DATA SHEET

DS-11054

Four-Channel Pulse Generator [PPG-4]

- **Four Nested Pulse Generators**
- **±10.24V, 50mA per Generator**
- **Pulse Widths from 200ns to 200s**
- **Variable Rise and Fall Times**
- **Synchronous, Armed Initiation**
- **Cycling without Relay Wearout**
- **Integrated into Applications Software**
- **Demonstrable Pulse Quality at Probe Card**

The PPG-4 provides four output pulses precisely related in time. Amplitudes can be independently programmed between -10.24V and +10.24V, allowing for differential voltages up to 20.48V.

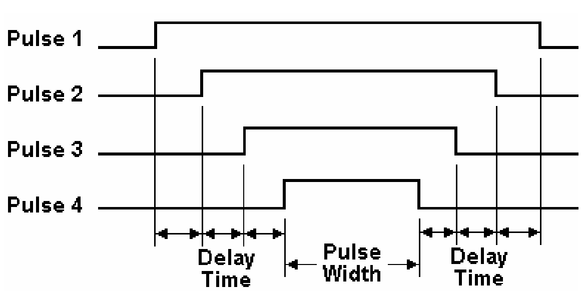

Figure 1 - Timing Diagram

Pulse width can be set between 200ns to 200s, and delay times between starting and falling edges for each nested pulse can be set between 100ns and 835ms. After triggering, a train of nested pulses is produced, with up to 65535 pulses in the train.

Pulsing to 20V

Although individual pulses are programmable between -10.24V and +10.24V, any two pulse generators can produce differentials >20V. Thus, the PPG-4 can be used in applications such as EEPROM programming which require program/erase voltages up to 20V. The user does not have to set up the differences because high level applications software automatically takes care of it.

Specifications

Clock Period	**2^n x 100ns**	**n = 0, 1, 2, ...15**
Pulse Period	Minimum	1µs or 10 clock periods
	Maximum	200s or 65535 clock periods
	Resolution	1 clock period
	Accuracy	Same as timebase accuracy
Pulse Width	Minimum	200ns or 2 clock periods
	Maximum	200s or 65527 clock periods
	Resolution	1 clock period
	Accuracy	See Comment 2
Pulse Delay	Minimum	100ns or 1 clock period
	Maximum	835ms or 255 clock periods
	Resolution	1 clock period
	Accuracy	See Comment 2
Pulse Number	1 to 65,535 per trigger	
Pulse Amplitude or Height	Range	-10.2397 to +10.2397V
	Resolution	312.5µV
	Overshoot	<5% at 100ns response time
	Max Uncertainty	±(0.25% of value + 25mV)
Rise/Fall Time	Exponential, cardinal time programmable: 100ns, 1µs, 10µs, 100µs, 1ms	
	Uncertainty	< 10% of programmed + 50ns
Output State	Each channel may be commanded to High Z state via a semiconductor switch	
Timebase Accuracy	0.01%, crystal controlled	
Output Impedance	Low Z, solid-state switch closed: Series resistance 30Ω max; Shunt capacitance 1000pF typical	
	High Z, solid-state switch opened: Shunt resistance 10MΩ; Shunt capacitance 1000pF typical	
Output Load Current	50mA/channel minimum	
Output Slew Rate	50V/µs minimum	

Comments:

1) Gain factor (% of value) errors apply after running SelfCal with an ideal (<±10ppm uncertainty) transfer DMM. Actual performance is calculated using http://www.reedholm.com/SuppNote/SN-115.pdf.
2) The accuracies of pulse width and pulse delay, although derived from the crystal timebase, are reduced by rise/fall time settings.
3) The PPG-4 can be used in most Reedholm test systems. To attain this performance in the RI-5X series test system, the signal is routed through a matrix card installed in the instrument card cage.

Programmable Rise/Fall Times

In addition to controlling pulse widths and delay times, further control over pulses is provided with a five decade span of rise/fall times. In applications that do not warrant short pulses, reducing rise/fall times can eliminate possibility of overshoot.

Coping with High Q Cabling

To accurately force and measure DC currents and voltages, signal paths in parametric testers have low series resistance (<1Ω) and high shunt resistance (>10^{12}Ω). This results in a high Q network whose resonant frequency depends on total signal path length, typically from 5-10MHz. The ringing resulting from fast rise and fall times degrades short pulses.

Clean Pulse Shapes

The PPG-4 was designed to deliver high integrity pulses at the probe pins without requiring specially designed probe cards. The output amplifiers have these features:

- Bandwidth to produce specified rise/fall times.
- Output drive currents for charging shunt capacitance while delivering specified DUT currents.
- Very low open loop output impedance so that excess phase shift created by shunt capacitance does not cause overshoot. By setting the driving point output resistance to approximately 20Ω, cable reflections are absorbed.

Relay Wearout Eliminated

Each pulse generator has FET plus high voltage reed relay output switches. Relays provide ±600V isolation when the PPG-4 is not connected so that performance of other instrumentation is not compromised.

FET switches permit much faster connections and disconnections encountered during NVM endurance cycle testing. Otherwise, the millions of cycles required for endurance testing would cause wearout of the output relays.

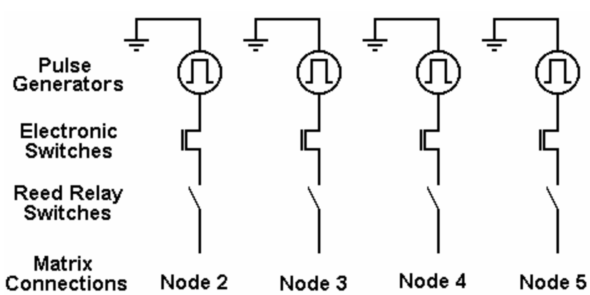

Figure 2 - Simplified Circuit Diagram

NVM Wearout Testing

Bandwidth of the Reedholm matrix is quite capable of delivering PPG-4 signals for charge pumping measurements and NVM wearout cycling. However, the 200nsec pulse width capability of the PPG-4 is not needed when program and erase times are several decades slower than read times.

Wearout is often deduced from a plot like the one shown below. It was generated by Reedholm applications software, and depicts the narrowing gap, or closure, between programmed and erased voltage thresholds for an EEPROM cell.

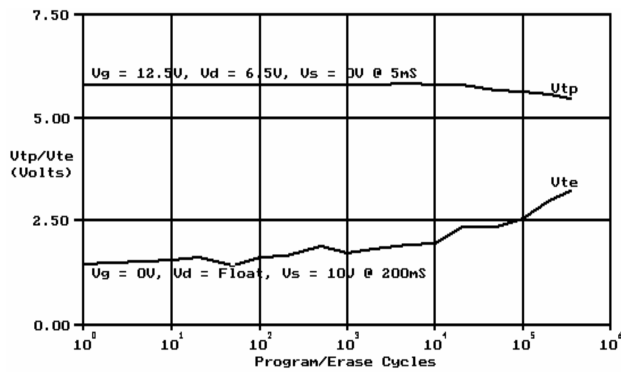

Figure 3 – Endurance Testing Threshold Closure

Shorter Endurance Cycles

When pulse generators are installed in parametric testers, relay wearout is a concern. In addition, using relays slows down the rate at which endurance cycling can be done. Even the best instrumentation reed relay switches take almost one millisecond to open or close. In comparison, connecting through an FET switch takes on a few microseconds.