

TIS-1W

Digital Input, One Watt Square Wave Output
1-60 MHz



Table of Contents

Overview.....2
Specifications.....2
Design.....2
Performance.....5
Output Filter Notes.....10

Overview

The TIS-1W takes a logic-level input (or a sine wave) and converts it to a 1 Watt square wave. This can be used to boost the output level of a low-power transmitter, or for many other test and measurement tasks. **This is not a linear amplifier**, and is intended for constant-amplitude signals. The TIS-1W is powered through a USB C connection. This design operates at any frequency between 1 and 60 MHz.

Specifications

Input: SMA 50 Ohm, 1.5V p-p nominal, 5V p-p maximum.

Output: SMA, 17V p-p square wave into 50 Ohm load (@ 10 MHz, varies with frequency)

Supply Voltage: 5VDC, USB C connector.

Typical current consumption:

Frequency	Load	DC Current
1 MHz,	50 Ohm	390 mA
10 MHz	50 Ohm	364 mA
60 MHz	50 Ohm	400 mA
10 MHz	No load	65 mA
10 MHz	25 Ohm	488 mA

Dimensions: 85mm x 30mm x 45mm

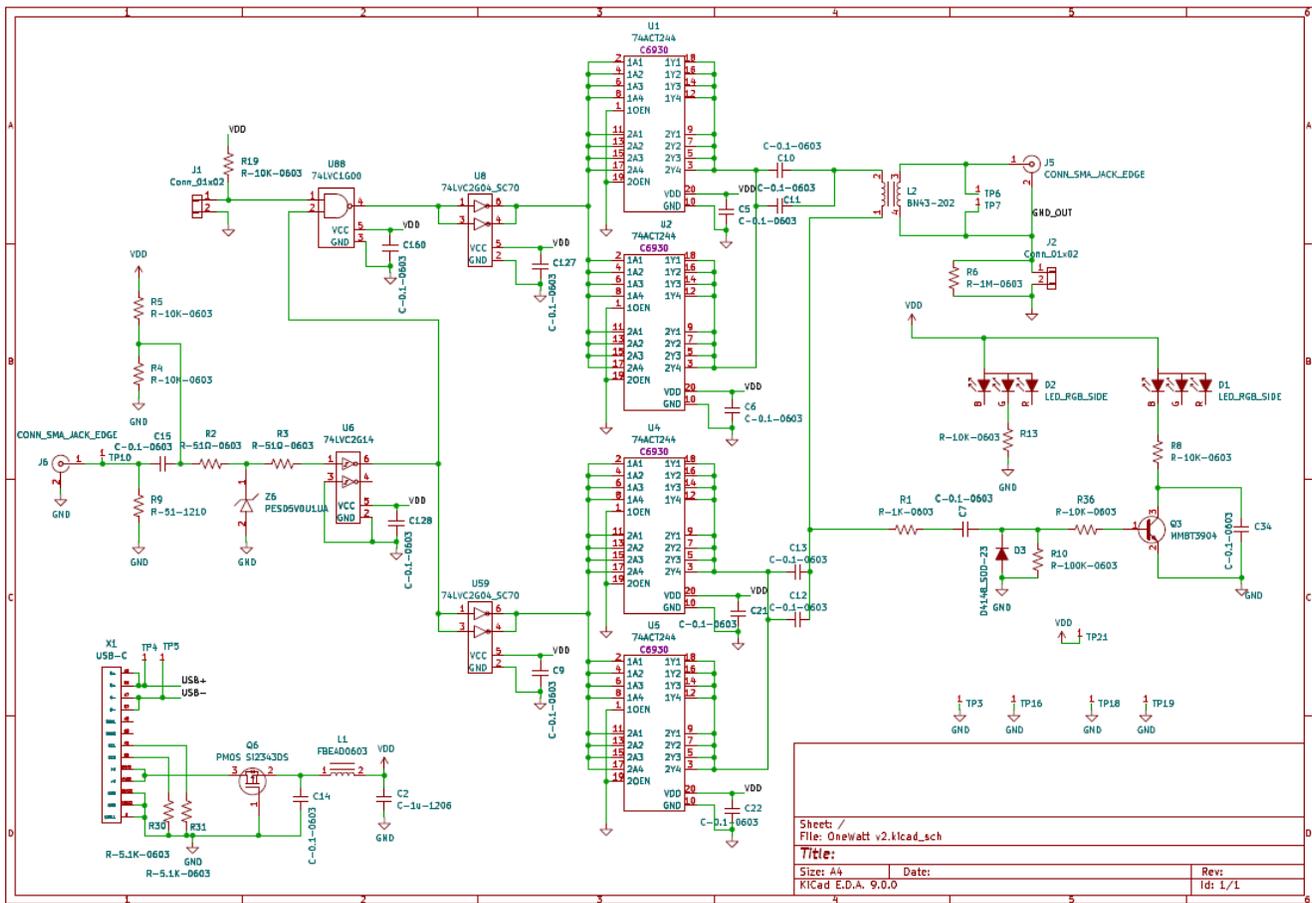
Weight: 79 g / 2.8 oz.

Design

The TIS-1W is based on the output stages of the 8-channel Turn Island Systems WSPRSONDE, and is designed to take a logic-level input and deliver a 1 W square wave output capable of driving a 50 Ohm load. The input is typically provided by 3.3V logic source through a 50 Ohm output resistance, resulting in a 1.5V p-p level signal. The TIS-1W can accept a DC-coupled or AC-coupled input.

The 1W output, being a square wave, contains many odd harmonics, and because nothing is

perfect some even harmonics as well. While this can directly feed an antenna, generally a low-pass (or bandpass) filter will be used to ensure a spectrally clean output signal.



The TIS-1W is powered from a 5V USB C connector. There is PMOS transistor in the supply path that acts as a very low-loss reverse-polarity protection diode. Input voltage in excess of 5V can damage the TIS-1W.

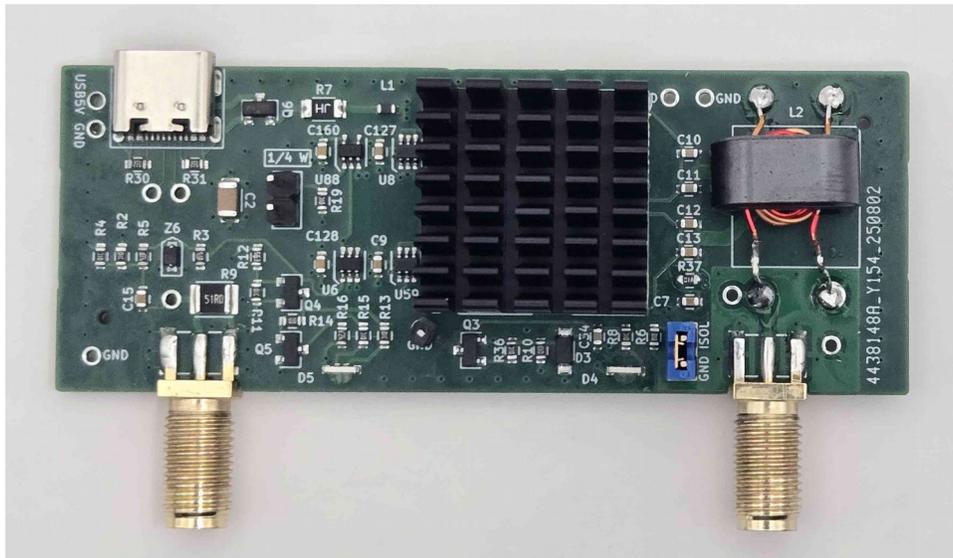
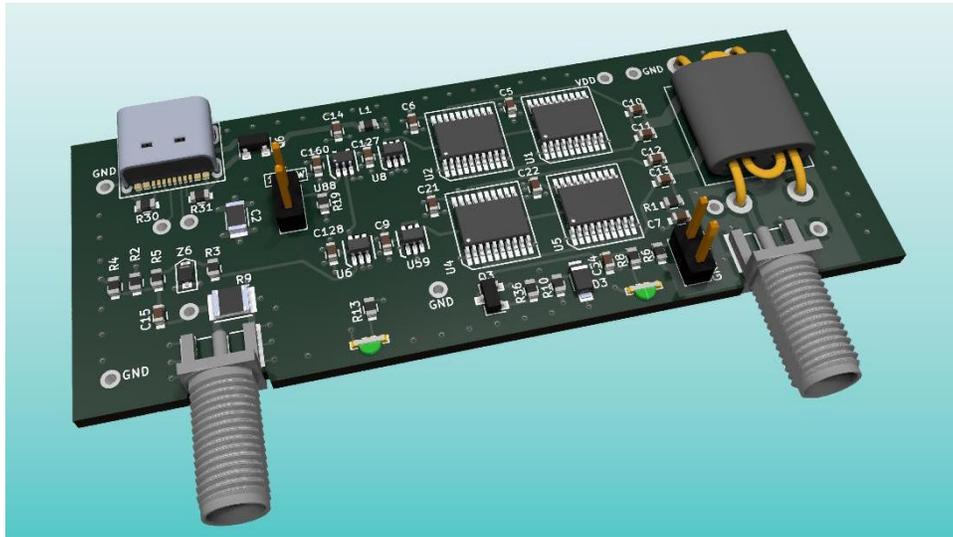
The input has a 50 Ohm DC termination, and is then AC-coupled to a high-speed CMOS schmitt trigger stage. The buffered signal is then sent through inverting and non-inverting buffer stages, and then to two pairs of paralleled octal high-current bus drivers in an H-bridge configuration. This H-bridge then drives a 1:2 step-up transformer designed for a 50 Ohm load (this provides a 12.5 Ohm load to the H-bridge.) There is a two-pin header in the board that, when shorted, disables one half of the H-bridge. This cuts the drive voltage swing in half, and so reduces the output power from 1W to 250 mW.

The SMA output jack is normally connected to the same ground plane as the input jack and the USB power via a two-pin header / jumper plug. Removing the jumper plug will float the output jack, which may be useful on some situations.

The TIS-1W has two front-panel indicator LEDs: a green LED that illuminates when the 5V supply is present, and a blue LED that is driven when the output is active.

One might reasonably question the technique of tying the octal bus driver outputs directly

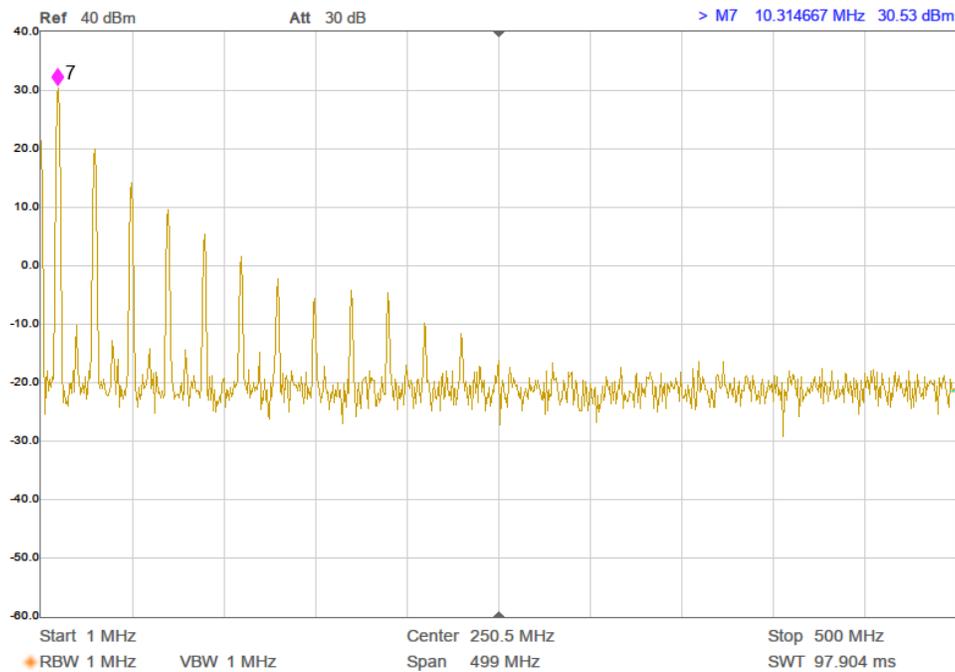
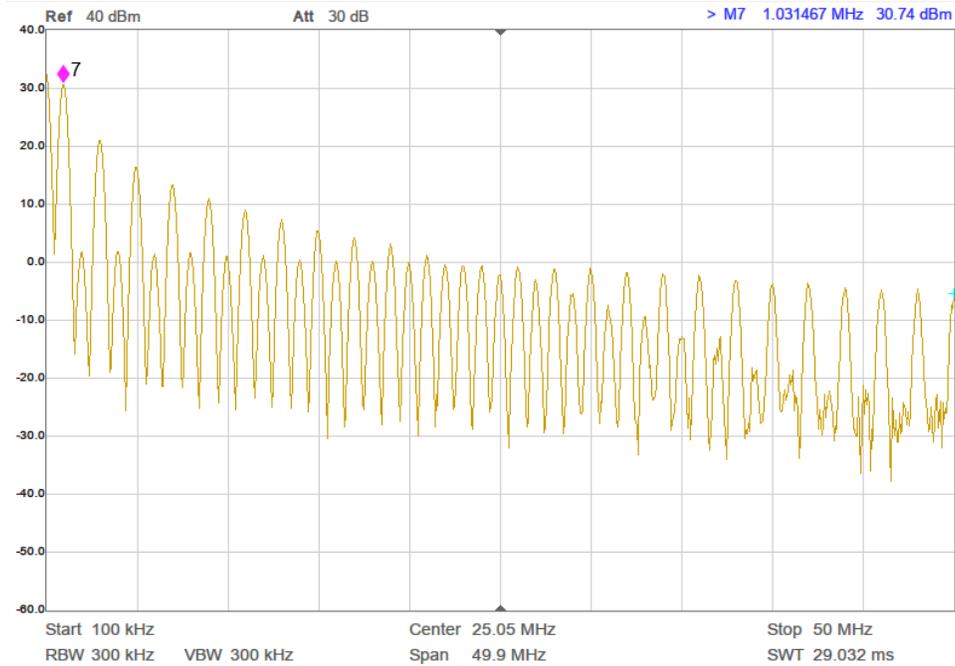
together, but testing and experience have shown that the “shoot through” current is negligible, therefore the loss that would be incurred by the use of ballast resistors is not warranted.

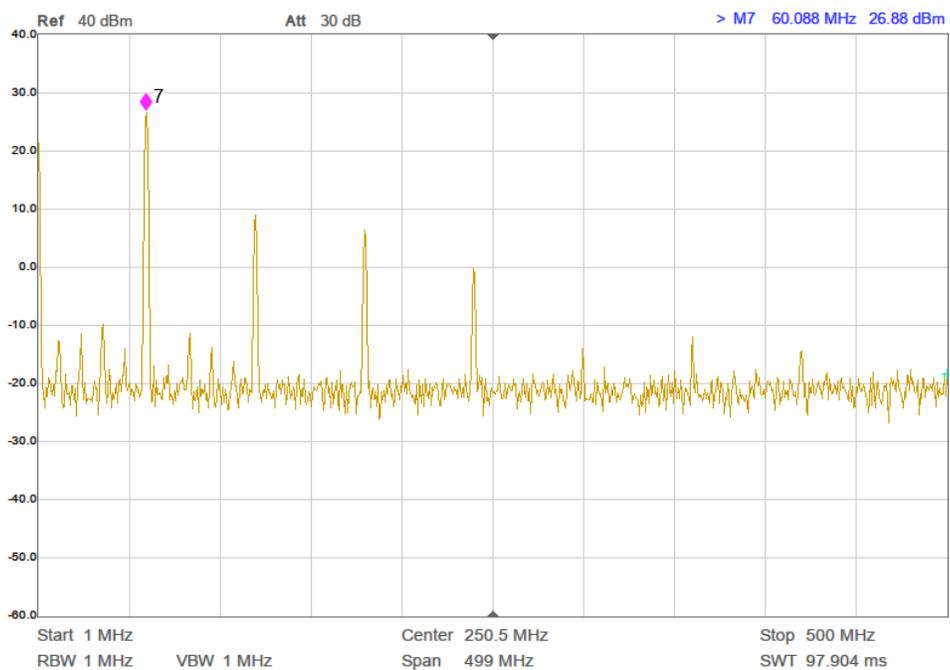
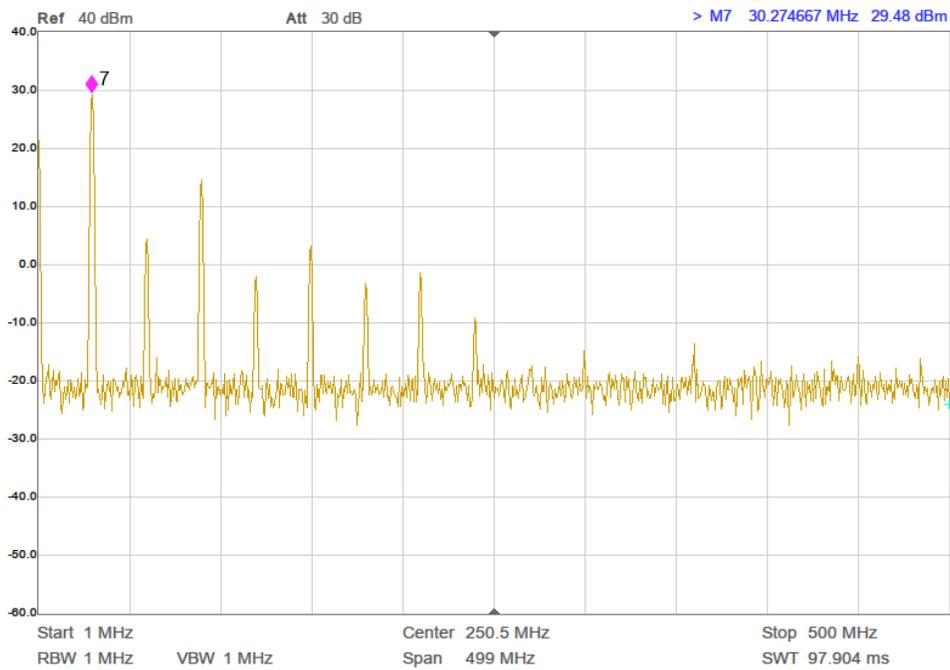


The board above is a prototype that contains a few extra current-monitoring components. These have been omitted in the production version.

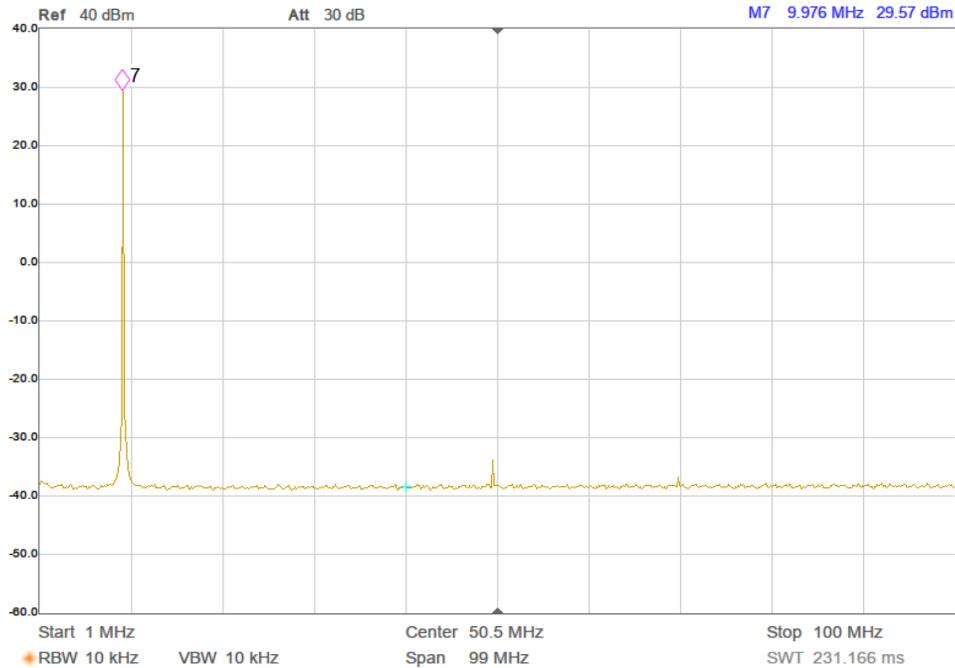
Performance

The spectrum analyzer plots below show the unfiltered output at 1, 10, 30, and 60 MHz. Note the even and odd harmonic content varies, particularly at 1 and 60 MHz.





The non-harmonic spurious signals in the above plot come from the function generator output that is driving the TIS-1W during this test. Do not blindly trust your test equipment!



The plot above shows the output at 10 MHz after being run through a Turn Island Systems filter-combiner, but the output filter requirements are easily met by a simple L/C/L “tee” network. The more common C/L/C “Pi” network will also work, but the inductor-input tee is preferred as it reduces the load on the output stage at the harmonic frequencies.

The waveforms below show the output signal, loaded by a 50 Ohm -30 dB attenuator (multiply the displayed voltage by 31.6 for the actual output voltage.)

The waveform at 1 MHz shows the effect of transformer inductance and coupling capacitor impedance at the low-frequency limit:



The waveforms at 10 and 30 MHz:





At 60 MHz the output stage is nearing the upper limit: It will also operate at 100 MHz, but not very well.



And below is the output waveform with no load, showing the effect of transformer parasitics (and probably scope-probe ground-lead inductance.) Unloaded operation does not harm the TIS-1W



Output Filter Notes

For more information on appropriate output filters please see this document:

<https://turnislandsystems.com/wp-content/uploads/2024/04/FC-2-1.pdf>

