UTILITY SWEEP GENERATOR TEST AND ALIGNMENT PRODEDURE

DRAFT ONE

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The Utility Sweep Generator - a highly versatile linear ramp voltage generator - is capable of impressive functionality when properly aligned. Alignment results in stable repeatable operation and - most conveniently - non-interaction of the sweep limit controls - which is a great aid in certain applications such as filter sweeps. A properly aligned USG permits independent setting OF both the low frequency and high frequency limits of an RF sweep generator driven by the USG so frequency scaling of a 'scope face is very easy.

The alignment of all generator functions is accomplished by adjusting circuit trim pots and panel controls in proper sequence. Because the process is sequential, it is necessary to resolve any difficulties as they occur throughout this procedure.

Items needed for the alignment procedure include a 2-ch DC coupled triggered 'scope, a DVM, and some test leads / jumpers with small size clips, and some patience! Understanding of the intended operation of the USG and a knowledge of 'scope and DVM operation is assumed.

Initial electrical checkout begins with NO socketed IC's installed except UC5. Upon initial powering up, confirm the 18 and 12 volt regulator outputs, and then the 8, 6, 4, and 2 volt sub regulators adjusting the latter associated trim pots to ROUGHLY set these last four levels. These will be "fine tuned" later in this procedure but all six voltages should be within +/-5% for now.

BASIC SWEEP OPERATION

Note: In the procedures that follow the text will reference front panel controls as given by the USG front panel labeling. These references may differ from other equivalent nomenclature shown on the schematic and layout drawings but the equivalency should be obvious. Also, frequent reference will be made to the SWEEP switch and its "manual" and "auto" positions. The manual position (switch left) is associated with the MANUAL SWEEP control, and the auto position (switch right) is associated with the repetitive sweep

controls labeled VARIABLE and MAX SEC.

Install IC1 and IC2. While monitoring the sweep signal at the SWEEP switch center contact with a 'scope / probe, and with this switch set to the "auto" position, the MAX SEC switch set to 0.05 SEC., and the RUN READY SINGLE switch set to RUN, adjust the 1-SHOT STABILITY trimmer fully in the direction of stopping the repetitive sweep. Then SLOWLY advance the trimmer until the sweep operation JUST starts - but no further. (Note: this adjustment displays some hysteresis so follow this procedure as described.)

Observe that the ramp voltage starts at approximately 4 volts and rises to approximately 8 volts. Observe that the positive going ramp is linear in appearance and the negative going fall time is "fast". Confirm repetitive sweep operation over all MAX SEC switch positions i.e. over all available sweep repetition rates. Observe that the RUN LED is ON during this sequence. Adjust the VARIABLE RATE control (for any sweep speed) over its range and confirm a variable sweep rate change of approximately 3:1.

Set the MAX SEC switch to 0.1 SEC and the VARIABLE rate control for the lowest speed (fully CCW) - i.e. - the "CAL" position. Set the 'scope time base to 10 mSec/Div and trigger on a negative going edge. Adjust the REP RATE CAL trimmer for proper timing (a sweep beginning at the left most grid and ending at the right most grid). This calibrates the MAX SEC switch when the VARIABLE control is in the CAL position.

Set the RUN READY SINGLE switch set to READY. The repetitive sweep should stop and the RUN LED should go OFF. Move the switch to SINGLE and observe a single output sweep. Observe that the RUN LED indicator comes ON during this sweep.

Confirm the functionality of the TRIG OUT signal by observing a negative going spike beginning a little below 2 volts amplitude and dropping down to near zero volts.

Set the MAX SEC switch to 5 SEC., activate the RAPID RESET momentary switch and observe the ramp is interrupted and reset to about 4 volts before initiating a new sweep.

Set the SWEEP switch to manual and observe approximately 4 to 8 volts DC motion as the MANUAL SWEEP control is adjusted over its range. Do not be concerned about the exact values at this point.

This completes the alignment of the basic sweep generation circuit

functions.

X-AXIS OUTPUT SIGNAL - PRELIMINARY

The "X" output port is normally connected to and drives the 'scope horizontal sweep input in most applications. The following confirms the basic functionality of this port signal.

Install IC2 and IC3. With the SWEEP switch in auto and the MAX SEC switch set to 0.05 SEC, verify the presence of a sweep signal at the "X" jack. The voltage swing here should be ABOUT negative 1 volt to ABOUT positive 1. Do not be concerned with the exact values - they will be correctly set later.

SWEEP OUTPUT - PRELIMINARY

With the MODE SELECT switch in the S/S ("start/stop") position, the SET LO V control fully CCW and the SET HI V control fully CW, observe some positive going ramp voltage output at the SWP OUT port. Observe that the 16 / 5 V switch changes the amplitude about 3:1. More detailed test and alignment of this output signal will follow later in this procedure.

OVERALL ALIGNMENT

The following alignment steps establish the final precision operation of the USG and involve the adjustment of several circuit trimmers in a specific sequence. Before continuing, it is important to note that the 12 volt regulator - which powers most of the sweep generation circuitry - is likely not exactly 12 volts. This is due to the tolerance of that IC regulator but the exact value (within tolerance) is NOT important. What is important are various voltage RATIOS throughout the USG.

Referring to voltage swing on the SWEEP switch center pin with this switch in auto position, the previously observed approximate 4 to 8 volt ramp peak values are actually dependent on both whatever the 12V regulator output is and on the internal precision of the 555 timer IC. So, while these levels (and other similar numbers to follow) shall be referred to (i.e. "named") as "4V" and "8V", they are usually slightly different. What is important is to adjust associated voltages and voltage ratios throughout the USG in concert with the actual peak values of the ramp - whatever they may be. In a sense, these peak voltages are the "system reference" for the entire USG.

Because what follows is dependent on the actual ramp start and stop

voltage values - the low and high signal peaks - a dynamic tune up scheme is used to pin-point correct settings of the sub regulator 8V and 4V outputs. This is accomplished by utilizing an otherwise dormant section of IC4 quad op amp as a comparator and the built-on-the-board precision convenience divider.

8 VOLT SUB REGULATOR

Referring to the "8V", "6V", "4V" and "2V" sub regulators and their associated trimmers, the first of these needing adjustment is the 8V. The idea is to adjust the 8V regulator trimmer so the actual 8V voltage is nearly perfectly equal to the peak ramp voltage. Since the ramp peak exists for a very short time, the above mentioned op amp is used to "catch" this point in time.

Set the MAX SEC control to 0.5 SEC. And the SWEEP switch to auto. Temporarily connect IC4 pin 10 to IC5 pin 14 and IC4 pin 9 to IC2 pin 8. (These temporary test connections are easily done with small clip leads / jumpers connected where conveniently possible on IC pins, associated circuit resistor leads, etc.)

Observing IC4 pin 8 with a 'scope, adjust the 8V trimmer until a rectangular waveform appears. This will happen when the ramp voltage and the 8V sub regulator voltage "overlap". This waveform will swing from a high voltage level to a low voltage level.

As the 8V trimmer is adjusted, the symmetry of the waveform will change. Slowly adjust the trimmer for a decreasingly narrow negative going part of the waveform. As the trimmer approaches and overshoots the correct setting this negative pulse will distort and disappear. Adjust the trimmer so that a very narrow but stable pulse remains visible. This is almost perfectly the coincident point of the 8V regulator output and the waveform positive going peak.

4 VOLT SUB REGULATOR

Alignment of the "4V" sub regulator is done in similar fashion. Temporarily connect IC4 pin 10 to IC5 pin 7 while leaving the other previous connections intact. Adjust the 4V trimmer so that an decreasingly narrow positive going pulse is displayed. Adjust the trimmer until a very narrow but stable pulse remains visible. This is almost perfectly the coincident point of the 4V regulator output and the waveform negative going peak.

These two steps have quite accurately matched the 8V and 4V sub regulator outputs equal to the actual ramp start and stop voltages

- no matter what they are exactly. It's the match of both that matters. The next steps accurately set the 6V and 2V sub regulators.

6V AND 2V SUB REGULATORS

Before proceeding with these adjustments, it is first necessary to adjust the on-board utility divider trimmer. This is done by adjusting the TEST/TUNE trimmer using an ohmmeter to measure from the "test loop" to each 10K fixed resistor and trimming until both measurements are equal. Use a DMM ohmmeter range that allows the greatest reading resolution. It does not matter what the final resistance values are but rather that the two legs of the divider are equal.

Connect this divider between the 8V and 4V sub regulator outputs using small clip lead jumpers. The divider will put the voltage at the test loop at the midpoint of these two voltages - named "6V" whether is actually perfectly is or not. Connect a DVM on its lowest scale between the test loop and the 6V sub regulator output. Adjust the 6V trimmer to null the DVM reading (~ +/- 2 mV) This adjustment effectively sets the 6V sub regulator to the mid point of the 4V to 8V ramp voltage.

Connect the divider between the 4V sub regulator output and ground. Connect the DVM between the divider test loop and the 2V sub regulator output and adjust the 2V trimmer for null condition, as above. This completes the adjustment of the sub regulators.

"X" OUTPUT FINAL ALIGNMENT

The following adjustments set the "X" output signal swing center and swing limits. During application this output drives the horizontal or X-axis input of the 'scope and will produce a full left to right display when the 'scope input attenuator is set to 0.2 volts/division provided the no-input horizontal position of the display is on the center grid line.

Begin by adjusting the UP/DN GAIN trimmer. Connect the divider between IC3 pins 8 and 14 (can also done at the MODE SELECT switch terminals). Connect a DVM on its lowest range between the 6V sub regulator output and the divider test loop. With the SWEEP switch in manual, rotate the MANUAL SWEEP control over the full range and observe the meter motion. Adjust the UP/DN GAIN trimmer until the DVM remains as motionless as possible as the MANUAL SWEEP control is moved back and forth over its range. The actual (but motionless) DVM reading will likely be <3 mV.

With no input signal present, adjust the vertical 'scope position to zero (screen center). Connect the "X" port signal to the 'scope vertical input with the MAX SEC switch set to 0.05 SEC. Iteratively adjust the X-AXIS GAIN and the X-AXIS OFFSET trimmers to result in a 2 volt peak to peak ramp that is centered on zero. That is, the "X" signal should sweep between -1V and +1 volt. This completes the X output signal alignment.

OUTPUT SWEEP FINAL ADJUSTMENT

The following adjustments align the SWP OUT OFFSET and SWP OUT CAL trimmers to establish the proper SWP OUT port waveform levels.

Set the MODE SELECT switch to "SS". Adjust the "SET LO V" control fully CCW and the "SET HI V" control fully CW. Set the SWEEP switch to manual. Connect a DVM to the SWP OUT port and the 16 / 5 volt switch to "16". Set the MANUAL control to zero (fully CCW) and adjust the SWP OUT OFFSET trimmer for zero volts nominal. Set the MANUAL control fully CW and adjust the SWP OUT CAL trimmer for 16 volts nominal rechecking both, although these limits are not particularly critical. Set the SWEEP switch to auto and observe a 16 volt nominal peak SWP OUT that begins at zero volts nominal. Set the 16/5 switch to "5" and confirm a SWP OUT voltage peak of a little over 5 volts.

The INTERACTION NULL trimmer will now be adjusted. Set both the SET LO V and SET HI V controls fully CCW. Observe the SWP OUT waveform with the 'scope vertical attenuator set for high sensitivity as needed. There will likely be some small sweep signal visible and it can be either positive or negative going. SLOWLY adjust the INTERACTION NULL trimmer for a "flat line" output (there will likely be some +/- spikes visible but the voltage ramps will blend to "flat"). Following this, reconfirm the SWEEP OUTPUT OFFSET and SWEEP OUT CAL settings.

This completes the alignment of the Utility Sweep Generator.