INSTRUCTION MANUAL
FOR
MODEL 2854-2
SPIKE GENERATOR

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Solar Type 9133-1 10 µF Delta Capacitor Assembly
Solar Type 9146-1 10 µF 'Wye' Capacitor Assembly
Solar Type 7032-1 Isolation Transformer, 115V / 115V 60 to 400 Hz
Solar Type 7032-2 Isolation Transformer, 230V / 230V 50 to 400 Hz
Solar Type 9233-50-TS-50-N Line Impedance Stabilization Network*
Solar Type 6512-106R Feed-Thru Capacitor*

***Products with higher voltage and current ratings available.**
See website www.solar-emc.com.

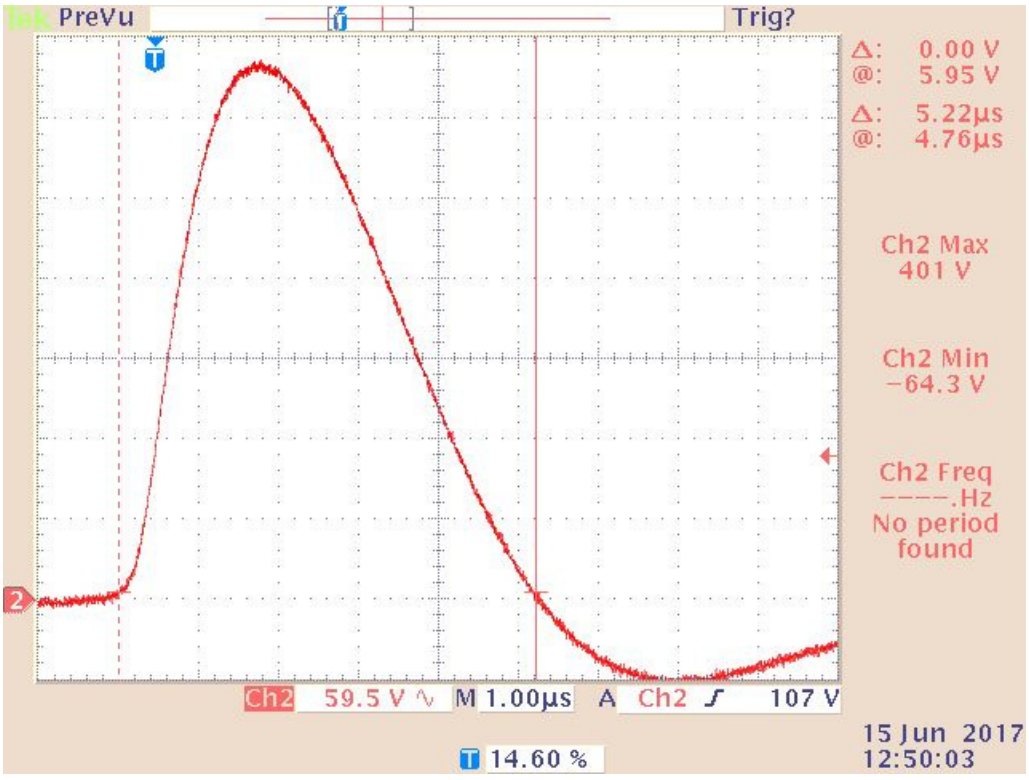
1.0 Application

The **Solar Model 2854-2 Spike Generator** was specifically designed for screen room use in making conducted transient susceptibility tests as required by MIL-STD-461F CS106 and other RFI/EMI specifications.

2.0 Description

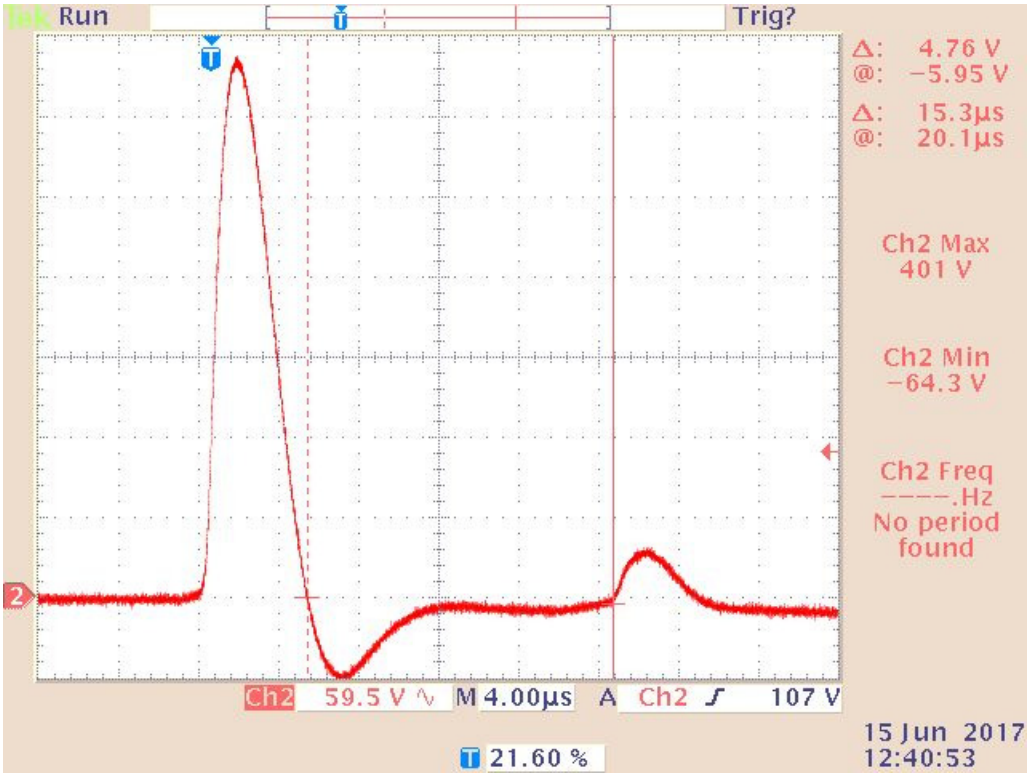
The Model 2854-2 Spike Generator provides a transient pulse (spike) with amplitude adjustable to greater than 400 V peak. Using series injection into a 5 ohm resistive load, the output transient closely follows an idealized curve with a rise time of 1.5 µS +/-0.5 µS and falling to 0 volts in 3.5 µS +/-0.5µS. See Graphs 1 and 2. The repetition rate is adjustable from 0.8 pulses per seconds (PPS) to 10 PPS.

Graph 1 – Pulse shape with 5 Ω load on either series or parallel output



Vertical: 100 V/div
Horizontal: 1 µS/div
Frequency: Single Pulse
Amplitude: 400 V peak into 5 Ω load

Graph 2 – Expanded horizontal scale



Vertical: 100 V/div
Horizontal: 4 µS/div
Frequency: Single Pulse
Amplitude: 400 V peak into 5 Ω load

The function select buttons allow either recurring spikes at a selected rate or provides for single spikes by a panel-mounted pushbutton. The function select buttons also provide for synchronization with 50/60 Hz or 400Hz lines.

When synchronizing with AC lines, the PULSE POSITION knob allows for phase adjustment of the spike to position it anywhere on the AC sine wave.

The PARALLEL output terminals provide for injection of the spike in parallel with the load. The SERIES output terminals provide connections for series injection. The output terminals are isolated from the chassis and the AC line.

3.0 Specifications

Spike Repetition Rate
Continuously adjustable from 0.8 PPS to 10 PPS

Spike Amplitude
Continuously adjustable from 5 V to > 400 V peak

Spike Duration
Output time duration 5 µS ±22% with a 5 Ω load on the SERIES output terminals

Rise Time
1.5 µS +/- 0.5 µS into 5 Ω resistive load

Spike Shape
Ringing characteristic as per Graphs 1 and 2

Phase Adjustment
Adjustable from 0° to 360° on 50/60 Hz or 400 Hz lines

Internal Impedance
Less than 2 Ω; typical 1.3 Ω

Power Line Current in Series Injection Mode
Handles 25 A RMS at power frequencies or DC

Power Requirement
115 V 50-400 Hz, 1.6 A
OR
230 V 50-400 Hz, 0.8 A

Size
19" rack panel, 7" high x 12-3/4" deep, less projections

Weight
US: 36 pounds; Metric: 16.3 kg.

4.0 Operation

4.1 General

Parallel Injection is to be only used for DC lines.
Series Injection is most often used on AC lines.

CAUTION!
PARALLEL INJECTION MUST NOT BE USED ON AC LINES
SINCE SEVERE DAMAGE TO THE SPIKE GENERATOR WILL RESULT.
SERIES INJECTION CAN BE USED ON EITHER AC OR DC LINES.

PRECAUTIONS MUST BE TAKEN WHEN THE HOT SIDE OF THE POWER LINE IS CONNECTED TO THE CHASSIS OF THE OSCILLOSCOPE.
USE AN ISOLATION TRANSFORMER IN THE POWER INPUT TO THE SCOPE.

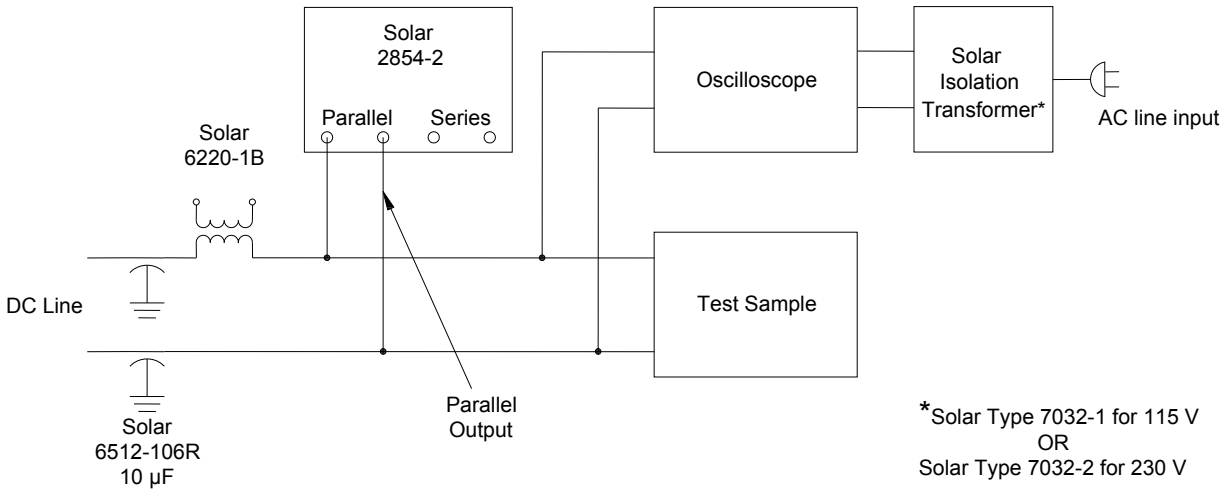
NOTE THAT THE CHASSIS OF THE SCOPE IS ABOVE GROUND
WHEN A POWER LINE TRANSFORMER IS USED.
AVOID TOUCHING THE SCOPE WHEN THE TEST LINE POWER IS APPLIED.

4.2 Interconnections for Parallel Injection

As shown in Diagram 1, connect the oscilloscope to the terminals marked PARALLEL. Also connect these terminals to the DC input power leads of the equipment under test. Take precautions to prevent grounding the load through the case of the oscilloscope. Use a Solar Isolation Transformer* or equivalent at the power input to the oscilloscope. All output terminals on the Spike Generator are isolated from the case of the unit.
When parallel injecting the spike into a DC line, it is desirable to use an inductor in series with the power source so that the spike is applied to the test sample without the RF shunting effect of the power source impedance. The secondary of Solar Type 6220-1B Audio Isolation Transformer is well suited for this application and is capable of carrying 50 A of test sample current.

*Solar Type 7032-1 for 115 V
OR
Solar Type 7032-2 for 230 V

DIAGRAM 1 - PARALLEL INJECTION ON DC LINE

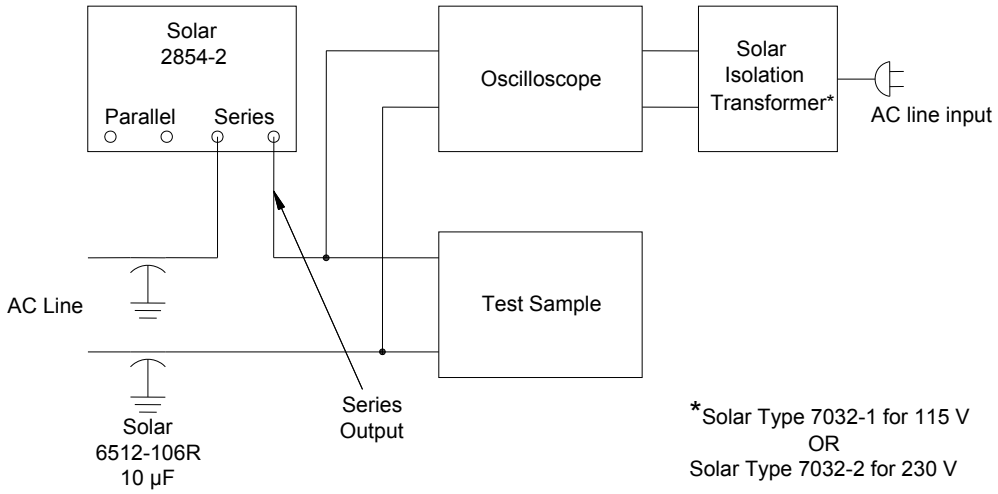


4.3 Interconnections for Series Injection

The series connection is capable of handling 25 A RMS or DC. This connection inserts approximately 75 µH in series with the test sample. The power frequency voltage drop across this reactance is 4.75 V at 25 A, 400 Hz.

For AC series injection, connect the output terminals marked SERIES in series between the power source and the test sample as shown in Diagram 2. It is recommended that the injection be in series with the ungrounded side of the power line. However, the spike as it appears on the AC waveform into the test sample is best seen by connecting the oscilloscope across the power input leads to the test sample, as shown in Diagram 2.

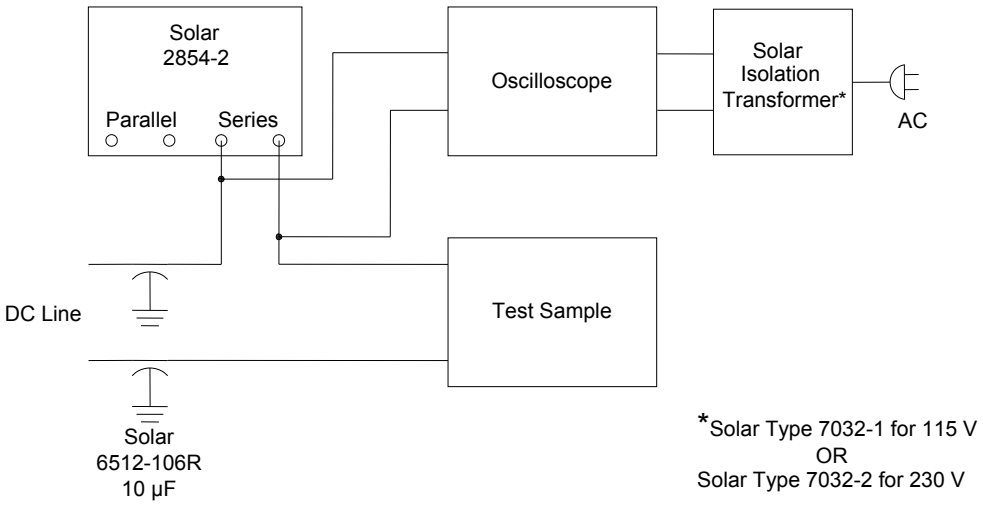
DIAGRAM 2 - SERIES INJECTION ON AC LINE



The oscilloscope should be connected across the SERIES output terminals to indicate the shape and magnitude of the spike being injected into the circuit. See Diagram 3. Precautions must be taken to avoid grounding the hot side of the power line through the case of the oscilloscope.

DIAGRAM 3 - SERIES INJECTION ON DC LINE

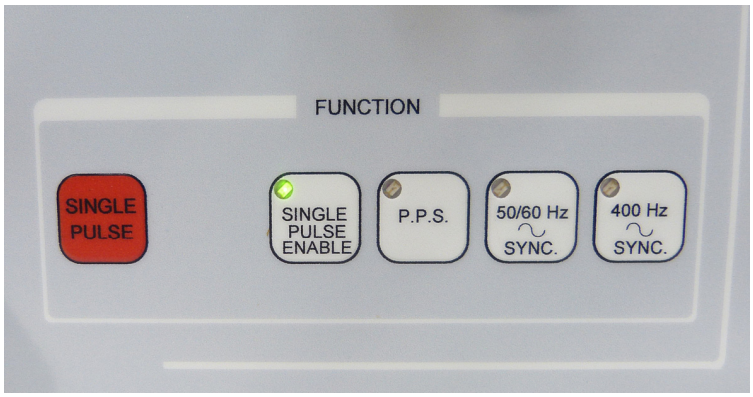
OSCILLOSCOPE MEASURING 2854-2 SPIKE ONLY



4.4 Function Select Buttons

The function select buttons are a horizontal set of white buttons on the lower right side of the front panel. These buttons enable the operator to select from four functions. When a function is active, the green LED in the top left corner of the button is illuminated. The default function selected at power up is SINGLE PULSE ENABLE. In the group of four white function buttons, it is the white button farthest to the left. When SINGLE PULSE ENABLE is selected, the generator is able to produce single transients when the **red** SINGLE PULSE button is pressed; it is to the left of the white SINGLE PULSE ENABLE button. The white PPS button selects the variable repetition rate function. The last two white FUNCTION buttons select pulse positioning on 50/60 Hz and 400 Hz AC power signals respectively.

IMAGE 2 – FUNCTION SELECT BUTTONS



4.5 Single Pulse Operation

Enables the user to discharge the 2854-2's output pulse manually by depressing the SINGLE PULSE red button to the left of the SINGLE PULSE ENABLE function button.

4.6 PPS (Auto Repetition Rate)

The calibration of the knob in PPS is reasonably accurate (approximately ±10%) at all panel markings. For applications where the exact rate is important, it may be measured on the time base scale of the associated oscilloscope. The rate is independent of load conditions.

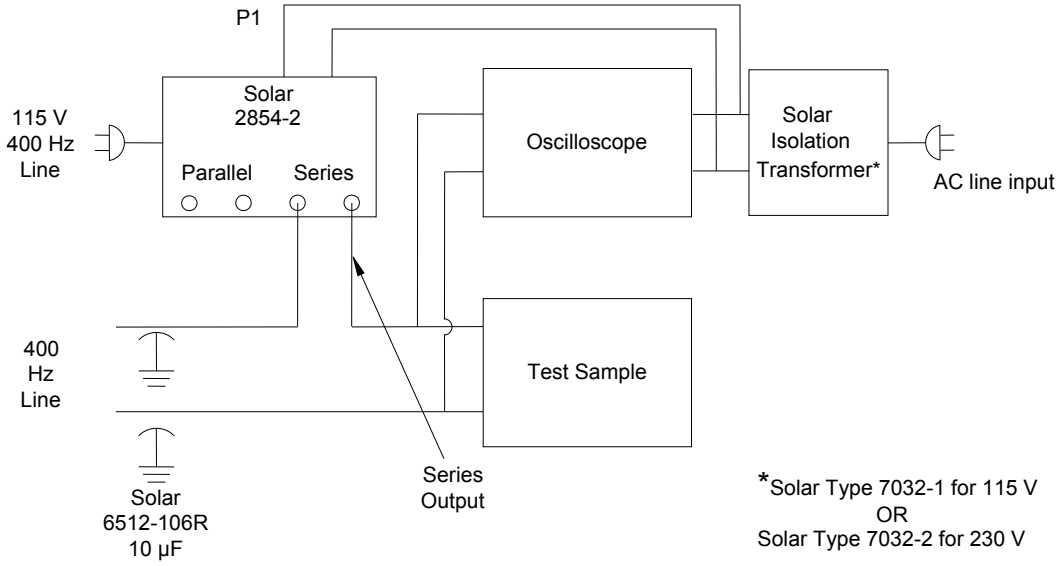
4.7 50/60 and 400 Hz Line SYNCs (Pulse Positioning)

With the equipment connected for series injection on AC lines, as shown in Diagram 2, select either the 50/60 Hz or 400 Hz SYNC buttons as required. **The power cord of the spike generator must be connected to the same power source as the test sample.**

However, when operating on a 400 Hz power line for the pulse position test, it is necessary to connect the blower fan to the standard 50/60 Hz line. See Diagram 4. This is accomplished by removing the parallel blade connector, P1, from its socket (adjacent to the fuses on the rear panel) and connecting it to a primary power source of 115 V 60 Hz.

Connect the oscilloscope across the power input to the test sample. Avoid grounding the hot side of the line through the case of the oscilloscope. A power line isolation transformer such as Solar Type 7032-1 for 115 V or 7032-2 for 230 V is suggested at the power input to the scope, as shown in Diagrams 2 and 4.

DIAGRAM 4 - SETUP FOR PULSE POSITION TEST ON 400 Hz LINE



The PULSE POSITION control in conjunction with the polarity reversing switch will enable phase shift of the injected spike through 360° as observed on the oscilloscope. The phase reversing switch at the bottom of the panel will allow adjustment of the spike position to the positive half cycle or the negative half cycle of the power line sine wave. Due to the phase difference existing, the knob position corresponding to the voltage zero crossover will differ from one test sample to another.

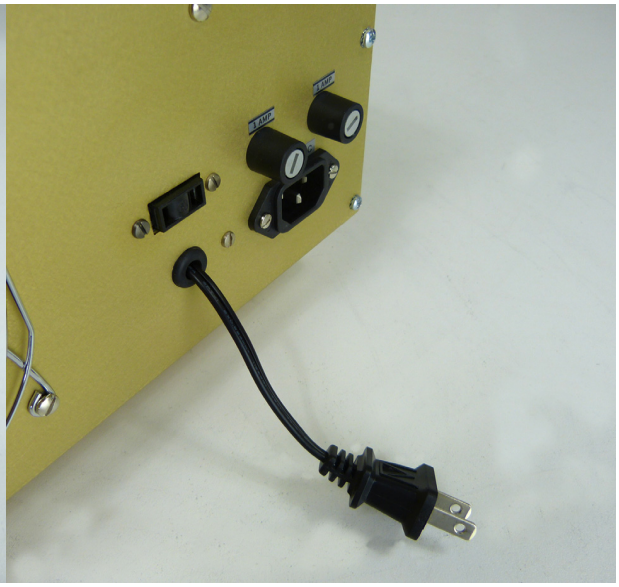
When synchronizing on a 50/60 Hz line, the spike appears on every 8th sine wave of the power frequency. On a 400 Hz line, the spike appears on every 64th sine wave. The spike position, however, is the same on each sine wave on which the spike appears. This periodic injection of the spike is due to the 7.5 PPS rate on 50/60 Hz lines and a rate of 6.2 PPS on 400 Hz lines. (In this equipment, the repetition rate must be kept below 10 PPS to allow time for the charging of the capacitors which provide the energy for the spike.)

CAUTION: WHEN OPERATING ON A 400 Hz POWER LINE, DO NOT LEAVE THE FUNCTION SWITCH IN THE 50/60 Hz POSITION FOR PROLONGED PERIODS SINCE IT MAY CAUSE OVERHEATING OF THE POWER SUPPLY.

ALSO, DISCONNECT THE FAN FROM THE AC RECEPTACLE ON THE BACK OF THE GENERATOR DURING ANY 400 Hz TESTING.

IMAGE 3 - FAN CONNECTED

IMAGE 4 – FAN DISCONNECTED



Upon completion of the 400 Hz pulse positioning test, reinsert the parallel blade connector of the fan into the mating socket. This connector should remain in this position for all other uses of the spike generator.

4.8 Spike Amplitude

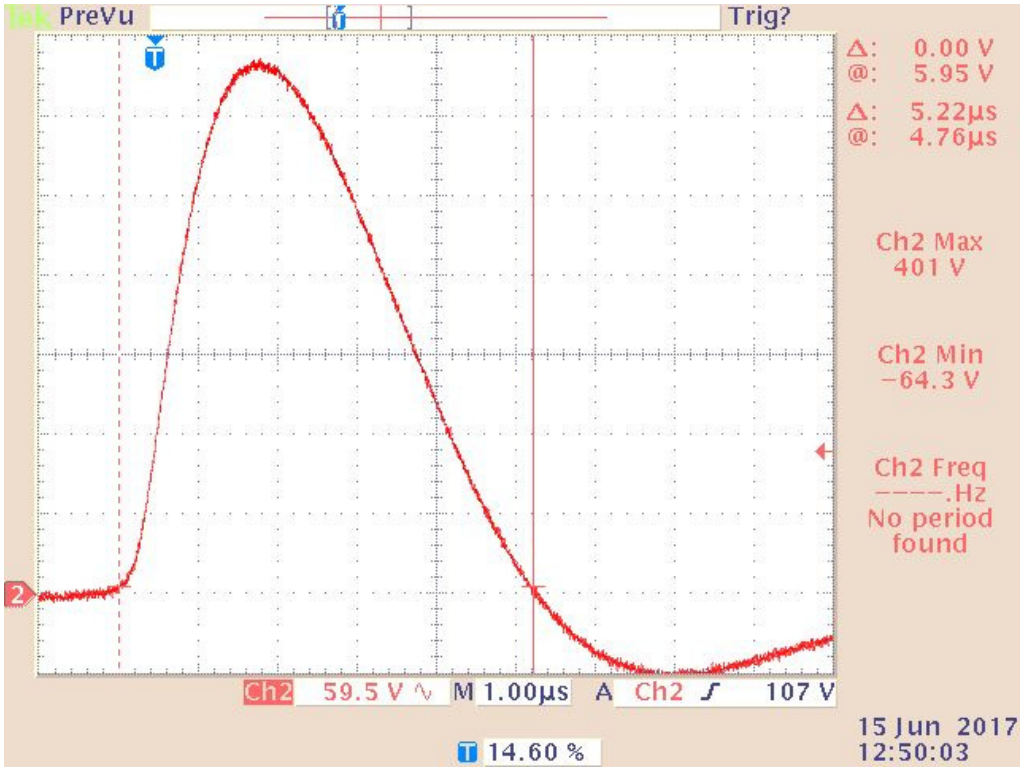
The amplitude of the spike is adjustable from approximately 5 V to 600 V peak by means of the AMPLITUDE knob. The calibration of this scale is most accurate at 400 V with a resistive load of 5 Ω at a pulse rate less than 1 PPS or pulsed manually with single pulse. For adjustment of amplitude into unknown loads, the knob must be adjusted while watching the spike amplitude on an oscilloscope with calibrated vertical amplitude.

4.8 Amplitude with Low Impedance Loads

Since the internal impedance of the spike generator is less than 2 Ω; typically 1.3 Ω,
the amplitude into a matched load will be one half that of the open circuit amplitude.
This characteristic enables the operator to estimate the load impedance when it is approaching the internal impedance of the generator.

4.9 Pulse Shape

When unloaded or connected to a purely resistive load, the spike shape is approximately that of Graph 1.



5.0 Calibration Assistance

Periodically make the following tests to verify the performance of the spike generator. Make any adjustments required to bring the performance within the specified limits.

5.1 Equipment Required

The following equipment is required for the tests and adjustments described below:

1 AC line voltage source (110/115V **OR** 220/230V), 50/60 to 400 Hz,
2 capable of handling 2 A

3. Calibrated oscilloscope

5. Single phase 400 Hz power source, capable of supplying 2 A

6. 5 Ω resistor, ±10%, ≥ 6 W (Solar Type 8525-1 or similar)

7. When testing the 400 Hz, a secondary AC line voltage source providing 50 Hz or 60 Hz AC of the generator's default voltage.

5.2 Preliminary Procedure

Plug the AC line voltage source into the back panel AC receptacle of the spike generator.

Connect the 5Ω 6W (Solar Type 8525-1) resistor across the SERIES output terminals on the spike generator.

Connect oscilloscope input to SERIES output terminals on the spike generator.

Adjust oscilloscope controls to display 600 V peak.

5.3 Checking the Single Pulse Function and 400 V Amplitude verification

To check the single pulse function and 400 V amplitude verification, proceed as follows:

Turn spike generator on.

Press the Single Pulse Enable button.

Rotate AMPLITUDE control knob to the 400 V on dial.

Press the Single Pulse button several times. Observe that each time the switch is depressed a pulse appears on the oscilloscope.

Oscilloscope should display peak amplitude of approximately 400 V.

On the oscilloscope, verify that the pulse reaches peak amplitude in 1.5 µS +/- 0.5 µS and decays to zero in 3.5 µS +/-0.5 µS.

NOTE: All other tests and adjustments will be made at 100 V amplitude.

When adjusting pulse rate or pulse position travel, it might be necessary to make adjustments to the main PCB, inside the generator.
To access the main PCB, be sure the line cord of the spike generator is disconnected from the primary source. Remove screws from the bottom cover and detach the bottom cover to expose the main PCB.

5.4 Check and Adjustment Check Auto Pulse Frequency

To check and adjust the frequency calibration, proceed as follows:

Place the 5Ω 6 W (Solar Type 8525-1) or higher power resistor on the SERIES output terminals and connect the oscilloscope across it.

Press the PPS function button and adjust the PPS knob dial to 10.

Set oscilloscope time scale for 20 mS/div and set amplitude scale to 20 V/div.

There should be a pulse on every 5th division on the oscilloscope grid.

If necessary, adjust 5K potentiometer R15, until 10 Hz is dialed in.

5.5 Check and Adjustment of Range of Pulse Position Control at 50/60 Hz

To check and adjust the range of the PULSE POSITION control at 50/60 Hz, proceed as follows:

Press the 50/60~SYNC. function button.

Set oscilloscope sweep for 2 mS/div, automatic sweep triggered to the positive (+) half of the line cycle.

Rotate PULSE POSITION control on spike generator. A pulse should appear on oscilloscope.

When the PULSE POSITION control is rotated over its full range, the pulse should travel at minimum 8.50 mS on the oscilloscope grid when working with 60 Hz. If working with 50 Hz the pulse should travel a minimum 10 mS. If necessary, adjust potentiometer R16, until the PULSE POSITION control moves the pulse a minimum 8.50 mS for 60 Hz (10 mS for 50 Hz) across the oscilloscope over its full range.

5.6 Check and Adjustment of Range of Pulse Position Control at 400 Hz

To check and adjust the range of the PULSE POSITION control at 400 Hz, proceed as follows:

Disconnect blower from the AC receptacle on the back of the generator.

Connect the male plug of the fan to the secondary AC line voltage source providing 50Hz or 60Hz AC of the generator's default voltage.

Connect the primary AC line input power source that produces 400 Hz to the back of the generator.

Press the 400~SYNC. function button and flip the sync phase switch (marked + and -) to +.

Turn on the spike generator.

Set the oscilloscope sweep for 200 µS/div, AC line trigger. The oscilloscope should display a single pulse.

Rotate PULSE POSITION control clockwise and counterclockwise so pulse travels across the display.

The pulse should travel at least 1.25 mS.

If necessary, adjust R17, until the pulse travels at least 1.25 mS.