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.

561S

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062-093
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For 561S, all serial numbers, not for 561, 561A or RM561A

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 adustments, 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).

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

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.

1. EQUIPMENT REQUIRED

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

3. 561S PRESETS

4. RESISTANCE CHECKS

5. POWER SUPPLIES

5b. Adjusted within ±.5%, max.
5c. Regulation: ±1%, max.
5d. Ripple maximums:

supply	full load	no load
-100 v	5 mv	5 mv
+125 v	10 mv	5 mv
+300 v	80 mv	10 mv
-12.2 v	3 mv	3 mv; min loading, 150 ma

6. CALIBRATOR

6b. Accuracy: ±2%, max.
6b. 100 mv: ±2%, max.
6c. Symmetry: ±20%, max.

7. INTENSIFIED PULSE CIRCUIT

8. HIGH VOLTAGE, FOCUS

8a. -3300: ±2%, max.
8a. Regulation: ±2%, max.

9. ALTERNATE SWEEP

10. DUAL-TRACE BLANKING

11. EXTERNAL CRT CATHODE INPUT

12. CRT COMPRESSION, EXPANSION

12b. Total: 1 mm, max.

13. SCALE ILLUM, ALIGN CRT

14. CALIBRATOR WAVEFORM, CRT, INT TRIGGER

15. GEOMETRY

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

16. VERT SENSITIVITY, CRT ELECTRICAL CENTER

16a. Vert sensitivity: 11.1 to 12.3 v/div.
16b. Crt electrical center: .3 major div, max.

17. HORIZ SENSITIVITY, ELECTRICAL CENTER

17b. Horiz sensitivity: 19.4 to 21.4 v/div.
17c. Crt electrical center: .8 major div, max.

18. LINE TRIGGER

19. CRT INTENSIFIED CIRCUIT

20. 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	3B1	Tektronix type time-base plug-in unit
2	TU-4	Tektronix type test loads

c. Test accessories

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

d. Miscellaneous equipment

1	630	Triplett meter, 20,000 Ω/v dc
or	262	Simpson meter, 20,000 Ω/v dc
1	--	Variable line voltage source with meter
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.

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. 561S Fuse

117 v operation :	159-005	3	a	mdl	slo-blo
234 v operation :	159-003	1.6	a	mdl	slo-blo
F720 (-12 v, internal):	159-023	2	a	mdx	slo-blo

c. Crt

Loosen crt neck clamp. Insert crt into indicator.

Level the crt by adjusting support bracket. Check neck pin connection tightness.

Note crt serial number.

Check crt for mechanical defects: phosphor defects, scratches, cracks around neck pins, etc.

Install graticule cover.

d. HV shield(s)

Install HV shield(s).

3. 561S PRESETS

a. External controls

FOCUS	ccw
INTENSITY	ccw
ASTIGMATISM	ccw
SCALE ILLUM	mid r
POWER	off
CALIBRATOR	OFF
TRACE ALIGNMENT	mid r

b. Internal adjustments

Geometry R865	ccw
High Voltage R841	ccw
low voltage adjustments	mid r
All other internal adjustments	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.

supply	approx resistance
117 v ac (power switch on)	inf
-100 v	10 k
+125 v	15 k
+300 v	60 k
-12 v	135 Ω (common lead to gnd)
+6 v unreg	75 Ω (common lead to gnd)

b. Terminal 18-19 continuity

Connect an ohmmeter between terminals 18 on both Amphenol connecting plugs and check continuity. Repeat procedure for terminals number 19. Check for inf resistance between terminals 18 and 19.

5. POWER SUPPLIES

a. Setup

Insert both TU-4's in 561S and connect a 52 Ω cable between TU-4's ripple and dc error connector and the H unit input. Set both TU-4's to 561 indicator; -100 v, full load.

Set test scope to .005 v/div, dc, 5 msec/cm, +line, auto. Connect 561S to variable line voltage, set source to 117 v and turn POWER ON. Allow sufficient warm-up time before proceeding.

b. Low voltage adjustments ±.5%, max

All regulated low voltage supplies must be adjusted within ±.5% of the rated values under full load.

Depress the push for gnd ref of TU-4 to obtain a zero error reading on the test scope. Push the push to remove ripple button to remove the supply ripple and set the -100 Volts R616 for zero error indication on test scope.

Repeat this procedure for adjustment of +125 Volts R656, +300 Volts R676, and -12.2 Volts R730. Recheck adjustments.

Note: +125 Volts R656 should be adjusted before -12.2 Volts R730 and +300 Volts R676.

c. Regulation ±1%, max

All regulated low voltage supplies must maintain regulation within ±1% of nominal values when the line voltage is varied from 105 to 125 v ac under full and no load conditions (min load of 150 ma for -12.2 v supply).

d. Check ripple to following maximums

supply	full load	no load
-100 v	5 mv	5 mv
+125 v	10 mv	5 mv
+300 v	80 mv	10 mv
-12.2 v	3 mv	3 mv; min loading, 150 ma

e. Line polarity neons at 117 v ac

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

5a. 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.

5b. Percent error

(1) Each div on the test scope (supply level compared to zero reference) represents a .5% error in supply voltage when H is at .005 volts/cm.

5c. -12 v loading

In order to check the -12 v supply under min load conditions both TU-4's should be set to no load and an external resistor connected between -12 v supply and gnd. The resistor, approx 80 Ω, should be picked so as to draw -150 ma.

5d. Ripple

When measuring ripple, release the push to remove ripple button and read ripple on test scope: 1 cm = 10 mv with .01 v/cm test scope sensitivity setting.

6. CALIBRATOR

a. Setup

accurate +100 v--52 Ω cable--cal in, standard cal
test scope, vert input--52 Ω cable--output, standard cal
561S 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:

561S CALIBRATOR VOLTS	stand cal volts	test scope sensitivity v/cm, ac	deflection max
100	100	.01 with Cal Adj R871	adjust to zero
50	50	.5	2 cm
20	20	.2	2 cm
10	10	.1	2 cm
5	5	.05	2 cm
2	2	.02	2 cm
1	1	.01	2 cm
.5	.5	.005	2 cm
.2	.2	.005	.8 cm
.1	.1	.005	.4 cm

Check for 100 mv signal into 50 Ω load with CALIBRATOR at .5 VOLTS.

.5	.1	.005	.4 cm

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

NOTES

6a. 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.

6b. 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 561S calibrator, whose accuracy we're checking).
(3) 561S cal % error = $\frac{\text{voltage difference} \times 100}{\text{561S CALIBRATOR setting}}$
(4) Example:

	case 1	case 2
Standard calibrator:	100 volts	20 volts
561S 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 6b, we've worked out the settings so that the deflection listed is the maximum allowable to remain within test specifications.

c. Cal symmetry ±20%, max

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.

7. INTENSIFIED PULSE CIRCUIT

a. D838 - D839 junction .3 to .6 v, max

Connect meter to D838 - D839 junction. Note meter reading: +.3 to +.6 v, max. If the reading exceeds +.6 v, any sweep unit with an intensifying circuit could be damaged. Remove meter.

8. HIGH VOLTAGE, FOCUS

a. HV Adj R841 -3300: ±2%, max
regulation: ±2%, max

Connect a meter from gnd to the crt filament end of R851 (100 k). Adjust HV Adj R841 for -3300 v.

Set INTENSITY max cw. Check hv supply for regulation by varying line voltage from 105 to 125 v ac at full load and no load.

Leave line voltage at 117 v ac.

b. FOCUS

Vary FOCUS over its range while noting meter. Voltage should not vary.

Remove meter.

9. ALTERNATE SWEEP

a. Alternate sweep

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

10. DUAL-TRACE BLANKING

a. Setup

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

b. Dual-trace blanking, left side only

Adjust 105 for 1 cm display of 100 kc signal. Adjust INTENSITY for normal trace intensity. Connect a jumper from the TU-4 signal input to the TU-4 Z axis input. Set the CRT CATHODE SELECTOR to CHOPPED BLANKING. Upper portion of the crt display must disappear and the lower portion will get brighter. Remove 105 signal and TU-4 jumper.

11. EXTERNAL CRT CATHODE INPUT

a. EXT CRT CATHODE

Remove EXT CRT CATHODE gnd strap from scope rear. Insert a 10 v calibrator signal to EXT CRT CATHODE. Set CRT CATHODE SELECTOR to EXT CRT CATHODE and check the sweep for intensity modulation. Remove the signal and replace the gnd strap.

12. CRT COMPRESSION, EXPANSION

a. Setup

105--50Ω term--52Ω 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 top of display to top graticule line. Note compression or expansion. Position bottom of display to bottom graticule line. Note compression or expansion: total must not exceed 1 mm. Remove 105 signal.

13. 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

Remove TU-4 and insert 2A60.

Set 2B67 to 1 msec/div, free-run. Adjust FOCUS and ASTIGMATISM for well defined trace. Adjust TRACE ALIGNMENT to align trace with the center horiz graticule line.

14. CALIBRATOR WAVEFORM, CRT, INT TRIGGER

a. CALIBRATOR waveform

Connect a jumper between CAL OUT and 2A60 input. Check for good waveform throughout all CALIBRATOR positions.

b. Int trigger

Trigger on 4 cm CALIBRATOR waveform. Remove signal, trace should disappear. Exchange plug-ins and recheck trigger. Exchange plug-ins once again.

c. Crt

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

15. GEOMETRY

a. Horiz geometry 1 mm, max total

Set 2B67 to 1 msec/div, free-run. Recheck crt alignment. Position the trace from top to bottom of graticule area and check for horizontal bowing or deviation from horizontal line: 1 mm, max total.

b. Vert geometry 1 mm, max

Connect 180A 1000 μsec and 100 μsec markers to 2A60 input. Adjust 2B67 triggering level for stable display and timing, if needed. 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 11.1 to 12.3 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. Total swing over 6 cm must be between 66.6 to 73.8 v.

b. Crt electrical center .3 major div, max

Short the vertical crt plates (use non-magnetic metal). Note distance of trace from crt graticule center: .3 major div, max.

17. HORIZ SENSITIVITY, ELECTRICAL CENTER

a. Setup

Interchange 2B67 and 2A60.

b. Horiz sensitivity 19.4 to 21.4 v/div

Connect a meter across horizontal deflection plates. Set trace to left vert graticule line, note meter reading. Set trace to right line, note meter reading. Total swing over 10 cm must be between 194 to 214 v.

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.

18. 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.

19. CRT INTENSIFIED CIRCUIT

a. Setup

Install 2A60 into left hand compartment and 3B1 into right hand compartment.

3B1 presets: normal sweep, time/div to 1 msec and delayed sweep to .1 msec, mode to norm, and normal sweep triggering coupling to auto. The sweep should appear on the crt. Set 3B1 mode to inten and check for an intensified portion of the sweep.

20. 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.

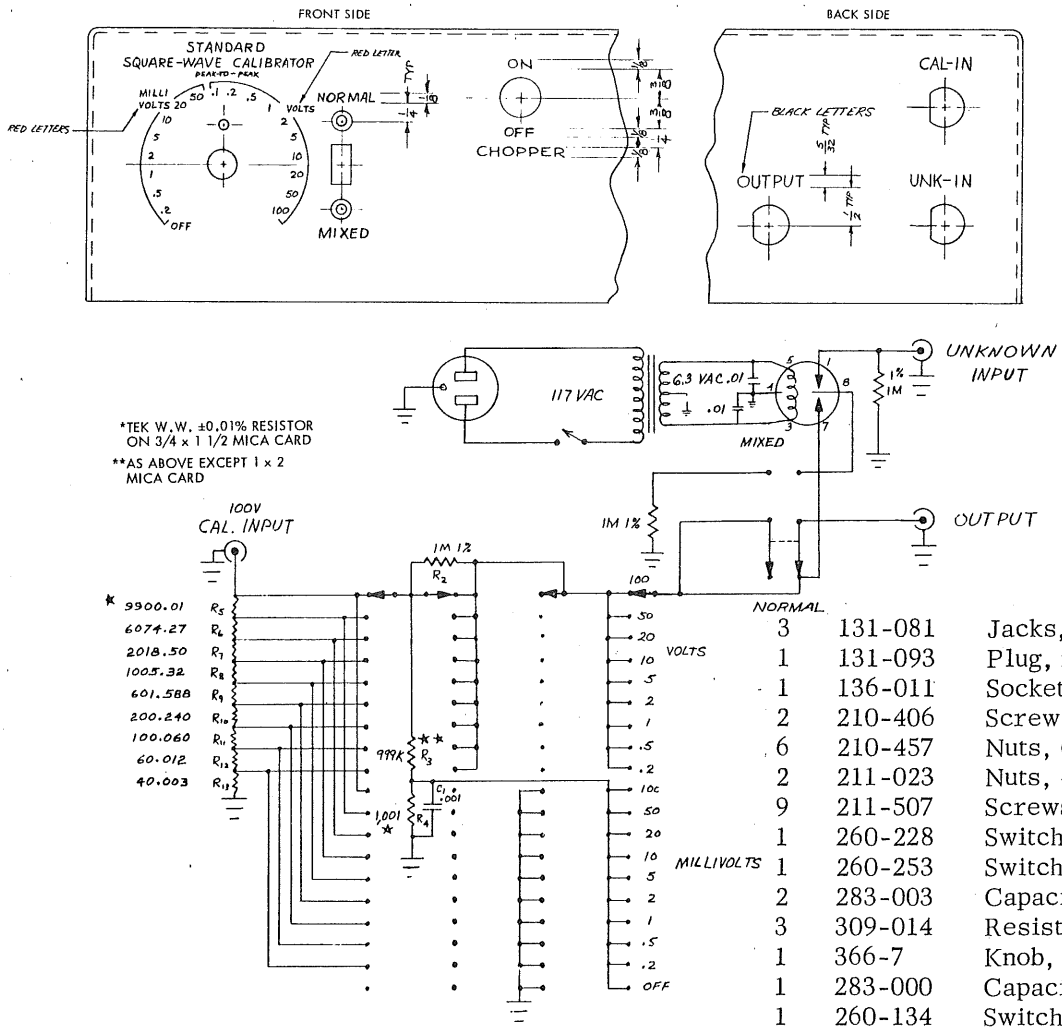
The circuit consists of a chopper and a divider network of 0.1% accurate resistors. The divider network provides a standard voltage output when loaded with 1 meg and when an accurate +100 v is applied to the input. The chopper allows the voltage output of the standard calibrator to switch between a known 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	366-7	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