FACTORY CALIBRATION PROCEDURE

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INTRODUCTION:

1L5

This is the guide for calibrating brand-new instruments, it therefore, calls out many procedures and adjustments that are rarely required for subsequent recalibration. *This procedure is company confidential.* In this procedure, all front panel control labels or Tektronix equipment names are in capital letters (VOLTS/DIV, etc.) internal adjustment labels are capitalized only (Gain Adj, etc.).

Tek form number:

0-355

September 1967

For all serial numbers.

FACTORY TEST LIMITS:

We initially calibrate the instrument to Factory Test Limits. These limits are often more stringent than advertised performance requirements. This helps insure that the instrument will meet advertised requirements after shipment, allows for inaccuracies of test equipment used, and may allow for changes in environmental conditions.

QUALIFICATION:

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

ABBREVIATIONS:

Abbreviations in this procedure will be found listed in TEKTRONIX STANDARD A-100.

CHANGE INFORMATION:

This procedure has been prepared by Product Manufacturing Staff Engineering. For information on changes that have been made to this procedure, to make suggestions for changing this procedure, or to order additional copies: please contact PMSE, 47-261. (KM)

EQUIPMENT REQUIRED:

The following equipment is necessary to complete this procedure:

a. TEKTRONIX Instruments

1	TYPE 549 OSCILLOSCOPE (plug-in scope)
1	TYPE 540B SERIES OSCILLOSCOPE (test scope)
1	TYPE 1A1 PLUG-IN UNIT (test scope plug-in)
* 1	TYPE 184 TIME MARK GENERATOR
1	TYPE 191 SIGNAL GENERATOR
1	TYPE 106 SQUARE-WAVE GENERATOR

b. Test Fixtures and Accessories

1	TYPE P6020 (010-0133-00)
1	TYPE P6006 10X PASSIVE PROBE (010-0127-00)
1	TYPE P6011 1X PASSIVE PROBE (010-0193-00)
3	50Ω cables, BNC (012-0057-00)
1	50Ω Termination (011-0049-00)
3	50Ω 5:1 Attenuators (011-0060-00)
4	50Ω 10:1 Attenuators (011-0059-00)
1	30pF Input RC Normalizer (067-0552-00)
1	Flexible extension (012-0039-00)
1	BNC T (103-0030-00)
1	50Ω 2½:1 Attenuator (011-0076-00)
* 2	LF Sine Wave Generators (067-0542-99, adjusted to 1%)
1	STANDARD AMPLITUDE CALIBRATOR (SAC) (067-0502-00)

c. Other Equipment

1	600Ω load cable for TO RECORDER output (PMPE Dwg #1439A)
1	Multimeter 20,000Ω/volt, calibrated to ±1% at 10 volts
1	Ohms picker (PMPE Dwg #1649A, 1670B, 1669B)

* This equipment must be traceable to NBS for instrument certification.

Substitute test equipment may be used. The Plant Staff Engineer must approve any substitutions. All equipment listed must perform within its manufacturer's specifications, unless otherwise stated.

It is assumed that all equipment is provided with BNC connectors; if equipment used has other than BNC connectors, adapters, not listed, may be needed.

QUALIFICATION

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1. PRELIMINARY INSPECTION

2. PRESETS

3. RESISTANCE

4. AC-GND-DC FAST SWITCH

5. POWER SUPPLIES + & -10V; within ±5%
Ripple and hash; ≤ 30mV P-P

6. OUTPUT AMPLIFIER Check Q410 collector voltage: 150V ±2.5%

7. REDUCE DISPERSION LIGHT

8. VIDEO GAIN

b. Adjust VIDEO CAL 4 cm

*9. VOLTS/CM ACCURACY

b. Check VOLTS/CM accuracy: ±2%, ÷100: ±2%
c. Check VOLTS/CM variable range: ≥3:1

10. POSITION CONTROL RANGE at least + & -8cm

11. INPUT ATTENUATOR COMPENSATION

b. Adjust VOLTS/CM capacitors

12. SWEPT OSCILLATOR PRELIMINARY SETUP

b,c. Preset L164, L191, L192, L194

13. CONVERTED SIGNAL

b. Adjust T290
c. Adjust 3 MHz Filter, L280
d. Adjust C323, C343

14. SWEPT OSCILLATOR

a. Adjust L191, R214
b. Adjust L164
c. Adjust 2-3 MHz Filter (L192, L194, R214)
d. Check for 00 and 0 decade sweeps

15. VERTICAL TRACE SHIFT

b. Set R428

16. CENTER FREQUENCY CAL

b. Adjust R156
c. Adjust BAL
d. Adjust 500 kHz CAL
e. Adjust R150
f. Adjust 10 kHz CAL
g. Compare OK and K decade dispersion; ≤ 0.5 div difference

17. K AND OK DISPERSION

a. Adjust 30 kHz CF

*18. OK AND K CENTER FREQUENCY TRACKING

b. Check center frequency tracking: Ok, within 10 kHz +4%; k, within 3 kHz +4%

*19. K AND OK DISPERSION ACCURACY AND LINEARITY

b. Check k and Ok dispersion: accuracy, ±14%; linearity, 2%
c. Check operation of units switching

20. O AND OO DECADE OSCILLATOR TRACKING

a. Adjust 0000 Hz CAL
b. Adjust R128

21. O AND OO DECADE DISPERSION

b. Adjust 5000 Hz CF

22. VARIABLE RESOLUTION AMPLIFIER

b. Adjust skirt response (C323, C343)
c. Adjust bandwidth (L327, L347): ≥500 Hz at 50% amplitude point
d. Readjust L280 for maximum amplitude
e. Adjust 10 Hz resolution amplitude (C323, C352)
f. Check resolution flatness 10 Hz-500 Hz: ±1dB
g. Check MAX resolution bandwidth: ≥500 Hz at 50% amplitude point
h. Check MIN resolution bandwidth: ≤10 Hz at 50% amplitude point

23. INCIDENTAL FM

b. Check incidental FM, 50 Hz to 9900 Hz: ≤3 Hz
c. Check incidental FM, 10kHz to 990 kHz ≤10 Hz

*24. O AND OO DECADE OSCILLATOR TRACKING ACCURACY

b. Check O and OO decade oscillator tracking: 00, within 100 Hz +4%; 0, within 50 Hz +4%

*25. O AND OO DECADES DISPERSION ACCURACY

b. Check O and OO decades dispersion: accuracy, within ±10%; linearity, within ±3%

26. 300 kHz SPURIOUS RESPONSE

b. Adjust L270 (Not necessary if using pre-calibrated filter)

27. LOG GAIN RANGE

b. Adjust Log Range R422: ≥50dB above 1cm

*28. LIN CAL, TO RECORDER OUTPUT

a. Adjust Lin Cal R316
b. Pick R432

29. BALANCED MIXER

Adjust spurious response amplitude (R85, C86): ≥1cm, ≤4cm

30. INTERMODULATION DISTORTION

c. Check intermodulation distortion: ≥50dB down

31. RANDOM SPURIOUS RESPONSES

b. Check random spurious responses: ≥50dB down

32. DISPLAY FLATNESS, 10Hz to 1MHz

b. Select C44
c. Adjust input compensation (C15, C13)
d. Check .005V/CM flatness, ÷100 in: ±0.5dB
e. Check .01 to 2V/CM flatness, ÷100 in and out: ±0.5dB
f. Check .001 and .002 V/CM flatness, ÷100 in and out: +0.5dB, -3dB
g. Check low frequency (10Hz) response .005 V/DIV, ÷100 in and out: ±0.5dB

*33. INPUT AMPLIFIER

b. Check input amplifier frequency response at .1 and .2 VOLTS/CM: ±0.5dB from 10 Hz to 700 kHz
c. Check input amplifier response at .5VOLTS/CM: ±0.5dB from 10 Hz to 1 MHz

*34. CALIBRATOR

a. Adjust calibrator frequency: 5 kHz ±0.5%
b. Set calibrator amplitude: 4cm

35. VARIABLE CENTER FREQUENCY-Hz

b. Check VARIABLE CENTER FREQUENCY range: ≥10 kHz, extending center frequency to ≥1 MHz

36. OSC OUT — Frequency sweep: ≥1MHz (3MHz to 2MHz)
Amplitude: ≥1.2V

37. VARIABLE DISPERSION

38. INT SWEEP MODE

39. MANUAL SWEEP MODE

b. Check manual sweep mode: range, ≥10cm

40. NOISE LEVEL

b. Check noise level: ≤5μvolts

41. SAWTOOTH SELECTOR SWITCH

b. Check sawtooth selector switch

*Indicates measurement characteristic; test equipment used must be traceable to the NBS for instrument certification.

1. PRELIMINARY INSPECTION

Check for unsoldered joints, rosin joints, proper lead dress and long wire ends. Check for loose hardware, protruding parts and foreign material. Check controls for smooth mechanical operation, proper indexing and sufficient spacing between knobs and front panel. Correct all defects found.

2. PRESETS

TYPE 540B SERIES OSCILLOSCOPE (test scope)

HORIZONTAL DISPLAY	A
TRIGGERING MODE	AUTO
TRIGGER SLOPE	+INT
TIME/CM	5mSEC

TYPE 1A1 PLUG-IN (for test scope)

VOLTS/CM	.005
MODE	CH 1
INPUT SELECTOR	AC

TYPE 549 OSCILLOSCOPE (plug-in scope)

HORIZONTAL DISPLAY	A
TRIGGERING MODE	AUTO
TRIGGERING SLOPE	+
TRIGGERING COUPLING	AC
TRIGGERING SOURCE	NORM
TIME/CM	10mSEC

TYPE 1L5 PLUG-IN

CENTER FREQUENCY-Hz	500K (CAL)
POSITION	centered
VOLTS/CM VARIABLE	CAL
VOLTS/CM	5 (outer scale)
VERTICAL DISPLAY	VIDEO
DISPERSION Hz/CM	100K
RESOLUTION	coupled

The RESOLUTION switch should be cross-coupled to the DISPERSION-Hz/CM switch unless the procedure calls out different settings for the two controls.

2. (cont'd)

DISPERSION VARIABLE	CAL
SWEEP MODE	EXT INPUT
MANUAL	0 (MAX ccw)
VOLTS/CM ÷ 100	in
INPUT SWITCH	AC FAST
All screwdriver adjustments and internal adjustments	midrange
Sawtooth selector (rear panel)	150V

3. RESISTANCE

Set multimeter to Ω X1K. Make resistance measurements from the Amphenol 16 pin connector to ground as in the following table:

	Approx Resistance	
Pin Number	Pos Gnd	Neg Gnd
1	8k	10k
2	0Ω	0Ω
3	6.2k	7.8k
4, 5	inf	inf
6	700Ω	700Ω
7, 8	inf	inf
9	4.5k	4.5k
10	6.2kΩ	9.5k
11	12k	12k
12	40k	50k
13, 14	inf	inf
15	1.8k	1.8k
16	inf	inf

4. AC-GND-AC FAST SWITCH

a. Setup

Connect BNC cable from test scope AMPLITUDE CALIBRATOR to TYPE 1L5 INPUT. Connect 10X probe from TYPE 1A1 CHANNEL 1 to the TYPE 1L5 input capacitor junction on first wafer (VOLTS/DIV switch) where 464Ω resistor and the first wafer meet.

4. (cont'd)

b. Check AC-GND-AC FAST SWITCH

Position TYPE 1A1 CHANNEL 1 trace to graticule electrical center. Switch TYPE 1A1 CHANNEL 1 INPUT SELECTOR to DC. Switch TYPE 1L5 AC-GND-AC FAST to AC FAST. Check for a square-wave display on test scope with bottom of display at graticule center. Change the TYPE 1L5 AC-GND-AC FAST to AC. Check for a square-wave display on test scope with top and bottom approximately equal distance above and below graticule center. Remove BNC cable and 10X probe from TYPE 1L5.

5. POWER SUPPLIES

+10V and -10V: within 5%
Ripple and hash: ≤30mV P-P

5. The +10V and -10V supplies are accessible on the 3 MHz IF Chassis, near Q280 and L280.

Connect TYPE 1L5 -- flexible extension -- plug-in scope Amphenol connector (in plug-in compartment). Turn the plug-in scope POWER ON. Measure the power supply voltages with the multimeter. Check ripple and hash with a 1X probe from INPUT 1 of the test scope plug-in.

6. OUTPUT AMPLIFIER

Q410 collector voltage: 150V ±25%

Measure the DC voltage at Q410 collector (transistor case).

7. REDUCE DISPERSION LIGHT

Check that the REDUCE DISPERSION light is lit in the following position:

TYPE 1L5 DISPERSION Hz/CM	TYPE 1L5 CENTER FREQUENCY-Hz			
100k	All except 500k			
10k	000k,	00k thru 49k,	0000 thru 9900,	000 thru 990
1k	000k,	00k thru 09k,	0000 thru 4900,	000 thru 990
500	000k,	00k thru 09k,	0000 thru 2900,	000 thru 990
200	000k,	00k,	0000,	000 thru 990
100	000k,	00k,	0000 thru 0900,	000 thru 490
50	000k,	00k,	0000 thru 0900,	000 thru 290
20	000k,	00k,	0000,	000 thru 090
10	000k,	00k,	0000,	000 thru 040

8. VIDEO GAIN

a. Setup

Connect the SAC to the TYPE 1L5 INPUT. Switch the TYPE 1L5 VERTICAL DISPLAY to VIDEO and the VOLTS/CM to .5 (outer scale). (V/CM ÷100 pulled out). Set the SAC to 20mVOLTS. Set the TYPE 549 TIME/CM for a usable display.

b. Adjust VIDEO CAL

Adjust VIDEO CAL to maximum deflection and check for at least 4.2cm of deflection. Set VIDEO CAL for 4 cm of deflection.

9. VOLTS/CM ACCURACY

a. Setup

Set the SAC AMPLITUDE to 5 mVOLTS and the TYPE 1L5 VOLTS/CM to .1, ÷100 pulled out.

b. Check VOLTS/CM accuracy: within ±2%

VOLTS/CM	SAC	Deflection	Max Error
.1	5mVOLTS	5cm	1mm
.2	10mVOLTS	5cm	1mm
.5	20mVOLTS	4cm	0mm (adjust to zero error)
1	50mVOLTS	5cm	1mm
2	.1 VOLTS	5cm	1mm
5	.2 VOLTS	4cm	.8mm
10	.5 VOLTS	5cm	1mm
20	1 VOLT	5cm	1mm
50	2 VOLTS	4cm	.8mm
100	5 VOLTS	5cm	1mm
2 (inner scale)	10 VOLTS	5cm	1mm

Change the SAC AMPLITUDE to 20 VOLTS. Set TYPE 1L5 VOLTS/CM to 5, ÷100 pushed in. Check for 4cm of deflection ±2%, ±error with ÷100 pulled out.

c. Check VOLTS/CM VARIABLE range: ≥3:1

Rotate the TYPE 1L5 VOLTS/CM VARIABLE to its fully ccw position and check for 1.33cm or less of deflection. Return the VARIABLE to fully cw (CAL). Disconnect SAC from TYPE 1L5 INPUT.

10. POSITION CONTROL RANGE at least + & - 8cm

Set TYPE 1L5 VOLTS/CM switch to 5, ÷100 in and connect a 50Ω cable from the plug-in scope CAL OUT to TYPE 1L5 INPUT. Set the AMPLITUDE CALIBRATOR to 5 VOLTS. Adjust VIDEO CAL for exactly 1cm of deflection. Change the VOLTS/CM to 1 and adjust the VOLTS/CM VARIABLE for 4cm of deflection. Increase the AMPLITUDE CALIBRATOR to 20 VOLTS. Rotate the POSITION control and check that the top of the display can be positioned below the center graticule line and that the bottom of the display can be positioned above the center graticule line.

11. INPUT ATTENUATOR COMPENSATION

a. Setup

Connect TYPE 106 as follows:

TYPE 106 -- BNC cable -- 10:1 ATTEN -- 10:1 ATTEN -- 50Ω Termination -- 30pF Normalizer -- TYPE 1L5.

b. Adjust VOLTS/CM compensation

Set TYPE 1L5 VOLTS/CM to .5, ÷100 out. Adjust TYPE 106 for 5cm of 1 kHz displayed signal. In the following table, readjust TYPE 106 AMPLITUDE control to maintain 5cm of deflection. The 10:1 Attenuator will have to be removed on the higher attenuator steps.

TYPE 1L5 VOLTS/CM	÷100	Adjust: For Best Front Corner	For Level
.5	out		C10
.5	in		C13
Repeat until there is no interaction.			
.5	in	C15	
1	out	C8C	C8A
2	out	C9C	C9A
5	out	C4C	C4A
10	out	Check	Check
20	out	Check	Check
50	out	C5C	C5A
100	out	Check	Check

Adjust 1 VOLTS/CM thru 50 VOLTS/CM to be the same as the straight through position (.5V/CM).

Push ÷100 in and check all positions of the VOLTS/CM switch.

12. SWEPT OSCILLATOR PRELIMINARY SETUP

a. Setup

Change DISPLAY to LIN. Connect a 50Ω cable from the plug-in scope SWEEP A to the TYPE 1L5 EXT INPUT (sweep). Change the plug-in scope TIME/CM to 10mSEC. Connect a 10X probe from the junction of R153 and R158 to the TYPE 1A1. Set the TYPE 1A1 VOLTS/CM to .2.

a. R153 and R158 are located by pin 0 of Discriminator Board.

b. Preset L164, L191, L192, L194 and R214

L164 - 5 turns down from top.
L191 - 3 turns down from top.
L192 - 1 or 2 turns above coil form.
L194 - 4 turns down from top of coil form.
R214 - Approximately 5° cw from midrange

c. Adjust L164, L191 and L194

Remove Q120 and adjust L164 for a test scope display at a frequency slightly above 3MHz.

Ground the cathode of D164 and observe that the signal on the test scope changes to ≤2MHz.

Adjust L191 for least distortion of the 2MHz sinewave.

Remove the ground from D164, replace Q120, and observe a swept frequency signal on the test scope.

Change SWEEP MODE to MANUAL SWEEP, adjust MANUAL for 2.5 MHz (2.5 cycles on test scope) and adjust L194 for best sinewave at point of maximum amplitude.

13. CONVERTED SIGNAL

a. Setup

Connect the 10X probe from the TYPE 1A1 to collector of Q280. Set the test scope TIME/CM to .1μSEC. Disconnect cable from EXT INPUT. Turn MANUAL fully cw.

b. Adjust T290

Adjust T290 for maximum amplitude of the 3.1 MHz signal displayed on test scope CRT. Remove probe from Q280. Reconnect cable to EXT INPUT. Return TYPE 1L5 SWEEP MODE to EXT.

b. The crystal will peak up on two different frequencies. If the oscillator is peaked up on the wrong one the 3 MHz filter will not peak up correctly.

CALIBRATION

NOTES

13. (cont'd)

c. Adjust 3 MHz filter, L280

Connect 500 kHz from the LFSWG to the TYPE 1L5 INPUT. There should be a marker-like signal displayed near the center of the TYPE 549 CRT. Adjust C252, C257, C262, C267, and L280 for maximum amplitude.

d. Adjust C323, C343

Ground pin J of the Discriminator board. Change the TYPE 1L5 DISPERSION to 1kHz/CM Center the signal with R156. (The signal may be off screen.)

Connect the 10X probe from the test scope to the emitter of Q330 on the Resolution board. Trigger the test scope externally with the + GATE A signal from the TYPE 549. Set TIME/CM of both scopes to 10mSEC.

Adjust C323 for minimum amplitude of the signal displayed on the test scope. (Fig. A)

Move the probe to the emitter of Q350 and adjust C343 for minimum amplitude of the test scope display. (Fig. B)

Remove the probe from Q350. Return the TYPE 1L5 DISPERSION to 100kHz/CM. Center the 500kHz signal with BAL. Remove the ground from pin J.

Change the TYPE 1L5 DISPERSION Hz/CM to 1k and center the signal with 500 kHz CAL. Return DISPERSION Hz/CM to 100k and disconnect the LFSWG.

On the Resolution board preset C323, C343 to approximately 7 o'clock. Preset L327, L347 3 turns down from flush with top.

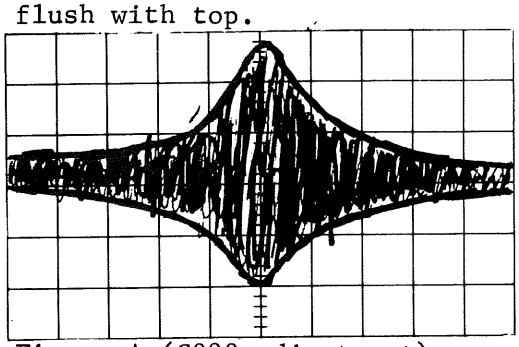


Figure A (C323 adjustment)

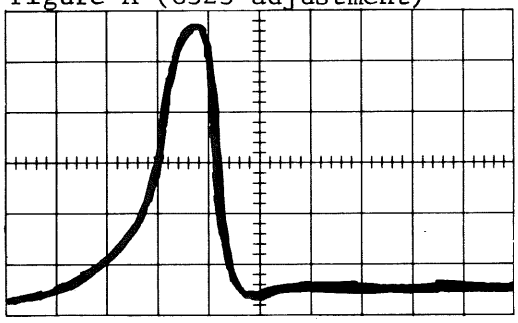


Figure B (C343 adjustment)

When tuning a precaled unit, apply 500kHz signal from LFSWG to TYPE 1L5 input. Change the DISPERSION Hz/CM to 10k. Tune T290 for maximum amplitude of 500kHz signal on TYPE 549. (There can be two or more points in the tuning of T290 where the signal will occur, pick the one with the maximum amplitude). Adjust L280 for maximum amplitude of 500kHz signal. (This note applies only to instruments having a precaled filter)

14. SWEPT OSCILLATOR

a. Adjust L191, R214

Connect 10mSEC markers from the TYPE 184

14. (cont'd)

to the TYPE 1L5 input. Adjust BAL so that the 500kHz harmonic response of the markers is at graticule center. Set 30kHz CF to midrange and adjust R214 for best dispersion linearity from 100kHz to 500kHz, ignoring display above 500kHz. Adjust L191 to point just before the markers on the left side of the graticule break up.

b. Adjust L164

Change CF to 00k, VOLTS/CM to CAL 4cm, DISPERSION to 10k. Rough set L164 so that one of the 5kHz calibrator marks appears to the left of the start spurii. With 10kHz CF CAL move start spurii to horizontal graticule center.

Change VOLTS/CM to 0.005 and TYPE 184 to 1mSEC markers. Change DISPERSION to 1kHz/CM and uncouple RESOLUTION to 100.

Adjust L164 for 5 harmonic responses of the 1mSEC markers to the left of the start spurious.

c. Adjust 2-3 MHz filter (L191, L194, R214)

Change CF-Hz to 500k and DISPERSION Hz/CM-COUPLED RESOLUTION to 100k. Change TYPE 184 to 10mSEC markers.

Adjust L192, L194 and R214 for best linearity of harmonics displayed on 549. (A slight readjustment of L191 for best separation of start spurii and 100kHz response may be necessary.)

L192 effects linearity on the left of display. L194 effects linearity in the center of display. If unable to make linearity, preadjust setting of R156 as directed in Step 16b.

d. Check 0 and 00 decade sweeps

Change DISPERSION Hz/CM to 1kHz, RESOLUTION (uncoupled) to 100. Change TYPE 184 to 1mS markers.

Change CF MULTIPLIER to 0 and 00 while checking to see that oscillator sweeps on lower decades.

If oscillator stops at lower decades of CF MULTIPLIER, check that 0000Hz, 5000Hz CF and R128 are at midrange.

Cement the slug of L164 to the coil form after completion of Step 14d.

Disconnect the TYPE 184 from the TYPE 1L5 INPUT.

15. VERTICAL TRACE SHIFT

a. Setup

Set TYPE 1L5 VERTICAL DISPLAY to LIN.
Set TYPE 549 TIME/CM to 20mSEC.
Set TYPE 1L5 RESOLUTION to 10.

If RESOLUTION is not set to 10 there will be a trace shift of about 1cm in LOG due to noise.

b. Set R428

Switch TYPE 1L5 VERTICAL DISPLAY from LIN to LOG and adjust R428 for minimum trace shift.

Switch TYPE 1L5 VERTICAL DISPLAY from VIDEO to LIN to LOG. Check for less than 2cm trace shift.

16. CENTER FREQUENCY CAL

a. Setup

Connect a 500kHz signal from the LFSWG to TYPE 1L5 INPUT. Connect a ground lead to pin J of the Discriminator board of the TYPE 1L5.

b. Adjust R156

Switch the TYPE 1L5 DISPERSION Hz/CM between 100k and 200 and adjust R156 so that the signal does not shift on the CRT. Return TYPE 1L5 DISPERSION Hz/CM to 100k.

c. Adjust BAL

Adjust BAL pot to position the 500kHz marker to the center graticule line. Remove ground lead from pin J.

d. Adjust 500kHz CAL

Switch the TYPE 1L5 DISPERSION Hz/CM to 1k and adjust the 500kHz CAL so the 500 kHz marker remains on the graticule center line as the TYPE 1L5 DISPERSION Hz/CM is switched between 100k and 1k.

Remove LFSWG.

16. (cont'd)

e. Adjust R150

Insert 10μSEC markers from TYPE 184. Switch the TYPE 1L5 DISPERSION Hz/CM to 10k and adjust R150 for minimum shift of the 10μSEC response as the TYPE 1L5 CENTER FREQUENCY -Hz is switched between 100k and 900k.

f. Adjust 10kHz CAL

Place AC-GND-AC FAST switch in GND position, DISPERSION Hz/CM to 1k with RESOLUTION coupled, set CF-Hz to 0000 and adjust 10kHz CAL to center the start spurious.

If there is insufficient range on the 10kHz CAL, recheck linearity according to Step 14. If linearity is good, R150 may be readjusted for greater range on 10kHz CAL.

Change the TYPE 184 to 10mSEC markers and TYPE 1L5 CENTER FREQUENCY-Hz to 500k. Return Input Selector to AC-FAST and repeat Steps 16d (500kHz Cal), 16c (R150) and 16f (10kHz CAL) until there is no interaction between the 500kHz CAL and the 100kHz CAL adjustments.

g. Compare 0K and K decade dispersion: ≤ 0.5 div. difference

With 10mSEC markers inserted from TYPE 184, set the TYPE 1L5 CENTER FREQUENCY-Hz to 500k and DISPERSION Hz/CM to 100k.

Change the TYPE 1L5 CENTER FREQUENCY-Hz to 30k and DISPERSION Hz/CM to 1k with RESOLUTION uncoupled to 100. Change TYPE 549 TIME/CM to 50mSEC/CM and TYPE 184 to 1mS markers.

Check for ≤ 0.5 divisions difference in DISPERSION between the 30k and 500k CENTER FREQUENCY settings. If necessary, repeat Steps 14 and 16.

17. K AND 0K DISPERSION

a. Adjust 30kHz CF

Set TYPE 1L5 CENTER FREQUENCY-Hz to 30k. Adjust 30kHz CF for one mark/cm.

Disconnect TYPE 184 from TYPE 1L5.

18. OK AND K CENTER FREQUENCY TRACKING

a. Setup

Set LF Sine Wave Generator to 500 kHz and connect to TYPE 1L5 INPUT. Set TYPE 1L5 CENTER FREQUENCY-Hz to 500k and the DISPERSION Hz/CM-COUPLED RESOLUTION to 100k. Readjust the LFSWG to center the signal on the graticule.

b. Check center frequency tracking
Ok: within 10kHz +4%
k: within 3kHz +4%

Using the chart below, check TYPE 1L5 oscillator tracking from 950kHz to 10kHz following the procedure given above.

TYPE 1L5		LF Sine Wave Generator
CENTER FREQUENCY	DISPERSION Hz/CM	Max deviation from CENTER FREQUENCY-Hz setting
500k	10k	10 kHz + 4% ± 30 kHz
600k	10k	10 kHz + 4% ± 34 kHz
700k	10k	10 kHz + 4% ± 38 kHz
800k	10k	10 kHz + 4% ± 42 kHz
900k	10k	10 kHz + 4% ± 46 kHz
950k	10k	10 kHz + 4% ± 48 kHz
400k	10k	10 kHz + 4% ± 26 kHz
300k	10k	10 kHz + 4% ± 22 kHz
200k	10k	10 kHz + 4% ± 18 kHz
100k	10k	10 kHz + 4% ± 14 kHz
10k	1k	3 kHz + 4% ± 3.4 kHz
20k	1k	3 kHz + 4% ± 3.8 kHz
30k	1k	3 kHz + 4% ± 4.2 kHz
40k	1k	3 kHz + 4% ± 4.6 kHz
50k	1k	3 kHz + 4% ± 5.0 kHz
60k	1k	3 kHz + 4% ± 5.4 kHz
70k	1k	3 kHz + 4% ± 5.8 kHz
80k	1k	3 kHz + 4% ± 6.2 kHz
90k	1k	3 kHz + 4% ± 6.6 kHz
99k	1k	3 kHz + 4% ± 6.96 kHz

Disconnect the LFSWG.

*19. K AND OK DISPERSION ACCURACY AND LINEARITY

a. Setup

Reconnect the TYPE 184 and set for 10μS markers.
Set the TYPE 1L5 CENTER FREQUENCY-Hz to 500k.
Set the DISPERSION Hz/CM to 100k.

b. Check dispersion: accuracy, k and 0k ±14%, linearity, ±2%

Use the chart below to check dispersion accuracy and linearity. Maximum dispersion error for the center 8 cm is 1.1 cm, maximum non-linearity within the center 8 cm is 1.6 mm.

TYPE 1L5 CENTER FREQUENCY-Hz	TYPE 1L5 DISPERSION Hz/CM	TYPE 184
500k	100k	10μS
100k thru 950k	10k	.1mS
100k thru 990k	1k	1mS
10k thru 99k	1k	1mS
50k	10k	.1mS
10k thru 99k	500	1mS

c. Check function of units dial

Set TYPE 184 for 10μS markers and set the TYPE 1L5 DISPERSION Hz/CM to 10k. Check that the 10μS marker is within 1 cm of the indicated position:

The marker should step approximately 1 cm with each change in CENTER FREQUENCY

TYPE 1L5 CENTER FREQUENCY-Hz	position of 10μS marker from center graticule line
500K	centered on graticule line
510K	1cm left
520K	2cm left
530K	3cm left
540K	4cm left
550K	5cm left & 5cm right
560K	4cm right
570K	3cm right
580K	2cm right
590K	1cm right

Set TYPE 184 for .1mSEC markers and set the TYPE 1L5 DISPERSION Hz/CM to 1k. Check that the .1mS marker is within 1 cm of the indicated position:

19c. (cont'd)

TYPE 1L5 CENTER FREQUENCY-Hz	position of .1mSec marker from center graticule line
90k	center graticule line
91k	1cm left
92k	2cm left
93k	3cm left
94k	4cm left
95k	5cm left & 5cm right
96k	4cm right
97k	3cm right
98k	2cm right
99k	1cm right

Disconnect the TYPE 184 from the TYPE 1L5.

20. 0 AND 00 DECADE OSCILLATOR TRACKING

a. Setup

Connect LF Sine Wave Generator to TYPE 1L5 INPUT. Set the LF Sine Wave Generator frequency to 5 kHz. Set the TYPE 1L5 CENTER FREQUENCY-Hz to 0000 and DISPERSION to 100 with RESOLUTION coupled. Change the Input Selector to GND and adjust the 0000 Hz CAL for no shift of the start spurious while switching the DISPERSION Hz/CM between 1k and 100.

b. Adjust R128

Change the Input Selector switch to AC FAST and the CENTER FREQUENCY-Hz to 5000. Set the DISPERSION Hz/CM to 100 with RESOLUTION coupled. Adjust R128 to position the 5kHz signal to the horizontal center graticule line.

Remove the LFSWG.

21. 0 AND 00 DECADE DISPERSION

a. Setup

Connect the TYPE 184 to the TYPE 1L5 INPUT. Set the TYPE 184 for 1ms marks. Set the TYPE 1L5 CENTER FREQUENCY-Hz to 5000 and the DISPERSION Hz/CM to 1k.

There is interaction between the adjustment of R128 and the 5000 Hz CF. Repeat Steps 20 & 21 until this interaction is eliminated.

21. (cont'd)

b. Adjust 5000 Hz CF

Adjust the 5000 Hz CF for one mark/cm. Disconnect the TYPE 184 from the TYPE 1L5 INPUT.

22. VARIABLE RESOLUTION AMPLIFIER

a. Setup

Connect the LF Sine Wave Generator to the TYPE 1L5 INPUT. Set the LF Sine Wave Generator frequency to 5 kHz. Set the TYPE 1L5 DISPERSION Hz/CM switch to 500 and the RESOLUTION (uncoupled) to 100k.

b. Adjust skirt response (C323, C343)

Adjust C323 and C343 for minimum and equal skirt response (see Figures A, B, and C).

c. Adjust bandwidth: (L327, L347) ≥500 Hz at 50% amplitude point

Adjust L327 and L347 for maximum bandwidth.

d. Readjust L280 for maximum amplitude

Adjust L280 for maximum amplitude. Recheck a, b, and c for interaction.

e. Adjust 10 Hz resolution amplitude (C332, C352)

Set TYPE 1L5 DISPERSION Hz/CM to 1k. Set plug-in scope TIME/CM to 20mSEC. Adjust the LF Sine Wave Generator frequency to 5kHz and amplitude for a 6cm display. Change the TYPE 1L5 DISPERSION Hz/CM to 10.

Change the LFSWG frequency as necessary to keep the signal at the center of CRT. Change the TYPE 549 TIME/CM to 2SEC. Adjust C332 amd C352 for a 6cm display.

f. Check 10 Hz - 500 Hz Resolution flatness: ±1dB

Change DISPERSION Hz/CM-COUPLED RESOLUTION to 1k.

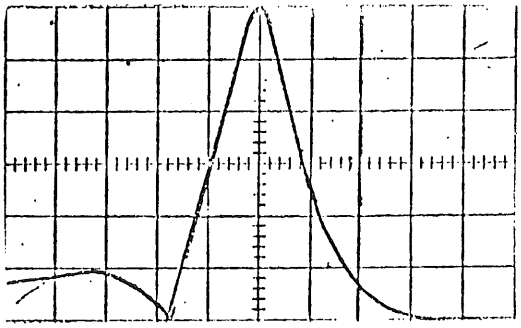


Fig. A
Incorrect adjustment of C343

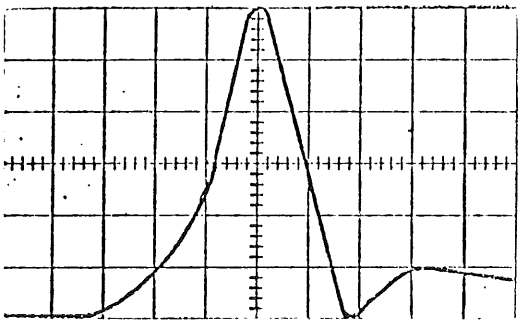


Fig.B
Incorrect adjustment of C323

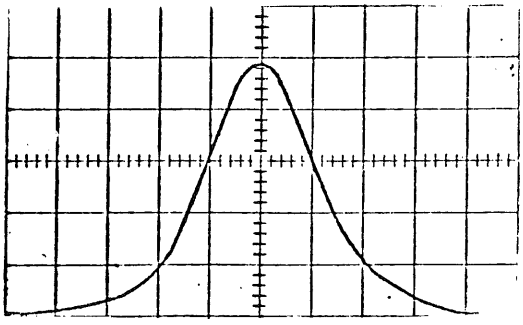


Fig. C
Correct adjustment of C323 & C343

22f. (cont'd)

Adjust LFSWG for 5cm display amplitude. Check all positions of the DISPERSION Hz/CM-coupled RESOLUTION switches for a display amplitude of 5cm ±1dB. (4.5cm to 5.6cm).

g. Check Maximum Resolution-Bandwidth: ≥500 Hz at 50% amplitude point

Set TYPE 1L5 DISPERSION to 500, RESOLUTION to 100K. Set LF Sine Wave Generator amplitude for 6cm, plug-in scope TIME/CM to 20mSEC. Check displayed signal for ≥500 Hz at 50% amplitude point.

h. Check Minimum Resolution-Bandwidth: ≤10 Hz at 50% amplitude point

Set TYPE 1L5 DISPERSION-coupled RESOLUTION to 10 and test scope TIME/CM to 2 SEC. Check Check displayed signal for ≤10 Hz width at 50% amplitude point.

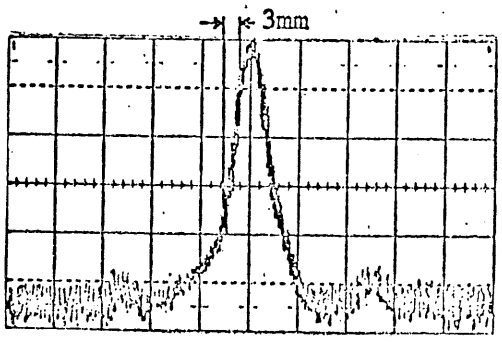
23. INCIDENTAL FM

a. Setup

Set the TYPE 1L5 as follows: CENTER FREQUENCY-Hz to 050, DISPERSION Hz/CM-coupled RESOLUTION to 10, and VOLTS/CM to .005, ÷100 pushed in. Set the TYPE 549 as follows: TIME/CM to 2 SEC, SCREEN SELECTOR AUTO ERASE to AFTER SWEEP, HORIZONTAL DISPLAY to SINGLE SWEEP, and push in on the store buttons. Connect the LF Sine Wave Generator to the TYPE 1L5 INPUT. Set the LF Sine Wave Generator to 50 Hz.

b. Check incidental FM, 50 Hz to 9900 Hz CF: ≤3 Hz

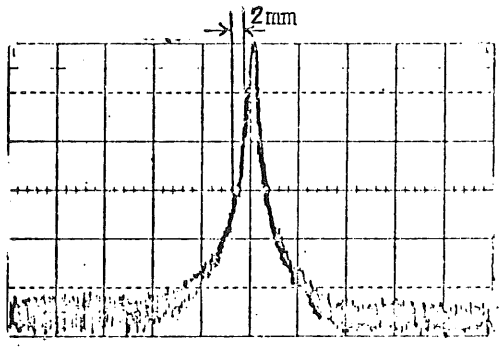
Set the amplitude of the LF Sine Wave Generator for 6cm of displayed 50Hz signal and check for ≤3mm trace width at the center graticule line. Repeat at several frequencies from 50Hz to 9900 Hz.



Disconnect the LF Sine Wave Generator from the TYPE 1L5 INPUT.

23. (cont'd)

c. Check incidental FM, 10kHz to 990kHz: ≤10 Hz



Change TYPE 549 TIME/CM to .5SEC and connect TYPE 184 .1mS markers to TYPE 1L5 INPUT. Set TYPE 1L5 CENTER FREQUENCY-Hz to 10k and DISPERSION Hz/CM -coupled RESOLUTION to 50. Adjust TYPE 1L5 VOLTS/CM and VARIABLE VOLTS/CM for 6cm display and position to center of graticule with CENTER FREQUENCY-Hz VARIABLE.

Disregard drift, check for ≤2mm trace width at the center graticule line. Check at several frequencies from 10kHz to 99kHz in a similar manner.

Change TYPE 184 to 10mSEC markers and check at several CENTER FREQUENCY settings from 100kHz to 990kHz.

Return CENTER FREQUENCY VARIABLE to CAL and disconnect the TYPE 184 from the TYPE 1L5.

24. 0 AND 00 DECADE OSCILLATOR TRACKING ACCURACY

a. Setup

Set the LF Sine Wave Generator to 9.9 kHz. Set the TYPE 1L5 CENTER FREQUENCY-Hz to 9900 and the DISPERSION Hz/CM to 100. Use the chart below to check the oscillator tracking.

TYPE 1L5		LF Sine Wave Generator
CENTER FREQUENCY-Hz	DISPERSION Hz/CM	Max deviation from CENTER FREQUENCY
9900	100	476 Hz 100 Hz + 4%
9000	100	460 Hz 100 Hz + 4%
8000	100	420 Hz 100 Hz + 4%
7000	100	380 Hz 100 Hz + 4%
6000	100	340 Hz 100 Hz + 4%
5000	100	300 Hz 100 Hz + 4%
4000	100	260 Hz 100 Hz + 4%
3000	100	220 Hz 100 Hz + 4%
2000	100	180 Hz 100 Hz + 4%
1000	100	140 Hz 100 Hz + 4%

24a. (cont'd)

TYPE 1L5 CENTER FREQUENCY-Hz	DISPERSION Hz/CM	LF Sine Wave Generator Max deviation from CENTER FREQUENCY
990	50	89 Hz 50 Hz + 4%
900	50	86 Hz 50 Hz + 4%
800	50	82 Hz 50 Hz + 4%
700	50	78 Hz 50 Hz + 4%
600	50	74 Hz 50 Hz + 4%
500	50	70 Hz 50 Hz + 4%
400	50	66 Hz 50 Hz + 4%
300	50	62 Hz 50 Hz + 4%
200	20	58 Hz 50 Hz + 4%
100	20	54 Hz 50 Hz + 4%
50	10	50 Hz 50 Hz + 4%

Disconnect the LFSWG from the TYPE 1L5.

25. 0 AND 00 DECADES DISPERSION ACCURACY

a. Setup

Connect the TYPE 184 to the TYPE 1L5 INPUT. Set the TYPE 1L5 CENTER FREQUENCY-Hz to 9000 and the DISPERSION Hz/CM to 200.

b. Check 0 and 00 decade dispersion: accuracy within ±10%; linearity within ±3%

Use the chart below to check the dispersion of the 0 and 00 decades. Maximum dispersion error for the center 8cm is 8mm; maximum non-linearity within the center 8cm is 2.4mm.

TYPE 1L5 CENTER FREQUENCY-Hz	DISPERSION Hz/CM	(uncoupled) RESOLUTION	TYPE 549 TIME/CM	TYPE 184
9000	200	50	.1s	5mS
8000	100	50	.1s	10mS
5000	1k	200	.1s	1mS
5000	500	100	.1s	1mS
5000	200	50	.1s	5mS
5000	100	20	.1s	10mS
5000	50	20	.1s	10mS
9900	20	10	.5s	50mS
7000	200	50	.1s	5mS
4000	500	100	.1s	1mS

25b. (cont'd)

TYPE 1L5 CENTER FREQUENCY	DISPERSION Hz/CM	(UNCOUPLED) RESOLUTION	TYPE 549 TIME/CM	TYPE 184
2000	200	100	.1s	5mS
1000	50	20	.1s	10mS
1000	20	10	.5s	50mS
500	100	20	.2s	10mS
990	20	10	.5s	50mS
990	10	10	1s	.1 S
700	50	20	.2s	10mS
300	50	20	.2s	10mS
100	20	10	.5s	50mS
50	10	10	1s	.1 S
500	10	10	1s	.1 S

26. 300 kHz SPURIOUS RESPONSE

(NOT NECESSARY IF USING PRE-CAL'D FILTER)

a. Setup

Connect a LF Sine Wave Generator to TYPE 1L5 INPUT. Set TYPE 1L5 CENTER FREQUENCY-Hz to 500k and DISPERSION Hz/CM-coupled RESOLUTION to 100k. Remove the screws securing the 3 MHz filter chassis. Turn chassis over so adjustment tool can be inserted in L270.

b. Adjust L270, L280, 3 MHz filter

Adjust LF Sine Wave Generator ouput and TYPE 1L5 VOLTS/CM so TYPE 1L5 is over-driven. A signal at 3cm will be present. Adjust L270 for minimum display amplitude of this signal.

c. Adjust 3 MHz filter

Reduce LFSWG output and adjust C252, C257, C262, C267, and L280 for maximum amplitude of the 500kHz signal displayed on the TYPE 549 CRT.

27. LOG GAIN

a. Setup

Connect the LFSWG to the TYPE 1L5 input through three 5:1 attenuators, a 2.5:1 attenuator and a 50Ω termination. Set the TYPE 1L5 as follows: VERTICAL DISPLAY to LOG, CENTER FREQUENCY-Hz to 5000, DISPERSION Hz/CM to 10 and VOLTS/CM to .005. Set the INPUT selector switch to GRD and position the top edge of the trace to the bottom line of the graticule.

Change the INPUT selector back to AC, DISPERSION Hz/CM to 1k and RESOLUTION (uncoupled) to 50. Set the LFSWG to 5kHz and adjust its amplitude for a 2-3 cm display on the TYPE 549.

Switch the TYPE 549 HORIZONTAL DISPLAY to EXT X1. Switch the TYPE 1L5 SWEEP MODE to MANUAL and rotate the MANUAL knob cw from zero toward 10. As the MANUAL knob is rotated it will cause the dot to rise and fall. Set the MANUAL knob to position the dot to the peak of the second rise. Adjust the LFSWG amplitude so the dot is 1cm above the bottom graticule line. Remove all four attenuators and reconnect the LFSWG through the 50Ω termination to the TYPE 1L5 INPUT.

b. Adjust LOG gain: ≥50dB above 1cm

Adjust R422 for a display amplitude of 5.6 to 6.0cm with the attenuators removed. (A readjustment of the LFSWG amplitude may be necessary.) Reinstall the three 5:1 attenuators and the 2.5:1 attenuator and readjust R422 for a 1cm display amplitude. Repeat until there is 1cm of display with the attenuators installed and a display of 5.6 to 6.0cm with the attenuators removed. (Be sure to keep the 50Ω termination installed on the TYPE 1L5 INPUT.)

28. LIN CAL

a. Setup

Connect the LF Sine Wave Generator to the TYPE 1L5 INPUT and the TYPE 1A1 as follows:

28a. (cont'd)

LF Sine Wave Generator -- BNC cable -- 50Ω termination -- BNC T -- BNC cable -- TYPE 1L5 INPUT
BNC T -- BNC cable -- TYPE 1A1 INPUT

Set the TYPE 549 HORIZ DISPLAY to A. Set the TYPE 1L5 SWEEP MODE to EXT INPUT, DISPERSION Hz/CM-coupled RESOLUTION to 1k and VERTICAL DISPLAY to LIN.

Set the LF Sine Wave Generator AMPLITUDE control for 70mV displayed on the test scope. Connect the 600 ohm load cable from the TYPE 1L5 TO RECORDER jack to the TYPE 1A1 INPUT.

b. Adjust LINE CAL, check for TO RECORDER output

Adjust LIN CAL for 6mV displayed on the test scope. Selection of R416 may be necessary.

c. Pick R432

Unsolder R432 (first resistor behind 422) and clip the Ohms Picker in its place. Adjust the Ohms Picker for a 5cm display on the TYPE 549 CRT. Replace the Ohms Picker with a resistor having the resistance indicated on the Ohms Picker dial. Adjust LIN CAL for exactly 5cm of signal displayed on the TYPE 549.

Disconnect the LF Sine Wave Generator and cabling from the INPUT connectors of the TYPE 1L5 and the TYPE 1A1. Remove the 600Ω load cable.

29. BALANCED MIXER — Zero Frequency feedthrough: ≥1 to ≤4cm

Adjust R85, C86

Set the TYPE 1L5 CENTER FREQUENCY-Hz to 000. Adjust R85 and C86 for proper display amplitude. Select C87 for proper display amplitude.

R85, C86 and C87 are at the rear of the Input Amplifier board. It may be helpful to reverse the leads to T80 and T90 to minimize spurious response.

CALIBRATION

NOTES

30. INTERMODULATION DISTORTION

a. Setup

Set TYPE 1L5 CENTER FREQUENCY to 500k, ÷100 out VERTICAL DISPLAY to LOG, VOLTS/CM to .005 (inner scale), DISPERSION Hz/CM to 10k and resolution to 50. Set the TYPE 549 TIME/CM to 50mSEC. Connect the TYPE 1L5 to two Generators (either LFSWG or TYPE 191) as shown below:

TYPE 191 -- 10:1 atten -- 10:1 atten -- BNC cable --

LFSWG -- 10:1 atten -- 10:1 atten -- BNC cable --

BNC T -- 5:1 atten -- 5:1 atten -- 5:1 atten -- 2.5:1 atten -- 50Ω term -- TYPE 1L5 INPUT

b. Set reference amplitude

Set one of the generators to 500kHz and the other generator to 520kHz. Adjust the generator Amplitude controls so there are two signals displayed on the TYPE 549. Reduce sweep speed to .2sec/cm and readjust the generator Amplitude controls for 1cm of signal.

c. Check intermodulation distortion: ≥50dB down

Remove all three 5:1 attenuators and the 2.5:1 attenuator. Connect the BNC T to the 50Ω termination. Signal will be approximately 6cm in amplitude. Side band amplitude shall not be greater than 1cm.

If the TYPE 1L5 does not satisfy this requirement, readjust Log Cal (Step 27) and Lin Cal (Step 28).

Disconnect the generators and associated equipment from the TYPE 1L5 INPUT.

31. RANDOM SPURIOUS RESPONSES

a. Setup

Change the TYPE 1L5 CENTER FREQUENCY Hz to 500k; DISPERSION Hz/CM to 100k, and RESOLUTION (uncoupled) to 50. Connect a 500kHz signal from the LF Sine Wave Generator through three 5:1 attenuators; a 2.5:1 attenuator and a 50Ω termination to the TYPE 1L5 INPUT. Set the plug-in scope TIME/CM to 2 SEC.

CALIBRATION

NOTES

31. (cont'd)

b. Check random spurious responses: ≥50dB down

Adjust the LF Sine Wave Generator amplitude for 1cm of displayed signal on the TYPE 549. (Adjustment of TYPE 1L5 VOLTS/CM may be necessary.) Remove the attenuators (leave the 50Ω termination connected). Disregarding start spurii, fundamental and harmonics, check for spurious responses of ≤1cm.

If the spurious response is greater than 1cm, adjust L270 (Step 26). If the spurious response at approximately 960k is greater than 2X noise, adjust T290; then recheck Step 28 (LIN CAL adjustment).

32. DISPLAY FLATNESS

a. Setup

If TYPE 1L5 is on the flexible extension (see Note 31b), reinstall in TYPE 549 plug-in compartment and set TYPE 549 TIME/CM to 20mSEC. Set TYPE 1L5 CENTER FREQUENCY-Hz to 5000, DISPERSION Hz/CM -coupled RESOLUTION to 1k, VOLTS/CM to .005 and ÷100 pulled out.

Connect LF Sine Wave Generator to TYPE 1L5 INPUT through three X10 attenuators and a 50Ω termination. Set LFSWG to 5kHz and adjust its signal amplitude for a 5cm display on the TYPE 549.

Throughout Steps 32 and 33, be sure to monitor output of LFSWG with test scope for constant amplitude on all frequency settings, referenced to 5cm display on TYPE 549 at 5kHz. Whenever frequency or amplitude of LFSWG must be changed, reference back to 5cm 5kHz display on TYPE 549 for constant amplitude on test scope.

b. Select C44 (1MHz, .005 VOLTS/CM, ÷100 out)

Change LFSWG to 1MHz, check amplitude on test scope. Set TYPE 1L5 CENTER FREQUENCY-Hz to 990k, bring signal on screen with VARIABLE CF.

Select C44 for 5cm display of 1MHz signal on TYPE 549.

In Step 32b through Step 32d, it may be necessary at times to change DISPERSION Hz/CM to 10k in order to center signal with VARIABLE. Be sure to return DISPERSION Hz/CM to 1k with RESOLUTION coupled.

CALIBRATION

NOTES

32. (cont'd)

c. Adjust input compensation

Set TYPE 1L5 CENTER FREQUENCY-Hz to 5000 and push in ÷100 switch. Change LFSWG to 5kHz and set its signal amplitude for 5cm display on TYPE 1L5. Change LFSWG to 1 Mhz while monitoring for constant amplitude on test scope. Change TYPE 1L5 CENTER FREQUENCY-Hz to 990k and bring signal on screen with VARIABLE.

Adjust C15 on the ÷100 attenuator for 5cm display on TYPE 549.

Pull out on the ÷100 switch, change VOLTS/CM to .01 and repeat the above procedure to adjust C13.

d. Check 50kHz-1 Mhz flatness -- .005 VOLTS/DIV, ÷100 in: ±0.5dB

Check at 50kHz, 500kHz, and at 990kHz for ±0.5dB flatness (4.7cm to 5.3cm).

+0.5dB = 1.06 voltage gain
-0.5dB = 0.944 voltage loss

+3dB = 1.41 voltage gain
-3dB = 0.71 voltage loss

e. Check 50kHz-1 MHz flatness -- .01 VOLTS/DIV to 2 VOLTS/DIV, ÷100 in and out: ±0.5dB

Check each setting of the TYPE 1L5 VOLTS/DIV from .01 through 2 for ±0.5dB flatness at 50kHz, 500kHz, and 990kHz.

Repeat this check with ÷100 pulled out.

The following capacitors may be adjusted slightly to improve the flatness on these ranges of the VOLTS/DIV switch:

.01	C8C
.02	C9C
.05, .1, .2	C4C
.5, 1, 2	C5C

f. Check 50kHz-1 Mhz flatness -- .001 and .002 VOLTS/DIV, ÷100 in and out: +0.5, -3dB

Check the .001 and .002 VOLTS/DIV settings at 5kHz, 500kHz, and 1 MHz for a display flatness of +0.5dB, -3dB (2.8cm to 4.2cm).

Repeat the same check with ÷100 pushed in.

C41 on the .001 range and C40 on the .002 range may be padded with another cap if necessary to make flatness.

32. (cont'd)

g. Check low frequency (50 Hz) flatness, .005 VOLTS/CM, ÷100 in and out: ±.5dB

Set the TYPE 1L5 CENTER FREQUENCY-Hz to 5000, VOLTS/CM to .005, ÷100 pushed in, DISPERSION-Hz/CM to 10 Hz with RESOLUTION coupled, and INPUT SELECTOR to AC.

Set LFSWG to 5kHz and adjust amplitude to 5cm display on TYPE 549. Change LFSWG to 50 Hz, monitor constant amplitude with test scope.

Change TYPE 1L5 CENTER FREQUENCY-Hz to 050 and check for 5cm ±.5dB display of 50 Hz signal. NOTE: If necessary, 0000 Hz CF may be adjusted for best separation of 50 Hz signal and start spurii, If this is done, be sure to readjust 0000 Hz CF to proper point.

Repeat with ÷100 pulled out.

33. INPUT AMPLIFIER

a. Setup

Set TYPE 1L5 VERTICAL DISPLAY to VIDEO. Connect LF Sine Wave Generator to TYPE 1L5 INPUT and TYPE 1A1 INPUT as shown below:

LF Sine Wave Generator -- 50Ω term --
BNC T -- BNC CABLE -- TYPE 1L5 INPUT
BNC CABLE -- TYPE 1A1 INPUT

b. Check input amplifier frequency response at .1 VOLT/CM and 2 VOLTS/CM: +.5dB, -3dB from 10Hz to 700kHz

Set LF Sine Wave Generator frequency to 5kHz. Set TYPE 1L5 VOLTS/CM to .1 (outer scale). Adjust the LF Sine Wave Generator for 4cm of sine wave signal. Note amplitude on TYPE 1A1.

It will be necessary to change the TYPE 1A1 VOLTS/CM to get a displayed signal on test scope as the TYPE 1L5 VOLTS/CM is changed.

Change LF Sine Wave Generator frequency to 10Hz. Check TYPE 1A1 display for same amplitude as at 5kHz. Check TYPE 549 display for 2.8cm to 4.2cm of 10Hz signal.

33b. (cont'd)

Change LF Sine Wave Generator frequency to 700kHz, again noting display on TYPE 1A1 for constant amplitude. Check TYPE 549 display for 2.8cm to 4.2cm of 700kHz signal.

If the display on the TYPE 1A1 changes in amplitude when the signal frequency is changed, readjust the LF Sine Wave Generator amplitude control for the same amplitude as at 5kHz.

Set TYPE 1L5 VOLTS/CM to .2. Set LF Sine Wave Generator frequency to 5kHz and increase the LF Sine Wave Generator amplitude for 4cm and repeat above procedure.

c. Check input amplifier frequency response at .5 VOLTS/CM: ±0.5dB, from 10 Hz to 1 MHz

Set TYPE 1L5 VOLTS/CM to .5. Set the LF Sine Wave Generator frequency to 5kHz. Adjust the LF Sine Wave Generator amplitude control for 4cm of displayed signal on the TYPE 549. Note amplitude displayed on test scope.

Change the LF Sine Wave Generator frequency to 10 Hz. Check test scope display for constant amplitude out of the LF Sine Wave Generator. Check TYPE 549 display for 3.8cm to 4.2cm of 10 Hz signal.

Change the LF Sine Wave Generator frequency to 1 MHz noting constant amplitude on test scope. Check TYPE 549 display for 3.8cm to 4.2cm of 1 MHz signal.

Disconnect the signal cable from the TYPE 1L5 INPUT.

34. CALIBRATOR

a. Adjust Calibrator frequency (R502): 5kHz ±0.5%

Set the TYPE 549 TIME/CM to .2mSEC. Set the TYPE 1L5 VOLTS/CM to CALIBRATE and VERTICAL DISPLAY to VIDEO. Adjust R502 for 1 mark/cm.

Change the TYPE 549 TRIGGER SOURCE to EXT and apply 1mSEC markers to its TRIG. INPUT. Readjust R502 for minimum drift of the Calibrator display across graticule.

Disconnect the TYPE 184 from the TYPE 564.

34. (cont'd)

b. Adjust Calibrator Amplitude (R522): 4cm

Set the TYPE 1L5 CENTER FREQUENCY-Hz to 5000, VERTICAL DISPLAY to LIN, and DISPERSION Hz/CM to 1k. Set the TYPE 549 TIME/CM to 50mSEC. Adjust R522 for 4cm display amplitude.

35. VARIABLE CENTER FREQUENCY-Hz

a. Setup

Set the TYPE 1L5 CENTER FREQUENCY-Hz to 990k and the DISPERSION Hz/CM to 10k. Set the TYPE 549 TIME/CM to 10mSEC. Set the TYPE 184 MARKER SELECTOR for 1μS markers.

b. Check VARIABLE CENTER FREQUENCY range: ≥10kHz, extending CENTER FREQUENCY to ≥1MHz

Rotate the VARIABLE CENTER FREQUENCY-Hz cw and check that the display on the CRT moves to the left 1cm or more, to cross the graticule center line.

Disconnect the TYPE 184 from the TYPE 1L5.

36. OSC OUT Must sweep ≥1MHz at ≥1.2V in amplitude

Set TYPE 1L5 CENTER FREQUENCY-Hz to 000k and DISPERSION-Hz/CM COUPLED RESOLUTION to 10. Connect 10X probe from OSC OUT to TYPE 1A1 INPUT 1 and TYPE 1A1 VOLTS/CM to .1. Check signal displayed on test scope for ≥3MHz sine wave with an amplitude of ≥1.2 volt.

Set TYPE 1L5 CENTER FREQUENCY-Hz to 990k, VARIABLE CENTER FREQUENCY cw. Check displayed signal on test scope for ≤2MHz sine wave frequency with an amplitude of ≥1.2V.

Return VARIABLE CENTER FREQUENCY to CAL.

37. VARIABLE DISPERSION

Set TYPE 1L5 CENTER FREQUENCY-Hz to 500K, DISPERSION Hz/CM to 100k. Connect 10X probe to pin F of sweeper board. Check the sawtooth waveform on test scope for an amplitude of approximately 1V. Rotate VARIABLE DISPERSION ccw; sawtooth should decrease in amplitude to approximately 0.

Remove X10 probe and set VARIABLE DISPERSION to CAL.

38. INT SWEEP MODE

Connect 10μS markers from TYPE 184 to TYPE 1L5. Observe 1 mark/cm on plug-in scope. Set SWEEP MODE switch to INT. Observe that marks on scope can be set 1/cm with VARIABLE DISPERSION.

Return VARIABLE DISPERSION to CAL and disconnect TYPE 184 from TYPE 1L5.

39. MANUAL SWEEP MODE

a. Setup

Connect a jumper between TYPE 1L5 OUTPUT and TYPE 549 HORIZ INPUT. Set TYPE 1L5 SWEEP MODE to MANUAL. Turn the MANUAL control ccw. Set the TYPE 549 HORIZONTAL DISPLAY to EXT X10 and adjust the HORIZONTAL POSITION to place the spot at the left edge of the graticule.

b. Check MANUAL SWEEP MODE
Range: 10cm, min

Set TYPE 549 EXT. HORIZ. VARIABLE 1-10 full cw. Turn the TYPE 1L5 SWEEP MODE MANUAL control cw. Check for $\geq$10cm of range. Check for smooth movement of the spot as the MANUAL control is rotated.

Return TYPE 1L5 SWEEP MODE to EXT. INPUT, TYPE 549 HORIZONTAL DISPLAY to A and remove jumper.

40. NOISE LEVEL

a. Setup

Set the TYPE 1L5 CENTER FREQUENCY-Hz to 500K and the DISPERSION Hz/CM to 100K. Set the TYPE 1L5 VERTICAL DISPLAY to LIN, VOLTS/CM to .001 and the V/DIV ÷ 100 PULL out. Set the SWEEP MODE to EXT INPUT.

b. Check noise level $\leq 5\mu volts$

Set AC-GND-AC FAST to GND. Check the trace width for 1/2cm or less of noise.

41. SAWTOOTH SELECTOR SWITCH

a. Setup

Set the SAWTOOTH selector switch on the back panel of the TYPE 1L5 to 100V. Connect 10μs markers from the TYPE 184 to the TYPE 1L5 INPUT.

b. Check SAWTOOTH selector switch

Observe signal displayed on TYPE 549 CRT. Now switch the SAWTOOTH selector to 150V position and observe that the distance between the 100 kHz marks becomes greater.

TIME vs. FREQUENCY DOMAIN:

On the standard oscilloscope, amplitude (plotted in the vertical direction) is graphically displayed against time (plotted in the horizontal direction); thus the display represents the amplitude of the phenomenon and the changes in amplitude for all, or any part, of the time during which it occurs.

In a spectrum analyzer display, amplitude is still plotted in the vertical direction. However, it is not plotted against time; the horizontal axis of a spectrum analyzer display represents frequency rather than time. Each individual point along the horizontal axis represents one particular frequency. The window (total range of frequencies, from the lowest on the left of the display to the highest on the right for the TYPE 1L5) as well as the dispersion (amount of frequency change from one graticule line to the next) are determined by the front panel controls of the spectrum analyzer.

OPERATION IN VIDEO: (refer to TYPE 1L5 Functional Block Diagram)

Regardless of the kind of signal applied to the front panel jack or the position of the VERTICAL DISPLAY switch, the functions of the INPUT ATTENUATOR and the INPUT AMPLIFIER are the same as any other vertical plug-in in general concept. The INPUT AMPLIFIER is AC coupled and has a bandpass of approximately 10Hz to 1MHz. With the VERTICAL DISPLAY switch in the VIDEO position, the output of the INPUT AMPLIFIER is fed directly to the OUTPUT BUFFER (bypassing the rest of the analyzer) and into the vertical of the plug-in scope.

The VARIABLE (VOLTS/CM) is a variable gain control as in any vertical plug-in.

The POSITION control, acting through the switching arrangement of the LOG ATTENUATOR, applies a DC positioning voltage to the OUTPUT BUFFER.

The INPUT ATTENUATOR compensation is initially adjusted for a square wave with square corners, but may need to be readjusted when checking flatness of frequency response. Square wave response serves as a very good present but is not the final determinant because VIDEO operation is a convenience and not a requirement of spectral analysis.

OPERATION IN LIN: (Refer to TYPE 1L5 Functional Block Diagram)

The INPUT ATTENUATOR and INPUT AMPLIFIER serve the same purpose as they did in the VIDEO mode of operation. However, the signal no longer bypasses the superhet portion of the plug-in.

The 1st IF MIXER heterodynes the incoming signal with the output of the SWEPT FREQUENCY GENERATOR to produce a 3 MHz intermediate frequency.

Heterodyning will produce four frequencies in the output of the mixer. They are: (1) the original input frequency, (2) the original local oscillator frequency, (3) the sum frequency, and (4) the difference frequency. We are interested in the sum frequency, but only when it is 3 MHz.

The adjustment of R85 (Mixer Bal) and C86, as well as the selection of C87, is for the proper amplitude of the start spurious. The start spurious is caused by feedthrough of the SWEPT FREQUENCY GENERATOR when its frequency matches that of the 1st IF. (3 MHz).

NOTE: For explanation of SWEPT FREQUENCY GENERATOR, DISPERSION SWITCHING and CENTER FREQUENCY SWITCHING, refer to TYPE 1L5 Swept Frequency Generator Diagram.

The purpose of the SWEPT FREQUENCY GENERATOR is primarily that of tuning. As the SWEPT FREQUENCY GENERATOR changes in frequency, at a rate proportional to the rate of the CRT trace, it will require a different input signal frequency for each instantaneous frequency of the generator to produce the desired 3 MHz IF. Keeping in mind that the only usable output of the 1st IF MIXER is 3 MHz, it is apparent that only when the incoming signal frequency and the swept generator frequency will add for a 3 MHz IF will the conditions be right to cause a vertical deflection on the CRT. The amount of deflection will be proportional to the amplitude of the incoming signal and its horizontal location will be proportional to the frequency of the incoming signal.

To maintain a constant relationship between the amplitude of the 3MHz IF signal and the amplitude of the incoming signal, the SWEPT FREQUENCY GENERATOR must maintain a constant amplitude over its entire range of frequencies. The AMPLITUDE REGULATOR in the feedback path of the SWEPT FREQUENCY AMPLIFIER controls the gain of the amplifier to hold the power output of the generator constant. R214 (Osc Amp) provides a DC reference to determine the amount of the amplitude regulated output.

To maintain a constant relationship between the horizontal location of the trace and the frequency of the SWEPT FREQUENCY GENERATOR, the generator must change in frequency at a rate consistent with the sweep rate of the plug-in scope. Therefore, in the primary mode of operation, the plug-in scope's sweep is used to control the frequency of the SWEPT FREQUENCY GENERATOR. This is accomplished through the SWEEP MODE and DISPERSION SWITCHING.

The SWEEP MODE switch selects the source of the signal used to control the frequency of the generator.

In the EXT mode any linear ramp may be used; however, it is best to use the sweep out of the plug-in scope in order to maintain the relationship between frequency and the horizontal location of the trace.

In the INT position of the SWEEP MODE switch, the sweep sawtooth of the plug-in scope is picked off at pin 6 of J11 (the 16 pin connector at the rear of the plug-in compartment) on those scopes having it available.

In the MANUAL mode the sweep sawtooth voltage is replaced by a "pot" (R102, MANUAL) which will deliver DC voltages corresponding to any instantaneous level of the sawtooth. When operating in MANUAL it is advisable to connect the MANUAL OUTPUT to the EXT HORIZ input of the plug-in scope and place the scope's HORIZONTAL DISPLAY switch to EXT HORIZ. This drives the trace horizontally with the MANUAL OUTPUT so that the frequency of the displayed signal and the horizontal location of the display will maintain the fixed relationship necessary to make meaningful measurements.

The DISPERSION circuit determines how much of the control voltage applied through the SWEEP MODE will be used. This in turn determines how large a portion of the total frequency range of the oscillator will be used.

The following chart gives examples of how the dispersion determines the amount of frequency change of the SWEPT FREQUENCY GENERATOR:

DISPERSION SETTING	TOTAL CHANGE OF OSCILLATOR FREQUENCY
100 kHz/cm	1 MHz
10 kHz/cm	100 kHz
1 kHz/cm	10 kHz
500 Hz/cm	5 kHz
200 Hz/cm	2 kHz
100 Hz/cm	1 kHz
50 Hz/cm	500 Hz
20 Hz/cm	200 Hz
10 Hz/cm	100 Hz

The total range of frequencies out of the SWEPT FREQUENCY GENERATOR is from 3 MHz to 2 MHz. In order for this to be a linear change it is necessary to modify the slope of the sawtooth applied through the DISPERSION circuit to match the requirements of the frequency determining components in the oscillator. The following is a list of the adjustments which determine the amount and type of this modification:

SW101, SAWTOOTH SELECTOR - fixed attenuation ratios for use with either 100 volt or 150 volt sawtooth from plug-in scope.

R108, BAL 1 kHz/CM CAL - determines the DC starting point of the sawtooth.

R110, 30 kHz CF 1 kHz/CM CAL - partially determines the total amount of attenuation.

R114, 5000 Hz CF 1 kHz/CM CAL - partially determines the total amount of attenuation. When the CENTER FREQUENCY multiplier switch is in either the K or OK position, R114 is out of the circuit.

R113, VARIABLE - when not in detent uncalibrates the dispersion in the EXT mode, but is used for calibrating the dispersion in INT.

The CENTER FREQUENCY - Hz determines the particular point in the total (3 MHz - 2 MHz) range of frequencies chosen as the center around which the DISPERSION will cause the frequency to change. The DISPERSION determines how large a window will be viewed while the CENTER FREQUENCY determines where this window will be located in the total frequency range of the instrument.

The CENTER FREQUENCY is nothing more than a DC reference for the modified sawtooth from the DISPERSION circuit. The modified sawtooth and the CENTER FREQUENCY reference voltage are fed to comparators which will position the ramp from the DISPERSION circuit to the DC reference determined by the CENTER FREQUENCY controls.

There are four adjustments to match the switchable DC reference of the CENTER FREQUENCY control to the requirements of the oscillator. They are: (1) R239, 500 KHz (CAL); (2) R232, 10 KHz (CAL); (3) R150; and (4) R128.

When the CENTER FREQUENCY MULTIPLIER is in the lower decades (0 or 00 as the last digits of the dial), R120, 0000 Hz CF CAL, adjusts the DC offset voltage of the feedback through the Hz DISCRIMINATOR. When the CENTER FREQUENCY MULTIPLIER is in the upper decades (K or OK as the last digits of the dial), R156, 500 KHz Center Frequency Bal., is the DC offset adjust for feedback through the KHz DISCRIMINATOR.

The purpose of both discriminators is to convert the change in frequency out of the oscillator into the changing voltage used in the comparators to modify the slope of the ramp to the exact slope required to maintain a linear change in frequency of the oscillator. For example, if the ramp out of the comparators was of a slope that would cause a nonlinear frequency change in the oscillator, the output of the discriminators would be such as to change the slope of the ramp by the correct amount and in the proper direction to correct for the nonlinearity.

The adjustment of L164 in the oscillator tank circuit and the tuning of the 3 MHz FILTER are made for constant power output over the entire 1 MHz frequency range of the oscillator.

The 1st IF AMPLIFIER amplifies the output of the 1st IF MIXER while the 3 MHz BANDPASS FILTER passes only the 3 MHz sum frequency. The 3 MHz BANDPASS FILTER is adjusted for best selectivity and lowest attenuation of the 3 MHz IF.

The 3.1 MHz 2nd IF LOCAL OSCILLATOR is heterodyned with the 3 MHz 1st IF in the 2nd IF mixer to produce a 100 KHz 2nd IF which will be used in the VARIABLE RESOLUTION AMPLIFIER. Adjustment of T290 peaks the power of the 3.1 MHz 2nd IF LOCAL OSCILLATOR at 3.1 MHz while adjustment of L280 gives maximum gain to the 100 KHz 2nd IF.

Tuned circuits in the VARIABLE RESOLUTION AMPLIFIER can discern slight frequency changes in the 100 KHz IF to a degree determined by the setting of the COUPLED RESOLUTION switch. As the RESOLUTION knob is set to a smaller number, the VARIABLE RESOLUTION AMPLIFIER is able to discern more accurately a small change in frequency of the 100 KHz IF. Increasing the degree of resolution amounts to increasing the selectivity of the amplifier.

Capacitors C323, C332, C343, and C352 compensate for the loss of gain with an increase of selectivity. R316 LIN CAL adjusts the overall gain of the VARIABLE RESOLUTION AMPLIFIER.

The DRIVER AMPLIFIER amplifies the output of the VARIABLE RESOLUTION AMPLIFIER and passes it to the RECORDER DETECTOR and DETECTOR.

The RECORDER DETECTOR removes the 100kHz IF component and delivers the envelope to the RECORDER OUTPUT front panel connector.

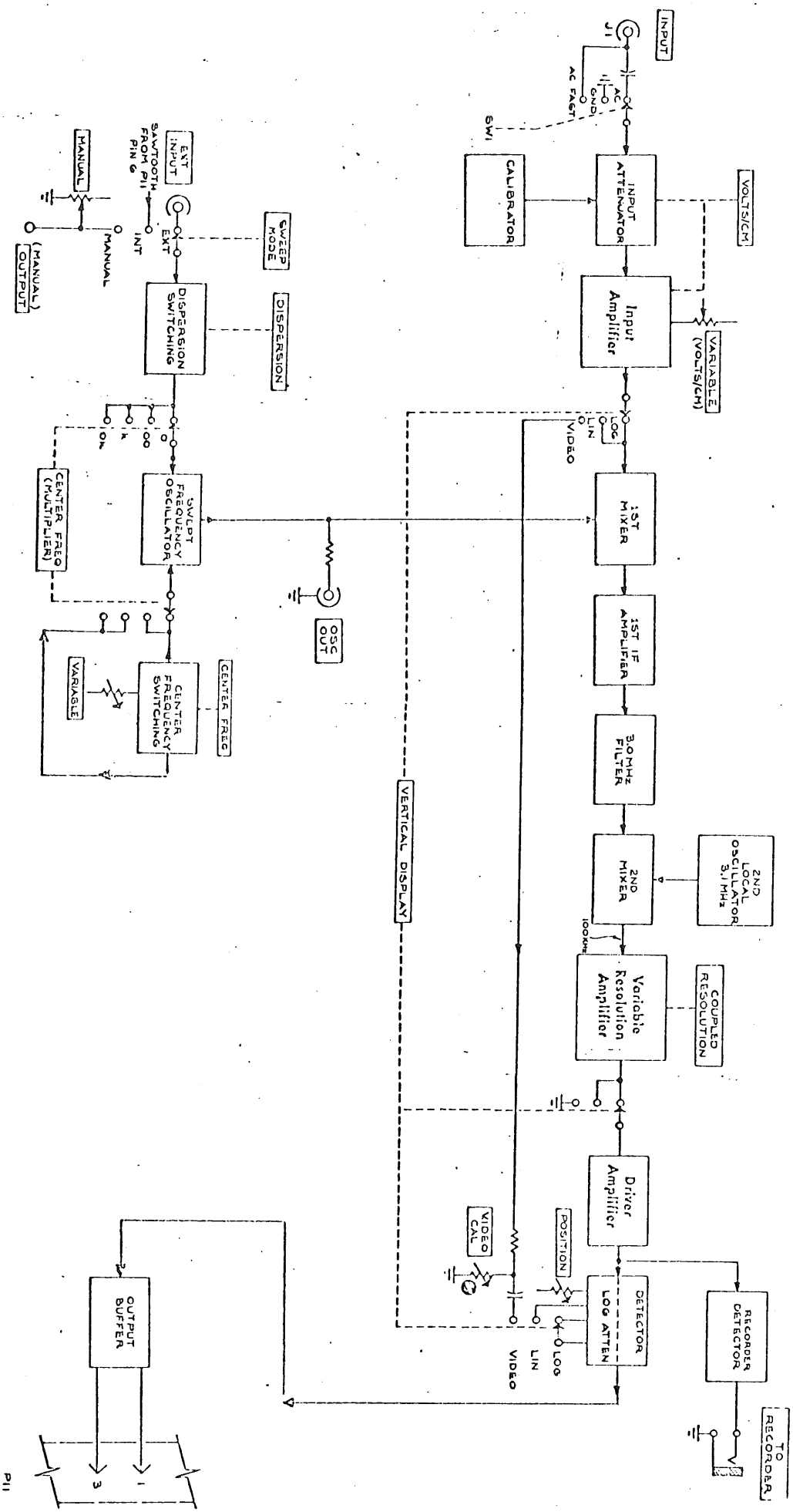
The DETECTOR removes the IF component of the DRIVER AMPLIFIER output and delivers the envelope to the OUTPUT BUFFER which matches the entire instrument to the requirements of the plug-in scope.

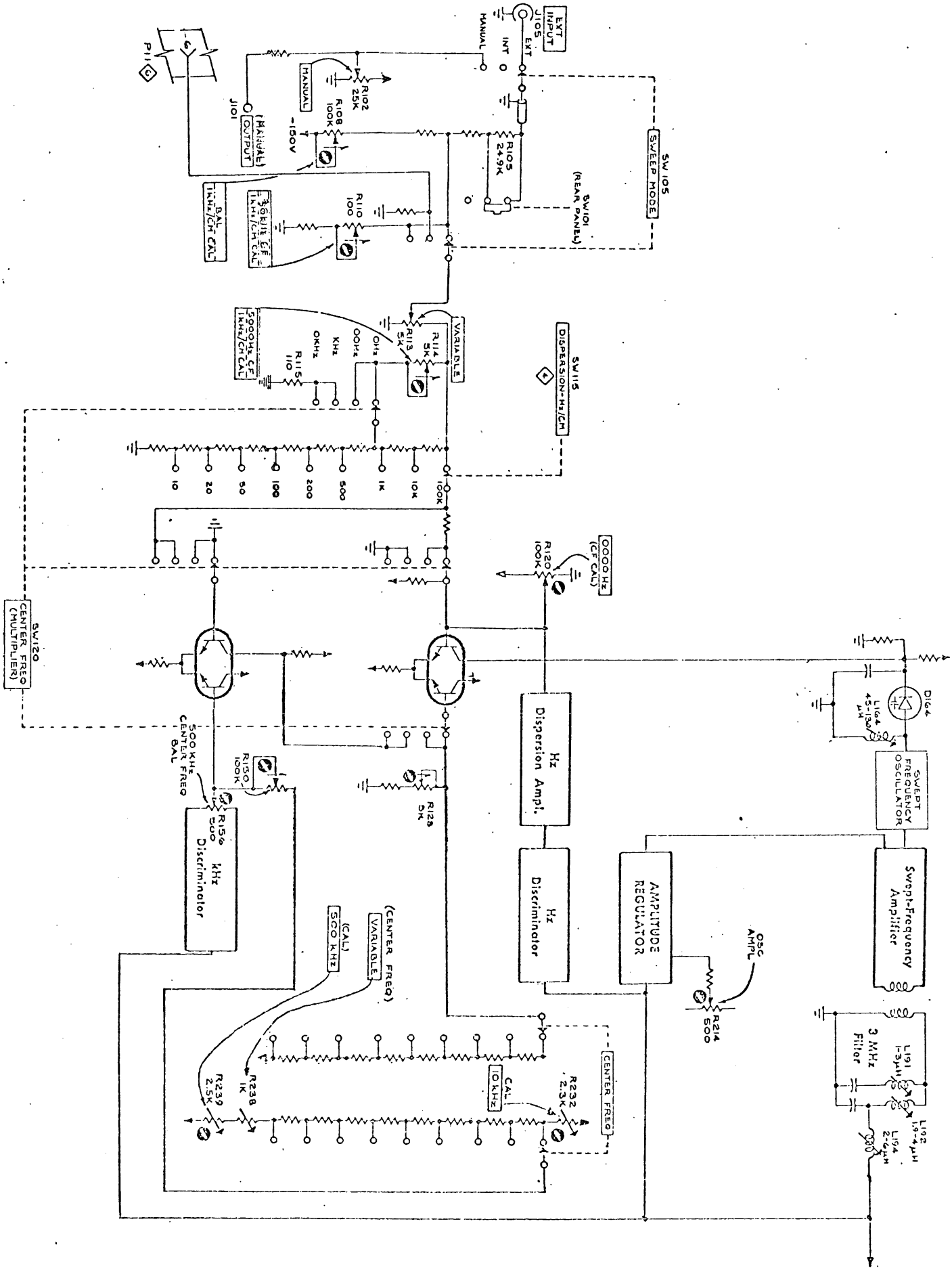
The POSITION control, acting through the switching arrangement of the LOG ATTENUATOR, applies a DC positioning voltage to the OUTPUT BUFFER.

OPERATION IN LOG:

Operation in the LOG position of the VERTICAL DISPLAY switch is the same as in LIN with the following exceptions. The vertical display is no longer calibrated as it was in LIN. Low amplitude signals receive much more gain than do high amplitude signals. To accomplish this, the signal out of the DETECTOR is fed to the OUTPUT BUFFER through a voltage-variable attenuator. As the amplitude of the DETECTOR output increases, the attenuation increases, and as the DETECTOR output decreases, the attenuation decreases, causing low amplitude signals to receive more gain than higher amplitude signals.

The Log Range Adj adjusts the total range of attenuation change of the LOG ATTENUATOR.


INPUT
J1
AC
GND
AC FAST
SW1
CALIBRATOR
INPUT ATTENUATOR
VOLTS/CM
Input Amplifier
VARIABLE (VOLTS/CM)
LOG
LIN
VIDEO
1ST MIXER
1ST IF AMPLIFIER
3.0 MHz FILTER
2ND MIXER
2ND LOCAL OSCILLATOR 3.1 MHz
100 KHz
Variable Resolution Amplifier
COUPLED RESOLUTION
Driver Amplifier
VIDEO CAL
POSITION
DETECTOR LOG ATTEN
LIN
LOG
VIDEO
RECORDER DETECTOR
TO RECORDER
VERTICAL DISPLAY
OSC OUT
SWEPT FREQUENCY OSCILLATOR
CENTER FREQ (MULTIPLIER)
CENTER FREQUENCY SWITCHING
VARIABLE
CENTER FREQ
DISPERSION SWITCHING
DISPERSION
SWEEP MODE
EXT INPUT
SAWTOOTH FROM P11 PIN 6
EXT
INT
MANUAL
(MANUAL) OUTPUT
.1
.01
.001
OUTPUT BUFFER
P11
3
1


EXT INPUT J105
INT
EXT
MANUAL
R102 25K
R108 100K
-150V
J101
(MANUAL) OUTPUT
R105 24.9K
SW 105 SWEEP MODE
SW101 (REAR PANEL)
R110 100
1kHz/CM CAL
5kHz C.F. 1kHz/CM CAL
5000Hz C.F. 1kHz/CM CAL
R115 110
R113 5K
R114 5K
VARIABLE
SW115 DISPERSION-Hz/CM
10
20
50
100
200
500
1K
10K
100K
0000 Hz (C.F. CAL)
R120 100K
SW120 CENTER FREQ (MULTIPLIER)
500 KHz CENTER FREQ BAL
R150 100K
R129 5K
Hz Dispersion Ampl.
Hz Discriminator
R154 500
500 KHz Discriminator
(CAL) 500 KHz
(CENTER FREQ) VARIABLE
R239 2.5K
R238 1K
CAL 10 KHz
R232 2.3K
CENTER FREQ
AMPLITUDE REGULATOR
OSC AMPL
R214 500
D164
L164 4.5-130 µH
SWEPT FREQUENCY OSCILLATOR
Swept-Frequency Amplifier
L191 1-3 µH
3 MHz Filter
L192 1.9-4 µH
L154 2-5 µH