FACTORY CALIBRATION PROCEDURE

CONTENTS:

INTRODUCTION:

This isn't a field recalibration procedure as is the procedure in your instruction manual. This is a guide in calibrating brand-new instruments, just assembled instruments that have never been turned on before. Therefore it calls out many procedures and adjustments that are rarely required for subsequent recalibration.

Even though we wrote this procedure primarily for our own factory test department, it's valuable to others also if used with some caution:

TENTATIVE

TENTATIVE

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For all serial numbers.

661

1. **Special test equipment,** if mentioned, is not available from Tektronix unless it's listed also in our current catalog. This special equipment is used in our test department to speed calibration. Usually you can either duplicate its function with standard equipment in your facility, devise alternate approaches, or build the special test equipment yourself.

2. **Factory circuit specifications** are not guaranteed unless they also appear as catalog or instruction manual specifications. Factory circuit specs usually are tighter than advertised specs. This helps insure the instrument will meet or exceed advertised specs after shipment and during subsequent field recalibrations over several years of use. Your instrument may not meet factory circuit specs but should meet catalog or instruction manual specs.

3. **Presetting internal adjustments,** if mentioned, usually is unnecessary. This is helpful for "first-time" calibration only. If internal adjustments are preset, you'll have to perform a 100% recalibration. So don't preset them unless you're certain a "start-from-scratch" policy is the best.

4. **Quality control men steps.** Factory calibration procedures are for our test department calibrators who first calibrate the instrument. Quality control men then check the initial calibration and perform additional fine points such as trimming resistor leads, installing shields, etc. In some cases a factory calibration procedure instructs the calibrator not to perform these fine points. You'll ordinarily have to include these fine points in your calibration.

In this procedure, all front panel controls for the instrument under test are in capital letters (SENSITIVITY) and internal adjustments are capitalized only (Gain Adj).

FACTORY CIRCUIT SPECIFICATIONS

Factory circuit specifications are not guaranteed unless they also appear as catalog or instruction manual specifications. Factory circuit specs usually are tighter than advertised specs. This helps insure the instrument will meet or exceed advertised specs after shipment and during subsequent field recalibrations over several years of use. Your instrument may not meet factory circuit specs but should meet catalog or instruction manual specs.

The numbers listed beside the specifications are the factory calibration procedure steps where the check or adjustment is made.

POWER SUPPLIES:

supply	9d. value	10b. ripple (max)
+300 v	0.5% (adj)	10 mv 7.5 mv at 117 v
+100 v	±2 %	10 mv 7.5 mv at 117 v
-100 v	±2 %	10 mv
+ 19 v	0.5% (adj)	5 mv
- 19 v	0.5% (adj)	5 mv
- 25.2 v	±5 %	15 mv

10b. All supplies should regulate between 105 and 125 v ac line for 117 v operation, and between 210 and 250 v for 234 v operation.

CATHODE RAY TUBE:

12c. Vertical scan: 8 cm min, within graticule area.

16a. Focus: vertical lines 1 mm apart and focused in center must not overlap anywhere within middle 8.8 horizontal cm of graticule.

16b. Geometry: vertical line 1° max tilt (1.3 mm to left or right of 8 cm vertical line) anywhere within graticule area.

16c. Compression: 0.25 mm max.

16c. Expansion: 0.25 mm max.

16c. Combined compression and/or expansion: 0.5 mm max.

-- Intensity uniformity: usable over entire trace when center of trace set for minimum intensity.

VERTICAL AMPLIFIER:

17c. Calibrator waveform spike: 2 mm max vertically.

17c. Calibrator waveform roll-off: none.

HORIZONTAL AMPLIFIER:

19c. SWEEP MAGNIFIER 20b. EXT HORIZ INPUT

X1	2%	.05	4%
X2	2%	.1	3%
X5	2%	.2	2%
X10	2%	.5	2%
X20	2%	1	2%
X50	3%	2	2%
X100	4%	5	2%

DELAYED PULSE 50Ω:

23f. Risetime: 0.4 nsec max.

AMPLITUDE/TIME CALIBRATOR:

	μSEC/CYCLE		MV AMPLITUDE	
22e.j.	10	±0.1%	1000	±1%
22e.j.	1	±0.1%	100	±2%
22e.j.	.1	±0.1%	10	±3%
22e.j.			1	±4%
24b.	.01	±1 %	1000	±5%
			100	±6%
			10	±7%
			1	±8%

SIGNAL OUTPUTS:

25b. HORIZ: 200 mv/cm 661 horizontal deflection ±1%.

CALIBRATION

NOTES

1. EQUIPMENT REQUIRED:

a.
- 1 Tektronix type 545 oscilloscope with H plug-in, X1 and X10 probes or 585 Tektronix oscilloscope with 81 adapter, H plug-in, CA plug-in, X1 and X10 probes as test scope
- 1 Tektronix type 4S1 dual-trace sampling plug-in for 661
- 1 Tektronix type 5T1 timing plug-in for 661
- 1 Tektronix type 180A time-mark generator

- 1 2 nsec 50 Ω cable (017-505)
- 1 10 nsec 50 Ω cable (017-501)
- 2 GR to UHF adapter (GR-874QUP)
- 1 50 Ω mid-line terminator (017-037)
- 2 52 Ω cable (012-001)

- 1 Triplett type 630 multimeter; 20,000 Ω/v dc checked for 1% accuracy
- 1 Variable line voltage control

- 1 Variable attenuator (special)
- 1 661 vertical test load unit (special)
- 1 661 sweep test load unit (special)
- 1 661 Bendix plug checker (special)

2. PRELIMINARY INSPECTION:

a. Check for unsoldered joints, rosin joints, wrong connections, lead dress and long ends. Check for loose hardware and correct silk-screening.

b. Check crt face-plate tilt and tight pin connections. Push crt forward to graticule and tighten clamp. Adjust graticule bulbs just short of being flush with graticule.

c. Check fuse data on rear panel and for correct fuse: 4 amp fast for 117 v; 2 amp fast for 234 v; 50 and 60 cps.

3. 661 PRESETS:

a.

FOCUS	ccw
INTENSITY	ccw
ASTIGMATISM	ccw
POWER AND SCALE ILLUM	ccw (off)
HORIZONTAL DISPLAY	X1 SWEEP MAGNIFIER
POSITION	mr
VERNIER	mr
VOLTS/CM	AC or DC
MV AMPLITUDE	1000
μSEC/CYCLE	OFF
All internal adjustments	mr

b. Leave controls and adjustments for any step as they were in the step preceding, unless noted otherwise.

4. RESISTANCE CHECKS:

a. Install vertical and sweep test load units (specials). Set both to HALF LOAD and to CONTINUITY OR GAIN (SWEEP) SET. Connect ohmmeter to either test load unit CONTINUITY banana jack.

b. Readings are taken with ohmmeter common lead grounded except where noted otherwise. Rotate vertical test load unit SUPPLY SECTOR (or sweep test load unit SUPPLY CONTINUITY if ohmmeter connected to sweep test load unit) to each supply and check resistance:

supply	ohmmeter range	resistance to ground
117 AC	X100 k	infinity
6.3	X10 k	50 k
100	X10 k	60 to 75 k +lead gnd'd
400	X10 k	8 k
-100	X1 k	10 k
300	X1 k	6.5 k
- 19	X100	200 to 700 Ω
19	X100	600 to 800 Ω
- 25	X10	9 Ω

c. Check line filter straight through continuity.

5. AMPHENOL CONTINUITY:

a. Be sure 661 power is off and both test load units are still set to NO LOAD and CONTINUITY OR GAIN (SWEEP) SET.

b. Set ohmmeter to X10 Ω and connect one lead to vertical test load unit CONTINUITY banana jack and the other to the sweep test load unit CONTINUITY banana jack.

c. Rotate vertical test load unit SUPPLY SELECTOR and sweep test load unit SUPPLY CONTINUITY controls to like settings. Start with 117 and go through all settings to -25. Check ohmmeter for zero resistance on all settings.

NOTES

6. DIGITAL READOUT CONTINUITY:

a. Be sure 661 power is off and both test load units are still set to NO LOAD and CONTINUITY OR GAIN (SWEEP) SET.

b. Install 661 Bendix plug checker to 661 rear Bendix plug.

c. Set Bendix plug checker to 4S1. Keep ohmmeter at X10Ω. Change one lead to Bendix plug checker banana plug and change the other to the vertical test load unit DIGITAL READOUT CONTINUITY banana jack.

d. Rotate Bendix plug checker control and vertical test load unit DIGITAL READOUT CONTINUITY control to like settings. Start with T and go through all settings to C. Read ohmmeter for zero resistance on all Bendix plug checker/vertical test load unit settings.

e. Set Bendix plug checker to 5T1. Keep ohmmeter at X10Ω and keep one lead at Bendix plug checker. Change other to sweep test load unit DIGITAL READOUT CONTINUITY banana jack.

f. Rotate Bendix plug checker control and sweep test load unit DIGITAL READOUT CONTINUITY control to like settings. Start with R and go through all settings to N. Read ohmmeter for zero resistance on all Bendix plug checker/sweep test load unit settings except G and H.

g. Set Bendix plug checker to G, remove ohmmeter lead from sweep test load unit DIGITAL READOUT CONTINUITY banana jack and connect it to D879 anode. Read ohmmeter for zero resistance.

h. Set Bendix plug checker to H, remove ohmmeter lead from D879 anode and connect it to coax ground braid (junction of R878, 1.5k, and R879, 3.9k; near V874 6DJ8 crt blanking amplifier).

i. Remove ohmmeter leads and Bendix plug checker.

7. TIME DELAY RELAY:

a. Change vertical test load unit to HALF LOAD. Turn 661 on and check that time delay relay closes after 15 to 45 seconds.

b. Graticule bulbs should be lit. See that fan rotates cw, viewed from front of scope. Check for smoke, obvious shorts and over-rated components.

8. EXPORT WINDINGS:

a. Connect a jumper between power transformer T601 terminals A and D. Connect ac voltmeter between B and C. Read 14 v approx. Remove meter and jumper.

9. VALUE, LOW VOLTAGE POWER SUPPLY:

a. Keep vertical test load unit at HALF LOAD, change to RIPPLE AND PERCENT DC ERROR. Change sweep test load unit to HALF LOAD. Set line voltage to 117 v.

b. Connect a 52 Ω cable (012-001) between vertical test load unit SIGNAL INPUT and test scope vertical input. Set test scope for .005 volts/cm; 5 millisec/cm; auto, +line trigger.

c. Set vertical test load unit SUPPLY SELECTOR to 300 and push the PUSH FOR GND REF button. Center test scope trace with vertical position control. Release PUSH FOR GND REF button and push the PUSH TO REMOVE RIPPLE button. Adjust +300 Volts R718 adjust to recenter test scope trace.

d. Check and/or adjust remaining supplies. Use paragraph c. procedure:

SUPPLY SELECTOR	tolerance	adjust
300	--	+300 Volts R718
100	±2% (±2 cm)	--
-100	±2% (±2 cm)	--
+ 19	--	+ 19 Volts R666
- 19	--	- 19 Volts R651
- 25	±5% *(±2.5 cm)	--

*test scope set to .01 volts/cm.

9d. Be sure to adjust +300 v first because all other supplies are referenced to it. Also, be sure to adjust +19 v before the -19 v because the -19 v is referenced to the +19 v.

NOTES

10. RIPPLE, LOW VOLTAGE POWER SUPPLY:

a. Change vertical test load unit SUPPLY SELECTOR back to 300 and test scope back to .005 volts/cm. Don't push the PUSH FOR GND REF or PUSH TO REMOVE RIPPLE buttons.

b. Check ripple from 105 to 125 v ac line:

SUPPLY SELECTOR	ripple mv ptp	notes
300	10 max, 7.5 at 117	select R706 for min ripple at 117 vac
100	10 max, 7.5 at 117	select R694 for min ripple at 117 vac
-100	10 max	
19	5 max	
- 19	5 max	
- 25	15 max	

c. Remove 52 Ω cable.

11. HIGH VOLTAGE POWER SUPPLY:

a. Set voltmeter to 6000 v range, -dc. Connect to junction of R847 and B847 on hv chassis. Rotate High Voltage R841 through its full range. Read approx -2300 to -3200 volt swing. Leave High Voltage at mr; this is a preliminary check only.

12. CRT ALIGNMENT:

a. Set 661 HORIZONTAL DISPLAY to SWEEP MAGNIFIER X1. Keep sweep test load unit at CONTINUITY OR SWEEP SET. Set test scope to B sweep, set A sweep for .5 millisec/cm, auto, and +int. Connect 150 v sawtooth from test scope to sweep test load unit SIGNAL INPUT. (CAUTION: the -150 v sawtooth bites--watch it.)

b. Obtain 661 trace. For vertical positioning use vertical test load unit POSITION control and 661 Vert DC Bal R477 adjust. For horizontal positioning use 661 HORIZONTAL DISPLAY POSITION and VERNIER controls and Horiz DC Bal R357 adjust.

c. Rotate 661 crt so trace is parallel with horizontal graticule lines. Position trace up and down and view vertical scan: 8 cm min, trace usable within graticule area.

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13. SWEEP LENGTH/HIGH VOLTAGE:

a. Adjust High Voltage R841 for 10 cm sweep length. You may have to increase INTENSITY.

b. Change sweep test load unit to VARIABLE SWEEP.

c. Rotate sweep test load unit SWEEP VARIABLE: view change in 661 sweep length.

14. BLANKING BALANCE:

a. Decrease 661 INTENSITY until trace just disappears. Connect voltmeter between crt pin 6 (junction of R871 and R874) and pin 7 (Blank Bal R866 wiper). Adjust Blank Bal R866 for zero volts on voltmeter. Remove meter.

15. SWEEP MAGNIFIER POSITION:

a. Change vertical test load unit to SIGNAL and test scope to 1 volt/cm; time base B, 1 millisec/cm, auto, int. Apply 2 v of test scope calibrator signal to vertical test load unit SIGNAL INPUT and to test scope vertical input.

b. NOTE: Use the rising (or falling) edge of the test scope calibrator waveform displayed on the 661 as a reference line for setting the 661 horizontal position.

c. Position calibrator reference line to 661 center vertical graticule line with 661 horizontal POSITION/VERNIER controls and sweep test load unit SWEEP VARIABLE.

d. Change 661 HORIZONTAL DISPLAY to X100 SWEEP MAGNIFIER and set horizontal VERNIER to mr. Reposition calibrator reference line to center graticule line with 661 horizontal POSITION control.

e. Change 661 HORIZONTAL DISPLAY back to X1. Reposition reference line to center graticule line with Horiz DC Bal R357 adjust.

f. d and e interact; repeat. Horizontal POSITION and VERNIER should end up mr: ±10°.

NOTES

16. CRT SPECS:

a. Set test scope calibrator for a 2 cm 661 display. Check 661 crt focus.

b. Change calibrator for 10 to 20 cm 661 display. Check geometry.

c. Change calibrator for exactly a 4 cm 661 display, centered vertically. Use a variable attenuator (special) if necessary. Position display to top: check compression or expansion. Position display to bottom: check compression or expansion.

17. VERTICAL AMPLIFIER:

a. Set vertical test load unit to CONTINUITY OR GAIN SET. Remove (or set for zero attenuation) variable attenuator (special). Change test scope calibrator to 100 v.

b. Obtain exactly 6 cm 661 vertical deflection by selecting resistors in parallel with R472, 429 k. The selected resistor is R473 = a 1/4 or 1/8 w TI prec 1, 2 or 5% resistor; 5 to 10 megs.

c. Turn 661 off and install R473. Turn 661 back on and recheck for 6 cm. Check calibrator spike: 2 mm max due to R473 stray capacity. Check roll-off: none. Turn down test scope calibrator to at least 20 volts, lest it bite.

d. Remove calibrator from vertical test load unit SIGNAL INPUT. Push the vertical test load PUSH TO SET DC BALANCE button and move 661 trace to center horizontal graticule line with Vert DC Bal R477 adjust. Release button.

NOTES

18. HORIZONTAL AMPLIFIER TAKEOFF GAIN:

a. Set sweep test load unit SWEEP VARIABLE for 10 cm 661 sweep length. Center trace between 0 and 10 graticule marks with 661 horizontal POSITION/VERNIER controls.

b. Set test scope for 5 volts/cm and connect 1X probe to junction of R391 and coax center conductor in 661. View sawtooth on test scope. Set bottom of sawtooth to ground (zero ck) with 661 Horiz Takeoff DC Level R378 adjust.

c. Change test scope to 20 volts/cm and adjust 661 Horiz Takeoff Gain R380 for a 50 v sawtooth.

d. Remove probe. Change 661 HORIZONTAL DISPLAY to F MANUAL SCAN. Horizontal POSITION and VERNIER controls should move spot off-screen to the left and right.

e. Change 661 HORIZONTAL DISPLAY to S MANUAL SCAN. Horizontal POSITION and VERNIER controls should move spot off-screen to the left and right.

f. Change 661 HORIZONTAL DISPLAY back to X1 SWEEP MAGNIFIER.

19. SWEEP MAGNIFIER ACCURACY:

a. Set test scope to 5 volts/cm, A sweep, 1 millisec/cm, ac, +int. Connect test scope 1X probe to vertical test load unit SIGNAL INPUT. Set 661 HORIZONTAL DISPLAY to X1 SWEEP MAGNIFIER.

b. Apply 1 millisec, 100 μsec and 10 μsec markers from 180A to vertical test load unit SIGNAL INPUT. Set sweep test load unit SWEEP VARIABLE for a 1 millisec mark per cm of 661 horizontal deflection.

c. Check or adjust 661 SWEEP MAGNIFIER ranges as follows:

SWEEP MAGNIFIER	markers
X1	one 1 millisec mark/cm
X2	one 1 millisec mark/2 cm
X5	two 100 μsec mark/cm
X10	one 100 μsec mark/cm
X20	one 100 μsec mark/2 cm
X50	two 10 μsec mark/cm
X100	one 10 μsec mark/cm

NOTES

20. EXT INPUT 25 KΩ:

a. Keep 180A connected and set to one millisec markers. Connect sweep test load unit SIGNAL OUT to 661 EXT INPUT 25 KΩ. Set sweep test load unit SWEEP VARIABLE to obtain one millisec marker per cm.

b. Keep 180A connected. Set to one millisec markers. Connect sweep test load unit SIGNAL OUT to 661 EXT INPUT 25 KΩ. Set 661 EXT HORIZ INPUT to 5 and sweep test load unit SWEEP VARIABLE to display one 1 millisec/cm.

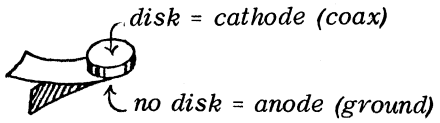
c. Check all ranges of EXT HORIZ INPUT:

EXT HORIZ INPUT	markers
5	one 1 millisec mark/cm
2	one 1 millisec mark/2.5 cm
1	two 100 μsec mark/cm
.5	one 100 μsec mark/cm
.2	one 100 μsec mark/2.5 cm
.1	two 10 μsec mark/cm
.05	one 10 μsec mark/cm

d. Change HORIZONTAL DISPLAY to X1 SWEEP MAGNIFIER and remove all cables connected to both test load units.

21. DELAYED PULSE 50Ω:

a. Check tunnel diode D992 for correct installation: anode to ground and cathode to coax cable (center conductor of GR fitting).



b. Set Delayed Pulse Gen Bias R990 full cw. Set voltmeter to .6 v -dc range and connect to 661 DELAYED PULSE 50 Ω connector.

c. Rotate Delayed Pulse Gen Bias R990 towards ccw. View meter: should increase to approx -.1 v and then jump up rapidly to -.5 v as tunnel diode fires. Adjust Delayed Pulse Gen Bias R990 to point just before tunnel diode fires.

22. AMPLITUDE/TIME CALIBRATOR, .1, 1, 10:

a. Set 661 MV AMPLITUDE to 1000 and μSEC/CYCLE to .1. Set Ampl Limit R959 ccw. Install calibrator-box cover and tube shield if not in already.

b. Attach a 50Ω mid-line terminator to one end of a 10 nsec cable. Attach a GR to UHF adapter to the mid-line terminator. Connect the cable between the 661 OUTPUT INTO 50Ω connector and the test scope vertical input with the GR to UHF adapter end to the test scope. Set test scope for .5 volts/cm and .1 μsec/cm.

c. NOTE: 661 AMPLITUDE/TIME CALIBRATOR frequency adjustments affect amplitude. Make frequency adjustments first and amplitude adjustments last.

d. Preliminary .1, 1 and 10 adjustments:

μSEC/ CYCLE	adjust	for (on test scope)	test scope time/cm
.1	10 MC Adj L911	1 cycle/cm	.1 μsec
.1	10 MC Cal Ampl R914	1 volt	
1	1 MC Adj L906	1 cycle/cm	1 μsec
1	1 MC Cal Ampl	1 volt	

Remove calibrator-box cover.

10	100 KC Adj L901	1 cycle/cm	10 μsec
10	100 KC Cal Ampl R904	1 volt	

Replace calibrator-box cover and recheck timing above.

e. Turn MV AMPLITUDE control to 100, 10 and 1. Check attenuation ratios on three μSEC/CYCLE ranges just adjusted. Change MV AMPLITUDE back to 1000 and μSEC/CYCLE back to .1.

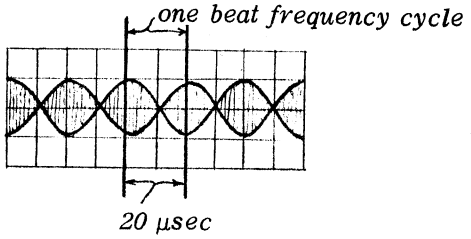
f. Remove 10 nsec cable from test scope, replace test scope H Unit with a CA Unit, and reconnect 10 nsec cable to CA Unit channel A. Connect a 52Ω cable (012-001) between CA channel B and 180A marker output.

g. Set 180A for 10 mc sine waves. Set CA for 2 cm of 661 AMPLITUDE/TIME CALIBRATOR signal and 2 cm of 180A marker signal. Set CA to added algebraically. Set test scope sweep to 2 μsec/cm and trigger +int on beat frequency (difference of 180A output and 661 AMPLITUDE/TIME CALIBRATOR output).

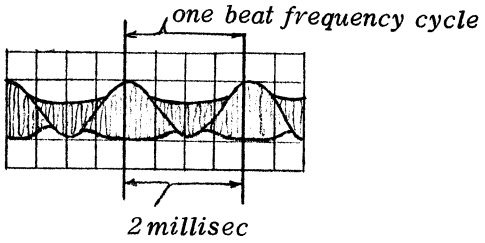
NOTES

h. NOTE: If the 180A is accurate, then the beat frequency equals the 661 AMPLITUDE/TIME CALIBRATOR *inaccuracy* in cycles per second.

i. BEAT FREQUENCY:



180A = 10 mc sine waves
661 = .1 μSEC/CYCLE (10 mc sine waves)
Test scope = 10 μsec/cm
Beat frequency = 20 μsec = 50 kc



180A = 1 μsec markers
661 = 1 μSEC/CYCLE (1 mc sine waves)
Test scope = 500 μsec/cm
Beat frequency = 2 millisec = 500 cps

time for one beat frequency = cycle	beat frequency in cycles per second	time for one beat frequency cycle	beat frequency = in cycles per second
1 μsec	1 mc	1 msec	1 kc
2 μsec	500 kc		
5 μsec	200 kc	1.25 msec	800 cps
10 μsec	100 kc		
20 μsec	50 kc	2 msec	500 cps
50 μsec	20 kc	5 msec	200 cps
100 μsec	10 kc	10 msec	100 cps
125 μsec	8 kc	12.5 msec	80 cps
200 μsec	5 kc	20 msec	50 cps
500 μsec	2 kc	50 msec	20 cps

j. Final .1, 1 and 10 adjustments:

μSEC/ CYCLE	180A	adjust	for beat freq less than	time for one cycle
.1	10 mc	L911	8 kc	125 μsec
1	1 μsec	L906	800 cps	1.25 msec
10	10 μsec	L901	80 cps	12.5 msec

k.

Compare 1000 MV AMPLITUDE setting on .1, 1 and 10 positions of μSEC/CYCLE control. Adjust Ampl Limit R959 for a very slight "nitch" on top of falling edge of waveform on .1 μSEC/CYCLE.

l. Adjust .01 μSEC/CYCLE (100 mc) in step 24.

m. Remove 10 nsec cable, mid-line terminator, GR to UHF adapter and 52 Ω cable.

NOTES

23. SAMPLING OPERATION:

a. Turn 661 off and remove test load units. Install 5T1 and 4S1 sampling plug-ins. Turn 661 back on.

b. NOTE: This procedure also matches the 5T1 to the 661. Whenever you exchange 5T1's in the 661 follow paragraphs b through e. Set 5T1 SWEEP TIME/CM to 10 NSEC and TIME DELAY to 0 (cw). Set 4S1 CHANNEL A MILLIVOLTS/CM to 200. Connect a 2 nsec 50 Ω cable between 661 DELAYED PULSE 50 Ω and 4S1 CHANNEL A INPUT 50 Ω.

c. Use 4S1 CHANNEL A VERTICAL POSITION to center display vertically. You may have to adjust the Delayed Gen Bias R990 to obtain a display.

d. Change 4S1 CHANNEL A MILLIVOLTS/CM to 20. Use VERTICAL POSITION to move display down so only start of pulse is visible. Adjust Delayed Gen Bias R990 cw until pulse disappears, then ccw until pulse start moves left 30 to 40 nsec (tunnel diode free-running). Adjust R990 halfway between no pulse and free-running.

e. Slowly remove 2 nsec 50 Ω cable from 4S1 INPUT 50 Ω until pulse is capacitively coupled, indicated by alternate negative and positive spikes. Tunnel diode may free run due to decreased dc load, again indicated by the spikes shifting to the left 30 to 40 nsec from where the pulse was originally when cable was fully connected. Readjust R990 cw until spikes are in time with the pulse. Reconnect 2 nsec cable fully.

f. Set 5T1 SWEEP TIME/CM to 1. Use TIME DELAY to reposition leading edge of pulse on-screen. View DELAYED PULSE 50 Ω risetime: .4 nsec or better.

g. Remove 2 nsec 50 Ω cable. Set 5T1 SAMPLES/CM to 5. Adjust C302 (on 661 HORIZONTAL DISPLAY switch) for minimum horizontal tail on dots.

24. AMPLITUDE/TIME CALIBRATOR, .01:

a. Reconnect 2 nsec cable to 4S1 CHANNEL A (or B) INPUT 50Ω. Connect other end to 661 AMPLITUDE/TIME CALIBRATOR OUTPUT INTO 50Ω. Set 661 AMPLITUDE/TIME CALIBRATOR μSEC/CYCLE to .01 and MV AMPLITUDE to 1000. Set 5T1 TRIGGERING SOURCE to CAL, and SAMPLES/CM to 100.

b. .01 adjustments:

μSEC/CYCLE	adjust	for (661 display)	5T1 SWEEP TIME/CM
.01	100 MC Cal Ampl C920	1 cycle/cm	10 NSEC
.01	C916	one volt	10 NSEC

24b. Any movement of the calibrator tube, tube shield, cover, or most anything else in the calibrator area affects the .01 μSEC/CYCLE (100 mc) frequency and amplitude.

c. Turn MV AMPLITUDE control to 100, 10 and 1. Check attenuation ratios on .01 μSEC/CYCLE setting.

d. Turn 661 MV AMPLITUDE to 100, 10 and 1 and check attenuation ratios on .1, 1 and 10 μSEC/CYCLE settings.

25. SIGNAL OUTPUT AND SCALE ILLUMINATION:

a. Attach test scope 10X probe to 661 SIGNAL OUTPUT VERT A binding post. View test scope: 200 mv per cm of 661 vertical deflection. Repeat for VERT B binding post.

b. Change probe to HORIZ binding post. View 200 mv per cm of 661 *horizontal* deflection. Remove probe.

c. Turn POWER AND SCALE ILLUM control towards cw. Graticule bulbs should evenly decrease brightness until out.

NOTES

26. THERMAL CUTOUT:

a. Turn 661 off and disconnect wire to one side of thermal cutout TK601. Turn 661 back on. ***Fan only*** should operate if scope is wired for 110, 117 or 124 v line.

b. Turn 661 off, reconnect wire, and turn 661 back on: tubes and graticule bulbs should light up. Turn 661 off.

27. THE END.

1. **INTERCHANGING PLUG-INS:**

a. Recheck 4S1 gain and 5T1 timing.

b. Readjust 661 Delayed Gen Bias R990 (see step 23b through e).

2. **WAVEFORMS:**

a. Presets:

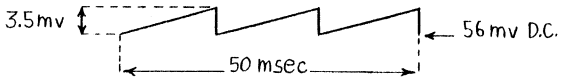
4S1:

MODE	A ONLY
VERT POSITION	trace centered

5T1:

SAMPLES/CM	100
TRIGGERING	FREE RUN
SWEEP TIME/CM	10 NSEC

b.

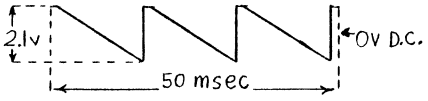


HORIZONTAL AMPLIFIER:
Q313 base
SWEEP MAGNIFIER X1

c.

HORIZONTAL AMPLIFIER:
Q313 base
SWEEP MAGNIFIER X100

d.



HORIZONTAL AMPLIFIER:
D334-R335 junction
SWEEP MAGNIFIER X1

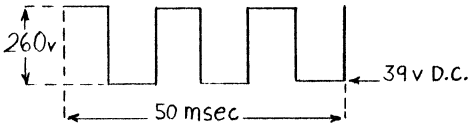
e.

HORIZONTAL AMPLIFIER:
D334-R335 junction
SWEEP MAGNIFIER X100

f.

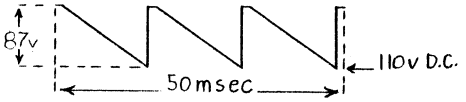
HORIZONTAL AMPLIFIER:
V364 pin 1
SWEEP MAGNIFIER X1

g.



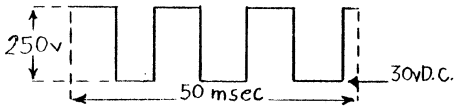
HORIZONTAL AMPLIFIER:
V364 pin 1
SWEEP MAGNIFIER X100

h.



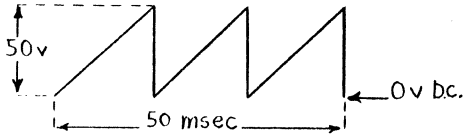
HORIZONTAL AMPLIFIER:
V364 pin 6
SWEEP MAGNIFIER X1

i.



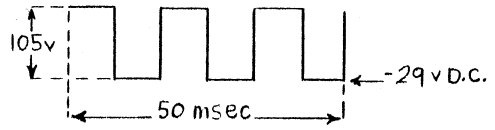
HORIZONTAL AMPLIFIER:
V364 pin 6
SWEEP MAGNIFIER X100

j.



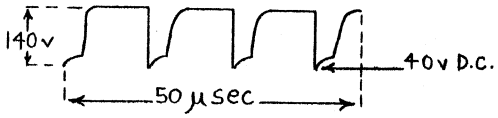
HORIZONTAL AMPLIFIER:
R391 coax junction
SWEEP MAGNIFIER X1

k.



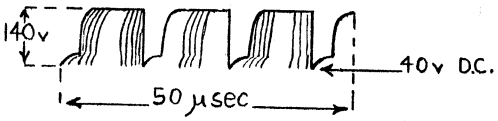
HORIZONTAL AMPLIFIER:
R391 coax junction
SWEEP MAGNIFIER X100

l.



CRT CIRCUIT:
V874 pin 6
SWEEP MAGNIFIER X1 to X100
NORMAL indication

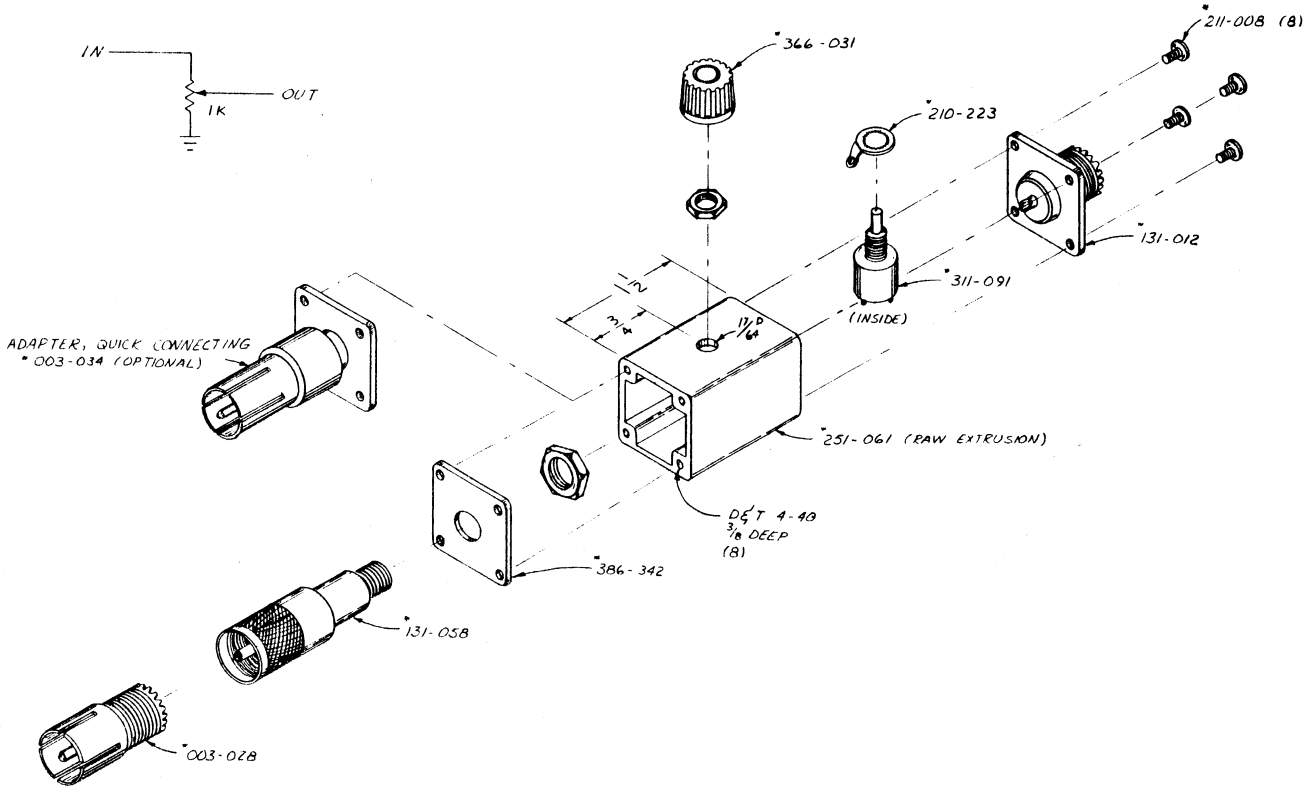
m.



CRT CIRCUIT:
V874 pin 6
SWEEP MAGNIFIER X1 to X100
TROUBLE indicated

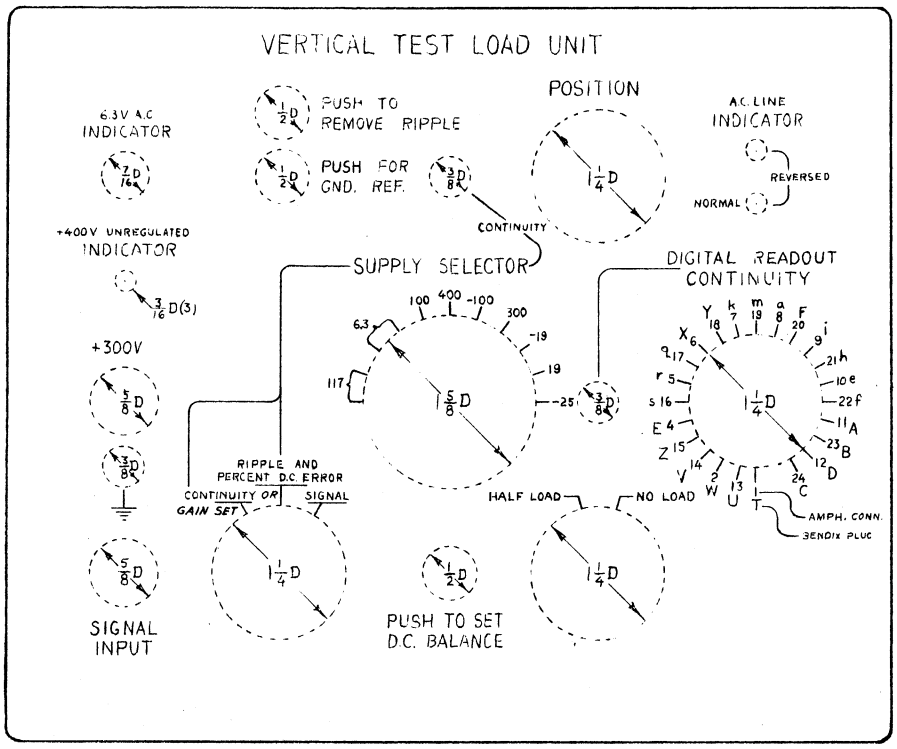
VARIABLE ATTENUATOR:

Dwg 67-B, 1-31-62

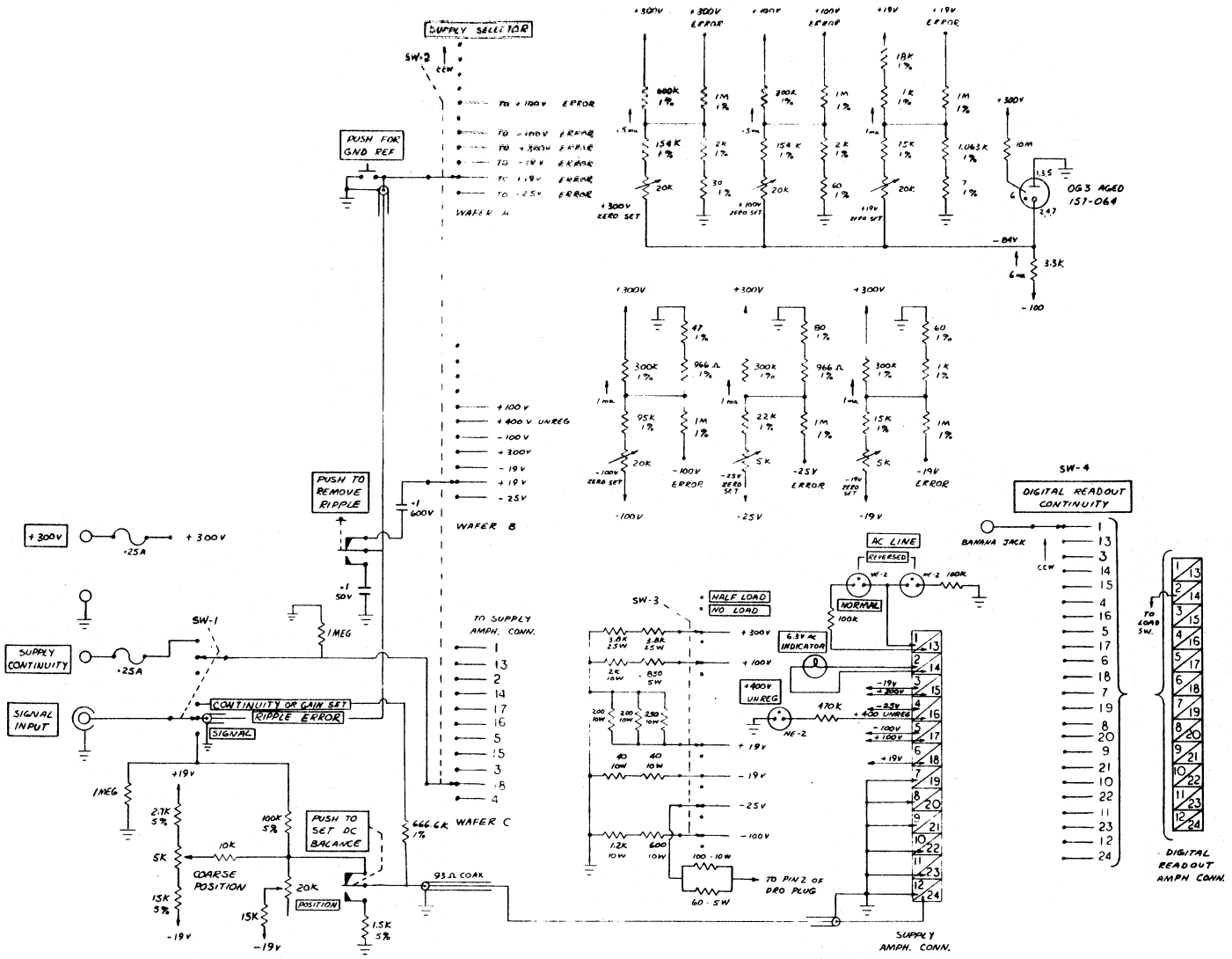


661 VERTICAL TEST LOAD UNIT:

Dwgs 728-B, 10-10-61 (front panel); 519-C, 10-11-61 (schematic); 732-B, 4-24-62 and 733-B, 4-24-62 (parts)



8	124-106	Strips, ceramic 11 notch	2	260-324	Switches, push button
1	124-145	Strip, ceramic 20 notch	1	283-008	Capacitor, .1 μf cer Discap 500 v
1	129-051	Post, binding	1	285-556	Capacitor, .1 μf ptm 600 v
1	129-054	Post, 5-way blue	1	301-104	Resistor, 100 k 1/2 w 5% comp
1	131-081	Connector, chassis mount coax female	1	301-152	Resistor, 1.5 k 1/2 w 5% comp
2	131-149	Connectors, chassis mount 24 contact male	1	301-272	Resistor, 2.7 k 1/2 w 5% comp
			1	302-103	Resistor, 10 k 1/2 w 10% comp
1	136-010	Socket, 7 pin without center pin	2	302-104	Resistors, 100 k 1/2 w 10% comp
1	136-047	Socket, light with no. 14 L red jewel assembly	1	302-153	Resistor, 15 k 1/2 w 10% comp
			1	302-332	Resistor, 3.3 k 1/2 w 10% comp
1	136-106	Socket, banana jack assembly black female	1	302-474	Resistor, 470 k 1/2 w 10% comp
			1	301-153	Resistor, 15 k 1/2 w 5% comp
1	136-107	Socket, banana jack assembly red female	1	302-106	Resistor, 10 meg 1/2 w 10% comp
			2	308-012	Resistors, 40 Ω 10 w WW
2	210-895	Shoulders, insulating for 136-106 and 107	2	308-013	Resistors, 200 Ω 10 w WW
3	150-002	Bulbs, NE-2 neon	1	308-014	Resistor, 250 Ω 10 w WW
1	150-018	Bulb, GE no. 12 incandescent	1	308-017	Resistor, 2 k 10 w Ward Leonard WW
1	157-064	0G3, checked	2	308-044	Resistors, 3.8 k 25 w WW
2	159-028	Fuses, fast-blo 1/4 amp	1	308-086	Resistor, 1.2 k 10 w WW
			1	308-187	Resistor, 850 Ω 5 w WW
1	260-	Switch, 11 position 1 section			
1	260-	Switch, 2 position 2 section	1	308-015	Resistor, 600 Ω 10 w WW
1	260-	Switch, 3 position 1 section	1	308-153	Resistor, 100 Ω 10 w WW
1	260-185	Switch, 25 position 1"	1	308-162	Resistor, 60 Ω 5 w WW
1	260-247	Switch, spst push button	6	309-014	Resistors, 1 meg 1/2 w 1% prec
			1	309-004	Resistor, 600 k 1/2 w 1% prec



1	309-036	Resistor, 18 k 1/2 w 1% prec
1	309-044	Resistor, 95 k 1/2 w 1% prec
1	309-051	Resistor, 200 k 1/2 w 1% prec
1	309-061	Resistor, 7 Ω 1/2 w 1% prec
2	309-067	Resistors, 60 Ω 1/2 w 1% prec
2	309-068	Resistors, 2 k 1/2 w 1% prec
3	309-180	Resistors, 300 k 1/2 w 1% prec
1	309-184	Resistor, 80 Ω 1/2 w 1% prec
1	309-212	Resistor, 47 Ω 1/2 w 1% prec
2	309-223	Resistors, 966 Ω 1/2 w 1% prec
1	309-233	Resistor, 30 Ω 1/2 w 1% prec
2	309-234	Resistors, 154 k 1/2 w 1% prec
1	309-323	Resistor, 75 k 1/2 w 1% prec
2	309-115	Resistors, 1 k 1/2 w 1% prec
1	309-395	Resistor, 15 k 1/2 w 1% prec
1	309-290	Resistor, 21.5 k 1/2 w 1% prec
1	309-007	Resistor, 666.6 k prec
1	311-018	Resistor, 20 k var type J
4	311-159	Resistors, 20 k var minipot
3	311-171	Resistors, 5 k var minipot

1	337-007	Shield, tube
1	343-002	Clamp, cable 3/16" plastic
1	343-004	Clamp, cable 1/4" plastic
3	343-012	Grommets, rubber 5/8"
1	352-006	Holder, neon double
1	352-008	Holder, neon single
1	352-025	Holder, fuse double
3	366-028	Knobs, small black
1	366-042	Knob, medium black
1	366-060	Knob, large black
18	361-007	Spacers, nylon for ceramic strips
1	387-612	Plate, rear subpanel
1	426-127	Plate, left side
1	426-146	Plate, right side
2	210-462	Nuts, 8-32 1/2 x 23/64" hex for 25 w resistors
10	210-478	Nuts, 6-32 5/16" for 5 and 10 w resistors
9	210-601	Eyelets, for 5 and 10 w resistors
2	210-809	Washers, brass for 25 w resistors
7	210-004	Lock washers, int no. 4 cad plated
1	210-011	Lock washer, int 1/4" cad plated

5	210-012	Lock washers, int 3/8 x 1/2" cad plated
1	210-201	Lug, solder SE-4
2	210-202	Lugs, solder SE-6
3	210-205	Lugs, solder SE-8
2	210-206	Lugs, solder SE-10
1	210-207	Lug, solder pot plain 3/8"
5	210-223	Lugs, solder 1/4" hole
14	210-406	Nuts, 4-40 3/16" hex brass cad plated
3	210-465	Nuts, 1/4-32 3/8 x 3/32" hex brass cad plated
1	210-455	Nut, 1/4-28 3/8 x 3/32" hex brass cad plated
5	210-457	Nuts, Kep no. 6
5	210-840	Washers
5	210-413	Nuts, 3/8-32 1/2" hex brass cad plated
2	210-804	Washers, 8s 3/8 x .032" steel cad plated
9	211-544	Screws, 6-32 1-1/2" rhs Phillips cad plated
1	211-554	Screw, 6-32 3/8" phs
8	211-559	Screws, 6-32 3/8" 100%
4	211-537	Screws, 6-32 3/8" truss phs
19	211-507	Screws, 6-32 5/16" bhs
1	211-510	Screw, 6-32 3/8" bhs
4	211-038	Screws, 4-40 5/16" fhs
2	211-033	Screws, 4-40 5/16" pan hs
4	211-008	Screws, 4-40 1/4" bhs
2	211-031	Screws, 4-40 1" fhs
2	212-004	Screws, 8-32 5/16" bhs
2	212-037	Screws, 8-32 3/8" for 25 w resistors