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:

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.

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).

560

Publication:
061-214
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For all serial numbers.

ABBREVIATIONS:

a	amp
ac	alternating current
approx	approximately
b	base
bulb	light, lamp, etc.
c	collector
ccw	counterclockwise or full counterclockwise
cer	ceramic
cm	centimeter
comp	composition (resistor)
cps	cycles per second
crt	cathode ray tube
cw	clockwise or full clockwise
db	decibel
dc	direct current
div	division
e	emitter
emc	electrolytic, metal cased (capacitor)
emt	electrolytic, metal tubular
fil	filament
freq	frequency
gmv	guaranteed minimum value (capacitor)
gnd	chassis ground
h	henry
hv	high voltage
inf	infinity
int	internal
k	kilo (10^3)
k	kilohm
m	milli (10^{-3})
ma	milliamp
max	maximum
mc	megacycle
meg	megohm
mh	millihenry
midr	midrange or centered
min	minimum
mm	millimeter
mpt	metalized, paper tubular (capacitor)
msec	millisecond
mt	mylar, tubular (capacitor)
mv	millivolt
μ	micro (10^{-6})
μf	microfarad
μh	microhenry
μsec	microsecond
n	nano (10^{-9})
nsec	nanosecond
Ω	ohm
p	pico (10^{-12})
pbt	paper, "bathtub" (capacitor)
pcc	paper covered can (capacitor)
pf	picofarad ($\mu\mu$f)
piv	peak inverse voltage
pmc	paper, metal cased (capacitor)
poly	polystyrene
pot	potentiometer
prec	precision (resistor)
pt	paper, tubular (capacitor)
ptm	paper, tubular molded (capacitor)
ptp	peak-to-peak
sec	second
sn	serial number
term	terminal
tub	tubular (capacitor)
unreg	unregulated
v	volt
var	variable
w	watt
WW	wire wound
x-former	transformer

FACTORY CIRCUIT SPECIFICATIONS

SPEC QUALIFICATION

Factory circuit specifications are qualified by the conditions specified in the main body of the calibration procedure. The numbers listed beside the specs correspond to the factory calibration procedure steps where the check or adjustment is made. Instruments may not meet factory circuit specs if calibration or check-out methods and test equipment differ substantially from those in this procedure.

NOT INTENDED FOR INCOMING INSPECTION

We initially calibrate the instrument to factory circuit specifications. These specs usually are tighter than advertised specs, thus helping to insure the instrument will meet or be within advertised specs after shipment and during subsequent recalibrations. Instruments that have left our factory may not meet factory circuit specs but should meet catalog or instruction manual specs.

1. EQUIPMENT REQUIRED

2. PRELIMINARY INSPECTION

2d. Crt faceplate tilt: 1/32", max.
2d. Crt faceplate concavity: 1/32", max.
2d. Crt faceplate convexity: 1/32", max.

3. 560 PRESETS

4. RESISTANCE CHECKS

5. UNREGULATED SUPPLIES

6. STARTING CIRCUIT

7. REGULATED LOW VOLTAGE SUPPLIES

7b. Value, 105 to 125 v ac

-100 v: ±2% at full and no load
+125 v: ±5% at full and no load
+300 v: ±2% at full and no load
- 12.2 v: -2% to +11% at full load and half load

7c. Ripple

Max ripple, 105 to 125 v ac

Supply	120 cps ripple	25 kc ripple
-100 v	10 mv	20 mv
- 12 v	10 mv	20 mv
+125 v	10 mv	50 mv
+300 v	40 mv	25 mv

8. LINE POLARITY

9. HIGH VOLTAGE

9a. -3300 v: ±3%, max.

10. CALIBRATOR

10b. Accuracy: ±2%, max.
10c. Symmetry: ±20%, max.

11. ALTERNATE SWEEP

12. SCALE ILLUM, ALIGN CRT

13. COMPRESSION, EXPANSION

13b. 1 mm, max total

14. CALIBRATOR WAVEFORM, CRT

15. GEOMETRY

15a. Horiz: 1 mm, max.
15b. Vert: 1 mm, max.

16. VERT SENSITIVITY, CRT ELECTRICAL CENTER

16a. Vert sensitivity: 21.6 v/div to 24.4 v/div
16b. Crt electrical center: .6 major div, max.

17. VERTICAL COMPENSATION INT TRIGGER

18. HORIZ SENSITIVITY, ELECTRICAL CENTER

18b. Horiz sensitivity: 17.6 to 19.8 v/div.
18c. Crt electrical center: .8 major div, max.

19. HORIZ COMPENSATION, INT TRIGGER

20. FREQ RESPONSE

20b. 1 mc, min at -3 db point

21. LINE TRIGGER

22. CRT CATHODE

23 THE END.

CALIBRATION

NOTES

1. EQUIPMENT REQUIRED

a. Test scope

1	530 series	Tektronix type scope
1	H	Tektronix type wide-band, high gain plug-in unit
1	10X probe	Tektronix type probe

b. Test equipment

1	2A60	Tektronix type amplifier plug-in unit
1	2B67	Tektronix type time-base plug-in unit
1	105	Tektronix type square-wave generator
1	180A	Tektronix type time mark generator
1	190B	Tektronix type constant amplitude sinewave generator
2	TU-4	Tektronix type test loads

c. Test accessories

1	011-045	50Ω termination
1	011-032	50Ω 5:1 attenuator
3	012-001	52Ω 42" cables, uhf connectors

d. Miscellaneous equipment

1	630	Triplett meter, 20,000Ω/v dc
or	262	Simpson meter, 20,000Ω/v dc
1	--	Variable line voltage source with meter
1	special	Crt capacitance standardizer
1	special	Standard calibrator

1b. Test equipment

(1) TU-40 may be substituted for 105 and 190B
(2) TU-50 may be substituted for 105, 180A and 190B

NOTES

2. PRELIMINARY INSPECTION

a. Check for unsoldered joints, rosin joints, lead dress and long leads. Check for loose hardware and protruding parts. Check controls for smooth mechanical operation, proper indexing, and knob spacing from front panel.

b. Fuse

Fuse--560

117 v operation: 159-023 2 a mdl slo-blo
234 v operation: 159-019 1 a mdl slo-blo

c. Crt faceplate tilt

Check crt faceplate tilt relative to front panel (keep 560 black light shield in place). Push crt forward to a straight edge firmly against the front panel, across a diameter of the crt. Check gap within phosphor area with rule or crt face tilt checker (special): 1/32", max. If necessary, adjust crt clamp bracket to bring face tilt within specs. Tighten crt clamp.

d. HV shield

Install HV shield.

3. 560 PRESETS

a. External controls

FOCUS	ccw
INTENSITY	ccw
ASTIG	mid r
SCALE ILLUM	mid r
POWER	off
CALIBRATOR	OFF

b. Internal adjustments

-100 Volts R641	mid r
Cal Ampl R871	mid r

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

3b. Presetting internal adjustments

(1) Presetting internal adjustments is helpful for "first-time" calibration but is usually unnecessary for recalibration. If you preset, you'll have to perform a 100% recalibration. Don't preset them unless you're certain a "start-from-scratch" policy is the best.

4. RESISTANCE CHECKS

a. Check resistance to ground; meter scale to 1 k.

supply	approx resistance
117 v ac (power switch on)	inf
-100 v	7 k
- 12 v	50 k
+125 v	1.7 k
+300 v	20 k
+210 v* unreg	1.8 k
+420 v* unreg	6.5 k

*Voltage may be labeled differently on some schematics.

5. UNREGULATED SUPPLIES

a. Setup

Remove V620, 6DQ5. Insert two TU-4 test-loads into 560. Set test-loads to full load, 560. Turn POWER ON.

Test scope presets

Volts/cm	.5
Input	A, dc
Time/cm	5 msec
Trigger	+line, auto

b. Unregulated supplies

Check value at given points.

check point	value
T601, term 10	225 v dc, approx
V657, 6GE8, pin 6	450 v dc, approx
V609, 0G3, pin 1	85 v dc, approx
V634, 6GE8, pin 9	2 v dc, typically ±2 v

Connect 10X probe to V634, pin 3. Note presence of 60 cycle (partially rectified), 5 v waveform. Turn 560 power off.

NOTES

6. STARTING CIRCUIT

a. Setup

Leave probe connected as in previous step. Replace V620, 6DQ5.

b. Oscillator operation

Turn POWER ON. The 60 cycle waveform should reappear immediately. As the oscillator begins to work, the 60 cycle waveform will disappear and in its place must appear the oscillator waveform. The oscillator waveform will be a 25 kc signal, approx 4 v amplitude.

7. REGULATED LOW VOLTAGE SUPPLIES

a. Setup

Test-load presets (both)

Supply	-100 v
Position	mid r
Dual-trace, normal	normal
Indicator	560

Connect, with 52 Ω 42" cable, the ripple and percent dc error of either test-load and the H input.

Test scope presets

Volts/cm	.02
Input	A, dc
Time/cm	5 msec
Trigger	+line, auto

b. Value, regulation

Set left TU-4 to full load, right TU-4 to no load.

Adjust -100 Volts R641 for 0% error on test scope.

Check each supply for value as the line voltage is varied from 105 to 125 v ac. Check under full and no load conditions, except -12.2 v supply which should be checked under half and full load conditions.

supply	max error div	percent
-100	±1	±2%
- 12.2	-1 to +5.5	-2% to +11%
+125	±2.5	±5%
+300	±1	±2%

7a. Test-load functions

(1) Each TU-4 is capable of half loading the supplies when set to full load. To check the supplies under full load conditions set both TU-4's to full load. Conversely, for low load conditions set both TU-4's to no load.

(2) The push to remove ripple button removes ripple so that a more accurate reading may be obtained.

(3) The push for gnd ref button will give a zero reference on test scope.

7b. Percent error

(1) Each div on the test scope (supply level compares to zero reference) represents a 2% error in supply voltage when H is at .02 volts/cm.

c. Ripple, 105 to 125 v ac.

Max ripple specifications are as follows:

supply	120 cps ripple	25 kc ripple
-100 v	10 mv	20 mv
- 12 v	10 mv	20 mv
+125 v	10 mv	50 mv
+300 v	40 mv	25 mv

Remove test-load connections

8. LINE POLARITY

a. Line polarity, 117 v ac only

Upper neon on and lower neon off indicates correct line polarity. If both neons are on line polarity is reversed.

9. HIGH VOLTAGE

a. -3300 v ±3%, max

Connect voltmeter between crt cathode end of R854 and ground. Set INTENSITY for normal setting. Set one TU-4 for full load and the other for no load.

Note voltage: -3300 v, ±3%, max from 105 to 125 v ac. Leave at 117 v ac.

7c. Ripple

When measuring ripple, release the push to remove ripple button and read ripple on test scope: 1 cm = 20 mv with .02 v/cm test scope sensitivity setting.

10. CALIBRATOR

a. Setup

accurate +100 v--52 Ω cable--cal in, standard cal
test scope, vert input--52 Ω cable--output, standard cal
560 CAL OUT--52 Ω cable--unk-in, standard cal

Set standard calibrator to 100 v, mixed.

Ground V884, pin 8.

b. Accuracy ±2%, max

Check CALIBRATOR accuracy as follows:

CALIBRATOR	stand cal	test scope sensitivity v/cm, ac	test scope deflection max
100 VOLTS	100 v	.01	adjust to zero with Cal Adj R871
10 VOLTS	10 v	.1	2 cm
1 VOLTS	1 v	.01	2 cm
.1 VOLTS	.1 v	.005	.4 cm
10 mVOLTS	10 mv	.005	min*
1 mVOLTS	1 mv	.005	min*

*For greater accuracy use a 2A63 to check these positions.

Remove V884, pin 8 gnd strap. Remove calibrator signal.

c. Cal symmetry

Connect voltmeter between V884, pin 7 and gnd. Note voltage as CALIBRATOR is turned through all of the steps: 40 to 60 v. Remove meter.

10a. Known accurate +100 v

(1) A good source is the test scope:
(2) Connect the standard calibrator cal in connector to the test scope cal out connector.
(3) Connect the standard calibrator output to the test scope input.
(4) Remove the output section of the test scope amplitude calibrator's multivibrator and set the amplitude calibrator control to 100 volts.
(5) Connect an accurate voltmeter (John Fluke type 803 differential voltmeter) to the cal out connector and adjust the Cal Adj for exactly +100 v on the voltmeter.
(6) Remove the meter.

10b. Interpreting display

(1) The test scope display is a 60 cps square wave: one half of each cycle is the standard calibrator dc reference (accurate); the other half is the calibrator dc reference (unknown accuracy).
(2) The amplitude of the display is the voltage difference between an accurate dc reference and a dc reference of unknown accuracy (the 560 calibrator, whose accuracy we're checking).
(3) 560 cal % error = $\frac{\text{voltage difference x 100}}{\text{560 CALIBRATOR setting}}$
(4) Example:

	case 1	case 2
Standard calibrator:	100 volts	20 volts
560 CALIBRATOR setting:	100 VOLTS	20 VOLTS
Test scope vert sensitivity:	5 v/cm	.1 v/cm
Test scope vert deflection:	1 cm	2 cm

Case 1: % error = $\frac{5 \times 100}{100} = 5\%$

Case 2: % error = $\frac{.2 \times 100}{20} = 1\%$

(5) In the table of step 10b., we've worked out the settings so that the deflection listed is the maximum allowable to remain within test specifications.

11. ALTERNATE SWEEP

a. Alternate sweep

Remove the left TU-4 and insert a 2B67. Set TU-4 to dual trace. Set 2B67 for free-run. Check for a displayed two traces. Interchange TU-4 and 2B67 and again check for two traces displayed. Reset TU-4 to normal.

12. SCALE ILLUM, ALIGN CRT

a. SCALE ILLUM

Rotate SCALE ILLUM through its range. Check for open spots and for brightest graticule lights when SCALE ILLUM is cw.

b. Align crt

Set 2B67 to 1 msec/cm, free-run. Adjust FOCUS and ASTIG for well defined trace. Align trace with the center horiz graticule line, using adjustment knob.

13. COMPRESSION, EXPANSION

a. Setup

105--50 Ω term--52 Ω cable--signal input TU-4 or TU-50--special atten head--signal input TU-4

b. Compression, expansion total: 1 mm, max

Adjust 105 for exactly 2 cm display at graticule center. Position display to top then to bottom graticule lines. Note compression or expansion: total must not exceed 1 mm. Remove 105 signal.

14. CALIBRATOR WAVEFORM, CRT

a. CALIBRATOR waveform

Remove TU-4 and insert 2A60. Connect a jumper between CAL OUT and 2A60 input. Check for good waveform.

b. CRT

Check crt for double-peaking, phosphor spots, and cathode interface.

15. GEOMETRY

a. Horiz geometry 1 mm, max

Set 2B67 to 1 msec/div, free-run. Adjust 2A60 for 8 major div deflection. The separation of the two traces must not vary by more than 1 mm from one end of the graticule area to the other. Remove CALIBRATOR signal.

b. Vert geometry 1 mm, max

Connect 180A 1 msec and 100 μ sec markers to 2A60 input. Adjust 2B67 triggering level for stable display. Adjust 2A60 for markers reaching from bottom to top of graticule. Adjust ASTIG and FOCUS for well-defined trace. Max deviation of vertical trace from vertical graticule line, top to bottom, is 1 mm. Remove 180A signal.

16. VERT SENSITIVITY, CRT ELECTRICAL CENTER

a. Vert sensitivity 21.6 to 24.4 v/div

Connect a meter across vertical deflection plates. Set trace to top graticule line, note meter reading. Set trace to bottom graticule line, note meter reading. Divide the algebraic difference in the meter readings by 8. This figure is the vert sensitivity. It must be between 21.6 and 24.4 v/div.

b. Crt electrical center .6 major div, max.

Short the vertical crt plates (use non-magnetic metal). Note distance of trace from crt graticule center: .6 major div, max.

17. VERT COMPENSATION, INT TRIGGER

a. Setup

Install a crt capacitance standardizer (special) in the left compartment, behind the 2A60 plug-in.

105-50 Ω term--52 Ω cable--2A60--standardizer--560
or TU-50, 105 gen--special atten head--2A60--standardizer--560

Set 2A60 to .05 v/div.

2B67 presets: +slope, ac slow coupling, int source.

b. Crt Plate Compensation C760

Set 105 for 10 kc signal. Adjust 105 and 2A60 for 6 major div of display. Adjust 2B67 triggering level for a stable display. Set Crt Plate Compensation C760 for best square wave.

c. Int trigger

Check internal trigger lead by changing 2A60 input to gnd. The trace should disappear. Reset to dc. Remove 105 signal.

18. HORIZ SENSITIVITY, ELECTRICAL CENTER

a. Setup

Interchange 2B67 and 2A60. Remove the crt capacitance standardizer at this time.

b. Horiz sensitivity 17.6 to 19.8 v/div

Connect a meter across vertical deflection plates. Set trace to left vert graticule line; note meter reading. Set trace to right line; note meter reading. Divide the algebraic difference in the meter readings by 10. This figure is the horiz sensitivity. It must be between 17.6 and 19.8 v/div.

c. Crt electrical center .8 major div, max

Short the horiz crt plates (use non-magnetic metal). Note distance of the trace from crt graticule center: .8 major div, max.

NOTES

19. HORIZ COMPENSATION, INT TRIGGER

a. Setup

Install a crt capacitance standardizer (special) in the right compartment behind the 2A60 plug-in.

105--50 Ω term--52 Ω cable--2A60--standardizer--560
or TU-50, 105 gen--special atten head--2A60--standardizer--560

Keep 2A60 to .05 v/div.

2B67 presets: +slope, ac slow coupling, int source.

b. Crt Plate Compensation C761

Set 105 for 10 kc signal. Adjust 105 and 2A60 for 6 major div of display. Adjust 2B67 triggering level for a stable display. Set Crt Plate Compensation C761 for best square wave.

c. Int trigger

Check internal trigger lead by changing 2A60 input to gnd. The trace should disappear. Reset to dc. Remove 105 signal.

20. FREQ RESPONSE

a. Setup

Remove crt capacitance standardizer and replace 2A60 into right-hand compartment. Set 2A60 to .05 v/div.

190B--50 Ω term--2A60 input

b. Freq response 1 mc, min at -3 db point

Set 190B to 50 kc. Adjust 190B for 4 major div deflection. Set 190B to 1 mc. Note deflection: 2.8 major div, min. Reverse plug-ins and repeat freq response check. Remove 190B signal.

21. LINE TRIGGER

a. Line trigger

Connect the uhf end of 10X probe to 2A60 input. Connect the probe to the ac line at the fuse holder. Check for proper 2B67 ± trigger phasing. Reverse plug-ins and repeat check. Remove probe.

22. **CRT CATHODE**

a. EXTERNAL INPUT--CRT CATHODE

Remove crt cathode ground strap (scope rear). Apply 10 v of test scope calibrator signal to CRT CATHODE. With normal trace intensity, trace should be modulated.

23. **THE END.**

SPECIAL TEST EQUIPMENT

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.

USE OF STANDARD CALIBRATOR

The standard calibrator, when calibrated, is traceable to NBS and is used to guarantee tolerances of vertical amplifiers and calibrators of Tektronix oscilloscopes.

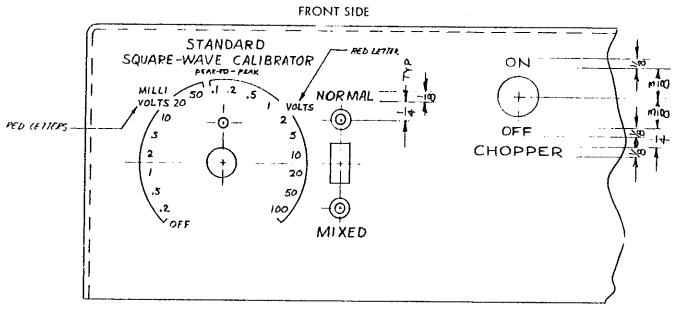
The circuit consists of a chopper and a divider network of 0.1% accurate resistors. The divider network provides a standard voltage output when loaded with 1 meg and when an accurate +100 v is applied to the input. The chopper allows the voltage output of the standard calibrator to switch between a known voltage and an unknown voltage. The difference between these voltages may then be determined by monitoring the output with an ac coupled scope.

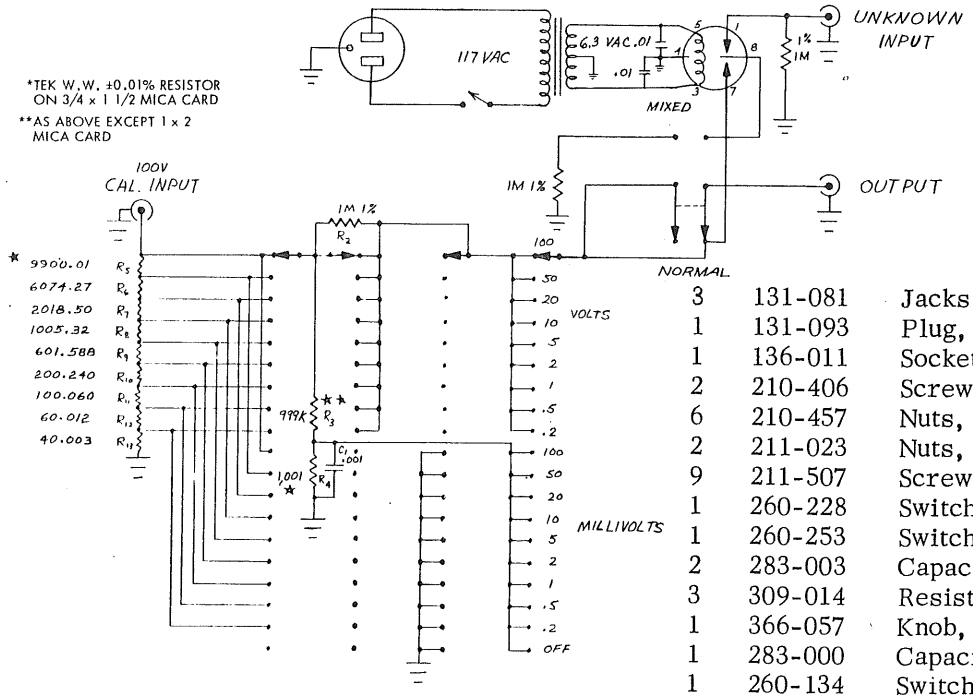
You must take the hum level of the standard calibrator into account when checking divider accuracy at low levels (.1 v and below). Measure the error introduced by hum level by turning both the standard calibrator and the calibrator of the scope under test to off. Observe the vertical displacement (hum level) and subtract this, when appreciable, from other readings.

Leave the standard calibrator in NORMAL when not in use.

STANDARD CALIBRATOR:

Dwgs 600-B, 7-10-61 (front and rear panels); 601-B, 7-10-61 (schematic); 918-A, (parts).





3	131-081	Jacks, Amphenol
1	131-093	Plug, receptacle
1	136-011	Socket, octal
2	210-406	Screws, 4-40 1/4"
6	210-457	Nuts, 6-32 Kep
2	211-023	Nuts, 4-40
9	211-507	Screws, 6-32
1	260-228	Switch, dpdt slide
1	260-253	Switch, 19 pos., 3 sec. rotary
2	283-003	Capacitors, .01 μf 150 v disc type
3	309-014	Resistors, 1 meg 1/2 w 1% prec
1	366-057	Knob, large black
1	283-000	Capacitor, .001 μf 500 v disc type
1	260-134	Switch, spst toggle
11	--	Resistors, special Tek-made WW, ±.01% mica plate

CRT CAPACITANCE STANDARDIZER

Dwgs: 457-B, 2-23-61 (schematic); 456-B, 2-23-61 (assembly).