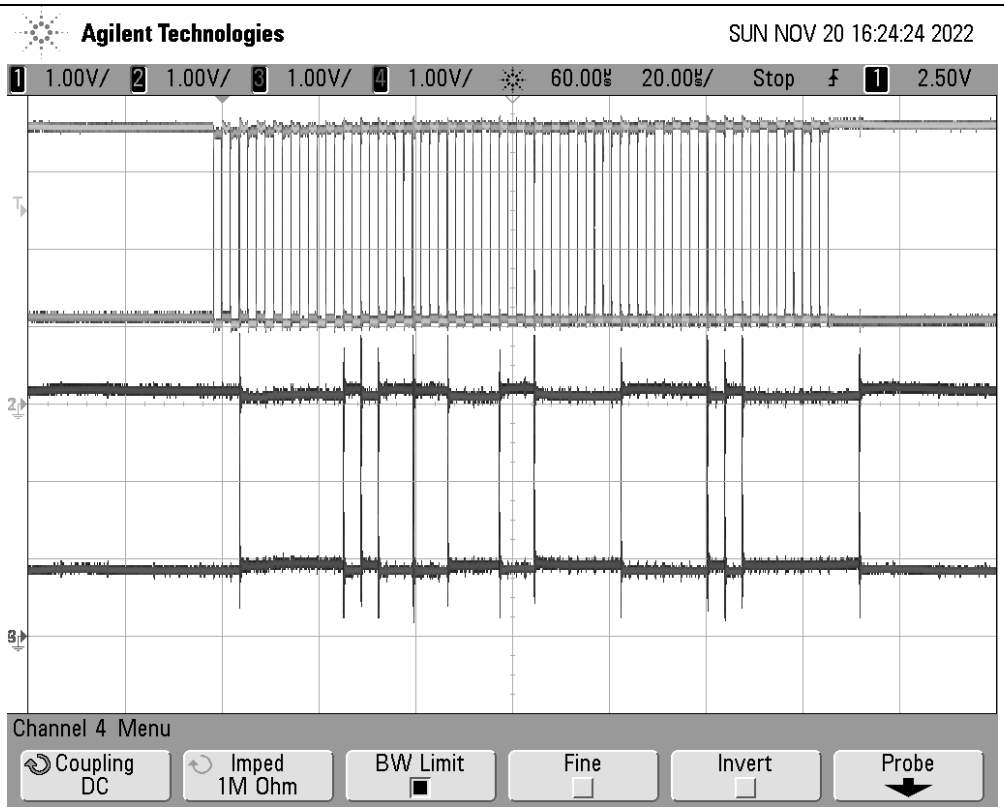
Shows +5V supply is 4.9 Vdc and clean.	Idle state is high.
 DB9 Connector Pin 7 (SLO-). Shows SLO- is complement of SLO+, as expected.	 DB9 Connector Pin 8 (0V). Shows pin 8 is 0 V (clean).
 DB9 Connector Pin 9 (0V). Shows pin 9 is 0 V (clean).	



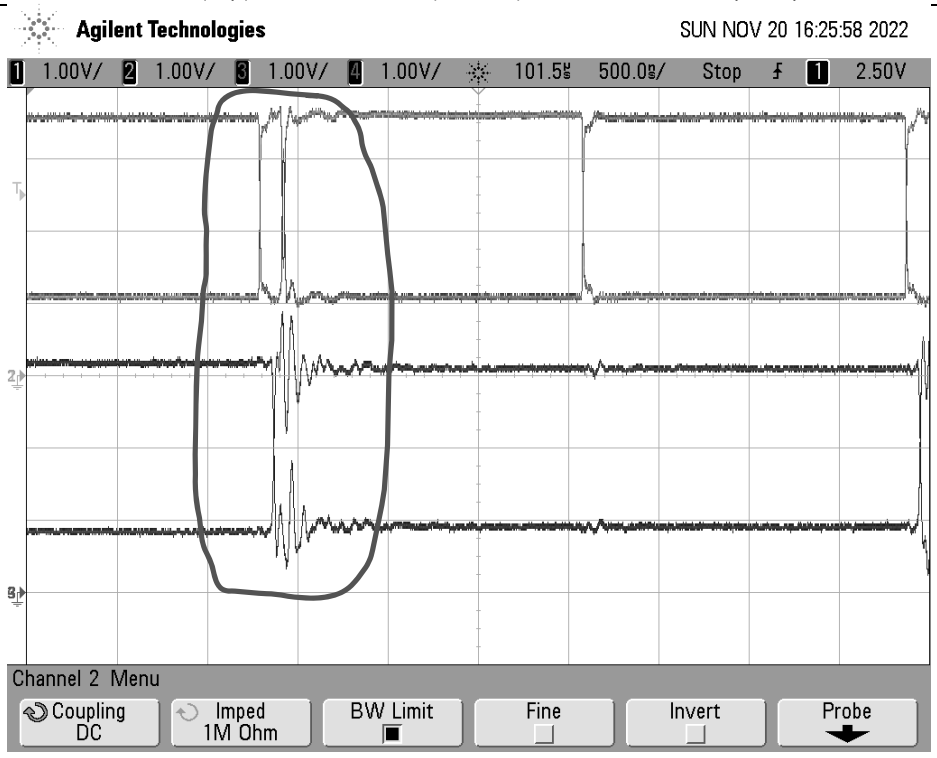
Zooming in on the MA+ and MA- (top) and Speedgoat (bottom) (1 µs per division).
MA+, MA- (top) and the single ended Clock (CLK) on the Speedgoat (bottom) on same oscilloscope capture.
Note glitches in MA+ / MA-.
Note glitch in the single ended Clock (CLK) on the Speedgoat when connected to the Texas Instruments THVD1551DGKR.



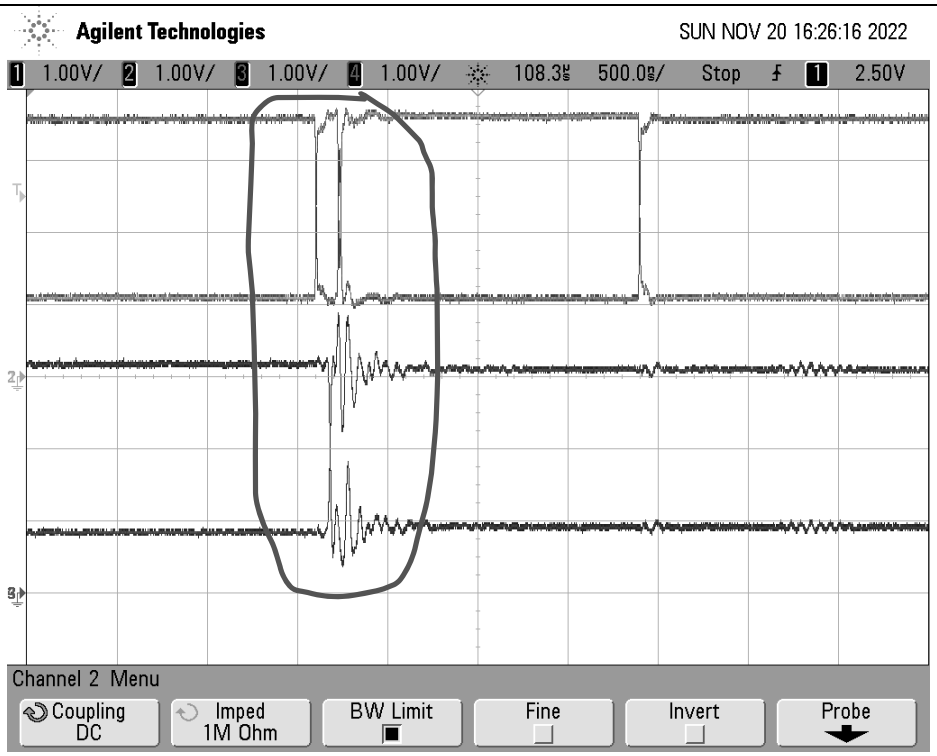
MA+, MA- (top) and SLO+, SLO- (bottom) on same oscilloscope capture.



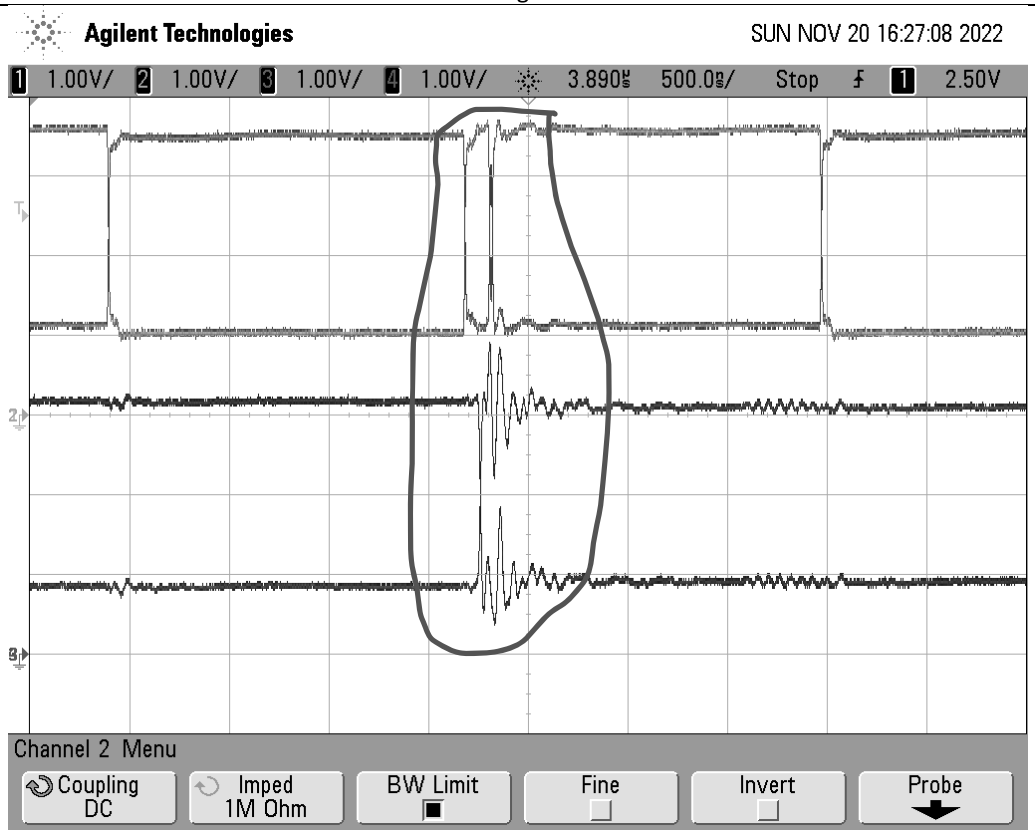
MA+, MA- (top) and SLO+, SLO- (bottom) on same oscilloscope capture.



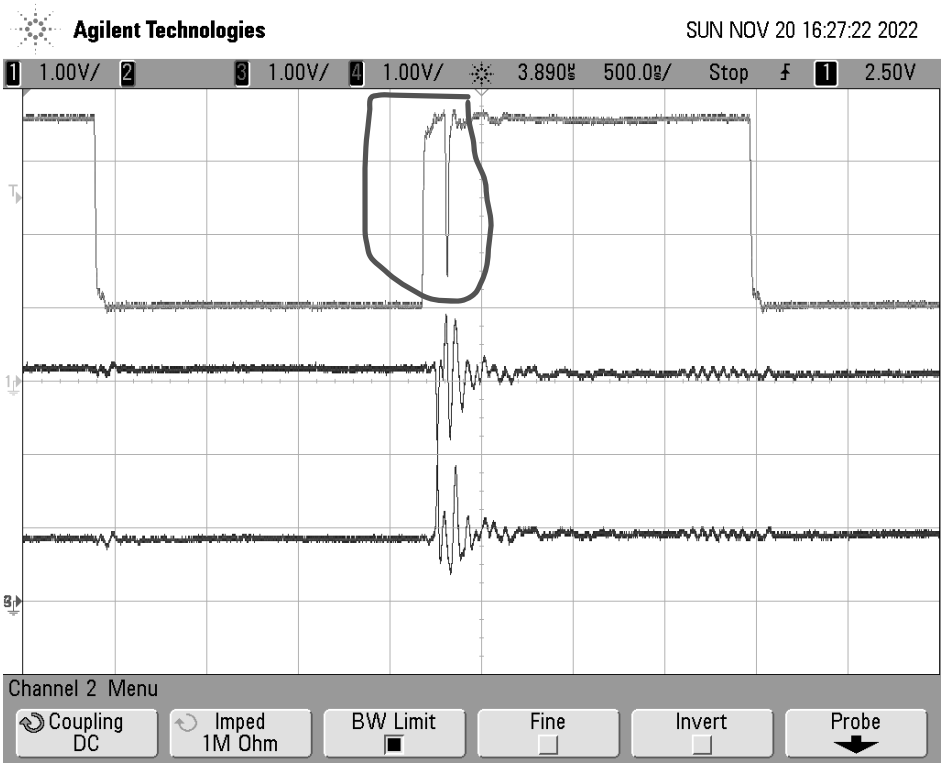
Zoomed MA+, MA- (top) and SLO+, SLO- (bottom) on same oscilloscope capture. Note glitch.



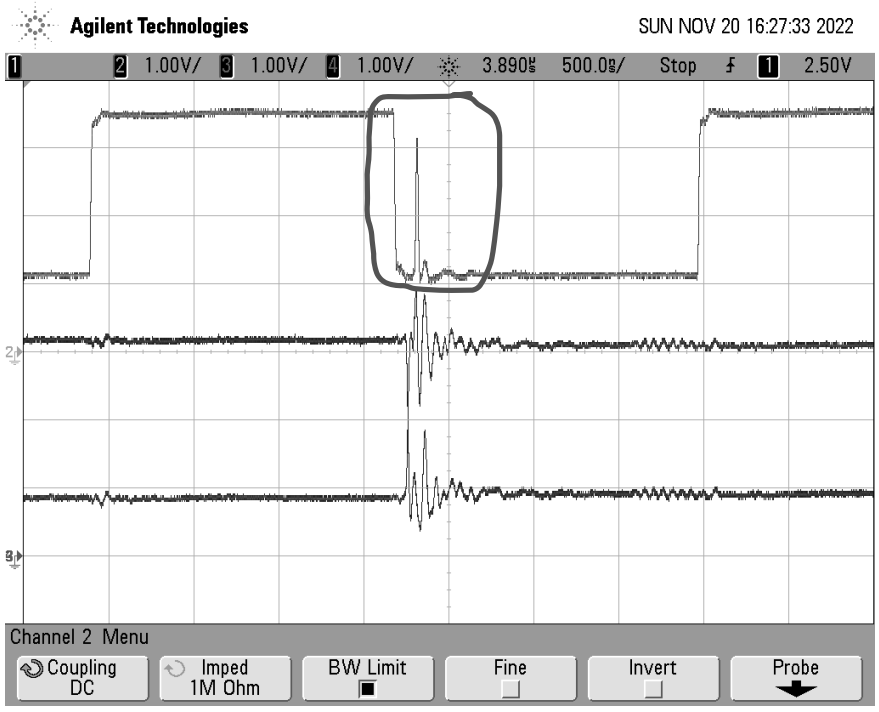
Zoomed MA+, MA- (top) and SLO+, SLO- (bottom) on same oscilloscope capture. Note glitch.



Zoomed MA+, MA- (top) and SLO+, SLO- (bottom) on same oscilloscope capture. Note glitch.



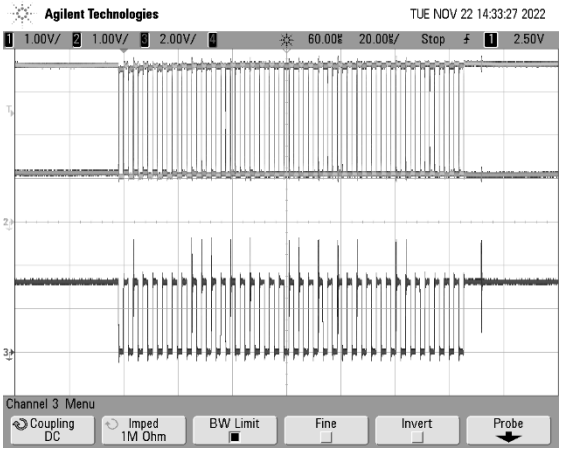
Zoomed MA+ only (top) and SLO+, SLO- (bottom) on same oscilloscope capture. Note glitch.



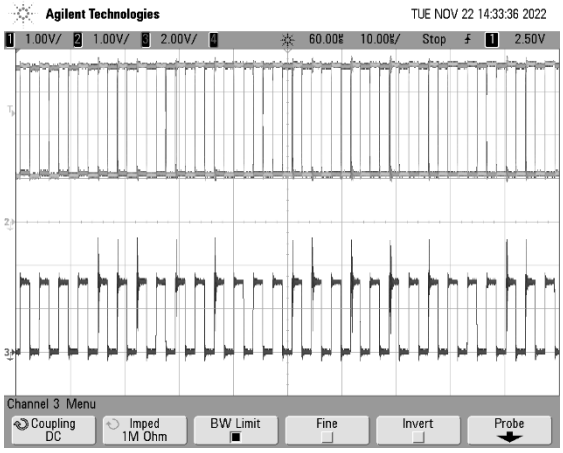
Zoomed MA- only (top) and SLO+, SLO- (bottom) on same oscilloscope capture. Note glitch.

10.5.3. Speedgoat Single-Ended MA Clock Signal Glitch

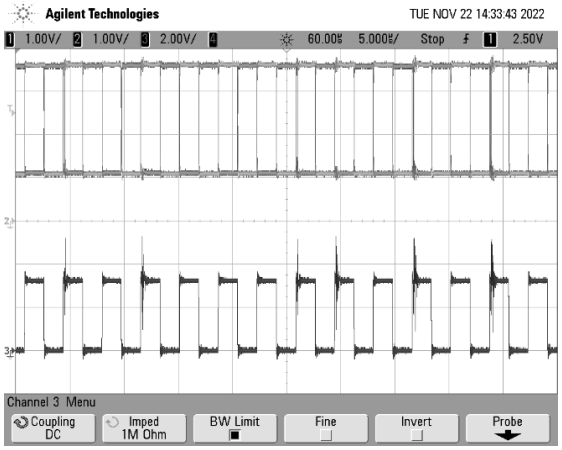
The "glitch" observed on the Speedgoat "BiSS Master CLK" is only present when connected to the Texas Instruments THVD1551DGKR [34].



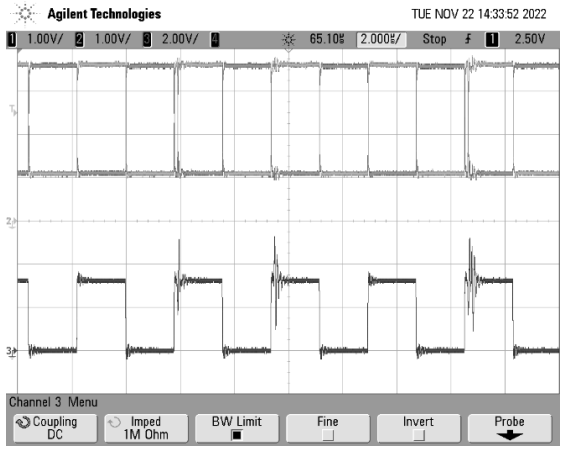
MA+, MA- (top) and Speedgoat "BiSS Master CLK" (bottom) on same oscilloscope capture. Note glitches.



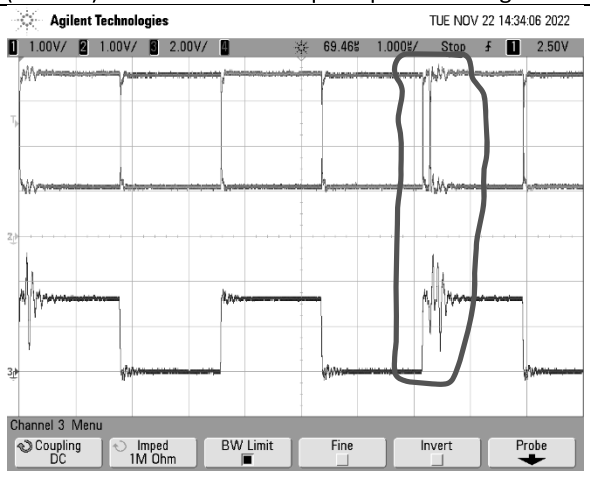
MA+, MA- (top) and Speedgoat "BiSS Master CLK" (bottom) on same oscilloscope capture. Note glitches.



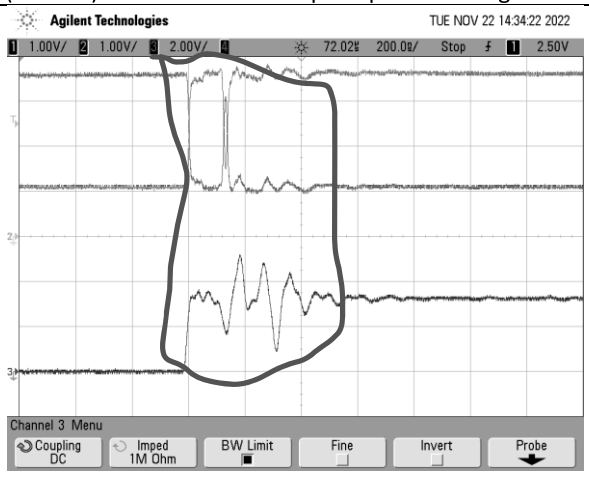
MA+, MA- (top) and Speedgoat "BiSS Master CLK" (bottom) on same oscilloscope capture. Note glitches.



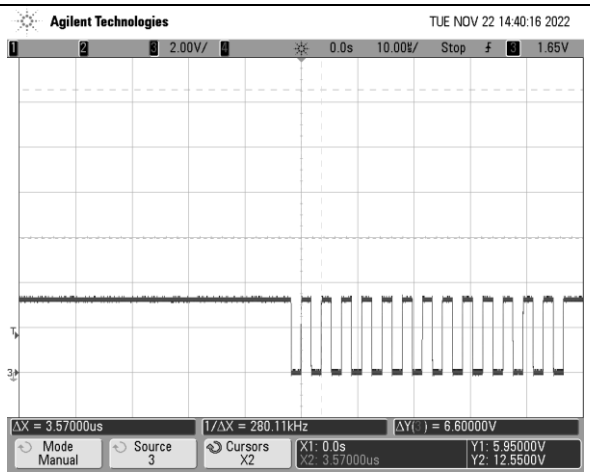
MA+, MA- (top) and Speedgoat "BiSS Master CLK" (bottom) on same oscilloscope capture. Note glitches.



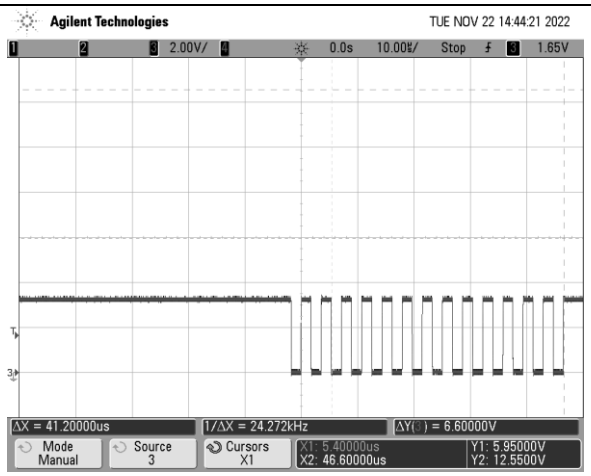
MA+, MA- (top) and Speedgoat "BiSS Master CLK" (bottom) on same oscilloscope capture. Note glitches.



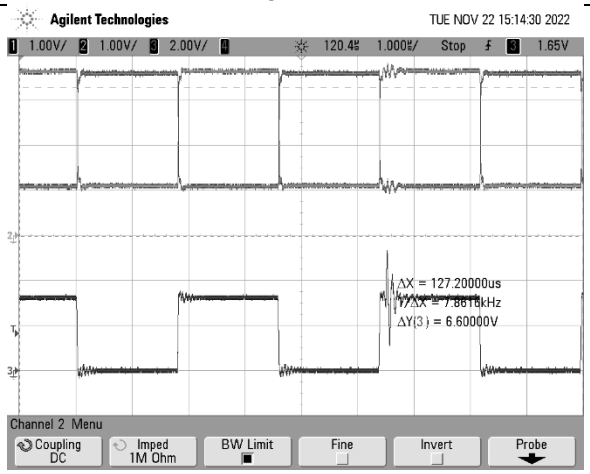
MA+, MA- (top) and Speedgoat "BiSS Master CLK" (bottom) on same oscilloscope capture. Note glitches.



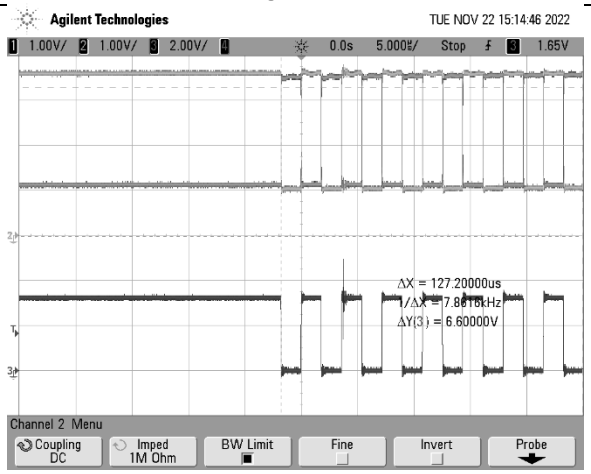
Speedgoat “BiSS Master CLK” disconnected from the Texas Instruments THVD1551DGKR. Note *no* glitches. Note 3000*tic = 40 µs timeout, as expected. Looks good.



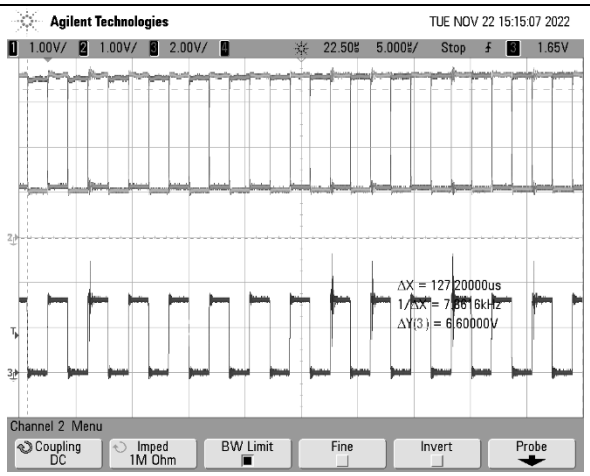
Speedgoat “BiSS Master CLK” disconnected from the Texas Instruments THVD1551DGKR. Note *no* glitches. Note 3000*tic = 40 µs timeout, as expected. Looks good.



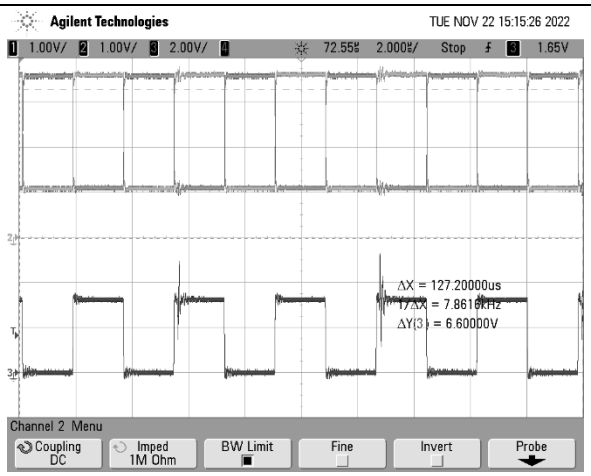
Added series termination resistor at Speedgoat “BiSS Master CLK”. Note poor signal integrity is still present, but good enough to prevent glitches at the Texas Instruments THVD1551DGKR MA+ and MA- outputs. Note *no* glitches in MA+ and MA-.



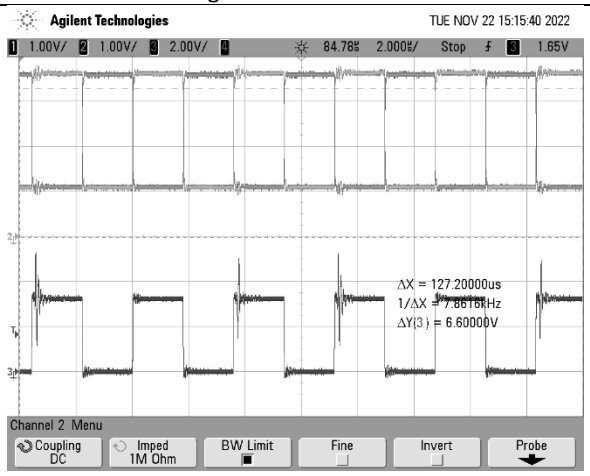
Added series termination resistor at Speedgoat “BiSS Master CLK”. Note poor signal integrity is still present, but good enough to prevent glitches at the Texas Instruments THVD1551DGKR MA+ and MA- outputs. Note *no* glitches in MA+ and MA-.



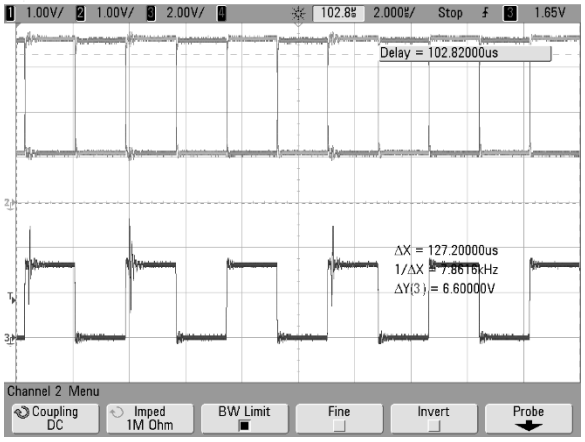
Added series termination resistor at Speedgoat “BiSS Master CLK”. Note poor signal integrity is still present, but good enough to prevent glitches at the Texas Instruments THVD1551DGKR MA+ and MA- outputs. Note *no* glitches in MA+ and MA-.



Added series termination resistor at Speedgoat “BiSS Master CLK”. Note poor signal integrity is still present, but good enough to prevent glitches at the Texas Instruments THVD1551DGKR MA+ and MA- outputs. Note *no* glitches in MA+ and MA-.

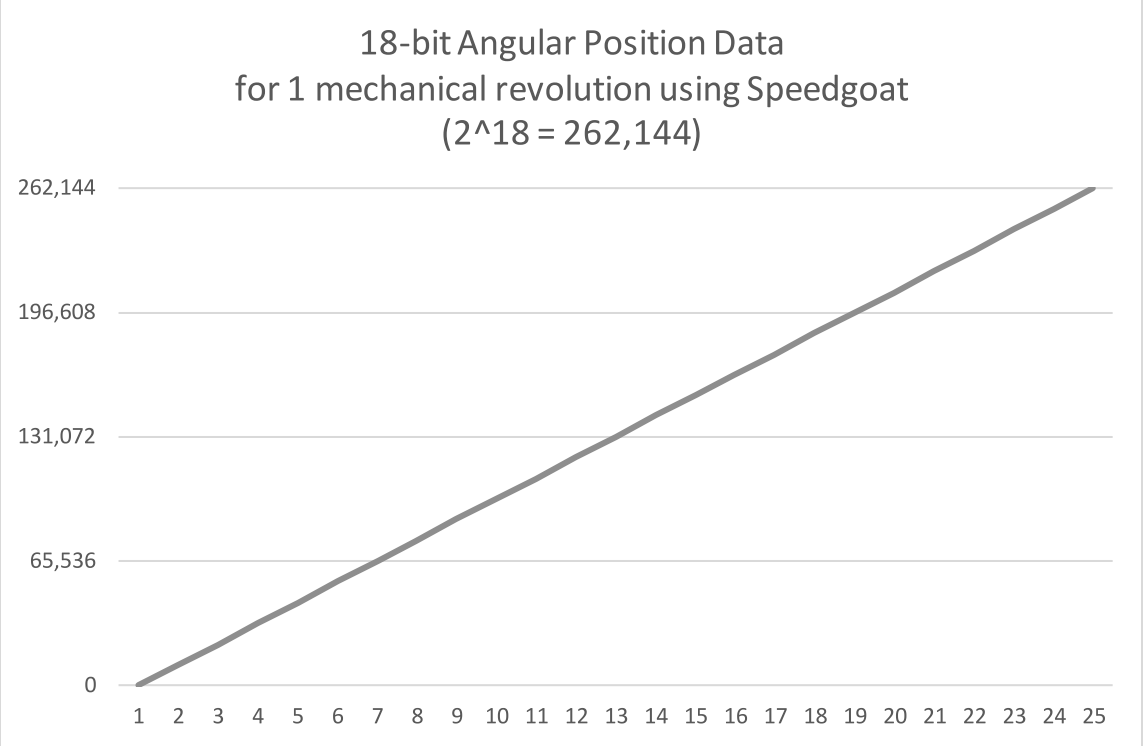


Added series termination resistor at Speedgoat “BiSS Master CLK”. Note poor signal integrity is still present, but good enough to prevent glitches at the Texas Instruments THVD1551DGKR MA+ and MA- outputs. Note *no* glitches in MA+ and MA-.



Added series termination resistor at Speedgoat “BiSS Master CLK”. Note poor signal integrity is still present, but good enough to prevent glitches at the Texas Instruments THVD1551DGKR MA+ and MA- outputs. Note *no* glitches in MA+ and MA-.

After the series termination resistor was added at the Speedgoat "BiSS Master CLK", 18-bit position data was measured every 15° using the Speedgoat and MATLAB Simulink. Measured 18-bit Rx Position data looks perfect.



10.5.4. Rotary Encoder Interface Problem Root Cause

The root cause of the problem was poor signal integrity between the Speedgoat "BiSS Master CLK" output and the Texas Instruments THVD1551DGKR [34] digital input. Adding a series termination resistor and twisted-pair ("BiSS Master CLK" and GND) improved the poor signal integrity enough to eliminate the glitches on MA+ and MA-.

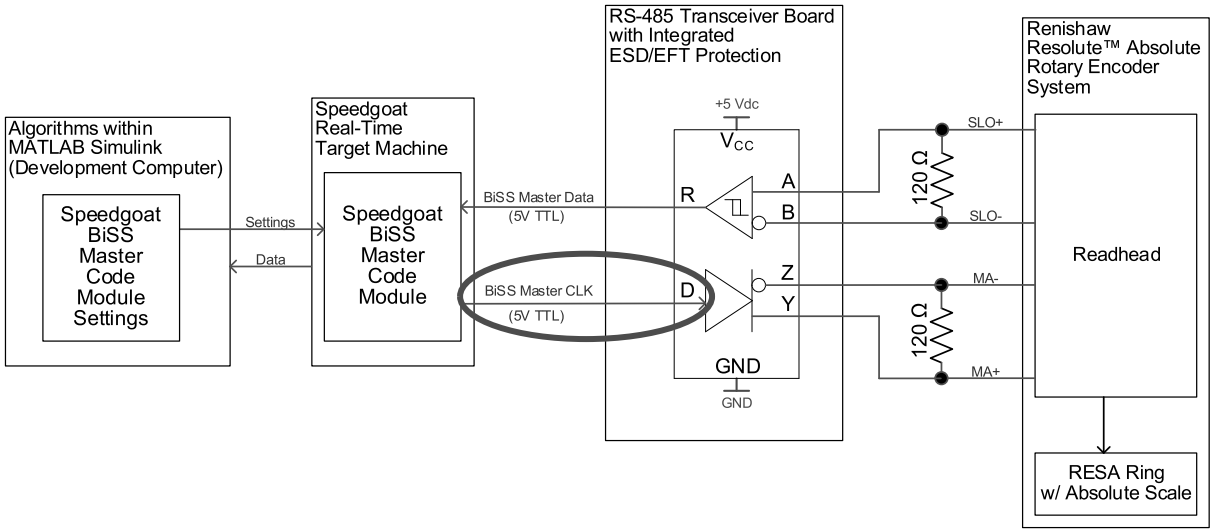


Figure 10.7 Rotary Encoder Interface Problem Root Cause