NOTE REGARDING FACTORY CALIBRATION PROCEDURES AND TEST SPECIFICATIONS

Factory Calibration Procedures and Test Specifications are intended for use at the factory as a general guide for calibrators and quality control men. Most of the tolerances listed in these sheets are closer than advertised specifications. This is done purposely in order to insure that the instrument will meet or exceed advertised specifications when it reaches the customer.

These calibration procedures and test specifications should be used, therefore, as a guide only.

Some of the test equipment referred to in the calibration procedures is not available commercially; the Tektronix field engineer will be glad to suggest alternate approaches.

1/16/61
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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.

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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.

For 53/54L and L, all serial numbers.

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).

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.

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

3. L PRESETS

4. RESISTANCE CHECKS

5. SETUP

6. OUTPUT DC LEVEL

6a. 67.5 v: ±2.5 v, max.

7. VARIABLE ATTEN BAL

7a. Mid r: ±90°, max.

8. GAS AND MICROPHONICS

8a. Gas: 2 mm, max.
8b. Microphonics: .5 mm, max; no ringing type.

9. VERT POS RANGE

9a. Mid r: ±90°, max.

10. VARIABLE ATTEN BAL X10

10a. Mid r: ±90°, max.

11. X10 AC MICROPHONICS

11a. Microphonics: .5 cm, max; no ringing type.

12. CATHODE-CURRENT ADJ

12a. +100 v
12a. Mid r: ±90°, max.

13. GAIN ADJUST

13b. Range: ±10%, min.
13c. VARIABLE range: 2.5 to 1, min.

14. AC-DC

15. GAIN ADJUST X10

15b. Range: ±10%, min.

16. VOLTS/CM

16a. Accuracy: ±2%, max.

17. INPUT CAPACITY

18. VOLTS/CM COMPENSATION

19. LOW FREQ ADJ

19b. Mid r: ±105°, max.

20. HF PEAKING

20b. Not against stop.

21. PREAMP HF COMP

22. FREQUENCY RESPONSE

22b. DC: dc to 30 mc (-3 db point).
-- AC: 2 cps (-3 db point) to 30 mc (-3db point).
22c. X10 GAIN AC: 3 cps to 24 mc (-3 db point).

23. THE END.

CALIBRATION

NOTES

1. EQUIPMENT REQUIRED

a. Plug-in scope

1	540 series	Tektronix type scope

1a. Plug-in scope

(1) Determine condition of delay line (front corner). Use P unit or known good K unit. A badly tuned delay line will affect appearance of high frequency waveform.

b. Test equipment

1	105	Tektronix type square-wave generator
1	107	Tektronix type square-wave generator
1	190B	Tektronix type constant amplitude sine-wave generator

1b. Equipment substitutes

(1) TU-40 may be substituted for 105 or 190B.
(2) TU-50 may be substituted for 105, 107, and 190B.

c. Test accessories

2	012-001	52Ω 42" cables, uhf connectors
1	011-031	50Ω 10:1 attenuator
1	011-045	50Ω termination
1	011-022	20pf input time-constant standardizer
1	013-019	Plug-in extension

d. Miscellaneous equipment

1	630	Triplett meter; 20,000Ω/v dc
	or 262	Simpson meter; 20,000Ω/v dc
1	special	Standard calibrator

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 spacing of knobs from front panel.

NOTES

3. L PRESETS

a. External controls

VERTICAL POSITION	mid r
VOLTS/CM	.05
VARIABLE	CALIBRATED
input	DC
GAIN ADJUST	cw
GAIN ADJUST X10	cw
VARIABLE ATTEN BAL	mid r
VARIABLE ATTEN BAL X10	mid r

b. Internal adjustments

All coil slugs	just below bottom of windings
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 resistances to ground

use	Amphenol pin	approx resistance
output	1	9 k
gnd	2	0 Ω
output	3	9 k
not used	4 to 8	inf
-150 v	9	14 k
+100 v	10	1.2 k
+225 v	11	8.5 k
+350 v	12	inf
not used	13, 14	inf
+75 v filament	15	90 Ω
not used	16	inf

5. SETUP

a. Plug-in scope presets

Trigger	-int, auto
Time/cm	1 msec

b. Connect L

Plug L into plug-in scope. Turn power on.

6. OUTPUT DC LEVEL

a. Voltage at pins 1 and 3 +65 to +70 v

Check voltage between pin 1 of Amphenol connector and gnd: +65 to +70 v. Check voltage between pin 3 and gnd: +65 to +70 v.

7. VARIABLE ATTEN BAL

a. VARIABLE ATTEN BAL mid r: ±90°, max

Rotate VARIABLE volts/cm back and forth while adjusting VARIABLE ATTEN BAL for no trace shift.

VARIABLE ATTEN BAL must be within ±90° of mid r after adjustment. Return VARIABLE to CALIBRATED.

8. GAS AND MICROPHONICS

a. Gas 2 mm, max

Jumper INPUT to ground. Move AC-DC from DC to AC. Note trace shift (gas): 2 mm, max. Return AC-DC to DC.

b. Microphonics .5 mm, max; no ringing type

Rotate VOLTS/CM through range and note microphonics: .5 mm, max; no ringing type.

NOTES

9. VERT POS RANGE

a. Vert Pos Range R6572

Momentarily short Amphenol connector pins 1 and 3 together and note trace vertical position (electrical center).

Recheck VARIABLE ATTEN BAL. Set VERTICAL POSITION to mid r. Adjust Vert Pos Range R6572 to move trace to plug-in scope's electrical center.

b. R6572 mid r, ±90°, max

Vert Pos Range R6572 must be within ±90° of mid r after adjustment.

10. VARIABLE ATTEN BAL X10

a. VARIABLE ATTEN BAL X10 mid r: ±90°, max

Set input to X10 GAIN AC. Return trace to electrical center with VARIABLE ATTEN BAL X10. VARIABLE ATTEN BAL must be within ±90° of mid r after adjustment.

11. X10 AC MICROPHONICS

a. Microphonics .5 cm, max; no ringing type

Rotate VOLTS/CM through range and note microphonics: .5 cm, max; no ringing type.

11a. Ringing or excessive micro

(1) Select V5832, V5942, V6042, and V6132.

12. CATHODE-CURRENT ADJ

a. Cathode-Current Adj R5922 +100 v
mid r: ±90°, max

Connect voltmeter from V6042, pin 6 to V6042, pin 2 or 7. Adjust Cathode-Current Adj R5922 for +100 v. Remove meter. R5922 must be within ±90° after adjustment.

13. GAIN ADJUST

a. Setup

accurate +100 v--52 Ω cable--cal in, standard cal
L INPUT--52 Ω cable--output, standard cal

L presets

input	DC
VOLTS/CM	.05
VARIABLE	CALIBRATED

b. GAIN ADJUST range: ±10%, min

Apply .1 v from standard calibrator to INPUT. Set GAIN ADJUST cw; note 2.2 cm deflection, min. Change GAIN ADJUST to ccw; note 1.8 cm deflection, max. Adjust GAIN ADJUST for exactly 2 cm deflection.

c. VARIABLE range: 2.5 to 1, min

Set VARIABLE to max atten. Note deflection: .8 cm, max. Note any noise or open spots during rotation of VARIABLE. Return to CALIBRATED.

14. AC-DC

a. Waveform shift

Move bottom of calibrator waveform to center graticule line with VERTICAL POSITION. Change input to AC. Waveform must shift so it's approximately centered about center graticule line.

15. GAIN ADJUST X10

a. GAIN ADJUST X10 range: ±10%, min

Apply 10 millivolts from standard calibrator to INPUT. Set input to X10 AC. Set GAIN ADJUST X10 cw; note 2.2 cm deflection, min. Change GAIN ADJ X10 ccw; note 1.8 cm deflection, max. Adjust GAIN ADJUST X10 for exactly 2 cm deflection. Reset input to DC.

13a. 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.

NOTES

16. VOLTS/CM

a. VOLTS/CM accuracy ±2%, max

VOLTS/CM	calibrator volts	deflection cm ±2%
.05	.1	*2 , ±.4 mm, adjustable
.1	.2	2 , ±.4 mm
.2	.5	2.5, ±.5 mm
.5	1	2 , ±.4 mm
1	2	2 , ±.4 mm
2	5	2.5, ±.4 mm
5	10	2 , ±.4 mm
10	20	2 , ±.4 mm
20	50	2.5, ±.5 mm

*Adjusted previously

17. INPUT CAPACITY

a. Setup

105--50 Ω term--52 Ω cable--20 pf stand--L INPUT
or TU-50, 105 gen--special atten head--20 pf stand--L INPUT

L presets

VOLTS/CM	.05
VARIABLE	CALIBRATED
input	DC

b. C5732

Set 105 for about 3.5 cm deflection of 1 kc signal. Adjust C5732, input capacitor, for best square wave.

18. VOLTS/CM COMPENSATION

a. Setup

Use an EP54 plug-in extension to connect L plug-in to plug-in scope. Place special shield over L plug-in atten.

b. Adjust compensation

Keep 3.5 cm, 1 kc 105 deflection and adjust for best square wave as follows:

VOLTS/CM	adjustment spike	level
.05	--	C5732*
.1	C5102	C5072
.2	C5162	C5142
.5	C5222	C5202
1	C5292	C5272
2	C5362	C5342
5	C5432	C5412
10	C5522	C5502
20	C5622	C5602

*Adjusted previously

19. LOW FREQ ADJ

a. Setup

Set plug-in scope to 5 msec/cm.

L presets

VOLTS/CM	.05
VARIABLE	CALIBRATED
input	AC

b. Low Freq Adj R6182 mid r: ±105°, max

Set 105 to 100 cps. Adjust 105 for 3.5 cm deflection. Note top slanting of square wave. Set input to X10 AC.

Readjust 105 for 3.5 cm deflection.

Adjust Low Freq Adj R6182 for same slant of waveform noted in AC. R6182 must be within ±105° of mid r after adjustment.

Remove 105 signal. Remove extension from L unit and insert L unit into scope.

20. HF PEAKING

a. Setup

107--52Ω cable--50Ω term--L INPUT

L presets

VOLTS/CM	.05
VARIABLE	CALIBRATED
AC-DC	DC

Set plug-in scope to .2μsec/cm.

b. HF Peaking R6692

Set 107 for about 3 cm deflection of approx 450 kc. Adjust HF Peaking R6692 for best square wave. R6692 must not be against stop after adjustment.

20b. Excessive peaking or rolloff

(1) Select V5832.
(2) Select V6242, V6342 (selected pair).

21. PREAMP HF COMP

a. Setup

107--52Ω cable--10:1 atten--50Ω term--L INPUT

Leave scope preset as before.

L presets

VOLTS/CM	.05
VARIABLE	CALIBRATED
input	X10 GAIN AC

b. L5902, L5942, L6012

Set 107 for about 3 cm deflection of approx 450 kc. Adjust L5902, L5942, and L6012 for best square wave. Remove 107 signal.

21b. Excessive peaking

(1) Select V5942, V6042.

22. FREQUENCY RESPONSE

a. Setup

Plug-in scope presets

Trigger	ac
Time/cm	.1 msec
Stability	cw

L presets

VOLTS/CM	.05
VARIABLE	CALIBRATED
input	DC

b. Response-DC input dc to 30 mc (-3 db point)

Attach a 50 Ω termination to 190B output and connect to L INPUT. Set 190B to 50 kc. Adjust 190B for exactly 3 cm deflection.

Increase 190B to 30 mc. Note deflection: 2.1 cm, min.

c. Response-X10 GAIN AC input
3 cps to 24 mc (-3 db point)

190B--10:1 atten--50 Ω term--L INPUT

Set input to X10 GAIN AC. Set 190B to 50 kc. Adjust 190B for exactly 3 cm deflection.

Increase 190B to 24 mc. Note deflection: 2.1 cm, min.

23. THE END.

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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.

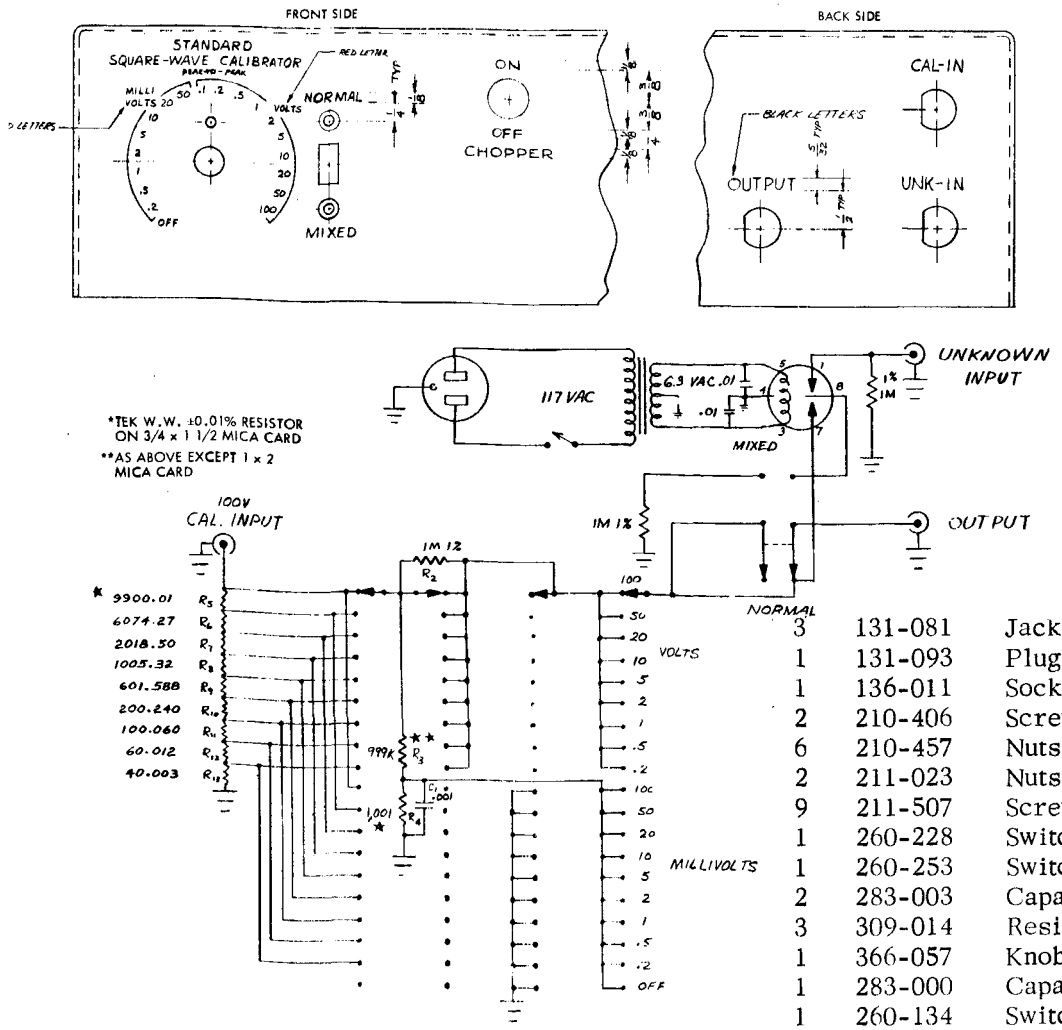
The circuit consists of a chopper and a divider network of 0.1% accurate resistors. The divider network provides a standard voltage output when loaded with 1 meg and when an accurate +100 v is applied to the input. The chopper allows the voltage output of the standard calibrator to switch between a known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