NOTE REGARDING FACTORY CALIBRATION PROCEDURES AND TEST SPECIFICATIONS

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

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

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

FIELD RECALIBRATION PROCEDURE

CONTENTS:

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INTRODUCTION:

This recalibration procedure is intended for Tektronix Field Repair Center use.

1A1

The specifications listed are factory specs and not guaranteed unless they also appear as catalog or instruction manual specs.

Special equipment has been kept to a minimum, depending on availability and recal time saved vs. production, distribution cost and complexity.

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062-135
March 1964

The recalibration steps were designed to make the procedure as simple and as fast as possible, and yet complete enough for a first-time recalibration. To accomplish this, each step was arranged in two parts--Setup and Adjustment; detailed setup procedures were replaced in many cases with general statements. Block diagrams or circuit diagrams were included in certain steps to help locate the adjustment and show what the adjustment does to produce the desired results to aid in trouble shooting. A simplified adjustment procedure was called out next to each adjustment on the block diagram or circuit diagram to help speed up the recal once a person becomes familiar with the instrument, and waveforms were shown where needed.

For all serial numbers.

The blank column on the right of the page is for notes on trouble shooting hints and general information concerning the recal. It will be filled in as we receive feedback from the Field or further information from the factory.

The "Certification Procedure", if included, shows what part of the instrument may be certified and what is required to perform the certification. Forms may be obtained from Customer Service.

A Recal check sheet has been included for those persons who have become familiar enough with the recal procedure to use it.

Since this procedure is for the Field, we hope all Field personnel will help us improve it. Address your communications to Field Technical Support. No suggestions will go unnoticed.

ABBREVIATIONS:

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

1A1 -- Three Mods Improve Reliability, Chopped Waveform and Alternate Trace Operation

All three mods are covered by production mod M8293, starting with S/N 540. 1A1's S/N 101 to 539 can be modified in the field by following these instructions:

PARTS REQUIRED:

Ckt. No.	Quantity	Description	Part Number
C303, C304	1	Capacitor, cer, 0.05 µf	283-010
C306, C316	1	Capacitor, cer, 47 pf	281-518
C344 (New)	1	Capacitor, cer, 150 pf	281-524
C491, C494 (New)	1	Capacitor, cer, 0.1 µf	283-057
D303	1	Diode, 1N3605	152-141
Q305, Q315	1	Transistor, 2N964, Selected*	153-530
R360	1	Resistor, comp, 2.7 meg 1/2 w 10%	302-275

* 2N964 transistors (153-530) are selected for a minimum Beta of 80 at 10 ma I_c

INSTRUCTIONS:

To Reduce Aberrations on Chopped Waveform

1) Replace C491 (0.001 µf capacitor, located from pin 10 of V243 to ground) with a 0.1 µf capacitor. Add a 3/8 in. piece of No. 18 varglass to the lead at pin 10.

2) Install C494 (a 0.1 µf capacitor) from pin 21 of the output board Bendix connector to the ground lug under R495 (WW resistor on rear plate). Add a 1/2 in. of No. 18 varglass to the lead at pin 21.

   NOTE: For the remaining steps of this procedure, refer to Fig. 5-3 on page 5-6 of the 1A1 Manual for a detailed parts layout.

3) Install a 150 pf capacitor in parallel with R343.

4) Remove and discard C260, a 0.001 µf capacitor.

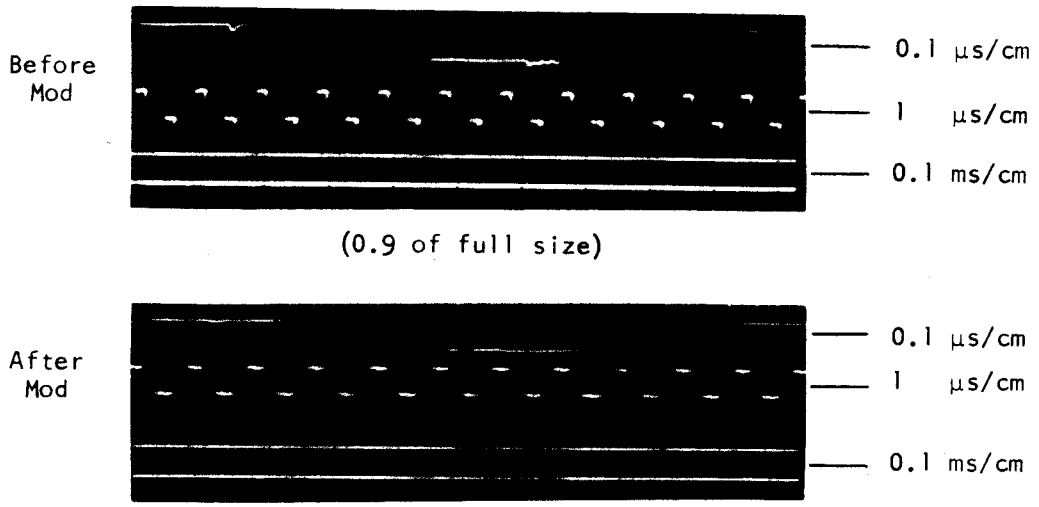


Fig. 1
Type 1A1 in Chopped Mode

To Reduce Field Failure of Q353

Install R360 (2.7 meg 1/2 w resistor) from contact 2R7 (white-green wire) to contact 2R8 (225 v wire) of the MODE switch.

To Assure ALTERNATE Trace Operation in all Units

1) Replace C303 and C304 (0.001 µf capacitors) with 0.05 µf capacitors.
2) Replace C306 and C316 (22 pf capacitors) with 47 pf capacitors.
3) Replace D303 (6075 diode) with a 1N3605 diode.
4) Replace Q305 and Q315 (2N964 transistors) with a pair of selected 2N964 transistors, part number 153-530.*

FEN, June 5, 1964

CIRCUIT SPECIFICATIONS

Factory circuit specifications are not guaranteed unless they also appear as catalog or instruction manual specs. Factory specs are usually tighter than advertised specs. This helps insure the instrument will meet, or exceed, advertised specifications after shipment and during subsequent Field recalibration over several years use.

The numbers listed beside the specifications are the calibration procedure steps where the check or adjustment is made.

1 DC BALANCE

2 INVERTER BALANCE

3 OUTPUT DC LEVEL
Pin 1 or 3 output DC level to ground 67.5 v ±2%.

4 GAIN
0.05 VOLT/CM gain range
+5% to -10% minimum
0.005 VOLTS/CM gain range
±10% minimum

5 MICROPHONICS
2.5 mv maximum

6 GRID CURRENT
5 nanoamps maximum with Grid Current zero pot cw.

7 AC, DC, GND

8 VOLTS/CM
Attenuator accuracy ±2% maximum VARIABLE VOLTS/CM range 2.5:1 minimum.

9 ADD
ADD accuracy ±2% maximum
Common mode rejection 20:1 maximum

10 ALT
Must alternate on all sweep rates from 0.1 sec to 0.1 μsec/cm. Ch 1 must slave to TIME BASE A and Ch 2 must slave to TIME BASE B when 547 is in the A ALT B mode on all sweep rates from 0.1 sec to 0.1 μsec/cm.

11 CHOP
Frequency 1 mc ±10% maximum.
Flat top slant 1 mm maximum at 0.005 volt/cm.

12 INPUT CAPACITY

13 VOLTS/CM COMPENSATION

14 HIGH FREQUENCY
Aberrations and slant 2% p-p AC or DC.

15 FREQUENCY RESPONSE
DC to 50 mc (-3 db) at 50 mv/cm
DC to 28 mc (-3 db) at 5 mv/cm

547 Risetime vs Combined Bandpass

547 t_r	Min Bandpass at 50 mv/cm	Min Bandpass at 5 mv/cm
6.25 ns	50.0 mc	28.0 mc
6.0 ns	51.5 mc	28.2 mc
5.75 ns	53.0 mc	28.8 mc
5.5 ns	54.7 mc	29.0 mc
5.25 ns	57.5 mc	29.1 mc

16 CH 1 SIGNAL OUT and TRIGGER OUT

Ch 1 SIGNAL OUT
Gain ±10% maximum
Risetime 10 nsec maximum
Distortion aberration or slant ±10%

Ch 1 TRIGGER OUT
Gain ±20% maximum
Risetime 70 nsec maximum
Distortion aberration or slant ±10%

NOTES

EQUIPMENT REQUIRED

1	Tektronix Type 547 Oscilloscope	
1	Tektronix Type 105 Square Wave Generator	
1	Tektronix Type 190B Constant Amplitude Signal Generator	
1	Tektronix Type TU-5 Tunnel Diode Pulser	
1	VOM Triplett 630 or Simpson 262 20,000 Ω/v	
1	Standard Square Wave Calibrator (FMS)	
1	John Fluke Differential Voltmeter	
1	15 pf Capacitance Standardizer	(011-073)
1	50 Ω Termination	(011-049)
1	50 Ω X10 Attenuator	(011-059)
1	50 Ω X 5 Attenuator	(011-060)
2	50 Ω Cables	(012-057)
1	BNC T	(103-030)

BASIC FRONT PANEL SETTINGS

Unless otherwise specified each step will have the following front panel settings.

547

TIME/CM	-- 1 msec
HORIZ DISPLAY	-- B
TRIGGERING	-- AUTO, +, AC, NORM
SINGLE SWEEP	-- NORMAL

1A1

VOLTS/CM (Ch 1 and Ch 2)	-- 0.005
INPUT SELECTOR (Ch 1 and Ch 2)	-- GND
MODE	-- CH 1
NORM/INVERT (Ch 1 and Ch 2)	-- NORM
POSITION (Ch 1 and Ch 2)	-- Mid range

RECALIBRATION

1. DC BALANCE

Setup

a) Insert 1A1 into scope and allow adequate warmup time (15 to 30 min).

Adjustment

b) With VOLTS/CM on 0.005 and MODE on CH 1, (or appropriate channel) adjust 0.005 V/CM VAR ATTEN BAL for no trace shift as VARIABLE VOLTS/CM is rotated through its range.

c) Position the trace to graticule center with the POSITION control (do not change POSITION control for the remaining portion of this step).

d) Change VOLTS/CM to 0.05 and reposition trace to graticule center with the 0.05 V/CM DC Bal (internal).

e) Repeat steps b and d until there is no trace shift as VOLTS/CM is changed from 0.005 to 0.05.

f) Repeat same procedure for CH 2.

2. INVERT BAL

Setup

a) Set CH 1 VOLTS/CM to 0.005, MODE to CH 1 and position trace to graticule center with the POSITION control.

Adjustment

b) Switch NORM/INVERT to INVERT and reposition trace to graticule center with the Inv Bal control (internal).

c) Repeat Setup and Adjustment procedure for CH 2.

3. OUTPUT DC LEVEL

Setup

a) Connect a John Fluke Differential Voltmeter from pin 1 or 3 of the blue ribbon Amphenol to ground.

Adjustment

b) Voltage on pins 1 or 3 should read 67.5 v ±1.35 volts (tol ±2%).

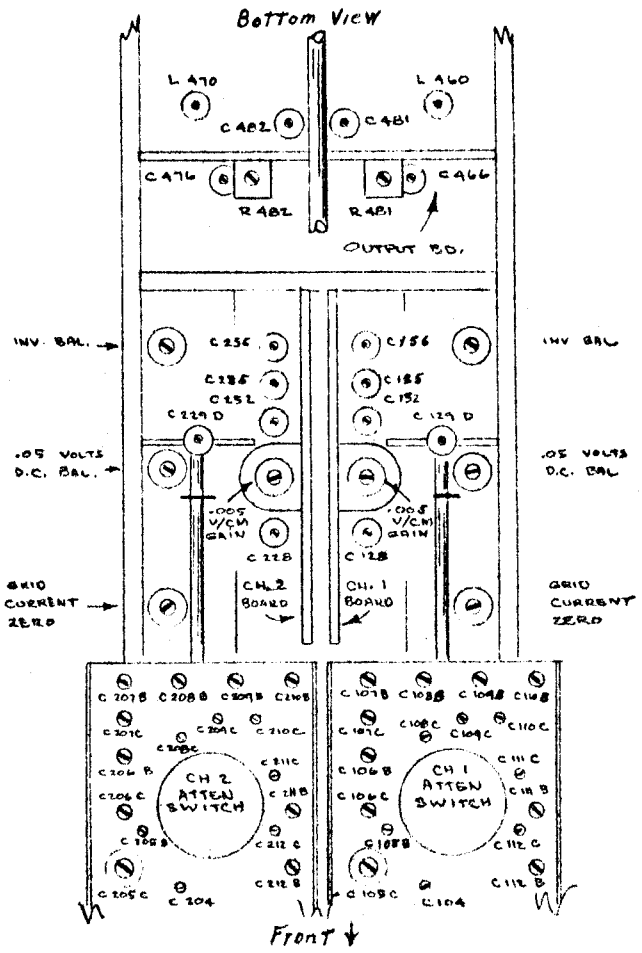
4. GAIN

Setup

a) Set both VOLT/CM switches to 0.05 and both INPUT SELECTOR switches to DC.

b) Apply 0.2 v from the Standard Square Wave Calibrator to CH 1 Input.

NOTES



4. Adjustment
   c) Adjust the 0.05 V/CM GAIN adjustment to both extremes and check for a 4.2 cm to 3.6 cm gain range (+5% to -10% min range).
   d) Now set 0.05 V/CM GAIN for exactly 4 cm deflection.
   e) Reduce Standard Square Wave Calibrator to 20 mv and change CH 1 VOLTS/CM to 0.005.
   f) Adjust the 0.005 V/CM Gain adjustment (internal) to both extremes and check for a range of at least 4.4 to 3.6 cm (tol ±10% min range).
   g) Now set 0.005 V/CM Gain for exactly 4 cm deflection.
   h) Steps d and g interact so repeat as necessary.
   i) Repeat entire step for CH 2.

5. MICROPHONICS

   Setup
   a) Set both VOLT/CM switches to 0.005.
   b) Set both INPUT SELECTOR switches to ground.
   c) Set MODE switch to ALT.

   Adjustment
   d) Position both traces on screen then rap left side of scope lightly with hand. Micro should not exceed 2.5 mv.

6. GRID CURRENT

   Setup
   a) INPUT SELECTOR (Ch 1 and Ch 2) -- GND
      VOLTS/CM -- 0.005
      MODE -- CH 1
   b) Position trace to graticule center with POSITION control.

   Adjustment
   c) Set Grid Current Zero adjustment fully cw.
   d) Switch INPUT SELECTOR from GND to DC. Trace shift should not exceed 1 cm (5 nano amps).
   e) Now adjust Grid Current Zero for no trace shift as INPUT SELECTOR is switched from GND to DC.
   f) Repeat procedure for CH 2.

If grid current is excessive, replace the input NuVistor.

7. AC, DC, GND

   Setup
   a) VOLTS/CM (Ch 1 and Ch 2) -- 0.05
      MODE -- CH 1
      INPUT SELECTOR -- DC
   b) Apply 0.1 v of CALIBRATOR signal to CH 1 Input.

NOTES

7. Adjustment
   c) Set baseline of CALIBRATOR signal to the center graticule line.
   d) Switch INPUT SELECTOR to AC. Trace should shift down approximately 50%. (If trace does not shift, this is an indication that the input capacitor is shorted or leaking heavily).

8. VOLTS/CM ACCURACY

   Setup
   a) VOLTS/CM (Ch 1 and Ch 2) -- 0.005
      MODE -- CH 1
      INPUT SELECTOR -- DC
   b) Connect 20 mv of signal from the Standard Square Wave Calibrator to the CH 1 Input.

   Adjustment
   c) Check all VOLTS/CM positions as follows for 2% accuracy or better:

VOLTS/CM	CALIBRATOR	CM of DISPLAY
0.005	20 mv	4 cm ±0.8 mm
0.01	50 mv	5 cm ± 1 mm
0.02	0.1 v	5 cm ± 1 mm
0.05	0.2 v	4 cm ±0.8 mm
0.1	0.5 v	5 cm ± 1 mm
0.2	1 v	5 cm ± 1 mm
0.5	2 v	4 cm ±0.8 mm
1	5 v	5 cm ± 1 mm
2	10 v	5 cm ± 1 mm
5	20 v	4 cm ±0.8 mm
10	50 v	5 cm ± 1 mm
20	100 v	5 cm ± 1 mm

   d) Check VARIABLE VOLTS/CM for at least a 2.5:1 range.

9. ADD

   Setup
   a) INPUT SELECTOR (Ch 1 and Ch 2) -- GND
      VOLTS/CM (Ch 1 and Ch 2) -- 0.05
      MODE -- CH 1

   Adjustment
   b) Position trace to the center graticule line then turn MODE switch to CH 2 and again position trace to center graticule line.
   c) Now switch MODE to ADD. Trace should not shift more than 0.5 cm.
   d) Set INPUT SELECTOR switches to DC and apply 0.1 v of signal from the Standard Square Wave Calibrator to both inputs through a BNC T and 50 Ω cables. There should now be 4 cm of deflection ±0.8 mm.

9. Adjustment (con'd)
   e) Switch CH 1 NORM/INVERT switch to INVERT and increase CALIBRATOR signal to 0.5 v. There should now be less than 0.5 cm deflection.
   f) Switch CH 1 NORM/INVERT back to NORM and switch CH 2 NORM/INVERT to INVERT. There should now be less than 0.5 cm deflection.

10. ALT

Setup

a) INPUT SELECTOR
   (Ch 1 and Ch 2) -- GND
   VOLTS/CM
   (Ch 1 and Ch 2) -- 0.005
   MODE -- ALT

Adjustment

b) Check for alternate trace operation on all sweep speeds from 0.1 sec to 0.1 μsec on both A and B sweeps.
c) Set 547 HORIZONTAL DISPLAY to A ALT B, A TIME/CM to 0.1 msec and B TIME/CM to 1 msec. CH 1 should be slaved to A sweep and CH 2 should be slaved to B sweep.

11. CHOP

Setup

a) 547
   HORIZ DISPLAY -- B
   B TIME/CM -- 1 μsec
   1A1
   MODE -- CHOP

Adjustment

b) Adjust traces approximately 2 cm apart and trigger the 547 on the chopping pulse. Chopping frequency should be 1 mc ±10% or 1 complete cycle/cm.
c) Switch 54 CATHODE SELECTOR to CHOPPED BLANKING. The rising and falling portion of the waveform should now be blanked.
d) Set 547 TIME/CM to 0.5 μsec. The slant on the unblanked portion of the waveform should be less than 1 mm disregarding wrinkles. Return CRT CATHODE SELECTOR to CRT CATHODE.

NOTES

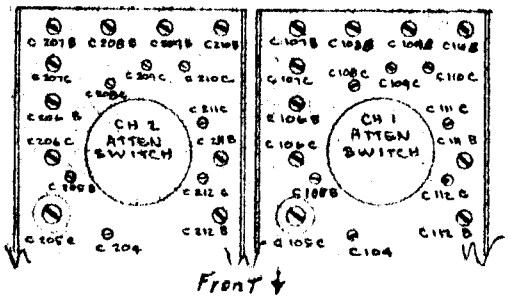
12. INPUT CAPACITY

Setup

a) VOLTS/CM (Ch 1 and Ch 2) -- 0.05
MODE -- CH 1
INPUT SELECTOR (Ch 1 and Ch 2) -- DC
TIME/CM (547) -- 0.2 msec

Adjustment

b) Apply 4 cm of 1 kc signal from the 105 Square Wave Generator to the Ch 1 Input through a 50 Ω cable, 50 Ω terminator, and 15 pf capacitance standardizer, in that order.
c) Adjust Ch 1 Input capacitor C104 for best flat top.
d) Switch MODE switch to Ch 2 and Adjust Ch 2 input capacitor C204 for best flat top.



13. VOLTS/CM COMPENSATION

Setup

a) Same as previous step.

Adjustment

b) Using table below, adjust the VOLTS/CM compensations.

VOLTS/CM	SPIKE ADJ CH 1	SPIKE ADJ CH 2	LEVEL ADJ CH 1	LEVEL ADJ CH 2
0.1	C105C	C205C	C105B	C205B
0.2	C106C	C206C	C106B	C206B
0.5	C107C	C207C	C107B	C207B
1.0	C108C	C208C	C108B	C208B

Remove the 50 Ω terminator and continue as follows:

2.0	C109C	C209C	C109B	C209B
5.0	C110C	C210C	C110B	C210B
10.0	C111C	C211C	C111B	C211B
20.0	C112C	C212C	C112B	C212B

14. HIGH FREQUENCY

Setup

a) VOLTS/CM (Ch 1 and Ch 2) -- 0.05
MODE -- CH 2
TIME/CM (547) -- 0.1 μsec
INPUT SELECTOR (Ch 1 and Ch 2) -- DC

b) Connect the TU-5 TD Pulser to the Ch 2 Input through a 50 Ω terminator and apply 100 volts of calibrator signal to the TU-5 Input through a 50 Ω cable.

14. Adjustment
    c) Adjust the TU-5 bias control so the pulser just fires. There should now be approximately 4 cm of signal displayed.
    d) Adjust TRIGGERING LEVEL for a stable display and position the top of the waveform 1 cm down from the top graticule line.
    e) Adjust C466 and C476 to midrange.
    f) Adjust L460 and L470 for minimum spike.
    g) Adjust C225, C256, C252 and C228 for the best front corner response. It may be necessary to readjust C466, C476, L460 and L470 to obtain optimum results.
    h) Apply TU-5 Output to Ch 1 through 50 Ω terminator, set MODE to CH 1 and adjust C125, C156, C152 and C128 (on CH 1 board) for best front corner. Recheck CH 2 adjustments.
    i) Set 547 TIME/CM to 0.2 μsec, MODE to CH 2, apply signal to CH 2 and adjust R482 and C482 for best long term level.
    k) Set 547 TIME/CM to 1 μsec and adjust R481 and C481 for best long term level.
    m) Connect 10:1 attenuator between the TU-5 pulser and the 50 Ω terminator and set VOLTS/CM (Ch 1 and Ch 2) to 0.005.
    n) With signal still applied to CH 2, adjust C229D for best front corner. Apply signal to CH 1, MODE to CH 1 and adjust C129D for best front corner (aberrations or slant must not exceed 2% p-p AC or DC).

15. FREQUENCY RESPONSE

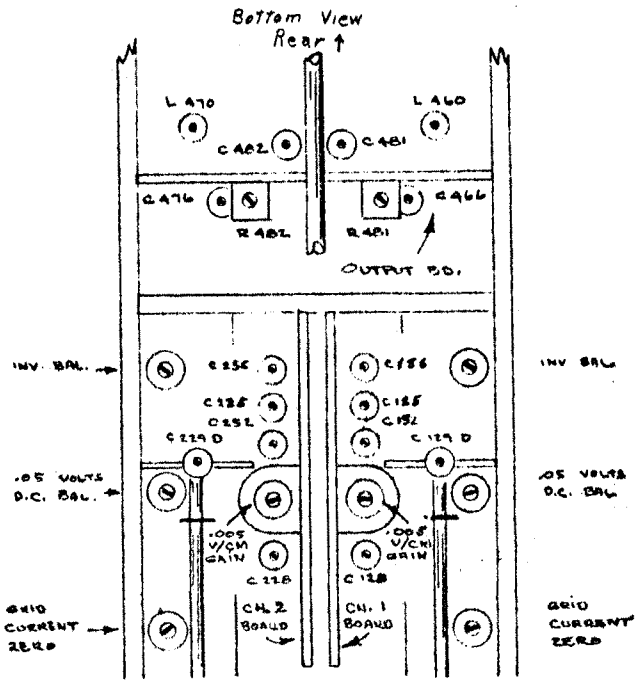
Setup

a) VOLTS/CM (Ch 1 and Ch 2) -- 0.05
   MODE -- CH 1
   INPUT SELECTOR (Ch 1 and Ch 2) -- DC

Adjustment

b) Connect a 50 kc signal from the 190B to the CH 1 Input (see note) and adjust the 190 amplitude for exactly 4 cm deflection.
c) Switch 190 RANGE SELECTOR to 21-50 range and adjust frequency for 50 mc. There should now be at least 2.8 cm of deflection.
d) Switch VOLTS/CM to 0.005 and insert a 10:1 attenuator between the 190 head and the input, or 50 Ω terminator, whatever the case may be and readjust 190 for 4 cm of 50 kc signal.
e) Now switch 190 to 28 mc. There should now be at least 2.8 cm of deflection.

NOTES



When properly adjusted, R481 and R482 should be near midrange. It may be necessary to repeat the front corner adjustments after R481, C481, R482 and C482 have been adjusted for optimum level.

If a 190A ATTENUATOR head is used, a 50 Ω terminator must be connected between the head and the input to obtain a 25 Ω source impedance. If a 190B ATTENUATOR head is used, no terminator is needed.

15. Adjustment (con'd)
    f) Repeat Adjustment procedure for CH 2.

    If the 54 risetime is faster than 6.25 nsec, use the following table to determine what the combined bandpass should be.

547 Risetime	Min Bandpass at 50 mv Sens	Min Bandpass at 5 mv Sens
6.25 ns	50.0 mc	28.0 mc
6.0 ns	51.5 mc	28.2 mc
5.75 ns	53.0 mc	28.8 mc
5.5 ns	54.7 mc	29.0 mc
5.25 ns	57.5 mc	29.1 mc

16. CH 1 SIGNAL OUT and TRIGGER OUT

    Setup
    a) CH 1 INPUT SELECTOR -- DC
       CH 2 INPUT SELECTOR -- AC
       VOLTS/CM (Ch 1 and 2) -- 0.05
       MODE -- CH 2

    Adjustment
    b) Apply 0.2 v of CALIBRATOR signal to CH 1 and connect CH 1 SIGNAL OUT to CH 2 Input. There should now be 4 cm of display on CH 2 ±10%.
    c) Decrease CALIBRATOR signal to 20 mv, and connect CH 1 TRIGGER OUT to CH 2 Input. There should now be 4 cm of display on CH 2 ±20%.
    d) Insert TU-5 Pulser and 50 Ω terminator between CH 1 Input and 50 Ω cable. Change CH 2 VOLTS/CM to 0.5 and increase CALIBRATOR signal to 100 v. Adjust TD bias for a fast rise pulse. Risetime of CH 1 TRIGGER OUT pulse, as seen on CH 2, must be 70 nsec or less.
    e) Change 547 TIME/CM to 0.5 μsec. Aberrations or slope should not exceed 10%.
    f) Connect CH 1 SIGNAL OUT to CH 2 Input and CH 2 VOLTS/CM to 0.05. Risetime of CH 1 SIGNAL OUT, as seen on CH 2, should be 10 nsec or less.
    g) Change 547 TIME/CM to 0.5 μsec. Aberrations or slope should not exceed 10%.

NOTES

In order to insure that 1A1 will meet bandpass specs in all 547, 546 and 544 instruments, it is necessary to know the exact risetime of the instrument being used to calibrate the 1A1. The risetime of the indicator will be essentially the combined risetime of the TU-7 and 547 minus 0.5 nsec.

If bandpass specs cannot be met, it may be necessary to peak the front corner slightly within specs.

RECALIBRATION CHECK SHEET

1. DC BAL _____
2. INVERTER BAL _____
3. OUTPUT DC LEVEL _____
4. GAIN
   - 0.05 VOLTS/CM range _____
   - 0.005 VOLTS/CM range _____
5. MICROPHONICS _____
6. GRID CURRENT _____
7. AC, DC, GND _____
8. VOLTS/CM
   - Accuracy _____
   - VARIABLE range _____
9. ADD
   - Accuracy _____
   - Common mode rejection _____
10. ALT _____
11. CHOP
    - Frequency _____
    - Distortion _____
12. INPUT CAPACITY _____
13. VOLTS/CM COMPENSATION _____
14. HIGH FREQUENCY
    - Aberrations _____
15. FREQUENCY RESPONSE
    - 50mv/cm _____
    - 5mv/cm _____
16. CH 1 SIGNAL OUT and TRIGGER OUT
    - Gain _____
    - Risetime _____
    - Distortion _____

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