FACTORY CALIBRATION PROCEDURE

CONTENTS:

This is the guide for calibrating new instruments in Product Manufacturing. The procedure consists of 4 sections:

Equipment Required

Factory Test Limits - Factory Test Limits are limits an instrument must meet before leaving Manufacturing. These limits are often more stringent than advertised performance requirements. This is to insure that the instrument will meet advertised requirements after shipment, allows for individual differences in test equipment used, and (or) allows for changes in environmental conditions.

Short Form Procedure - The Short Form Procedure has the same sequence of steps and the same limits on checks or adjustments as the Main Procedure.

Main Procedure - The Main Procedure gives more detailed instructions for the calibration of the instrument. This procedure may require that some checks and adjustments be made so that performance is better than that required by the Factory Test Limits. This insures the Factory Test Limits will be met when side panels are added, permits some normal variation in test equipment and plug-in scopes, etc.

Abbreviations in this procedure will be found listed in TEKTRONIX STANDARD A-100. Definitions of terms used in this procedure may be found in TEKTRONIX STANDARD A-101.

In this procedure, all front panel control labels and Tektronix instrument names are in capital letters (VOLT/DIV, etc). Internal adjustment labels are capitalized only (Gain Adj, etc).

This procedure is company confidential

422

April 1969

For all serial numbers 20,000 and up.

CHANGE INFORMATION:

This procedure has been prepared by Product Manufacturing Staff Engineering. For information on changes made to this procedure, to make suggestions for changing this procedure, or to order additional copies: please contact PMSE, 39-307.

EQUIPMENT REQUIRED:

The following equipment is necessary to complete this procedure:

a. TEKTRONIX Instruments

1	TYPE 530 or 540 SERIES OSCILLOSCOPE
1	TYPE B PLUG-IN UNIT
1	TYPE D PLUG-IN UNIT
1	TYPE 106 SQUARE-WAVE GENERATOR
*1	TYPE 184 TIME-MARK GENERATOR
*1	TYPE 191 CONSTANT AMPLITUDE SIGNAL GENERATOR
1	TYPE 76TU LINE VOLTAGE CONTROL UNIT
1	TYPE P6006 10X PROBE
1	TYPE P6028 1X PROBE

b. Test Fixtures and Accessories

*1	Standard Amplitude Calibrator (067-0502-00)
*1	DC Voltage Bridge (067-0543-99)
1	33pF Input RC Normalizer (067-0540-00)
1	Low Frequency Sine-Wave Generator (LFSWG) (067-0542-99)
3	50Ω 42" BNC Cables (067-0057-00)
1	50Ω BNC Termination (011-0049-00)
1	AC Power Supply (016-0072-00) (Modified)
1	Displayed Noise Checker (PMIE Dwg #2678B)

Modification: The AC Power Supply is modified by replacing R659 with a pot and resistor in series. This allows the +12V to be adjusted to exactly +12V.

* Equipment must be traceable to NBS for certification of measurement characteristics.

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.

Factory Test Limits are qualified by the conditions specified in the main body of the Factory Calibration Procedure. The numbers and letters to the left of the limits correspond to the procedure steps where the check or adjustment is made. Steps without Factory Test Limits (setups, presets, etc.) are not listed. Instruments may not meet Factory Test Limits if calibration or checkout methods and test equipment differ substantially from those in this procedure.

3. RESISTANCE

Continuity between Pins 1 & 3 and 4 & 6

4. POWER SUPPLIES

b. -12V: ±1%, between 103.5 and 126.5VAC
c. -81V: -80V to -83V, between 103.5 and 126.5VAC
d. +12V: ±2%, between 103.5 and 126.5VAC
e. +10.5: ±2%, between 103.5 and 126.5VAC
f. Power Supply Ripple:

Supply	Line Ripple	HF Ripple
-12V	1mV	15mV
-81V	2mV	
+12V	1mV	10mV
+10.5V	1mV	

5. HIGH VOLTAGE

a. -1385V: ±5%
b. +4600V: ±20%

6. UNBLANKING CENTER: ≤3 volts between CRT pins 7 and 12

7. SCALE ILLUM AND CRT

a. Scale Illum: no illum ccw, max illum cw

8. TRACE ALIGNMENT

a. Trace Rotation range: 4°, min
b. Trace alignment: 0.05 div, max
c. Y axis align: 0.05 div, max

9. GEOMETRY

a. Geometry: 0.1div, max
b. Horizontal geometry: 0.1div, max

10. CH 1 BALANCE

c. STEP ATTEN BAL RANGE: >1.5Div

11. CH 2 BALANCE

c. STEP ATT BAL range: >1.5Div
d. INVERT Balance: ≤1div

12. ALTERNATE: must alternate at all sweep speeds

13. COMMON MODE CURRENT: 0V ±0.25V, max

14. GAIN

b. CH 1 GAIN Range: +10%, -5%, min
d. CH 2 GAIN Range: +10%, -5%, min
*f. ALG ADD: ±2%

15. VOLTS/DIV

*a. CH 1 VOLTS/DIV accuracy: ±2%, max
b. CH 1 VARIABLE range: 2.5:1, min
*c. CH 2 VOLTS/DIV accuracy: ±2%, max
d. CH 2 VARIABLE range: 2.5:1, min
*e. CH 2 X10 GAIN AC: ±3%

16. COMPRESSION, EXPANSION

a. CH 2 compression and expansion: 0.15div, max
b. CH 1 compression and expansion: 0.15div, max

18. VERTICAL POSITION RANGE

a. CH 2 POSITION range: 20div, min
b. CH 1 POSITION range: 20div, min
c. CH 1 POSITION centering: ±2.5div
d. CH 2 POSITION centering: ±2.5div

19. LINE VOLTAGE DRIFT

a. Trace drift with line voltage change: 0.2div, max
b. Gain change with line voltage change: ±1%, max

20. INPUT CURRENT: No trace shift

21. POSITION CROSSTALK: 0.1div, max

22. TRACE STABILITY

a. X10 GAIN trace jump: 0.05 div, max
b. Displayed Noise: $\leq$60µV

23. VOLTS/DIV COMPENSATION

b. CH 1 Compensation: ±2%, max
c. CH 2 compensation: ±2%, max

24. HIGH FREQUENCY COMPENSATION

b. CH 1 HF compensation: ±2%, max
c. CH 2 HF compensation: ±2%, max

25. BANDWIDTH

*b. CH 1 bandwidth: $\geq$16.5MHz @-3dB
*c. CH 2 bandwidth: $\geq$16.5MHz @-3dB
*d. CH 2 X10 GAIN AC bandwidth: $\geq$5MHz @-3dB

26. COMMON MODE REJECTION RATIO

b. Common Mode rejection Ratio: 100:1, min

27. ATTENUATOR ISOLATION

b. Isolation: 10,000:1, min

29. TRIGGERING

a. Internal triggering

TRIGGERING MODE	frequency	amplitude
AC LF REJ	50kHz	0.2div
DC, AC and	5 MHz	0.2div
AC LF REJ	15MHz	1div

b. Trigger DC Levels: ±1 div of graticule center
c. External triggering

MODE	frequency	amplitude
AC LF REJ	50kHz	0.125V
DC, AC and	5 MHz	0.125V
AC LF REJ	15MHz	0.6V

d. Low frequency triggering

MODE	INTERNAL	EXTERNAL
AC	0.2div	0.125V

e. LF REJ: not trigger with 1div of 50 Hz
f. AUTO triggering cycle rate: trigger at 50mSEC and not at 100mSEC

31. MAG RESISTER AND SWEEP LENGTH

a. Mag Register: ±0.2div, max
b. Sweep length: 10.4 to 12.1div

32. X10 TIMING AND POSITION

*a. MAG timing 20µSEC thru .5 SEC:
8 div: ±3%, max
2 div: ±6%, max
b. HORIZ POSITION range: ends of sweep go past center

33. VARIABLE TIME/DIV: 2.5:1, min

36. TIME/DIV ACCURACY

*a. X10 timing: -2%, +3% over 8 div
±6% over 2 div
*b. X1 timing: ±2% over 8 div
±3% over 2 div

37. EXT HORIZ

*a. Deflection factor: 10v/div, ±25%
b. HORIZ ATTEN range: 10:1, min
*c. Bandpass: ≥500kHz @-3dB

38. CHOPPED OPERATION

CHOPPED frequency: 150kHz ±20%

39. EXT BLANKING

b. Blanking: +2V, min

40. GATE OUT

b. GATE amplitude: 0.5V, min

41. CALIBRATOR

*b. Cal Ampl: 0.5%
*c. 200mV internal calibration: 1%, max
e. Repetition rate: 1kHz, ±20%
f. Duty cycle: 45% to 55%

(THE FOLLOWING CHECKS ARE NOT MADE ON 100% OF THE INSTRUMENTS BUT ARE DONE ON A SAMPLING BASIS.)

42. LOW FREQ BANDWIDTH

b. CH 1 LF Bandwidth: ≤2 Hz
c. CH 2 LF Bandwidth: ≤2 Hz
d. CH 2 X10 LF Bandwidth: ≤5 Hz

THE END

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

Factory Test Limits are limits an instrument must meet before it leaves Manufacturing; therefore, it must be possible to inspect to these limits. Because of normal variations in test equipment and plug-in scopes, addition of side panels, etc, it is necessary to set up some circuits so their performance is better than required by Factory Test Limits. Therefore, the instructions given in the Factory Calibration Procedure may call for checks or adjustments which result in less error than that allowed by the Factory Test Limits.

1. MODIFICATIONS

Check for current modifications

2. TYPE 422 PRESETS

3. RESISTANCE

Check power amphenol resistance

4. POWER SUPPLIES

b. Check -12 volts: check that supply remains between -11.88V and 12.12V while varying line between 103.5 and 126.5VAC
c. Check for -81 volts: check for -80 to -83V between 103.5 and 126.5VAC
d. Check +12 volts: ±2% between 103.5 and 126.5VAC
e. Check +10.5 volts: ±2% between 103.5 and 126.5 VAC
f. Check ripple:

Supply	Line Ripple	HF Ripple
+12V	1mV	15mV
-81V	2mV	
+12V	1mV	10mV
+10.5V	1mV	

5. HIGH VOLTAGE:

a. Check -1385V: ±5%
b. Check +4600: ±20%

6. UNBLANKING CENTER

≤3 volts between CRT pins 7 and 12

7. SCALE ILLUM AND CRT

a. Check SCALE ILLUM: no illum ccw, max illum cw
b. Check CRT

8. TRACE ALIGNMENT

a. Check Trace Rotation range: 4° min
Rotate R851 and check for 4° range
b. Align trace: 0.05div max
adjust R851 to align trace
c. Adjust Y Axis align: 0.05div max
adjust R856 to align markers vertically

9. GEOMETRY

a. Adjust and check Geometry (R854): 0.1 div, max
b. Check horizontal geometry: 0.1div, max

10. CH 1 BALANCE

a. Adjust STEP ATTEN BAL
b. Adjust Var Bal
adjust R35 for no trace shift
c. Check STEP ATTEN BAL range:
≥1.5div

11. CH 2 BALANCE

a. Adjust STEP ATTEN BAL
b. Adjust Var Bal
adjust R135 for no trace shift
c. Check STEP ATTEN BAL range: ≥1.5Div
d. Check INVERT balance: ≤1.0div

12. ALTERNATE: must alternate at all sweep speeds

13. COMMON MODE CURRENT: adj R215 for OV on the emitter of Q224

14. GAIN

b. Check CH 1 GAIN range: +10%, -5%, min. Rotate CH 1 GAIN and check for a range of 3.8 to 4.4 div.
c. Adjust CH 1 GAIN: set for 4div
d. Check CH 2 GAIN RANGE: +10%, -5%, min
Rotate CH 2 GAIN and check for a range of 3.8 to 4.4div
e. Adjust CH 2 GAIN: adjust CH 2 GAIN for signal cancellation
f. Check ALG ADD: ±2%

15. VOLTS/DIV:

a. Check CH 1 VOLTS/DIV accuracy ±2%, max
b. Check CH 1 VARIABLE range: 2.5:1, min
c. Check CH 2 VOLTS/DIV accuracy ±2%, max
d. Check CH 2 VARIABLE range: 2.5:1, min
e. Check CH 2 X10 GAIN AC: ±3%

16. COMPRESSION, EXPANSION

a. Check CH 2 compression and expansion: 0.15div, max
b. Check CH 1 compression and expansion: 0.15div, max

17. INPUT SWITCHES

a. Check CH 1 AC-GND-DC switch
b. Check CH 2 AC-GND-DC switch

18. VERTICAL POSITION RANGE

a. Check CH 2 POSITION range: 20div, min
b. Check CH 1 POSITION range: 20div min
c. Check CH 1 POSITION centering: ±2.5div
d. Check CH 2 POSITION centering: ±2.5div

19. LINE VOLTAGE DRIFT

a. Check trace drift with line voltage change: 0.2div, max
b. Check gain change with line voltage change: ±1%, max

20. INPUT CURRENT: No trace shift Switch AC-GND-DC switch between ground and DC. Check for no trace shift

21. POSITION CROSSTALK: check CH 1 CH 2 crosstalk 0.1div, max

22. TRACE STABILITY

a. Check X10 GAIN trace jump 0.05div, max. With X10 GAIN AC pulled out Check trace jump or jitter for 0.05 div, max
b. Check displayed noise: ≤60μV

23. VOLTS/DIV COMPENSATION

b. Adjust or check CH 1 compensation: ±2%, max
c. Adjust or check CH 2 compensation: ±2%, max

24. HIGH FREQUENCY COMPENSATION

b. Adjust HF compensation: ±2%, max
c. Check CH 2 HF compensation: ±2%, max

25. BANDWIDTH

b. Check CH 1 bandwidth: ≥16.5MHz at -3dB
c. Check CH 2 bandwidth: ≥16.5MHz at -3dB
d. Check CH 2 X10 GAIN AC bandwidth: ≥5MHz at -3dB

26. COMMON MODE REJECTION RATIO

b. Check common mode rejection ratio: 10,000:1, min

27. ATTENUATOR ISOLATION

b. Check isolation: 10,000:1, min

28. TRIGGER COMPENSATION

b. Adjust internal compensation: Adjust C353 and C217 for optimum square-wave.
c. Adjust external compensation: Adjust C302 for optimum square-wave
d. Check trigger limiting
e. Adjust Trigger DC Level (R57) for 0V

29. TRIGGERING

a. Check internal triggering
b. Check trigger DC level: ±1 div of graticule center
c. Check external triggering
d. Check low frequency triggering
e. Check LF REJ: not trigger with 1 div of 50Hz
f. Check AUTO triggering cycle rate: Trigger with 50mSEC markers and will not trigger on 100mSEC markers

30. SWEEP CAL

b. Adjust Sweep Cal: adj R512 for 1 mark/div at .5mSEC.

31. MAG REGISTER AND SWEEP LENGTH

a. Adjust Mag Register: ±0.2div, max adjust R535
b. Check sweep length: 10.4 to 12.1div

32. X10 TIMING AND POSITION

a. Check X10 MAG timing 20μSEC thru .5 SEC: ±3% over 8 div, ±6% over 2 div
b. Check HORIZ POSITION range: check that ends of trace go past center

33. VARIABLE TIME/DIV:

Check VARIABLE range 2.5:1, min

34. 5μSEC TIMING

Adjust C440A for 1 mark/div

35. .5μSEC TIMING

a. Preset C511 to midr
b. Preset C537: set for best linearity
c. Adjust C527:
d. Adjust C511:
e. Repeat step b as needed

36. TIME/DIV ACCURACY

a. Check X10 timing: -2% +3% over 8 div
   ±6% over 2 div
b. Check X1 timing accuracy:
   ±2% over 8 div
   ±3% over 2 div

37. EXT HORIZ

a. Check deflection factor: 10V/div, ±25%
b. Check HORIZ ATTEN range: 10:1, min
c. Check bandwidth: ≥500kHz @-3dB

38. CHOPPED OPERATION

Check frequency: 150kHz, ±20%

39. EXT BLANKING

b. Check blanking: +2V, min

40. GATE OUT

b. Check amplitude: 0.5V, min

41. CALIBRATOR

b. Adjust Cal Ampl (R780)
c. Check 200mV internal calibration: 1%, max
d. Check CALIBRATE 4 DIVISIONS
e. Check repetition rate: 1kHz, ±20%
f. Check duty cycle: 45% to 55%

SAMPLE CHECK

42. LOW FREQ BANDWIDTH

b. Check CH 1 LF Bandwidth: ≤2 Hz
c. Check CH 2 LF Bandwidth: ≤2 Hz
d. Check X10 LF Bandwidth: ≤5 Hz

THE END

1. MODIFICATIONS AND FUSES

Check for current modifications

2. TYPE 422 PRESET

INTENSITY	ccw
FOCUS	midr
ASTIGMATISM	midr
SCALE ILLUM	cw
CH 1 and CH 2	
VOLTS/DIV	.05
VARIABLE	CAL
AC GND DC	DC
POSITION	midr
GAIN	midr
STEP ATT BAL	midr
mode	CH 1
INVERT	Pushed IN
X10 GAIN AC	Pushed IN
TIME/DIV	1mSEC
VARIABLE	CAL
horiz POSITION	midr
X10 MAG	pushed IN
TRIGGERING	CH 1 & 2; AC
	SLOPE +
TRIGGERING LEVEL	midr
POWER	OFF

3. RESISTANCE

Check power amphenol resistances to ground (neg meter lead to gnd)

Pin	Scale	Approx resistance
1 - 6		inf
7	X10	120Ω
8		inf
9	X10k	70k
10		inf
11	X10k	55k
12 - 14		inf
15	X10k	11k
16		inf
17		0
18		0
19	X100	310Ω
20 - 24		inf

Connect multimeter between pins 1 and 3 and check for continuity. Connect multimeter between pins 4 and 6 and check for continuity.

4. POWER SUPPLIES

a. Setup

Connect AC POWER SUPPLY to TYPE 422 using the extension. Connect AC POWER SUPPLY to TYPE 76TU. Set TYPE 76TU to 115VAC and turn TYPE 422 POWER ON (Switch power supply ON)

b. Check -12 volts

Connect DCVB to the -12 volt supply and check for -12 volts.

Supply must remain between 11.88V and 12.12V while varying line between 103.5 and 126.5VAC.

c. Check -81 volts: -80 to -83V between 103.5 and 126.5VAC

Connect DCVB to the -81V supply. Check that supply measures between 80 and 83 volts while varying line between 103.5 and 126.5VAC.

d. Check +12 Volts supply: ±2% between 103.5 and 126.5VAC

Connect DCVB to the +12 Volts supply and check that supply remains between 11.76V and 12.24V while varying line between 103.5VAC and 126.5VAC.

e. Check +10.5 Volt Supply: ±2% between 103.5 and 126.5VAC

Connect DCVB to the 10.5 Volt supply and check that supply remains between 10.29V and 10.71V while varying line between 103.5 and 126.5VAC.

f. Check ripple

Connect X1 probe to the appropriate supply and measure ripple while varying line from 103.5VAC to 126.5VAC.

SUPPLY	LINE RIPPLE	HF RIPPLE
-12V	1mV	15mV
-81V	2mV	
+12V	1mV	10mV
+10.5	1mV	

5. HIGH VOLTAGE

a. Check -1385V: ±5%

Connect DCVB to pin 3 of CRT socket and check that supply measures between -1315.5 and -1454.5V with the intensity ccw.

b. Check +4600V ±20%

Connect voltmeter to CRT anode connector and check for +4600V ±920V.

6. UNBLANKING CENTER

≤3 volts between CRT pins 7 and 12

Set TRIGGERING LEVEL to AUTO and sweep speed to .5 SEC/DIV. Set VARIABLE TIME/DIV ccw, ASTIGIMATISM ccw and FOCUS midr. Set INTENSITY for a dim spot. Adjust R869 for the best defined spot. Check for ≤3 volts between CRT pins 7 and 12.

7. SCALE ILLUM AND CRT

a. Check SCALE ILLUM: no illum ccw; max illum cw

Rotate SCALE ILLUM through its range. Check for a smooth increase in illumination with no illumination at ccw and max illumination at full cw.

b. Check CRT

Check CRT for double-peaking, flare, grid emission, burrs, phosphor defects, scan and tears or warping of the mesh.

b. Do not reject a CRT without consulting a trained CRT checker or referring to the Cathode Ray Tube Checkout Procedure.

8. TRACE ALIGNMENT

a. Check Trace Rotation range: 4° min

Rotate R851 full cw and ccw and check for at least 4° (.7div) range.

8. (CONT)

b. Align trace: 0.05div max

Adjust R851 to align trace with center horizontal graticule line. Reverse leads to the rotator coil if necessary to reverse the direction of rotation.

c. Adjust Y Axis Align: 0.05div max

Connect TYPE 184 to CH 1 INPUT. Set TYPE 184 for 100µs and 1mS markers. Set CH 1 VOLTS/DIV and POSITION so marker extend from the bottom to the top of the graticule. Set TRIGGERING LEVEL for a stable display. Adjust R856 to align markers with center vertical graticule line. Reverse the leads to R856 if necessary to reverse direction of rotation.

9. GEOMETRY

a. Adjust and check Geometry: 0.1div, max

Adjust R854 for mim curvature of the markers.

b. Check horizontal geometry: 0.1div, max

Remove TYPE 184 markers and set LEVEL to AUTO. Position trace to the top and bottom graticule lines and check for less than 0.1div or deviation from horizontal graticule lines.

9. These CRT checks are simplified. For further information on CRTs see the CRT Checkout Procedure or consult a trained CRT checker.

10. CH 1 BALANCE

a. Adjust STEP ATTEN BAL

Adjust STEP ATTEN BAL for no trace shift when switching VOLTS/DIV from .05 to .01. Set to .05.

b. Adjust Var Bal

Adjust CH 1 Var Bal (R35) for no trace shift while rotating VARIABLE thru its range. Repeat STEP ATTEN BAL and Var Bal adjustments if necessary due to interaction.

10. (CONT)

c. Check STEP ATTEN BAL range: ≥1.5div range after adjustment

Position trace to graticule center set VOLTS/DIV to .05 and rotate STEP ATTEN BAL. Trace must position at least than + and - 1.5 div from graticule center. Reset trace to graticule center.

11. CH 2 BALANCE

a. Adjust STEP ATTEN BAL

Adjust CH 2 STEP ATTEN BAL as in step 10a.

b. Adjust Var Bal

Adjust R135 as in step 10b.

c. Check STEP ATTEN BAL range: ≥1.5div after adjustment

Check CH 2 STEP ATTEN BAL range as in Step 10c.

d. Check Invert Balance: ≤1div

Adjust CH2 position pot until there is no trace shift when the invert switch is pulled. Trace must be within 1 div of graticule center.

12. ALTERNATE

Alternates at All Sweep Speeds

Change mode to ALT and position traces 2div apart. Check for alternate sweeps at all TIME/DIV settings. Set TIME/DIV to .5msec.

13. COMMON MODE CURRENT

Position both traces to graticule center. Connect the X10 probe to the emitter of Q224. Adjust R215 for OV on the emitter of Q224. Waveform displayed must be ±.25 volts or less.

14. GAIN

a. Setup

SAC---BNC Cable--BNC T connector--
CH 1 INPUT
CH 2 INPUT

b. Check CH 1 GAIN range: +10%, -5%, min

Set SAC to .2 VOLTS and CH 1 VOLTS/DIV to .05. Rotate CH 1 GAIN cw and ccw and check for a range of at least 3.8 to 4.4 div.

c. Adjust CH 1 GAIN

Set CH 1 GAIN for 4div deflection.

d. Check CH 2 GAIN RANGE: +10%, -5%, min

Set mode to CH 2 and rotate GAIN cw and ccw and check for a range of at least 3.8 to 4.4div.

e. Adjust CH 2 GAIN

Position both traces to graticule center. Switch mode to ALG ADD and pull INVERT. Adjust CH 2 GAIN for signal cancellation.

f. Check ALG ADD ±2%

Set SAC to .1 VOLTS and push INVERT. Check for 4div deflection ±2%.

15. VOLTS/DIV

a. Check CH 1 VOLTS/DIV accuracy ±2%, max

Switch CH 2 input to GND and mode to CH 1. Check CH 1 VOLTS/DIV accuracy as in the table below:

VOLTS/DIV	SAC	DIV DEFLECTION	±DIV
.01	50mv	5	0.1
.02	.1 v	5	0.1
.05	.2 v	4	0.08
.1	.5 v	5	0.1
.2	1 v	5	0.1
.5	2 v	4	0.08
1	5 v	5	0.1
2	10 v	5	0.1
5	20 v	4	0.08
10	50 v	5	0.1
20	100 v	5	0.1

15. (CONT)

b. Check CH 1 VARIABLE range: 2.5:1, min

Turn VARIABLE ccw. Check for not more than 2div of deflection. UnCal neon must be lit when VARIABLE is out of detent. Return VARIABLE to CAL.

c. Check CH 2 VOLTS/DIV accuracy ±2% max

Switch mode to CH 2 and GND CH 1 and repeat step a for CH 2.

d. Check CH 2 VARIABLE range: 2.5:1 min

Repeat step b for CH 2. Return VARIABLE to CAL.

e. Check CH 2 X10 GAIN ±3%

Set SAC to 20mVOLTS and VOLTS/DIV to .05. Pull X10 GAIN AC. Check for 4div deflection ±3%. Push X10 GAIN switch.

16. COMPRESSION, EXPANSION

a. Check CH 2 compression and expansion: 0.15div max

Change SAC to .1v and check for exactly 2div deflection when positioned to graticule center. Position top of display to top graticule line and note compression or expansion. Position bottom of display to bottom graticule and note compression or expansion. Compression or expansion must not exceed 0.15 div at the top or bottom.

b. Check CH 1 compression and expansion: 0.15div max

Change mode to CH 1, CH 1 VOLTS/DIV to .05 and CH 1 input to DC. Repeat compression, expansion check.

17. INPUT SWITCHES

a. Check CH 1 AC-GND-DC switch

Position display so bottom is at center of graticule. Switch to AC and check that waveform shifts downward.

b. Check CH 2 AC-GND-DC switch

Switch mode to CH 2 and repeat step a. Leave switch in AC position.

18. VERTICAL POSITION RANGE AND CENTERING

a. Check CH 2 position range: 20div min

Change SAC to 1 VOLT. With the POSITION control full ccw the top of the display must be below graticule center. With the POSITION control full cw the bottom of the display must be above graticule center.

b. Check CH 1 position range: 20div min

Switch mode to CH 1 and repeat step a.

c. Check CH 1 POSITION centering: ±2.5div

Switch AC-GND-DC switch to GND. Set POSITION knob index to center and check that trace is within 2.5div of graticule center.

d. Check CH 2 POSITION centering: ±2.5div

Switch MODE to CH 2 and repeat step c.

19. LINE VOLTAGE DRIFT

a. Check trace drift with line voltage change: 0.2div, max

Change SAC to .2 VOLTS, mode to ALT and TRIGGERING LEVEL to AUTO. Position both displays to graticule center. Change line voltage to 103.5V and 126.5V for 30 seconds and check that trace drift does not exceed 0.2div.

b. Check gain change with line voltage change ±1%, max

Check change in amplitude of display when changing line voltage to 103.5V and 125.6V. Must not exceed 0.04div.

Return line voltage to 115V. Remove SAC signal.

20. INPUT CURRENT

No trace shift

Center both traces with POSITION controls. Switch AC-GND-DC switches between GND and DC and check for no trace shift.

21. POSITION CROSSTALK

Check crosstalk 0.1div, max

Turn CH 1 POSITION full cw and ccw while checking movement of CH 2 trace for 0.1div, max.

Repeat using CH 2 POSITION and noting CH 1 trace.

22. TRACE STABILITY

a. Check X10 GAIN trace jump 0.05 div, max

Set mode to CH 2, CH 2 VOLTS/DIV to .01 and X10 GAIN AC pulled out. Check trace jump or jitter for 0.05 div, max.

b. Check displayed noised: ≤60μV

SAC--BNC cable--Displayed Noise Checker--CH 2 INPUT.

Set SAC to .2 VOLTS. Set TYPE 422 SWEEP SPEED to 10μS. Set Displayed Noise Checker to point where dark area between traces just disappears. Set SAC to 20 VOLTS. 1 DIV displayed squarewave is equal to 10μV noise. Check for ≤ than 6 div.

23. VOLTS/DIV COMPENSATION

a. Setup

TYPE 106 (HI AMPLITUDE)--10X attenuator--
50Ω cable--50Ω Term--33pF standardizer--INPUT I

TYPE 422 presets:

both VOLTS/DIV	.05
both AC-GND-DC switches	DC
mode	CH 1

Adjust TYPE 106 for 5div of 1kHz signal.

b. Adjust or check CH 1 compensation ±2%, max

Check or adjust for best square wave as in the following table. Maintain 5div of signal when possible, removing attenuator as needed. Top of square wave must be within 2% of being flat.

VOLTS/DIV	corner	flat top
.05		C12
.02	check	
.01	check	
.1	C3C	C3B
.2	C4C	C4B
.5	C5C	C5B
1	check	
2	check	
5	C6C	C6B
10	check	
20	check	

c. Adjust or check CH 2 compensation ±2%, max

Change mode to CH 2 and TYPE 106 signal to INPUT 2. Adjust or check for best square wave as follows. Top of square wave must be within 2% of being flat. CH 2 .05 VOLTS/DIV waveform must match CH 1 witnin 1%.

VOLTS/DIV	corner	flat top
.05		C112
.02	check	
.01	check	
.1	C103C	C103B
.2	C104C	C104B
.5	C105C	C105B
1	check	
2	check	
5	C106C	C106B
10	check	
20	check	

24. HIGH FREQUENCY COMPENSATION

a. Setup

TYPE 106 (FAST-RISE)--50Ω GR cable--
50Ω GR to BNC termination--INPUT 1

Change mode to CH 1, both VOLTS/DIV to .05, TIME/DIV to .5μSEC and X10 MAG on. Set TYPE 106 for 4.0div of 100kHz signal.

b. Adjust hf compensation ±2%, max

Position display to center of graticule. Adjust R237, C237, L245 and L255 for best square-wave. Overshoot and ringing must not exceed 2% of signal amplitude.

c. Check CH 2 hf compensation ±2%, max

Change mode to CH 2 and TYPE 106 signal to INPUT 2. Check overshoot and ringing. Must not exceed 2% of signal amplitude.

Remove TYPE 106 signal.

25. BANDWIDTH

a. Setup

Set mode to CH 1, TIME/DIV to 1mSEC, X10 MAG off (pushed-in) and TRIGGERING LEVEL to AUTO. Connect TYPE 191 to INPUT 1.

b. Check CH 1 bandwidth ≥16.5MHz at -3dB

Adjust TYPE 191 for 6div of 50kHz signal. Set TYPE 191 to 16.5MHz. Check for at least 4.2 div of deflection.

Repeat bandwidth check at .02 and .01 VOLTS/DIV.

c. Check CH 2 bandwidth ≥16.5MHz at -3dB

Change mode to CH 2 and TYPE 191 signal to INPUT 2. Repeat bandwidth checks for CH 2.

Return both VOLTS/DIV to .05.

25. (CONT)

d. Check CH 2 X10 GAIN bandwidth ≥5MHz at -3dB

Pull out X10 GAIN AC. Adjust TYPE 191 for 6 div of 50 kHz. Set TYPE 191 to 5 MHz. Check for at least 4.2 div of deflection. Push in X10 GAIN AC.

26. COMMON MODE REJECTION RATIO

a. Setup

Connect TYPE 191 to INPUT 1 and INPUT 2 using a T connector. Adjust TYPE 191 for 8div of 50kHz signal.

b. Check common mode rejection ratio 100:1, min

Change mode to ALG ADD and pull out INVERT. Check deflection for 0.08 div, max.

Remove TYPE 191 signal.

27. ATTENUATOR ISOLATION

a. Setup

Set CH 1 VOLTS/DIV to 2, CH 2 VOLTS/DIV to .01, CH 2 input to DC and MODE to ALT. Apply 10V of 1MHz signal from LFSWG to INPUT 1.

b. Check isolation 10,000:1, min

Check CH 2 display for 0.1div, max.

Change CH 1 VOLTS/DIV to .01, CH 2 to 2, CH 1 input to DC and CH 2 to DC. Apply LFSWG signal to INPUT 2. Check CH 1 display for 0.1div, max.

Remove LFSWG signal,

28. TRIGGER COMPENSATION

a. Setup

TYPE 106 (+FAST RISE)--50Ω cable--10X attenuator--50Ω termination--INPUT 1.

Remove Q364 from socket.

Set CH 1 VOLTS/DIV to .05, CH 1 input to GND, mode to CH 1 and TRIGGERING source to CH 1. Connect test scope 10X probe to base of Q364.

b. Adjust internal compensation

Set TRIGGERING LEVEL for zero volts as indicated on test scope. Switch CH 1 input to DC and adjust TYPE 106 for 0.1 volt of 10kHz signal at base of Q364. Adjust C353 for optimum square-wave in the negative direction.

Switch TRIGGERING source to CH 1 and 2 and adjust C217 for optimum square-wave in the negative direction.

c. Adjust external compensation

Connect TYPE 106 signal to TRIG IN and set TRIGGERING source to EXT. Remove X10 atten. Adjust TYPE 106 AMPLITUDE for 0.1 volt at base of Q364. Adjust C302 for optimum square-wave in the negative direction.

d. Check trigger limiting

Turn LEVEL cw and ccw but not to FREE RUN or AUTO. Display amplitude should be reduced by approx 10 times at each direction of rotation.

e. Adjust CH 1 trigger DC level

Switch CH 1 INPUT to GND. Switch TRIGGERING to CH 1 and DC. Adjust R57 for 0V on test scope. Replace Q364 in socket. Remove TYPE 106 and X10 Probe.

29. TRIGGERING

a. Check internal triggering

Check that stable display is obtainable at TYPE 191 frequencies and amplitudes listed below in CH 1 & 2 and CH 1 positions of trigger selector.

29a. (cont'd)

TRIGGERING mode	frequency	amplitude
AC LF REJ	50kHz	0.2div
DC, AC and	5MHz	0.2div
AC LF REJ	15MHz	1div

b. Check trigger DC levels: ±1div of graticule center

Set TRIGGERING mode to DC and SOURCE to CH 1. Set TRIGGER LEVEL to trig on .2div of 50kHz signal. Switch MODE to CH 1 and 2. Position display for stable triggering. Display must trigger within 1 div of graticule center.

c. Check external triggering

Connect TYPE 191 signal to INPUT 1 and TRIG IN using a T connector. Set TRIGGERING to EXT and check that a stable display can be obtained at frequencies and amplitudes listed below:

Mode	frequency	amplitude
AC LF REJ	50kHz	0.125V
DC, AC and	5MHz	0.125V
AC LF REJ	15MHz	0.6V

c. External triggering

Adjust amplitude with TYPE 191 set to 50kHz and then switch to specified frequency.

d. Check low freq triggering

Connect LFSWG signal to INPUT 1 and TRIG IN. Set generator for 50 Hz and check that a stable display can be obtained at amplitudes listed below:

Mode	internal	external
AC	0.2div	0.25V

e. Check LF REJ: not triggered with 1 div of 50 Hz

Set TRIGGERING to CH 1 and 2, AC LF REJ and check that a stable display cannot be obtained with 1 div of 50 Hz. Remove LFSWG.

f. Check AUTO triggering cycle rate: triggers at 50mS and not at .1S

Connect TYPE 184 to CH 1 INPUT. Set TRIGGERING LEVEL to AUTO and check for stable triggering with 50mS markers, and will not trigger with .1S markers.

30. SWEEP CAL

a. Setup

Set TIME/DIV to .5mSEC. Switch TYPE 184 to .5ms and 50μS markers.

b. Adjust sweep cal (R512)

Adjust sweep cal for 1 large marker each div.

Unless noted otherwise, use the middle 8 horizontal div when adjusting or checking timing.

31. MAG REGISTER AND SWEEP LENGTH

a. Adjust Mag Register (R535) ±0.2div, max

Pull out X10 MAG and position the first time mark to center vertical graticule line. Push in X10 MAG and adjust Mag Register so first time mark is at center graticule line. Check mag register at center of sweep. Must be within 0.2div.

b. Check sweep length 10.4 to 12.1 div

With X10 MAG pushed in check total sweep length for 10.4 to 12.1 div.

32. X10 TIMING AND POSITION

a. Check MAG timing 20μSEC thru .5 SEC: 8 div ±3%, max
2 div ±6%, max

Pull X10 MAG. Check MAG timing accuracy. It is necessary to check MAG on slow ranges only if the difference between magnified and unmagnified exceeds 1%. Check for accuracy within ±3% over center 8 div and ±6% over any 2 div within center 8 div.

b. Check HORIZ POSITION range: ends of sweep past center

Rotate HORIZ POSITION cw and ccw and check that ends of sweep position past center graticule line.

33. VARIABLE TIME/DIV

Check VARIABLE range 2.5:1, min

Set TYPE 184 for 5msec markers and push in X10 MAG. Turn VARIABLE TIME/DIV full ccw. Check for 1 marker every 4div or less. Check that UNCAL neon is lit when VARIABLE is out of detent. Return VARIABLE to CAL.

34. 5µSEC TIMING

Adjust C440A

Set TIME/DIV to 5µSEC and TYPE 184 for 5µSEC markers. Adjust C440A for 1 marker per div.

35. .5µSEC TIMING

a. Preset C511

Preset C511 to midr.

b. Preset C537

Switch TIME/DIV to .5µSEC and TYPE 184 to .5µS markers. Adjust C537 for best linearity over the first three markers.

c. Adjust C527

Pull X10 MAG. Switch TYPE 184 to 50nS markers. Position display to the center of sweep and adjust C527 for 1 cycle per 1div.

d. Adjust C511

Position sweep so that 2nd cycle is aligned with the 1st graticule line and adjust C511 for optimum timing from the 1st to 9th graticule line.

e. Repeat step b as needed

36. TIME/DIV ACCURACY

a. Check X10 timing: -2% +3% over 8 div
±6% over 2 div

With X10 MAG pulled out set TIME/DIV and TYPE 184 as in the following table and check timing accuracy to be within -2%, +3% over any 8 div from 2nd to 90th div and with ±5% over any 2 div within center 8 div of graticule.

TIME/DIV	TYPE 184	Check for
.5µSEC	50nSEC	1 cycle/div
1µSEC	.1µSEC	1 mark/div
2µSEC	.1µSEC	2 mark/div
5µSEC	.5µSEC	1 mark/div
10µSEC	1µSEC	1 mark/div

b. Check X1 timing: ±2% over 8 div
±3% over 2 div

Push in X10 MAG. Set TIME/DIV and TYPE 184 as in the following table and check timing accuracy to be within ±2% over any 8 div and within ±3% over any 2 div within center 8 div of graticule.

Triggers will not operate in AUTO at the slower sweep speeds.

TIME/DIV	TYPE 184	Marks/div
.5µSEC	.5µSEC	1
1µSEC	1µSEC	1
2µSEC	1µSEC	2
5µSEC	5µSEC	1
10µSEC	10µSEC	1
20µSEC	10µSEC	2
50µSEC	50µSEC	1
.1mSEC	.1mSEC	1
.2mSEC	.1mSEC	2
.5mSEC	.5mSEC	1
1mSEC	1mSEC	1
2mSEC	1mSEC	2
5mSEC	5mSEC	1
10mSEC	10mSEC	1
20mSEC	10mSEC	2
50mSEC	50mSEC	1
.1SEC	.1SEC	1
.2SEC	.1SEC	2
.5SEC	.5SEC	1

Remove the TYPE 184 signal.

37. EXT HORIZ

a. Check deflection factor: 10V/div ±25%

Set TIME/DIV to EXT HORIZ and HORIZ ATTEN full cw. Set the SAC to 50VOLTS and connect to HORIZ IN. Check deflection for 4.0 to 6.7div.

b. Check HORIZ ATTEN range: 10:1, min

Turn HORIZ ATTEN cw and pull out X10 MAG. Check for equal to or less than the deflection in 37a.

Remove SAC signal.

c. Check bandwidth $\geq$500kHz at -3dB

Turn HORIZ ATTEN ccw. Connect TYPE 191 to HORIZ IN and set for 4div of 50kHz.

Change TYPE 191 to 500kHz and check deflection for 2.8div, min.

Remove TYPE 191 and push in X10 MAG.

38. CHOPPED OPERATION

Check frequency 150kHz ±20%

Set TIME/DIV to 2µSEC, MODE to CHOPPED, and TRIGGERING LEVEL to obtain a triggered display. Check duration of one complete cycle of chopped wave for 5.5 to 8.3µsec. Check for complete blanking of switching transients between chopped segments.

39. EXT BLANKING

a. Setup

Connect a 50Ω cable from the TYPE 191 through a T connector to INPUT 1. Connect a 50Ω Term to the unused side T connector. Set TIME/DIV to 10μSEC, MODE to CH 1 and CH 1 VOLTS/DIV to 1. Establish a ground reference on the TYPE 422 and set the TYPE 191 for 2 Volts positive 50kHz signal from the reference level.

b. Check blanking: +2 volts, min

Connect a 50Ω cable from the 50Ω Term on the T connector to EXT BLANKING. Check that the top portion of the sinewave is blanked at normal intensity.

Remove the SAC.

40. GATE OUT

a. Setup

Connect GATE OUT through a 50Ω cable to vertical of test scope. Set the TYPE 422 TRIGGERING LEVEL to AUTO.

b. Check amplitude: 0.5V, min

Check for -0.5V, min, gate waveform, the duration of which will be the total sweep length of the TYPE 422.

41. CALIBRATOR

a. Setup

Connect the DCVB between gnd and the 2 VOLT PROBE CALIBRATOR.

b. Adjust Cal Ampl (R780)

Remove Q775 and adjust Cal Ampl (R780) for negative 2 Volts.

41. (CONT)

c. Check 200mV internal calibration 1.0%, max

Connect the DCVB to Pin J of the calibration board and check for negative 200mV 1.0%, max.

Replace Q775 and remove the DCVB.

d. Check CALIBRATE 4 DIVISIONS

With both VOLTS/DIV to CALIBRATE 4 DIVISIONS, switch mode to CH 1 and to CH 2 checking for a 4div square-wave display.

e. Check repetition rate 1kHz ±20%

Set the TYPE 422 TIME/DIV to .2mSEC. Check duration of one complete cycle of waveform for 0.84 to 1.25mSEC (4.2 to 6.25div).

f. Check duty cycle 45% to 55%

Set the TYPE 422 TIME/DIV and VARIABLE so one cycle, of waveform causes 8div. Duration of each half cycle must be from 3.6 to 4.4div.

SAMPLE CHECK

42. LOW FREQ BANDWIDTH

a. Setup

Set MODE to CH 1, TIME/DIV to 1mSEC, X10 MAG off (pushed-in) and TRIGGERING LEVEL to AUTO. Connect LFSWG to INPUT 1.

b. Check CH 1 LF Bandwidth: ≤2 Hz

Adjust LFSWG for 6 div of 1 kHz signal. Set LFSWG to 2 Hz. Check for ≥4.2 divisions amplitude.

c. Check CH 2, LF Bandwidth: ≤2 Hz

Repeat step b for CH 2.

d. Check X10 LF Bandwidth: ≤5 Hz

Pull X10 GAIN AC. Repeat step c. Check for ≥4.2 div at 5 Hz.

THE END