

# OmniTES

The OmniTES simulator is an excellent choice for cost-effective TEMPEST training. The simulator creates a single RF carrier with adjustable noise and selectable RED signal modulation types including:

- QPSK with Sinewave Impairments to I and Q
- 100Base-TX and 100Base-FX Fast Ethernet
- Raster Video
- Class D Audio Amplifier
- Traditional ASCII Signals



The OmniTES is especially useful for training new users on the many features of the Rohde & Schwarz FSWT Test Receiver. Check out the videos on using the OmniTES with the FSWT at <https://gaultemptest.screencasthost.com/channels/cYif0FVfBQ>

The OmniTES includes a dual-channel arbitrary waveform generator, an RF signal generator, and a breakout box to simplify the interconnections. A laptop PC is included which provides a user interface powered by a custom-designed LabVIEW run-time executable file.

Note that OmniTES creates only one carrier at a time. Refer to the 4TES and TSS datasheets for simulators that are more appropriate for hands-on proficiency testing. For more information, contact Harry Gaul at 480-223-7368 or by email at [harry@tabargaul.com](mailto:harry@tabargaul.com).

- Setup Help
- Traditional
- 100Base-TX
- Video
- QPSK
- Class D
- File Builder

**CONFIGURE**

Press the CONFIGURE button once upon entering the QPSK tab.

Noise Level % QPSK

0

To create a noisier signal, enter a value for the random white noise between 0% (none) and 120% (max) and press ENTER on the keyboard.

Impairment Selection

- No Impairment
- AM on Both I and Q
- Phase Mod on Both I and Q
- AM on Just I
- AM on Just Q

**Steps in Adjusting an FSET to Display I/Q Impairment**

1. First find the carrier and adjust gain as necessary to just below saturation.
2. Select MODE, DIGITAL DEMOD, QPSK
3. Select MODULATION PARAMETER, SYMBOL RATE, 10 kHz
4. Select MEAS FILTER, NONE
5. Select REFERENCE FILTER, RAISED COSINE
6. Select Alpha/BT, 0.2
7. Select MEAS RESULT, POINTS PER SYMBOL, 1 POINT/SYMBOL
8. " " " " " " RESULT LENGTH, 80 SYMBOLS
9. " " " " " " FRAME LENGTH, 400 SYMBOLS
10. " " " " " " MEMORY SIZE, 8192 POINTS
11. Select MEAS SIGNAL, POLAR (I) CONSTELLATION
12. " " " " " " SYMBOL DISPLAY, DOTS
13. " " " " " " (review the I eye diagram and Q eye diagram)
14. " " " " " " (although you might want more points/symbol)
15. Select ERROR SIGNAL, MAGNITUDE (observe EVM for impairment)
16. " " " " " " PHASE (observe phase error for impairment)
17. Use RANGE to change the scale.

Carrier Frequency (MHz)

72

The frequency can be set from 10 to 700 MHz except for QPSK which must be 68 to 72 MHz.

**EXIT**

Press the INITIALIZE button to start the program.

**INITIALIZE**

VISA resource SDG6022X AWG

USB0:-0\F4EC:-0x1101::SDG6XBAX2R0224:

SDG6022X Error

status code source

0

VISA resource SSG3021X Signal Generator

USB0:-0\F4EC:-0x1501::SSG3GCC4R0006::INSTR

SSG3021X Error

status code source

0

Breakout Box USB Error

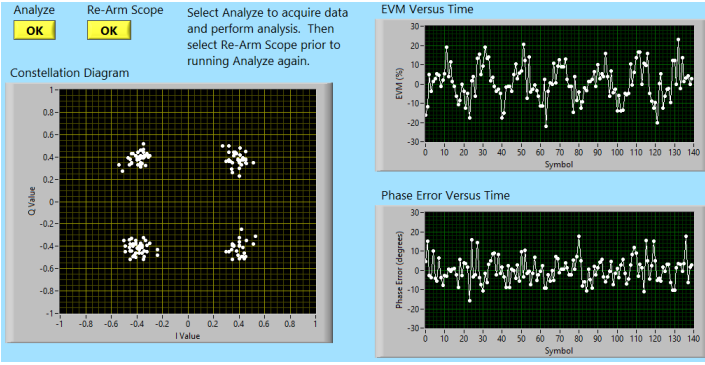
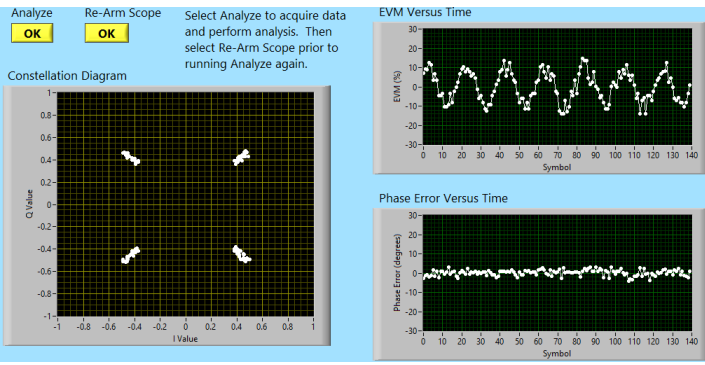
**FT\_OK**

Check the USB connection to the Breakout Box if the error message reads FT\_DEVICE\_NOT\_FOUND.

## Example Vector Analysis of the Impaired QPSK Signals

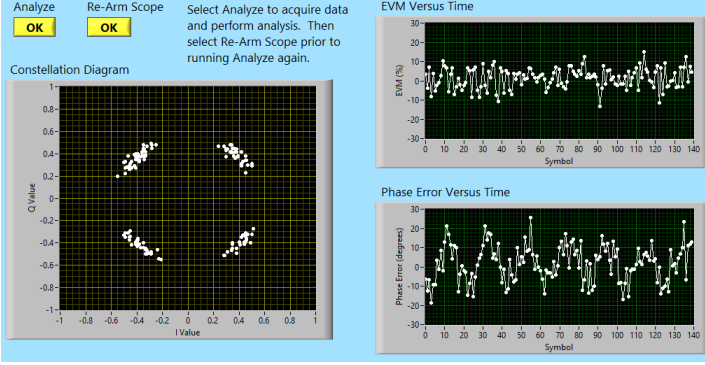
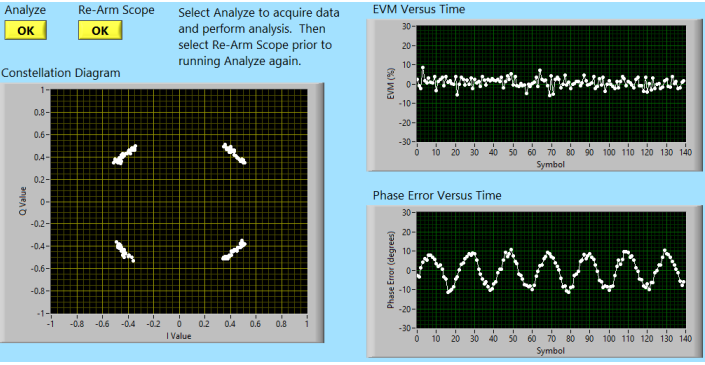
### AM on Both I and Q (no noise)

### AM on Both I and Q (with noise)



### Phase Mod on Both I and Q (no noise)

### Phase Mod on Both I and Q (with noise)



Waveform Selection 100Base-TX/FX **OmniTESwithRelay-4.7** Copyright 2020 Gaul TEMPEST Consulting Services LLC

Setup Help  
 Traditional  
 100Base-TX/FX  
 Video  
 QPSK  
 Class D  
 File Builder

**Carrier Frequency (MHz)**  
72

The frequency can be set from 10 to 700 MHz except for QPSK which must be 68 to 72 MHz.

**CONFIGURE** Press the CONFIGURE button once upon entering the 100Base-TX tab.

Signal-to-Noise Level (dB)  
0 Enter a value for the signal-to-noise level between 0 dB (no noise) and -40 dB (full noise) and press ENTER on the keyboard.

The simulated signal is 100Base-TX or 100Base-FX Ethernet with an Rd of 125 Mb/s and an Rt on the order of 40 Mb/s.

You will likely need a bandwidth of 100 MHz or greater to see the correlation. Do not blindly follow the bandwidth rules! Note that this is typical when testing 100Base-TX/FX signals.

For 100Base-TX (MLT-3), the best way to trigger the scope is to program a pulse trigger on the oscilloscope to trigger on the 100Base-TX/FX monitor of the OmniTES breakout box. The pulse width trigger should be set for  $\geq 125$  ns and the pulse polarity should be set to negative. The trigger level needs to be located in the upper half of the waveform. An alternative way to trigger the scope is to use the AUX OUT on the back of the SDG6022X although there will be some slight jitter in the monitor.

For 100Base-FX (NRZI), the best way to trigger the scope is to program an interval trigger on the oscilloscope to trigger on the 100Base-TX/FX monitor of the OmniTES breakout box. The interval should be set to  $\geq 60$  ns for successive rising edges. The trigger level should be set for midway between the top and bottom of the waveform. An alternative way to trigger the scope is to use the AUX OUT on the back of the SDG6022X although there will be some slight jitter in the monitor.

**Ethernet Selection**  
 100Base-TX (MLT-3)  
 100Base-FX (NRZI)

Press the INITIALIZE button to start the program.

**INITIALIZE**

VISA resource SDG6022X AWG  
 USB0::0xF4EC::0x1101::SDG6XBAX2R0224:  
 SDG6022X Error  
 status code source  
 0

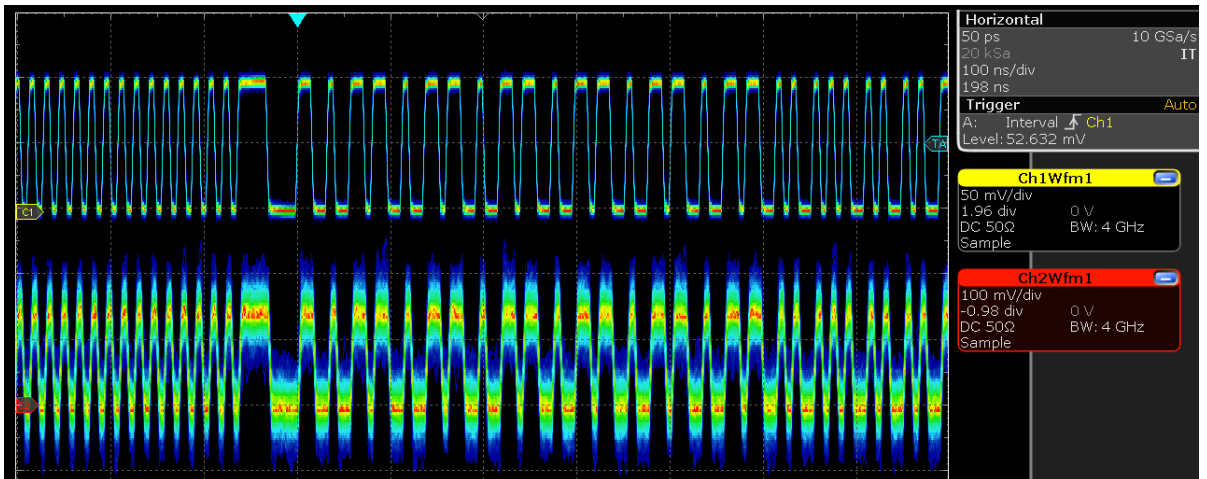
VISA resource SSG3021X Signal Generator  
 USB0::0xF4EC::0x1501::SSG3XGCC4R0006::INSTR  
 SSG3021X Error  
 status code source  
 0

Breakout Box USB Error  
 FT\_OK  
 Check the USB connection to the Breakout Box if the error message reads FT\_DEVICE\_NOT\_FOUND.

**EXIT**

## 100BASE-FX (NRZI)

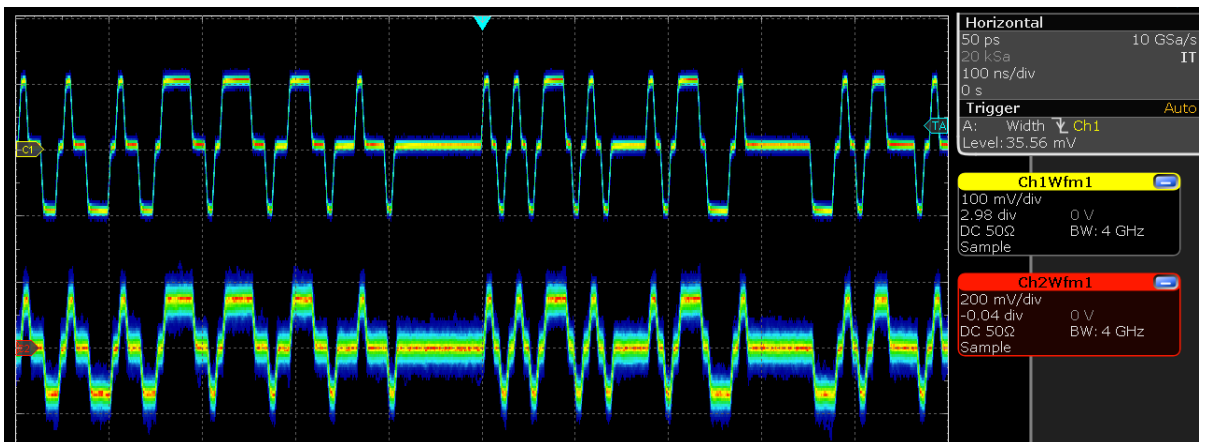
Monitor



RCVR  
Video

## 100BASE-TX (MLT-3)

Monitor



RCVR  
Video

- Setup Help
- Traditional
- 100Base-TX

- Video
- QPSK
- Class D
- File Builder

Carrier Frequency (MHz)

72

The frequency can be set from 10 to 700 MHz except for QPSK which must be 68 to 72 MHz.

EXIT

Press the CONFIGURE button once upon entering the Video tab.

CONFIGURE

The recommended receiver bandwidth is 2 to 20 MHz.

Raster Selection

E  
E  
E  
E

- Raster1
- Raster2
- Raster3
- Raster4

Noise Level (%) Video

0

To create a noisier signal enter a value for the noise modulation between 0 (none) and 100 percent and press the ENTER button on the keyboard.

Vertical Refresh Rate

64

Enter a value for the vertical refresh rate between 50 Hz and 71.5 Hz and press the ENTER button on the keyboard.

The horizontal scan rate is 512 times the vertical refresh rate.

The pixel rate is 512 times the horizontal scan rate.

Press the INITIALIZE button to start the program.

INITIALIZE

VISA resource SDG6022X AWG

USB0::0xF4EC::0x1101::SDG6XBAX2R0224:

SDG6022X Error

status code	source
0	

VISA resource SSG3021X Signal Generator

USB0::0xF4EC::0x1501::SSG3XGCC4R0006::INSTR

SSG3021X Error

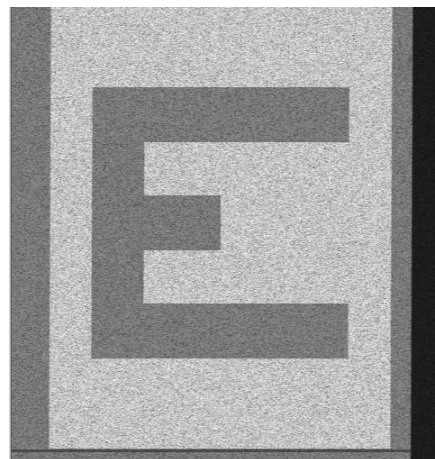
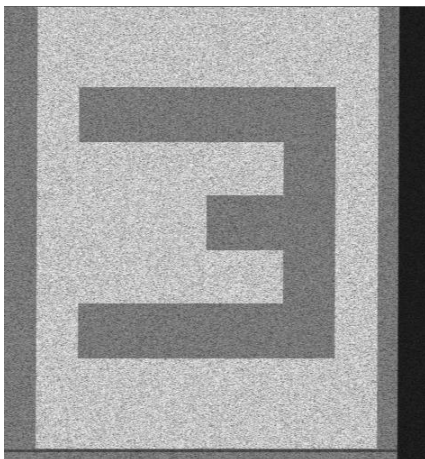
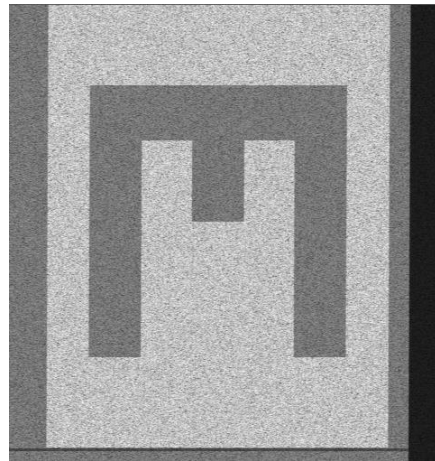
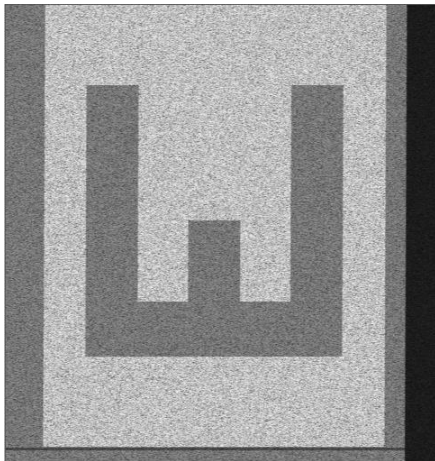
status code	source
0	

Breakout Box USB Error

FT\_OK

Check the USB connection to the Breakout Box if the error message reads FT\_DEVICE\_NOT\_FOUND.

## Re-Rastered Images of the Four Possible Video Raster Patterns



Vertical refresh rate is 64 Hz (adjustable)

Horizontal scan frequency is  $512 \times 64 = 32.768$  kHz

Pixel rate is  $512 \times 512 \times 64 = 16.777$  MHz

Waveform Selection Class D **OmniTESwithRelay-4.4** Copyright 2020 Gaul TEMPEST Consulting Services LLC

Setup Help  
 Traditional  
 100Base-TX  
 Video  
 QPSK  
 Class D  
 File Builder

**CONFIGURE** Press the CONFIGURE button once upon entering the Class D.

Noise Level Class D Enter a value for the noise level between 0% (none) and 100% and press ENTER.

Audio Frequency (Hz)  Input an audio frequency in Hz between 50 and 6000 and press ENTER.

Audio Frequency (Hz)	Full Bit Width Switching Rate (kHz)	Rising and Falling Edges Only Rise/Fall Times (ns)	Recovered Audio Tone (Hz)
500	256	40	1000
1000	512	20	2000
2000	1024	10	4000

The suggested bandwidth for Full Bit Width is 2 MHz.  
 The suggested bandwidth for Rising and Falling Edges Only is 20 MHz.

**Carrier Frequency (MHz)**   
 The frequency can be set from 10 to 700 MHz except for QPSK which must be 68 to 72 MHz.

**EXIT**

**Audio Signal Control**  
 Steady Tone  
 Tone On/Off at 1.5 Hz Rate

**Waveshape Control**  
 Rising and Falling Edges Only  
 Full Bit Width

Press the INITIALIZE button to start the program.

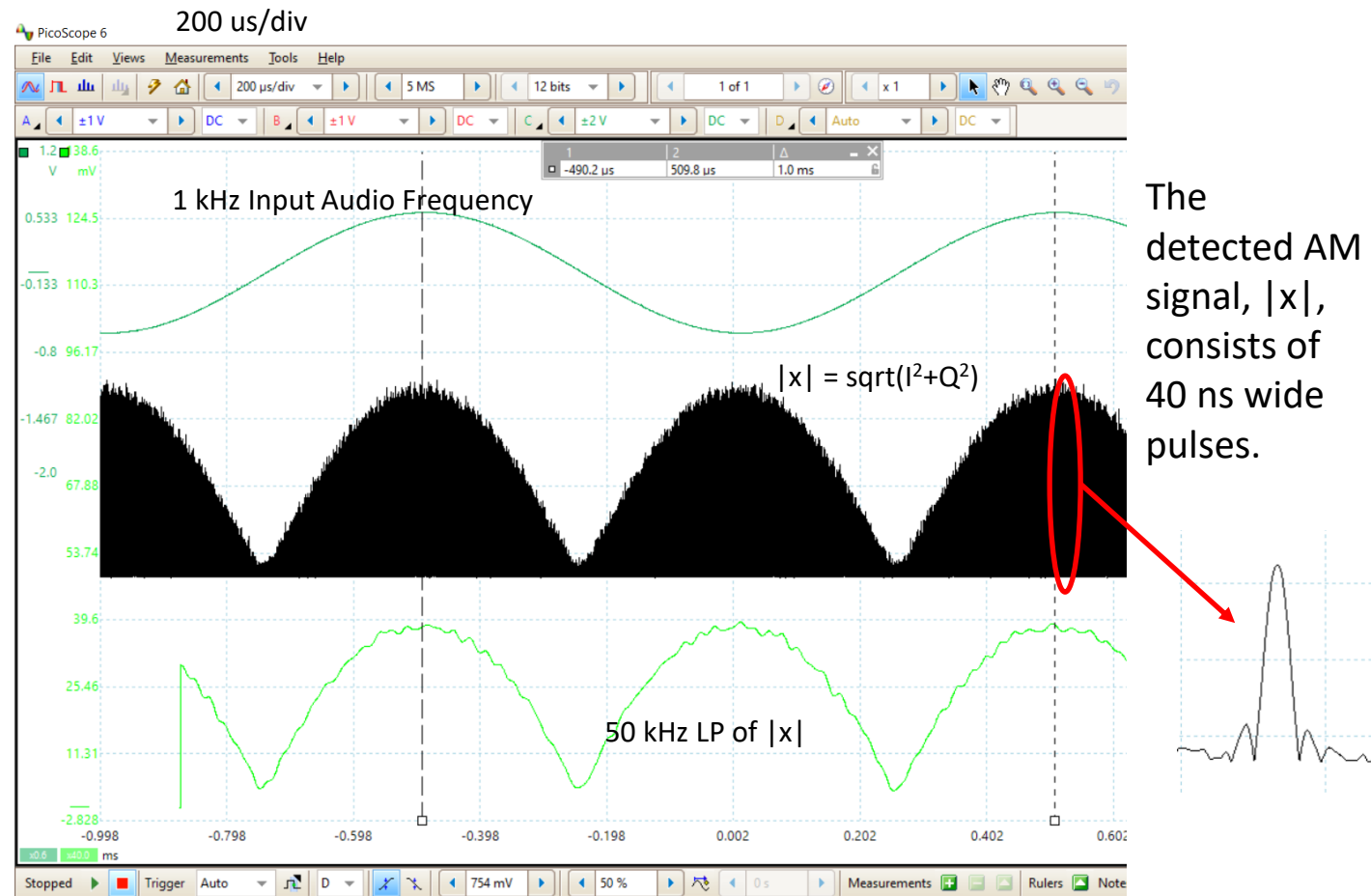
**INITIALIZE**

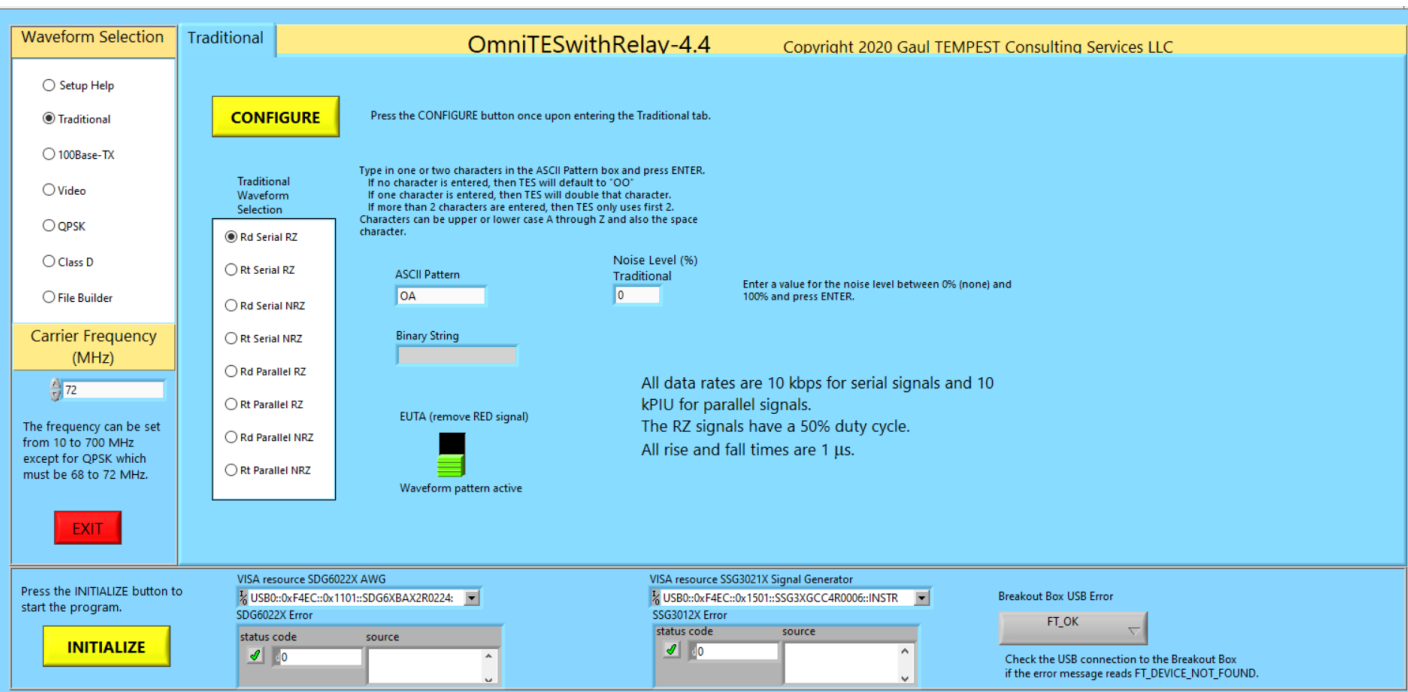
VISA resource SDG6022X AWG  
 % USB0::0xF4EC::0x1101::SDG6XBAX2R0224:  
 SDG6022X Error  
 status code source

VISA resource SSG3021X Signal Generator  
 % USB0::0xF4EC::0x1501::SSG3XGCC4R0006::INSTR  
 SSG3021X Error  
 status code source

Breakout Box USB Error  
  
 Check the USB connection to the Breakout Box if the error message reads FT\_DEVICE\_NOT\_FOUND.

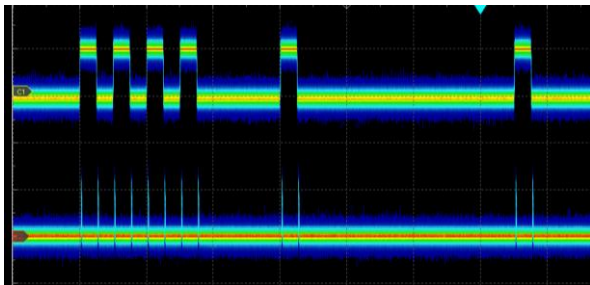
## Vector Network Analysis (VNA) of the Class D Audio Amplifier Signal



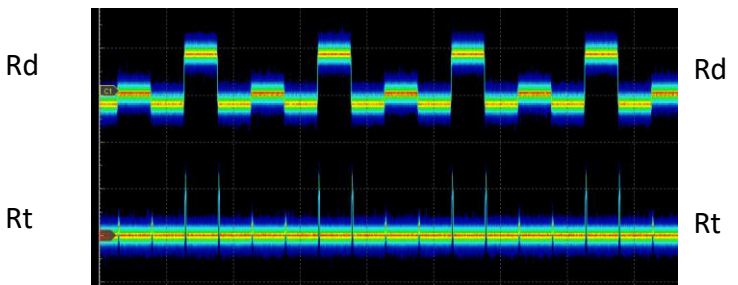


## Traditional ASCII

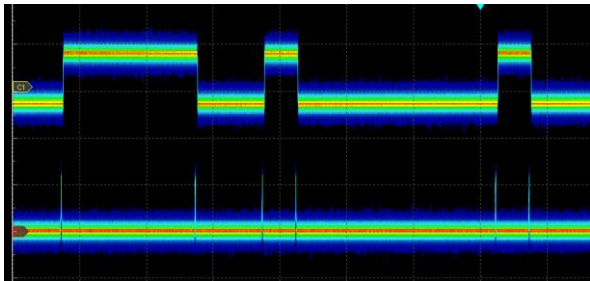
Serial RZ Pattern of "O Sp ..."



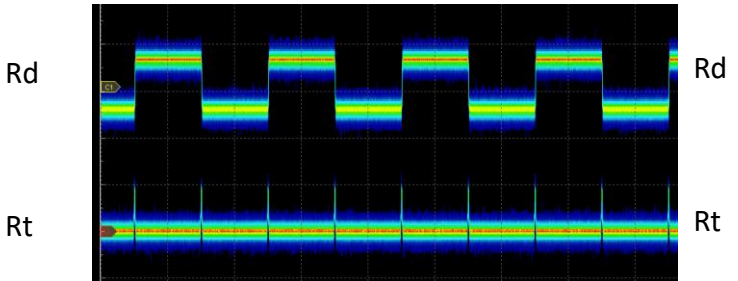
Parallel RZ Pattern of "O Sp ..."



Serial NRZ Pattern of "O Sp ..."



Parallel NRZ Pattern of "O SP ..."



The OmniTES is available at \$29,900. Gaul TEMPEST Consulting can accept company or government purchase orders. Price includes free shipping.

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