FACTORY CALIBRATION PROCEDURE

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INTRODUCTION:

4S2

This isn't a field recalibration procedure as is the procedure in your instruction manual. This is a guide in calibrating brand-new instruments, just assembled instruments that have never been turned on before. Therefore it calls out many procedures and adjustments that are rarely required for subsequent recalibration.

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Even though we wrote this procedure primarily for our own factory test department, it's valuable to others also if used with some caution:

1. **Special test equipment**, if mentioned, is not available from Tektronix unless it's listed also in our current catalog. This special equipment is used in our test department to speed calibration. Usually you can either duplicate its function with standard equipment in your facility, devise alternate approaches, or build the special test equipment yourself.

For all serial numbers.

2. **Factory circuit specifications** are not guaranteed unless they also appear as catalog or instruction manual specifications. Factory circuit specs usually are tighter than advertised specs. This helps insure the instrument will meet or exceed advertised specs after shipment and during subsequent field recalibrations over several years of use. Your instrument may not meet factory circuit specs but should meet catalog or instruction manual specs.

3. **Presetting internal adjustments**, if mentioned, usually is unnecessary. This is helpful for "first-time" calibration only. If internal adjustments are preset, you'll have to perform a 100% recalibration. So don't preset them unless you're certain a "start-from-scratch" policy is the best.

4. **Quality control men steps.** Factory calibration procedures are for our test department calibrators who first calibrate the instrument. Quality control men then check the initial calibration and perform additional fine points such as trimming resistor leads, installing shields, etc. In some cases a factory calibration procedure instructs the calibrator not to perform these fine points. You'll ordinarily have to include these fine points in your calibration.

In this procedure, all front panel controls for the instrument under test are in capital letters (SENSITIVITY) and internal adjustments are capitalized only (Gain Adj).

ABBREVIATIONS:

a	amp
ac	alternating current
approx	approximately
b	base
bulb	light, lamp, etc.
c	collector
ccw	counterclockwise or full counterclockwise
cer	ceramic
cm	centimeter
comp	composition (resistor)
cps	cycles per second
crt	cathode ray tube
cw	clockwise or full clockwise
db	decibel
dc	direct current
div	division
e	emitter
emc	electrolytic, metal cased (capacitor)
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

TYPE 4S2 DUAL TRACE SAMPLING PLUG-IN

F A C T O R Y T E S T S P E C I F I C A T I O N S

(Tentative)

Note: All specifications apply to both Channel A and Channel B equally, unless otherwise specified.

1. With a 5 nsec cable connected to the input, but no signal applied, the trace should not move more than 5 cm while rotating the MV/CM switch 200 to 5 with the X100 Offset Monitor set to zero volts.

2. On 200 MV/CM, the trace should not move more than one major graticule division while rotating the SMOOTHING control. Pot should not cause more than one major division of noise when rotated.

3. On 200 MV/CM, the trace should not shift more than two minor divisions when switching the NORMAL-INVERTED switch and output of Memory is zero volts.

4. With the A Vert and B Vert signal output jacks (661) set to zero volts with 4S2 DC OFFSET control, and 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 graticule. The Vert. DC Bal. pot in the 661 should be set with a 1.5 k 1% resistor from Vertical Input (pin 24, J1) to ground.

5. A-B Bal. pot and B Cal. pot should provide ±10% gain of 1/3 referred to output of Memory boards & MV/CM VARIABLE in CALIBRATED pos. (Check at 200 MV/CM)

6. Microphonics must be less than 2 cm at 5 MV/CM sensitivity when striking the top front corner of the instrument with your hand.

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

8. Gain at the Vert. Signal Outputs on the 661 must be ±2% of signal applied to Input of 4S2 in 200 MV/CM position. Use 50 Ω Ampl. Standard at 1.2 v.

   Indicated gain (crt) on 200 MV/CM: 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 - 2 MV/CM, ±3%.

9. Variable MV/CM control must have at least 3:1 gain at all MV/CM positions.

10. The 4S2 should operate with a 1 v (5 cm at 200 MV/CM) 3 trace (mult. triggered) 111 signal of + or - polarity with no more than 5% amplitude of base line pulses.

11. There should be no apparent vertical compression or expansion due to the 4S2 displaying a 5 cm (1 v) signal when turning VERT POS controls to ends and repositioning with the DC Offset controls and 200 MV/CM sensitivity. Repeat for 5 MV/CM sensitivity and 25 mv of signal.

12. In Added Algebraically, a 4 cm like signal (time occurence and waveshape) in each channel should indicate 8 cm signal, ±1 mm, in 200 MV/CM position.

13. DC Offset control should provide a ±1 v level swing, ±5%, at the Vert. Signal Output jacks on 661 when the 4S2 is in 200 MV/CM position. Level change noted on 661 crt should be ±1.5% of level change read at Vert. Signal Output jacks checked with a Z Unit or John Fluke voltmeter. Zero level transfer should be within 55 mv of zero volts. % tracking error =

$$\left| 1 - \frac{\text{DC Offset}}{100} \right| \text{X100\%}$$

14. X100 Offset Monitor level should vary to ±100 v, ±5%.

15. The Dual Trace chopping frequency should be 50 kc ±20%.

16. With MV/CM switch in the 5 position, SMOOTHING control NORMAL, MODE in A ONLY, B ONLY or A VERT-B HORIZ; noise should not exceed 3 mv p-p. With MODE switch in DUAL TRACE or ADDED ALGEB., noise should not exceed 4 mv p-p.

17. Overshoot or undershoot, when observing 4S2 100 ma TD Pulser, should not exceed 5% in first 300 psec after top corner (100%) of rise.

18. Risetime should be 100 picosec or less, computed depending on fast rise source.

19. Rejection ratio should be 40:1 or better when using a flat-topped pulse of one volt to each channel on 50MV/CM.

20. While observing the delayed pulse or a fast-rise tunnel diode pulse, cross-talk should not exceed 1% from one channel to the other.

21. With MV/CM switch set to 200, the trace width must not exceed .5 major divisions when the system is triggered on a 10 cps repetitive waveform.

22. Base line (trace) shift must not exceed 4 mm with a change in triggering rate from 50 pps to 100 kc when MV/CM switch is set to 10. Be sure 5T1 is not counting down before 100 kc.

23. With the 4S2 displaying a fast rise pulse, there should be no more than 20 picosec time difference between Channel A and Channel B.

24. With the 4S2 properly adjusted for risetime and sampling efficiency and the bridge balanced, there should be at least + and - 2.5 v across each half of the bridge (5 v total minimum across the bridge),

25. 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 should be positive with respect to A. (Voltages are regulated by the 661 power supplies).

26. A 2.5 to 3.0 cm waveform (one volt into 25 Ω) from AMPLITUDE/TIME CALIBRATOR, displayed on both 4S2 channels in DUAL TRACE, with VERT. POSITION controls mid-range and waveforms centered vertically, should display as 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.

TYPE 4S2 DUAL TRACE SAMPLING PLUG-IN

F A C T O R Y C A L I B R A T I O N P R O C E D U R E

WITH TEST SPECIFICATIONS

(Tentative)

RECOMMENDED EQUIPMENT

1	540 or 580 series Oscilloscope
1	081 Adaptor for 580 scope, if used
1	H Plug-In with X1 and X10 Probes
1	661 with 5T1
1	Type 105
1	Z Plug-In or John Fluke Voltmeter
1	Type 111
1	50 Ω Resistance Standard or R Bridge
1	50 Ω Amplitude Calibrator Standard
1	Risetime Pulse Generator -- 4S2 (100 ma tunnel diode)
1	630 NA Triplett (or equivalent)
2	GR Connector to UHF Adaptor (017-022)
1	Flex Amphenol inter-connecting cable (012-064)
1	3' 50 Ω coax with Greymar connectors
1	X2 GR Attenuator (017-003)
2	X5 GR Attenuators (017-002)
4	X10 GR Attenuators (017-044)
1	Extender board for 4S2 Plug-In chassis (same as 4S1)
2	5 nsec cables (017-502)
2	10 nsec cables (017-501)
2	2 nsec cables (017-505)
1	GR Tee connector
1	GR 10 cm or 20 cm Air Line

PRELIMINARY INSPECTION:

Check all boards individually and 4S2 frame for unsoldered joints, rosin joints, wrong connections shorted coax cables, loose hardware, correct silk-screening and wire dress. Also check for correct transistors, tubes and GaAs diodes in the right location. GaAs diodes as follows: 152-114, green code, in Sampling Bridges; 152-083, red code, in Memory boards; observe correct polarities. Make sure all the 2N1516, OC170 and PADT-35 transistors use the fourth pin to provide for a grounded case. Snap-off diode in Gate board is 152-112 with green code. Check to see that all plug-in board chassis are seated properly when installed. Check for shield on AC Amp board and tube shields on 6DJ8's in Memory boards. Be sure avalanche drive cable from Greymar connector is tight. To remove or replace front sampling bridge diodes, it is necessary to remove shield over diodes.

TYPE 4S2 DUAL TRACE SAMPLING PLUG-IN

O U T L I N E C A L I B R A T I O N P R O C E D U R E

(Tentative)

1. PRESETS

   4S2 Front Panel and Internal
   5T1 Front Panel
   661 Front Panel

2. RESISTANCE CHECKS: (boards installed)

   Power Connector P1
   DRO Connector P2
   Input Termination (test spec #7)

3. APPLY POWER TO 4S2:

   Check for smoke and allow five minute warm up.

4. AVALANCHE VOLTS PRELIMINARY ADJUSTMENT:

   Check free run position.

5. DC OFFSET AND MODE POSITIONS, CHECK:

   Locate traces
   Rotate MODE switch

6. MEMORY GATE WIDTH PRELIMINARY ADJUSTMENT:

   Set width to 300 nsec.

7. SMOOTHING BALANCE ADJUSTMENT: (test spec #2.)

   Adjust both channels for no trace shift

8. BRIDGE VOLTS PRELIMINARY ADJUSTMENT:

   Obtain Type 111 triple trace (multiple triggering)

9. MEMORY GATE WIDTH ADJUSTMENT:

   Set for maximum dot transient response.
   Readjust for any change in avalanche volts adj.

10. AC AMPLIFIER C1107 and C2107 ADJUSTMENT:

    Set for minimum dot transient response.

11. BRIDGE BALANCE ADJUSTMENT: (test spec #1, & #10)

    Use 5 nsec cable on INPUT 50 Ω.
    Rebalance for change of Bridge Volts or Avalanche Volts.

12. NOISE & MEMORY SLASH CHECK: (Test Spec #6, 16 & 21)

    Check for 3 mv or less noise.
    Slash, .5 cm or less at 10 pps.

13. BRIDGE HOLD-OFF BIAS, CHECK: (test spec #24)

    Use test scope and X10 Probe.
    Look for 2.5 v + and - minimum.

14. INVERTER ZERO ADJUSTMENT: (test spec #3)

Set for no trace shift.
Leave DISPLAY in NORMAL.

15. DUAL TRACE OPERATION, CHECK: (test spec #4, 15 & 16)

Chopping rate.
Trace levels.

16. A-B BAL. and B CAL. GAIN POTS ADJUSTMENT & MV/CM CHECK: (test spec #5, 8 & 9)

Use 50 Ω Amplitude Calibrator Standard.
All Positions of MV/CM switches.

17. ADDED ALGEB. & REJECTION CHECK: (test spec #12, 16 & 19)

Use 50 Ω Standard
Leave DISPLAY in NORMAL

18. VERT A & VERT B SIGNAL OUTPUTS:GAIN & TRACKING, CHECK: (test spec 8, 13 & 14)

Use 50 Ω Standard for gain.
Tracking referred to X100 OFFSET MONITOR.

19. A VERT-B HORIZ CHECK: (test spec #26)

Use 661 Amplitude/Time Calibrator.
Check x and y gain and position.

20. TRACE SHIFT WITH REP-RATE CHECK: (Test Spec #22)

Check for 4 mv or less of shift; 50 pps to 100 kc.

21. COMPRESSION & EXPANSION, CHECK: (test spec #11)

Use Type 111.
Do for 1 volt and 25 mv.

22. RISETIME, CHECK: (test spec #17 & 18)

Use 100 ma TD Pulser.
Accurate check on timing with air line.

23. CROSSTALK, CHECK: (test spec #20)

Use 100 ma TD Pulser.
Check both channels for interference.

24. TIME COINCIDENCE OF CHANNELS, CHECK: (test spec #23)

Use 100 ma TD Pulser.
Install 4S2 in 661.

25. PROBE POWER, CHECK: (test spec #25)

Check for wiring only.

- END OF OUTLINE -

1. PRESETS:

4S2 (*Both Channels)

Front Panel		Internal	
*MILLIVOLTS/CM	200	Avalanche Volts (R1057)	Mid-range
*VARIABLE	CALIBRATED	A Bridge Volts (R1074)	cw
*VERT POSITION	Mid-range	A Bridge Balance (R1078)	Mid-range
*SMOOTHING	NORMAL	B Bridge Volts (R2074)	cw
*DC OFFSET	Mid-range	B Bridge Bal. (R2078)	Mid-range
*DISPLAY	NORMAL	Memory Gate Width (R2045)	cw
MODE	A ONLY	A & B Smoothing Bal. (R1125)	Mid-range
A-B BAL	Mid-range	A Inverter Zero (R1161)	Mid-range
		B Inverter Zero (R2161)	Mid-range
		B Cal. (R2182	Mid-range

5T1		661	
SAMPLES/CM	X100	HORIZONTAL DISPLAY	X1
TIME DELAY (nSEC)	Mid-range	POSITION	Mid-range
SOURCE	+ EXT	VERNIER	Mid-range
RECOVERY TIME	Mid-range	AMP/TIME CALIB µSEC/CYCLE	OFF
THRESHOLD	30° ccw of 0	mv AMPL.	1000
SWEEP MODE	REPETITIVE	VOLTS/CM	AC
SWEEP TIME/CM	10 nSEC		
VARIABLE	CALIBRATED		

2. RESISTANCE CHECKS: (with all boards plugged in)

Pwr. Conn. (P1) Pin No.	Circuit	Ohmmeter Range	Res.	*Current
1	117 VAC	X100 k	inf.	0
2	6.3 VAC	X100 k	inf.	0
3	-19 v	X10	9-15 Ω	440 ma
4	-25.2 v	X100 k	inf.	0
5	-100 v	X1 k	2-2.5 k	70 ma
6	staircase in	X100 k	inf.	
7	Gnd	X10	0	
8	(B) out to Horiz	X10	0	
9	braid for 21	X10	0	
10	(B) Vert out	X1 k	8-11 k	
11	(A) Vert out	X1 k	8-11 k	
12	Gnd	X10	0	
13	117 VAC	X100 k	inf.	0
14	6.3 VAC	X100 k	inf.	0
15	+300 v	X1 k	9 k	30 ma
16	+400 v	X100 k	inf	0
17	+100 v	X1 k	9 k	40 ma
18	+19 v	X100	400 to 500 Ω	115 ma
19	staircase out	X100 k	inf.	
20	braid for 8	X10	0	
21	blanking out	X100 k	10 to 50 Meg	
22	braid for 10	X100 k	inf.	
23	braid for 11	X100 k	inf.	
24	vert sig out	X1 k	4-5 k	

*Currents shown are for a typical, calibrated instrument less c.f. probes.

DRO Conn. (P2) Pin No.	Circuit	Ohmmeter Range	Res.
1	open	X100 k	inf
2	-12.6 v	X100 k	inf
3	chop out	X1 k	10 k
4	(B)÷ Gnd	X100 k	inf
5	÷2	X100 k	inf
6	(A) Dec. unit Gnd	X100 k	2 Meg
7	open	X100 k	inf
8	Dec. 3	X100 k	inf
9	open	X100 k	inf
10	open	X100 k	inf
11	braid for 23	X100 k	inf
12	(B) Vert out	X1 k	8 - 11 k
13	open	X100 k	inf
14	braid for 3	X10	0
15	(A)÷ Gnd	X100 k	inf
16	÷1	X100 k	inf
17	÷5	X100 k	inf
18	(B) Dec. Unit Gnd	X100 k	2 Meg
19	Dec. 2	X100 k	inf
20	Dec. 4	X100 k	inf
21	milli	X100 k	inf
22	volt	X100 k	inf
23	(A) Vert out	X1 k	8-11 k
24	braid for 12	X100 k	inf

Input Termination (test spec #7)

Check resistance of INPUT 50 Ω for 50 Ω; ±1% using an accurate Resistance Bridge or a comparison standard.

3. APPLY POWER TO 4S2:

Connect the flex amphenol inter-connecting cable from J1 of 661 to P1 of 4S2. Connect the 3' 50 Ω coax with the Greymar connector from the inboard Greymar connector (Strobe trigger from 5T1) of 661 to the avalanche drive Greymar connector of 4S2. Pull out AC Amp board and reinstall on extender board. Turn on scope power with POWER AND SCALE ILLUM control. Look for shorts, over-rated components and smoke. Allow five minutes warm-up.

4. AVALANCHE VOLTS PRELIMINARY ADJUSTMENT:

Connect test scope probe to center arm of Avalanche Volts pot and set test scope for 50 V/CM AC and 10 μSEC/CM. 5T1 should be free running. If not, readjust THRESHOLD control. Rotate Avalanche Volts ccw until avalanche free runs denoted by signal rate of more than 100 kc on test scope. Return Avalanche Volts cw about 10° off of free run position.

5. DC OFFSET AND MODE POSITIONS CHECK:

With test scope probe, zero DC OFFSETS by setting OFFSET MONITOR to zero volts. (test scope at 50 MV/CM DC). Locate A Channel trace with A Bridge Volts, A Bridge Balance, A Memory Smoothing Balance and/or A SMOOTHING control. Leave SMOOTHING control in NORMAL. Turn MODE to B ONLY. Also locate B trace. Check MODE for trace on all positions except A VERT-B HORIZ and two traces on DUAL TRACE. Return MODE to A ONLY.

6. MEMORY GATE WIDTH PRELIMINARY ADJUSTMENT:

Connect test scope probe to pin V of A Channel memory board. It will be necessary to turn 4S2 on its side to reach connection. Set test scope for 5 V/CM AC and 0.1 μSEC/CM and adjust Memory Gate Width pot for 300 nsec pulse width. Check B Channel Memory board, pin V for same waveform. Reset 4S2 upright.

7. SMOOTHING BALANCE ADJUSTMENT: (test spec #2)

Adjust A Channel Smoothing Balance pot for NO trace shift while rotating SMOOTHING control. (test spec: 1 cm, next week or month in different 661) Pot should not cause more than 1 cm of noise. (test spec: 1 cm) Turn MODE to B ONLY and repeat adjustment for B Channel. Leave SMOOTHING controls in NORMAL. Return MODE to A ONLY.

8. BRIDGE VOLTS PRELIMINARY ADJUSTMENT:

Connect Type 111 signal to 4S2 A INPUT 50 Ω through X10 GR Attenuator. Connect 111 trigger pulse to 5T1 EXTERNAL TRIGGER INPUT through X10 and X5 GR Attenuators.
Locate pulse on trace with 5T1 TIME DELAY control. Set 111 for positive pulse and 50 - 100 kc rep-rate. Adjust 5T1 THRESHOLD control and 111 REPETITION RATE control until 3 traces (3 pulses of different amplitudes) are obtained. If pulses exhibit more noise than the trace, rotate Avalanche Volts cw just until noise disappears. Adjust A Bridge Volts until small pulse amplitude is zero. Turn MODE to B ONLY and set B Bridge Volts with 111 signal.

9. MEMORY GATE WIDTH ADJUSTMENT:

With triple traced Type 111 signal displayed on either 4S2 Channel, adjust the Memory Gate Width pot for maximum separation between trace pulses. Now readjust A and B Bridge Volts adjustments for zero amplitude of small pulses. Note: It will be necessary to recheck Memory Gate Width adjustment each time the Avalanche Volts Adjust may have to be reset, for avalanche noise, etc. as the Avalanche Volts setting affects the Memory Gate Width.

10. AC AMPLIFIER C1107 and C2107 ADJUSTMENT:

With Type 111 mult. trace signal displayed on A Channel, adjust C1107 on AC Amp board for minimum separation between trace pulses. Now readjust A Bridge Volts for zero amplitude of small pulse. Switch 111 signal to B Channel and repeat adjustments on C2107 and B Bridge Volts.

11. BRIDGE BALANCE ADJUSTMENT: (test spec #1, & #10)

Remove Type 111 signal from 4S2 INPUT 50 Ω and replace with 5 nsec cable on A INPUT 50 Ω. With test scope probe, set A Channel OFFSET MONITOR to zero volts. Now adjust A Bridge Balance pot for no trace shift while rotating the MV/CM switch from 200 to 2 (test spec: 5 cm next week or month in different 661). Note: At maximum sensitivities, a wide or double trace can be caused by the mult. triggered 111 rates; solution: retrigger Type 5T1. Switch MODE and 5 nsec cable to B Channel and adjust B Bridge Balance. Leave MV/CM switches in 200 position. Disconnect 5 nsec cable and reconnect Type 111 double triggered pulse. Recheck A and B Bridge Volts adjustments. If readjustment is necessary, it will also be necessary to rebalance the bridges. These adjustments should be repeated until no interaction exists. (remember to use 5 nsec cable when balancing). Now display double triggered 111 signal and switch 111 OUTPUT POLARITY to -. Small pulse amplitude should be no more than 5% (test spec, 5% max.) of large pulse ampl. when large pulse is near 1 v. (Use more or less GR Atten. if necessary.) Repeat check for other channel. Return 111 signal to +.

12. NOISE & MEMORY SLASH CHECK: (Test Spec #6, 16 & 21)

Retrigger 5T1 for a properly triggered signal. Remove signal from 4S2 INPUT 50 Ω. Check A ONLY and B ONLY at 5 MILLIVOLTS/CM position for 3 mv or less of noise (Test Spec: 3 mv max.). Check each channel at 5 MILLIVOLTS/CM for 2 cm or less of microphonics when striking top front of 4S2 with hand (Test Spec: 2 cm max at 5 MV/CM).

Return MILLIVOLTS/CM switches to 200. Decrease 111 rep-rate to 10 pps. Check A ONLY and B ONLY MODE positions for trace width no greater than .5 cm (Test Spec: .5 cm a 10 pps rep-rate). It may be necessary to re-check Smoothing Balance adjustment, Step #7. Increase 111 rep-rate to over 50 kc.

13. BRIDGE HOLD-OFF BIAS, CHECK: (test spec #24)

Turn 4S2 on side to check bridge volts. Set test scope for 2 V/CM DC and touch probe on ends of 10 k resistors mounted on sampling bridge boards. Check each channel for + and -2.5 v minimum voltage, 5 v across each bridge. (test spec: + and - 2.5 v, 5 v total minimum). Use X10 Probe.

14. INVERTER ZERO ADJUSTMENT: (test spec #3)

With test scope set to 50 MV/CM DC, connect probe to pin X of A Memory. Adjust A DC OFFSET control to set pin X to zero volts. Now adjust A Inverter Zero for no trace shift when switching DISPLAY NORMAL to INVERTED. (test spec: ±two minor divisions next month in different 661) Switch MODE to B ONLY and probe to B Memory (pin X) and adjust B Inverter Zero. Turn 4S2 upright. Recheck adjustments of A & B Smoothing Balance pots. Leave DISPLAY switches in NORMAL. Turn off scope and reinstall AC Amp board without extender. Turn on power and allow five minute warm up. Recheck 4S2 loop gain for unity. Reset bridge volts if necessary.

15. DUAL TRACE OPERATION, CHECK: (test specs #4, 15 & 16)

Turn MODE to DUAL TRACE and MV/CM switches to 5. Check for 4 mv or less of noise on traces. Return MV/CM switches to 200 position. With test scope, set to 1 V/CM AC and 20 μSEC/CM, touch probe on pin #3 of DRO Amphenol on back of 4S2. Look for about 3 v of 50 kc ±20%, multivibrator waveform. (test spec: 50 kc ±20%) Reset test scope for 50 MV/CM DC and with probe set VERT A and VERT B SIGNAL OUTPUTS on 661 to zero volts with DC OFFSET controls. Now with test scope probe, set VERT POSITION pot center arm to zero volts. (both channels). Traces must be within 1 cm of each other (test spec: 1 cm) and within 1 cm of center line (test spec: 1 cm) of graticule. Note: (test spec: 661 Vert DC Bal. pot set with 1.5 k 1% resistor from pin #24, J1 to ground). Note ADDED ALGEB position and A VERT-B HORIZ position checked after gain set step.

16. A-B BAL. AND B CAL.GAIN POTS ADJUSTMENT & MV/CM CHECK: (test specs #5, 8 & 9)

Turn MODE to A ONLY. Connect 50 Ω Amplitude Calibrator Standard to A Channel INPUT 50 Ω. Connect Calibrator Standard to Type 105 (TU50) and set frequency to 10 kc. Adjust 105 amplitude till bulb in calibrator standard glows then decrease until bulb just goes out. Remove Type 111 trigger signal from 5T1 EXT TRIGGER INPUT. Connect trigger signal from Calibrator Standard to 5T1 INPUT. Set 5T1 TIME/CM to about 20 μSEC. Retrigger 5T1. Set Calibrator Standard to 1.2 v. Be sure MV/CM VARIABLE is CALIBRATED. Check range of A-B CAL pot for ±10% of 6 cm (test spec: ±10%). Adjust A-B CAL pot for for exactly 6 cm of signal. (test spec: ±1.5% later in different 661) Check all positions of MILLIVOLTS/CM switch as follows:

Cont. next page

50 Ω Ampl. Cal. Std.	MV/CM Switch	Vert. Defl.	Test Spec	50 Ω Ampl. Cal. Std.	MV/CM Switch	Vert. Defl.	Test Spec
1.2 volts	200	6 cm	±0%	.06 volts	10	6 cm	±1%
.6 volts	100	6 cm	±1%	.03 volts	5	6 cm	±3%
.3 volts	50	6 cm	±1%	.012 volts	2	6 cm	±3%
.12 volts	20	6 cm	±1%				

Switch MODE and Calibrator Standard to B Channel. With Calibrator Standard at 1.2 volts, check range of B Cal. pot for ±10% of 6 cm. Adjust B Cal. for exactly 6 cm of signal. Repeat other positions check for B Channel.

Using any combination of input signal and MV/CM sensitivity, check MV/CM VARIABLES for at least 3:1 increase in gain. Return to CALIBRATED.

17. ADDED ALGEB. AND REJECTION CHECK: (test specs #12, 16 & 19)

Turn MODE to ADDED ALGEB and both MV/CM switches to 5. Noise on trace should not exceed 4 mv. Return MV/CM switches to 200 and turn MODE to DUAL TRACE. Connect the 50 Ω amplitude calibrator standard to both channel inputs with GR Tee. Set standard to 1.2 v. Set both MV/CM switches to 200. Using the MV/CM VARIABLE, set each channel deflection to exactly 4 cm. Turn MODE to ADDED ALGEB. and view 8 cm of signal ±1 mm (test spec: ±1 mm) Switch either channel DISPLAY to INVERTED and increase calibrator to 2 v. Turn both MV/CM switches to 50 and VARIABLES to CALIBRATED. Look for 1 cm or less of signal. Reverse both DISPLAY switches and check for less than 1 cm signal. Return DISPLAY switches to NORMAL and remove Calibrator Standard. Return both MV/CM switches to 200.

18. VERT A AND VERT B SIGNAL OUTPUTS GAIN & TRACKING CHECK: (test spec #8, 13 & 14)

Reconnect calibrator standard, at 1.2 v to A Channel INPUT 50 Ω. Turn MODE to A ONLY. With test scope and Z Unit, check VERT A SIGNAL OUTPUT for 1.2 v ±2%. Be sure to figure loading of test scope and probe. (test spec: ±2%) Switch MODE and Calibrator Standard to B Channel. Check VERT B SIGNAL OUTPUT for 1.2 v ±2%. Remove Calibrator Standard from INPUT 50 Ω and trigger from 5T1 INPUT. Return 5T1 SWEEP TIME/CM to 5 nsec and re-connect Type 111 trigger signal to 5T1 INPUT. Trigger 5T1. With Z, check tracking of VERT A and VERT B SIGNAL OUTPUTS referred to X100 OFFSET MONITORS. Check at 0 v, +50 v, +100 v and -50 v -100 v (MONITOR) with VERT A & B SIGNAL OUTPUTS, 0 v -.5, -1 v and +.5, +1 v. Tracking voltage(MONITO should be within ±2% of SIGNAL OUTPUTS. (Test Spec: ±2%). Zero level at OFFSET MONITOR should provide zero volts, ±55 mv at SIGNAL OUTPUTS (Test Spec: ±55 mv).

19. A VERT-B HORIZ CHECK: (test spec #26)

Connect a 10 mc waveform from the 661 AMPLITUDE/TIME CALIBRATOR to both 4S2 Channel INPUT 50 Ω connectors. Use GR Tee and two 2 nsec cables. Trigger 5T1 on CAL. and set SWEEP TIME/CM to 50 nSEC. Turn 4S2 MODE to DUAL TRACE and each channel to 200 MV/CM. There should be about 2.5-3 cm of signal on each channel. Center VERT POSITION controls and center waveforms vertically with DC OFFSET controls. Switch MODE to A VERT-B HORIZ. The display should be a diagonal line of equal x and y amplitudes and equal to defl. in DUAL TRACE pos. ±1.5%. The display should fall horizontally within the center 8 cm of the graticule. (test spec: w/in center 8 cm) Remove signal from 4S2 and increase MV/CM switches to 5. Reposition with DC Offset controls if necessary. Check for 3 mv or less of noise. (Test Spec: 3 mv max.).

20. TRACE SHIFT WITH REP-RATE CHECK: (Test Spec #22)

Reconnect 111 trigger signal to 5T1 and trigger 5T1 EXT + on 111. Turn MODE to A ONLY and A MV/CM to 10. Increase 111 rate to 100 kc. Be sure 5T1 is not counting down (RECOVERY TIME control ccw to MIN.). Now decrease 111 rep-rate to 50 pps and observe trace shift. Trace should not shift more than 4 mv or 4 mm (Test Spec: 4 mm from 50 pps to 100 kc). Turn MODE to B ONLY and B MV/CM to 10. Repeat rep-rate check. Return MV/CM switches to 200.

21. COMPRESSION & EXPANSION CHECK: (test spec #11)

Connect the 111 signal to B Channel INPUT 50 Ω. Using suitable attenuation, adjust the pulse amplitude to 1 v. With 5T1 THRESHOLD and 111 REPETITION RATE obtain double trace. With a positive pulse displayed, turn VERT POSITION ccw and re-position with DC OFFSET.control and look for compression or expansion of signal. Switch 111 OUTPUT POLARITY to - and turn VERT POSITION cw. Re-position negative pulse with DC OFFSET control and look for compression or expansion. Switch signal and MODE to A channel. Repeat compression check for A Channel. Adjust signal amplitude to 25 mv and turn MV/CM switch to 5 and repeat compression and expansion check. Turn MODE to B ONLY and signal to B INPUT 50 Ω. Turn B MV/CM switch to 5 and repeat compression and expansion check with 25 mv for Channel B. Return both MV/CM switches to 200. Disconnect 111 signal and trigger from 4S2.

22. RISETIME CHECK: (test specs #17 & 18)

Connect the 4S2 risetime standard to both channel INPUTS through a GR Tee and two 2 nsec cables. Connect risetime standard trigger to 5T1 TRIGGER INPUT. Re-trigger 5T1 and turn SWEEP TIME/CM to 1. Locate negative pulse rise with TIME DELAY control. Turn MODE to DUAL TRACE and rotate both channel SMOOTHING controls ccw. Increase both channel MV/CM switches to obtain only two vertical lines of the rise of the pulse on each channel. Increase the 661 HORIZONTAL DISPLAY switch to X10 SWEEP MAGNIFIER position. Now adjust either channel VERT POSITION or DC OFFSET control until no difference in time is detectable between vertical traces. Disconnect one channel INPUT cable and insert a 10 or 20 cm air line and reconnect to INPUT. Check time difference. between traces to be equal in time delay of air line inserted. Remove air line and recheck traces to be together. Repeat and readjust 5T1 timing if necessary. Now decrease MV/CM switches to 100 and replace GR Tee and two 2 nsec cables with air line and connect to INPUT 50 Ω. Turn both channel SMOOTHING controls cw. Adjust signal amplitude to 8 cm with VARIABLE and position horizontally with 661 HORIZONTAL POSITION or VERNIER. Do not use TIME DELAY control for positioning of pulse after timing check on 5T1 before reading risetime. Check risetime for 100 psecs or less, computed, depending on risetime of standard. (test spec: 100 psec or less) Re-connect air line and pulser to other channel and check risetime. Overshoot or undershoot of the first 300 psecs after the pulse rise should not exceed 5%. (test spec: 5% max.)

23. CROSSTALK CHECK: (test spec #20)

With the 4S2 risetime standard connected to either channel, decrease 661 SWEEP MAGNIFIER to X1. Decrease MV/CM to 200 and VARIABLE to CALIBRATED. Observe pulse amplitude in cm and turn MV/CM to 2. Switch MODE to other channel and MV/CM to 2. Check for no more than 1% of crosstalk. Switch pulse and MODE to opposite channels and check crosstalk again. (test spec: 1% or less)

24. TIME COINCIDENCE OF CHANNELS CHECK: (test spec #23)

Disconnect risetime standard through air line and reconnect to both channels with GR Tee and two 2 nsec cables. Turn both SMOOTHING controls ccw. Turn MODE to DUAL TRACE and position rise of traces to be alike in amplitude (about 10 cm) and vertical position. Remove pulse cable from A INPUT 50 Ω and connect it to 5T1 TRIGGER INPUT in place of pulser trigger cable. Retrigger if necessary and position B Channel pulse to center of screen with 661 POSITION controls only. Switch 661 SWEEP MAGNIFIER to X20 and center pulse carefully with VERNIER. Disconnect pulse from B INPUT 50 Ω and connect to A INPUT 50 Ω. Pulse rise should be centered within 20 psecs of other channel pulse. Repeat back and forth to make accurate check. (test spec: 20 psec max.) Disconnect risetime standard from 4S2 and turn off scope power. Remove inter-connecting cables and install 4S2 in 661. Check mechanical fit and alignment of Greymar connector and latch dog and lever. Turn power on.

25. PROBE POWER CHECK: (test spec #25)

Check at both Channels A and B PROBE POWER connectors for 100 v between pins A and D and 12.6 v between pins B and C. Pin C should be positive with respect to B,and D should be positive with respect to A. This is a wiring check only as the voltages are regulated by the 661 power supplies.