NOTE REGARDING FACTORY CALIBRATION PROCEDURES AND TEST SPECIFICATIONS

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

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

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

1/16/61
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FIELD RECALIBRATION PROCEDURE

CONTENTS:

INTRODUCTION:

4S2

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

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.

Publication:
061-673
December 1962

For all serial numbers.

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 troubleshooting. 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.

The blank column on the right of the page is for notes on troubleshooting 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" 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)
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
mid r	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

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.

Terminating Resistor

The Input termination resistance shall be 50 Ω ±1% (checked with an accurate bridge or by a comparison method).

Smoothing Balance

3b On 200 mv/cm the trace should not move more than one major graticule division while rotating SMOOTHING CONTROL. Pot should not cause more than one major division of noise when rotated.

Bridge Balance

7c With 5 nsec cable connected to the input, no signal applied, the trace should not move more than 5 cm (10 mv error at 2 mv/cm) while rotating the mv/cm switch from 200 to 2. X100 off-set monitor set to zero volts.

Loop Gain Linearity

7e The 4S2 should operate with a 1 v (5 cm at 200 mv/cm) double trace (double triggered) 111 signal of '+' or '-' polarity with no more than 5% amplitude of base line pulse.

Microphonics

7f Microphonics must be less than 2 cm at 5 mv/cm sensitivity when striking the top front corner of the instrument with the hand.

Hold-off Bias

8b With the 4S2 properly adjusted for rise-time and sampling efficiency and the bridge balanced, there should be at least '+' or '-' 2.5 v across each half of the bridge (5 v total <u>minimum</u> across the bridge).

Inverter Zero

9d On 200 mv/cm, the trace should not shift more than two minor divisions when switching the NORMAL-INVERTED switch and X100 Offset Monitor is zero volts.

Amplifier Balance

10e When the A Vert and B Vert Signal Output jacks (661) are set to zero volts with the 4S2 DC Offset control, and the wiper of Vert Pos pots are set to zero volts (use test scope) the two traces on DUAL TRACE should be less than 1 cm apart and within 1 cm of centerline of the graticule. The Vert DC Bal of 661 should be set with a 1.5 k 5% resistor from Vertical Input (pin 24, J1) to ground.

Chopping Frequency and Noise

10d The Dual Trace chopping frequency should be 50 kc ±20%. With mv/cm switch in the (5) position, Smoothing control normal, MODE in A only, B only or A Vert - B Horiz, noise should be less than 3 mv p-p. With MODE switch in DUAL TRACE or ADDED ALGEBRAIC noise shouldn't exceed 4 mv p-p.

Variable Range

11d Variable mv/cm control must have at least 3:1 gain at all mv/cm positions.

A-B Bal and B Channel Gain

11d, 11e A-B Bal pot and B Cal pot should provide ±10% gain of 1/3 referred to output of Memory boards (check at 200 mv/cm).

Added Algebraic Operation

12c In ADDED ALGEBRAIC, a 4 cm signal (like time occurrence, and waveshape) in each channel should indicate 8 cm signal, ±1 mm in 200 mv/cm position.

Rejection Ratio

12d Rejection ratio should be 40:1 or better when using flat-topped pulse, of one volts to each channel on 50 mv/cm.

Vertical Signal Outputs (gain)

13d Gain of Vert Signal Outputs on the 661 must be ±2% of the signal applied to Input of 4S2 in 200 mv/cm position. Use 50 Ω Amplitude Standard set at 1.2 v.

CIRCUIT SPECIFICATIONS (continued)

Vertical Gain -- Normal and Inverted

13e Indicated gain (CRT) on 200 mv/cm position:

NORMAL	±1.5%
INVERTED	±2.5%

Attenuator (mv/cm) position accuracies, referred to 200 mv/cm position, must be:

100 mv/cm to 10 mv/cm	±2%
5 mv/cm to 2 mv/cm	±3%

DC Offset Range

13f DC Offset control should provide a ±1 v level swing ±5% at the Vert Signal Output jacks on the 661 when the 4S2 is in 200 mv/cm position. Level change noted on the 661 CRT should be ±1.5% of the level change read at the Vert Signal Output jacks.

X100 Offset Monitor level should vary to ±100 v ±5% with the rotating of DC Offset control.

X-Y Operation

14c A 2.5 to 3.0 cm sine wave (1 volt into 25 Ω) from AMPLITUDE/TIME CALIBRATOR, displayed on both 4S2 channels in DUAL TRACE, with VERT POSITION controls midrange and waveforms centered vertically, should display a diagonal line of equal X and Y amplitudes ±1.5% when MODE is switched to A Vert - B Horiz. Display should fall horizontally within center 8 cm of graticule.

Memory Slash

15c With mv/cm switch set to 200, the trace width must not exceed 0.5 major divisions when the system is triggered on a 10 cps repetitive waveform.

Scaling Drift

15d Base line (trace) shift must not exceed 4 mm with a change in triggering rate from 10 cps to 100 kc when mv/cm is set to 10. Be sure 5T1 is not counting down before 100 kc.

Compression and Expansion

16c, d, e, There should be no apparent vertical compression or expansion due to the 4S2 when displaying a 5 cm (1 volt) signal and turning the VERTICAL POSITION to the extreme ends while repositioning the DC Offset controls at 200 mv/cm sensitivity. Repeat for 5 mv/cm sensitivity and 25 mv of signal.

Risetime

17d Overshoot or undershoot, when observing 109, 110 or TD pulser should not exceed 5%. Risetime should be 100 psec or less, computed depending on the fast rise source.

Crosstalk

18c Crosstalk should not exceed 1% from one channel to the other while observing the delayed pulse or a fast-rise tunnel diode pulse.

Time Difference Between Channels

19c With the 4S2 displaying a fast rise pulse, there should be no more than 20 psec time difference between channel A and channel B.

Probe Power Voltages

20 At the PROBE POWER connectors, there should be 100 v between pins A and D (±2%); 12.6 v between pins B and C (±5%). Pin C should be positive with respect to B. Pin D positive with respect to A.

RECALIBRATION PROCEDURE

NOTES

Equipment Required

1	Type 540 or 580 Series Oscilloscope	
1	081 Adapter for 580 Oscilloscope	
1	Type H Plug-in with X1 and X10 Probes	
1	Type 661 Indicator	
1	Type 5T1 Timing Plug-in	
1	Type 105 Square Wave Generator	
1	Type Z Plug-in or John Fluke Voltmeter	
1	Type 111 Pulse Generator	
1	50 Ω Resistance Standard(Resistance Bridge)	
1	50 Ω Amplitude Calibrator Standard	(FMS)
1	Risetime Pulse Gen., 4S2, 100 ma TD	(FMS)
2	GR to UHF Adapters	(TEK 017-022)
1	Flex Amph Connect Cable	(TEK 012-064)
1	50 Ω (3 ft.) Coax with Greymar Connectors	(TEK 012-070)
1	X2 GR Attenuator	(TEK 017-003)
2	X5 GR Attenuators	(TEK 017-002)
4	X10 GR Attenuators	(TEK 017-044)
1	Extender Board for 4S2 Plug-in Boards	(TEK 012-069)
2	GR 5 nsec Cables RG8/AU	(TEK 017-502)
2	GR 10 nsec Cables RG58/AU	(TEK 017-501)
2	GR 2 nsec Cables RG58/AU	(TEK 017-505)
1	GR Tee Connector	(TEK 017-069)
1	GR 10, 20 or 30 cm Air Line	(FMS)

BASIC FRONT PANEL SETTINGS

Unless otherwise specified, all of the following steps will have the following front panel settings:

Type 5T1

SAMPLES/CM	100
TIME DELAY	0
SOURCE	+EXT
RECOVERY TIME	0
THRESHOLD	10 o'clock
SWEEP TIME/CM	10 nsec
VARIABLE	calibrated

Type 4S2 (both channels)

MILLIVOLTS/CM	200
VARIABLE	calibrated
VERT POSITION	12 o'clock
SMOOTHING	NORMAL
DISPLAY	NORMAL
MODE	A only

Basic Front Panel Settings: (con'd)

Type 661

HORIZONTAL DISPLAY	X1
POSITION	mid-range
VERNIER	mid-range
AMP/TIME CALIBRATOR	OFF
MV AMPL	1000
VOLTS/CM	AC

Use flexible interconnecting cable to connect the 4S2 to the 661. Use the inside connectors on both the 4S2 and 661. Connect the fast ramp cable in on the 4S2 to the 661 with the Greymar ends cable. Use 50 Ω, 5 nsec cable (RG8/AU) connected to the inputs of the 4S2 for 50 Ω termination, unless applying an input signal

Preliminary -- For minor recalibration, skip the following Preset and Steps 1, 2 and 3.

Preset:

Avalanche Volts	(R1057)	mid-range
A Bridge Volts	(R1074)	cw
A Bridge Bal	(R1078)	mid-range
B Bridge Volts	(R2074)	cw
B Bridge Bal	(R2078)	mid-range

Check resistance of the Input 50 Ω for 50 Ω ±1%, using an accurate Resistance Bridge as a comparison standard.

Pull out the AC Amp board and re-install it on the extender board. Turn power on and allow five (5) minutes warm up.

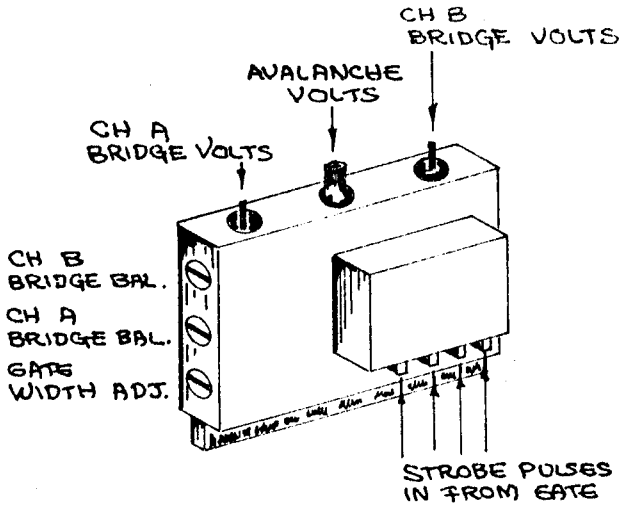


FIG. 1A.

RECALIBRATION

NOTES

1. AVALANCHE VOLTS (R1057)(preliminary)

Setup

a) 5T1 THRESHOLD -- 2 o'clock (no sweep)

b) Connect X10 probe (5 v/cm, 10 μsec ac) to center arm of Avalanche Volts pot. (Use test scope, H unit combination).

Adjustment

c) Rotate the Avalanche Volts pot ccw until the Avalanche free-runs, denoted by a signal rate of approximately 100 kc. Back up the Avalanche Volts from this free-running point (approx. 10°cm). See Fig. 1.

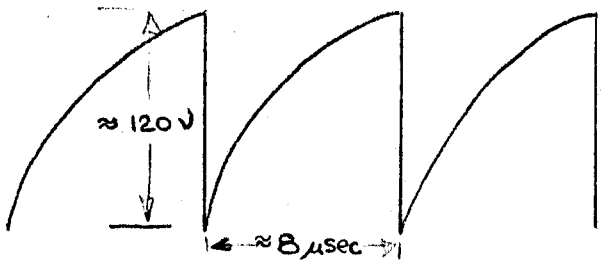


FIG. 1

2. MEMORY GATE WIDTH (R2045) (preliminary)

Setup

a) Turn 4S2 on its right side.

b) With X10 probe (0.5 v/cm, ac, 0.1 μsec) connect to pin V of A channel Memory board (front Memory board).

Adjustment

c) Adjust MEMORY GATE WIDTH pot for approximately 300 nsec pulse width (measured at 50% points) and a pulse amplitude of 18 v ±5%. (See Fig. 2). Check for the same pulse and amplitude on channel B Memory board, pin V. Set 4S2 upright again.

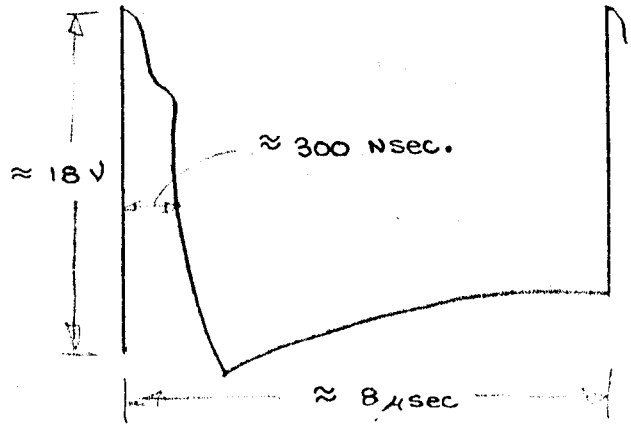


FIG. 2

3. SMOOTHING BALANCE (R1125)
(preliminary)

Setup
a) Initial settings.

Adjustment
b) Adjust SMOOTHING BALANCE. (NOTE: Be sure input is terminated with 5 nsec cable, RG8/AU) for no trace shift while rotating SMOOTHING control. Return SMOOTHING to normal. Repeat for channel B with MODE in B only.

4. BRIDGE VOLTS (R1074)

Setup
a) 5T1 to +EXT.
4S2 to 200 mv/cm.
b) Connect Type 111 Signal Generator (rep. rate, max 10 kc, 5 nsec charge line) to 4S2 A channel input through X10 GR attenuator. Connect the trigger output pulse from Type 111 to the 5T1 EXTERNAL input through X10 and X5 attenuators. Locate pulse on screen with 5T1 TIME DELAY control and by rotating THRESHOLD until triggered. Adjust THRESHOLD control and 111 REPETITION RATE control until two traces (two pulses of different amplitude) are obtained (see Fig.3). If pulses exhibit more noise than trace width, adjust Avalanche controls cw until noise disappears.

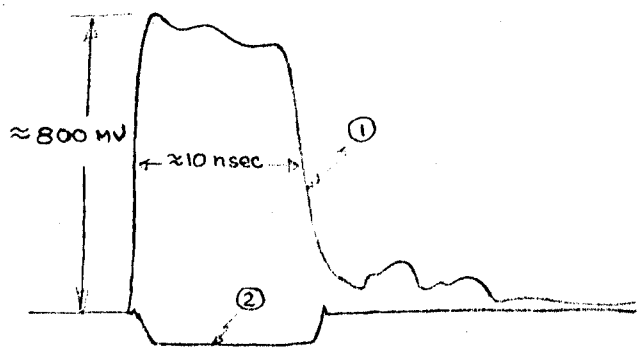


Fig. 3

4. Bridge Volts (con'd)

Adjustment

c) Adjust A BRIDGE VOLTS, R1074 until the small pulse amplitude is zero (level with base line). If unable to adjust Bridge Volts, turn Avalanche Volts cw. Turn MODE to B only and repeat the step to set B BRIDGE VOLTS, R2074.

5. MEMORY GATE WIDTH (R2045)(Final adj)

Setup

a) Same as Step 4.

Adjustment

b) Adjust MEMORY GATE WIDTH pot for maximum separation between trace pulses (obtain trace pulses by adjusting THRESHOLD and REP RATE on 111). Now re-adjust channel A and B Bridge Volts for zero amplitude of small pulse.

Avalanche Volts may have to be re-adjusted to give enough range for Bridge Volts. It may be necessary to recheck the MEMORY GATE WIDTH adjustment each time the Avalanche Volts is adjusted due to Avalanche noise, etc. since the Avalanche Volts setting affects the MEMORY GATE WIDTH setting.

6. AC AMPLIFIER RESPONSE (C1107, C2107)

Setup

a) Same as Step 4.

b) Display a Type 111 double trace signal (double triggered).

Adjustment

c) Adjust C1107 (front left-side variable cap on AC Amp board) for maximum separation between trace pulses. Now it is necessary to re-adjust A BRIDGE VOLTS for zero amplitude of the small pulse. Switch MODE to B only and connect 111 signal to channel B input. Repeat adjustments on C2107 (right-hand side) and reset B BRIDGE VOLTS. Return MODE to A only.

7. BRIDGE BALANCE (R1078, R2078)

Setup

a) Initial setup.

b) Set A channel OFFSET Monitor to zero volts, with test scope probe (5 v/cm, dc 1 μsec).

7. Bridge Balance (con'd)

Adjustment

c) Adjust A BRIDGE BALANCE, R1078, for no trace shift while rotating the MV/CM from 200 to 2. It may be necessary to retrigger the 5T1 at the maximum sensitivities for sometimes a wide double trace appears, due to the double triggered 111 rep rate.

d) Switch MODE to B only and connect the 5 nsec (RG8/AU) cable on the 4S2 channel B input. Repeat adjustment for channel B BRIDGE BALANCE by rotating MV/CM from 200 to 2 and adjusting for no trace shift. Return MV/CM to 200 (both channels). Disconnect 5 nsec cable and connect Type 111 pulse into 4S2 channel B input. Display double triggered pulse. Recheck A and B BRIDGE VOLTS adjustments. If re-adjustment is necessary, it will also be necessary to rebalance the bridges. These adjustments are to be repeated until no interaction exists. (Always use 5 nsec cable on the input of the channel being balanced).

e) Display double triggered 111 pulse and switch the 111 OUTPUT polarity to NEGATIVE. The small pulse amplitude should be no more than 5% of large pulse amplitude when large pulse is one volt. (Obtained by using GR attenuators). Repeat check for channel B.

f) Remove signal from 4S2 inputs. With MV/CM controls at 5 (both channels), check for 3 mv or less of noise on both channels. At 5 MV/CM check both channels for less than 2 cm of microphonics when striking top front of 4S2 with hand. Return MV/CM to 200 (both channels).

8. SAMPLING BRIDGE HOLD-OFF BIAS

Setup

a) 5T1 Display trace on screen with THRESHOLD control.
   4S2 Turn on its side.
   MV/CM -- 200

8. Sampling Bridge Hold-Off Bias (con'd)

Check

b) With X10 probe (0.2 volts, dc 20 μsec) check bridge volts at the ends of the 10k resistors mounted on sampling bridge. Check each channel for '+' and '-' 2.5 volts minimum voltage, 5 v total across the bridge on each channel. Return 4S2 to upright position.

9. INVERTER ZERO (R1161)

Setup

a) 5T1 Adjust THRESHOLD to display trace on screen.

b) 4S2 Turn on its side.

c) With X10 probe (0.005 v, dc 20 μsec), connect it to pin X of A channel Memory board. Adjust DC OFFSET control on A channel to set pin X to zero volts on test scope.

Adjustment

d) Adjust A channel Inverter Zero, R1161 for no trace shift on 661 display when switching DISPLAY NORMAL to INVERTED. Swith MODE to B only and connect probe to pin X, channel B Memory board (farthest from the front panel). Set to zero volts as before, then adjust Inverter Zero in the same manner as before.

Turn 4S2 upright. Recheck adjustments of channel A and B Smoothing Bal pots. Return DISPLAY switches to NORMAL. Turn off scope, and re-install AC Amp board inside the 4S2 without the extender board. Turn power on and allow five minutes warm up.

10. DUAL TRACE CHECK

Setup

a) 5T1 Display trace on screen with THRESHOLD control.

4S1 MODE -- DUAL TRACE
MV/CM -- 5

b) Connect an X10 probe (.1 v/cm, ac 20 μsec) to pin 3 of of DRO Amphenol on back of 4S2 (right-hand side, viewing from rear).

10. Dual Trace Check (con'd)

Setup

c) Check DC Bal of 661.

Check

d) Check for less than 4 mv or less of noise on trace in 661 display. Check for about 3 v of 50 kc ±20% of multi waveform on test scope.

e) Use X10 probe (0.005 v, dc 20 μsec) to connect to VERT A and VERT B SIGNAL OUTPUTS, respectively, on 661 and with the DC OFFSET CONTROL set to zero volts on the test scope. Use the same probe, set VERT POSITION pot center arm to zero volts (both channels. Traces displayed on 661 must be within 1 cm of each other and within 1 cm of the center line of graticule.

Check DC Bal by inserting test load unit, or by removing cable extender from 4S2 and adjust DC Bal with a 1.5 k, 5% resistor from pin 24 (of extension cable) and ground.

11. VERTICAL GAIN: A-B BAL (R1172)
B CAL (R2174)

Setup

a) 5T1 -- +EXT
Display trace on screen.
SWEEP TIME/CM -- 20 μsec
SAMPLES/CM -- 20 μsec

b) 4S2
MV/CM -- 200
MODE -- A only

c) Connect 50 Ω AMPLITUDE CALIBRATOR STANDARD to A channel input. Connect a 10 kc signal from Type 105 to AMPLITUDE CALIBRATOR STANDARD. Connect trigger signal from CALIBRATOR STANDARD to 5T1 EXTERNAL INPUT. Trigger 5T1. Check range of A-B BAL pot for ±10% of 6 cm.

Adjustment

d) Adjust A-B BAL for 6 cm of signal. Check all ranges of MV/CM switch for the following:

Gain may vary by ±1.5% when using the 4S2 in another 661 (instrument other than the one it is calibrated in).

50 Ω CAL STANDARD	MV/CM SWITCH	VERT DEFL	SPECS
1.2 v	200	6 cm	±0%
0.6 v	100	6 cm	±2%
0.3 v	50	6 cm	±2%
0.12 v	20	6 cm	±2%
0.06 v	10	6 cm	±2%
0.03 v	5	6 cm	±3%
0.012 v	2	6 cm	±3%

11. Vertical Gain (con'd)

Adjustment

e) Switch MODE to B only. Connect CALIBRATOR STANDARD to B channel input. Set CAL STD to 1.2 volts and check range of B CAL pot (±10% of 6 cm). Adjust B CAL pot for 6 cm signal. Check attenuator in same manner as A channel. Return MV/CM to 200.

f) At any input signal and MV/CM sensitivity, check MV/CM VARIABLE for <u>at least</u> 3:1 increase in gain. Return to CALIBRATED position.

12. ADDED ALGEBRAIC and REJECTION CHECK

Setup

a) Switch MODE to ADDED ALGEBRAIC and both MV/CM switches to 5. (Noise should not exceed 4 mv). Return MV/CM to 200 (both channels). Turn MODE to DUAL TRACE.

b) Connect 50 Ω AMPLITUDE CALIBRATOR to both channel inputs through a GR Tee. Set Standard to 1.2 volts. Using the MV/CM Variable, set each channel deflection to 4 cm exactly, at the same base level.

Check

c) Switch MODE to ADDED ALEGBRAIC and check for a gain of two (8 cm, ±1 mm). Return VARIABLE to CALIBRATED.

d) Switch either DISPLAY to INVERTED. With the CALIBRATOR STANDARD set at 2 v, and both MV/CM switches to 50, set POSITIONING and DC OFFSET for min signal. Check for less than 1 cm of signal (40:1 rejection ratio). Reverse both DISPLAY switches and check for less than 1 cm of signal. Return DISPLAY to NORMAL, and MV/CM to 200 (both channels).

13. VERT A and VERT B, SIGNAL OUTPUTS

Setup

a) 5T1

SWEEP TIME/CM	--	20 μsec
SOURCE	--	+EXT
SAMPLES/CM	--	100

4S2

MV/CM	--	200

13. Vert A and Vert B, Signal Outputs (con'd)

Setup

b) Switch the CALIBRATOR STANDARD to 1.2 v and connect it to A channel input. Turn MODE switch to A only. Display 6 cm of signal on A channel and note amount of deflection. Set Z unit Vert Atten to (X1) .05 v position and using X1 probe with Polarity '-' and comparison voltage set to 10 v position, insert probe in A VERT SIGNAL OUT jack, trigger 5T1.

c) Use a Z unit in the test scope. Set test scope to 50 μsec/cm and trigger it. Turn the Helidial on Z unit to 0. The top of the waveform may be set to zero reference of Z unit with DC OFFSET control. After zero reference has been obtained, turn Helidial so that it registers the bottom of the trace exactly, to the zero reference line.

Check

d) Check to see that the A VERT SIGNAL OUT reads 1200 mv (±1% to -3%) provided the Vertical Display on 661 is exactly 6 cm. Repeat check for B channel.

Because of the 10 k output impedance of the 661, the Z unit will load the VERT SIGNAL OUT, reducing the signal by 1%.

e) Check NORMAL and INVERTED gain of both channels, using the same lash-up. INVERTED gain may deviate by ±2.5%.

Tracking Check

f) With the Z unit check VERT A and VERT B SIGNAL OUTPUT jacks referred to the X100 OFFSET MONITORS. Check by setting X100 OFFSET MONITORS at +50 v and -50 v (on test scope) with DC OFFSET controls. Monitor output of VERT A and B SIGNAL OUTPUTS for a change of 1 v (±2%). Use DC reference on test scope. Tracking voltages should be within ±2% of X100 OFFSET MONITORS.

When OFFSET MONITOR is set at 0 v, the VERT SIGNAL should be at 0 volts ±55 mv. DC Offset control should provide a ±1 v level swing ±5% at the Vert Signal Output jacks on the 661 when the 4S2 is in 200 MV/CM position.

14. LISSAJOUS OPERATION CHECK

Setup

a) 5T1
SWEEP TIME/CM -- 50 nsec
SOURCE -- CAL
4S2
MODE -- DUAL TRACE
MV/CM -- 200 (both channels)

b) Remove all inputs from 4S2 and 5T1 and apply 10 mc signal from 661 AMPLITUDE TIME CALIBRATOR (0.1 μsec, 1000 mv) to both channels through GR Tee and two 2 nsec (RG58/AU) cables. Display about 2.5 to 3 cm signal on each channel. Superimpose the waveforms and set them to the same level and amplitude with VARIABLE MV/CM and DC OFFSET and VERT POSITION controls on the screen center.

Check

c) Switch MODE to A VERT - B HORIZ. Display should be diagonal line with equal X and Y displacement and should equal the DUAL TRACE deflection (±1.5%). Display should fall within center 8 cm of graticule.

Serial numbers below 101 will not fall in the middle 8 cm, horizontally.

15. MEMORY SLASH and SCALING DRIFT CHECK

Setup

a) 5T1
SOURCE -- +EXT
SAMPLES/CM -- 100
4S2 (both channels)
MV/CM -- 200
MODE -- A only
SMOOTHING -- NORMAL

b) Connect Type 111 (rep rate max, 10 kc) signal through X10 attenuator to 4S2 channel A input. (Use 10 nsec cable, RG58/AU). Connect trigger to 5T1 EXT TRIGGER INPUT. (Check to see that the A channel SMOOTHING BALANCE is balanced).

15. Memory Slash, etc. (con'd)

Check

c) Reduce the Type 111 signal rep rate to 10 cps. The displayed trace on 661 should be no wider than 5 mm.

d) Turn MV/CM switch to 10 and position trace on screen with DC OFFSET. Turn 5T1 TIME DELAY cw to 100 nsec. Increase the Type 111 rep rate to 100 kc; the trace should not change level (vertically) more than 4 mm. Turn MODE to B only. Rotate SMOOTHING control to check SMOOTHING BALANCE. Repeat check for slash and scaling drift in B channel.

The greatest change in level will take place as you approach 100 kc.

16. COMPRESSION and EXPANSION CHECK

Setup

a) 5T1
SWEEP TIME/CM -- 20 nsec
SOURCE -- +EXT
4S2
MV/CM -- 200
MODE -- A only

b) Disconnect all inputs from 4S2 and 5T1 and connect Type 111 (rep rate max, 10 kc) signal to 4S2 channel A input and to the 5T1 EXT TRIGGER INPUT and by rotating THRESHOLD and Rep Rate controls (Type 111), obtain a double trace display. Use attenuators and VARIABLE MV/CM to display 5 cm of signal.

Check

c) With positive pulse displayed, turn VERT POSITION fully ccw, and reposition with DC OFFSET control and look for no apparent compression or expansion of signal.

d) Switch the Type 111 output Polarity to Neg and turn VERT POSITION fully cw. Reposition negative pulse on screen with DC OFFSET control and look for no apparent compression or expansion. Repeat compression check for B channel.

e) Adjust signal amplitude of Type 111 to 25 mv and with the MV/CM switch to 5, repeat compression and expansion check. Repeat for A channel. Disconnect 111 signal from 4S2 and trigger from 5T1. Return MV/CM VARIABLES to CALIBRATED.

17. RISETIME CHECK

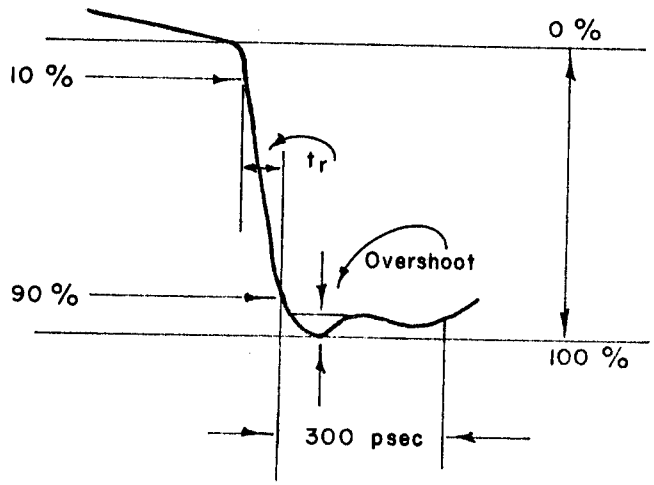
Setup

a) 5T1
SWEEP TIME/CM -- 1 nsec
SOURCE -- +EXT
4S2
MODE -- DUAL TRACE
SMOOTHING -- fully ccw

b) Connect the RISETIME STANDARD to both channel inputs through GR Tee, and two 2 nsec (RG58/AU) cables. Connect the RISETIME TRIGGER to 5T1 EXT input. Locate negative pulse rise with the TIME DELAY control. Increase MV/CM (both channels) so that only two vertical lines of the rise of the pulse are displayed on each channel. Increase the 661 HORIZ DISPLAY to X10 MAG. Now adjust either channel VERT POS or DC OFFSET so that no time difference is detectable between the two vertical traces. Disconnect one channel INPUT cable and insert a 10, 20 or 30 cm AIR LINE and reconnect to INPUT. Check time difference to be equal in time delay to the AIR LINE inserted. Remove the AIR LINE and recheck traces to be together. Readjust timing and repeat, if necessary. (Do not touch TIME DELAY control after checking timing and before reading risetime).

AIR LINE	TIME DELAY
10 cm	333 psec
20 cm	667 psec
30 cm	1 nsec

c) Switch MV/CM switches to 100. MODE switch to A only and replace GR Tee and 2 nsec cables with an AIR LINE and connect to INPUT channel A. Turn both SMOOTHING controls cw. Adjust displayed signal to 8 cm with VARIABLE MV/CM and position horizontally with 661 POSITION or VERNIER.



$$t_{r(4S2)} = \sqrt{t_r^2 - t_{r(pulser)}^2}$$

$t_{r(4S2)}$ = 4S2 risetime

t_r = indicated risetime

$t_{r(pulser)} \approx$ pulser risetime (50 psec)

Check

d) Check risetime for 100 psec or less computed, depending on the risetime of the pulser. Overshoot or undershoot after the first 300 psec after the pulse rise should not exceed 5%. Reconnect pulser to other channel, check timing and check risetime.

18. CROSSTALK

Setup

a) 5T1
SWEEP TIME/CM -- 1 nsec
SOURCE -- +EXT
4S2 (both channels)
MV/CM -- 200
VARIABLE -- CALIBRATED
SMOOTHING -- NORMAL

b) With the 4S2 risetime pulser connected to either channel, decrease 661 HORIZ DISPLAY to X1 MAG. Observe and record pulse amplitude. Turn MV/CM to 2. Switch MODE to opposite channel and MV/CM to 2.

Check

c) Check for no more than 1% of crosstalk (1% of amp noted in setup). Insert pulse to other channel and repeat. Check again.

19. TIME COINCIDENCE OF CHANNELS CHECK

Setup

a) 5T1
SWEEP TIME/CM -- 1 nsec
SOURCE -- +EXT
4S2 (both channels)
MV/CM -- 200
MODE -- DUAL TRACE
SMOOTHING -- fully ccw

b) Connect Risetime Standard through two 2nsec (RG58/AU) cables and GR Tee to both channel inputs on 4S2. Connect the pulser trigger input to 5T1 EXT INPUT. With VARIABLE MV/CM position and DC OFFSET, display two traces of like rise and amplitude (about 10 cm) and superimpose them. Remove the pulse from the A channel INPUT and connect it to 5T1 EXT INPUT, in place of the pulser trigger input. With 5T1 polarity in '-', retrigger and position B channel pulse to center of screen with 661 controls only. Switch 661 HORIZ DISPLAY to X20 MAG and center pulse carefully with Vernier. Disconnect pulse from B INPUT and connect it to A INPUT.

19. Time Coincidence, etc. (con'd)

Check

c) Check to see that the pulse rise is centered within 20 psec of the other channel pulse. Repeat back and forth to make accurate check.

d) Disconnect the inputs to 4S2. Turn off scope power. Remove cables and install 4S2 in 661. Check fit and alignment of Greymar connector and latch dog lever. Turn power on.

20. PROBE POWER CHECK

Check at both channels A and B PROBE POWER connectors for 100 v between pins A and D; 12.6 v betweens pins B and C. Pin C should be positive with respect to B; pin D should be positive with respect to A. This is a wiring check only, the voltages are supplied by the 661.