March 16, 1964

Specification 101/104

ENGINEERING INSTRUMENT SPECIFICATION

TYPE 545B/RM545B

OSCILLOSCOPE

COMPANY CONFIDENTIAL

TEKTRONIX, INC.

Specification 101/104

March 16, 1964

ENGINEERING

INSTRUMENT SPECIFICATION

TYPE 545B/RM545B

OSCILLOSCOPE

Prepared by Ralph Show
Engineering Product Evaluation

Approved By:

Instrument Engineering

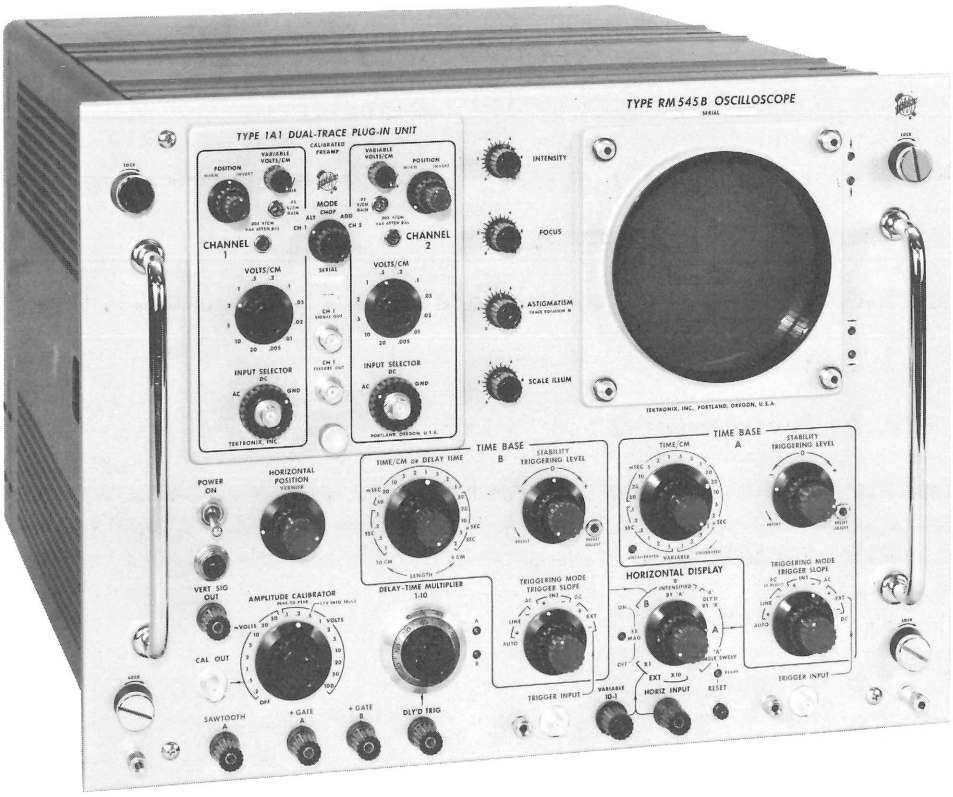
Project Manager _____

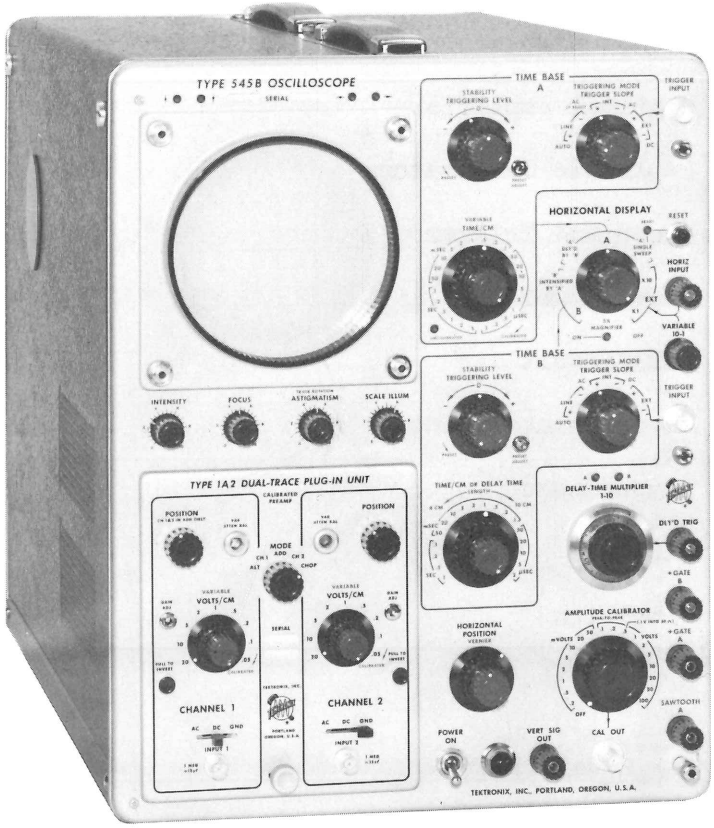
Manufacturing

Instrument Evaluation Mgr. J. L. Shannon

Evaluation Engineer George Anderson

CONTENTS


TYPE RM 545B OSCILLOSCOPE
TYPE 1A1 DUAL-TRACE PLUG-IN UNIT
CHANNEL 1
CHANNEL 2
INTENSITY
FOCUS
ASTIGMATISM
SCALE ILLUM
TIME BASE B
TIME BASE A
HORIZONTAL DISPLAY
POWER ON
HORIZONTAL POSITION
AMPLITUDE CALIBRATOR
DELAY-TIME MULTIPLIER
TRIGGERING MODE
TRIGGER SLOPE
TRIGGER INPUT
VERT SIG OUT
CAL OUT
SAWTOOTH
+GATE A
+GATE B
DLY'D TRIG
HORIZ INPUT
RESET
TEKTRONIX, INC., PORTLAND, OREGON, U.S.A.


TYPE 545B OSCILLOSCOPE
TYPE 1A2 DUAL-TRACE PLUG-IN UNIT
CHANNEL 1
CHANNEL 2
TIME BASE A
TIME BASE B
HORIZONTAL DISPLAY
INTENSITY
FOCUS
SCALE ILLUM
POWER ON
HORIZONTAL POSITION
AMPLITUDE CALIBRATOR
DELAY-TIME MULTIPLIER
TRIGGER INPUT
VERT SIG OUT
CAL OUT
SAWTOOTH
+GATE A
+GATE B
DLY'D TRIG
HORIZ INPUT
RESET
TEKTRONIX, INC., PORTLAND, OREGON, U.S.A.

INTRODUCTION

This is the INSTRUMENT SPECIFICATION for the Types 545B and RM545B Oscilloscopes, and is the reference document for all company activity concerning performance requirements.

This INSTRUMENT SPECIFICATION supersedes and replaces the Type 545B TARGET SPECIFICATION 101, dated February 3, 1964, and the Type RM545B TARGET SPECIFICATION 104, dated February 28, 1964.

The Customer Performance Requirement column in Section 1 of this specification lists Major and Minor requirements. Major requirements identify those characteristics Instrument Engineering considers to be of major importance to a customer. Minor requirements are characteristics Instrument Engineering considers to be of lesser importance to a customer, but which may be of significance to the factory. Information in the Factory Test Limit column was obtained from the Factory Calibration Procedure, and lists those limits in effect at the date of this issue.

General Information

The Types 545B and RM545B are improved models of the Types 545A and RM545A, respectively, and are intended for laboratory or nonsevere environments.

The following "B" version characteristics represent changes from or additions to the "A" version.

1. 6-cm vertical scan
2. Non-distributed vertical amplifier
3. Fixed-tuned delay line
4. Triggering to 30 mc (No HF Sync)
5. Trace Rotator
6. Internal graticule, illuminated, risetime type
7. 0.1 v into 50 Ω added to Calibrator output
8. Gray knobs instead of black

Characteristics Summary (performance figures are typical)

Vertical Deflection	
Risetime	10 nsec
Frequency Response	35 mc
Signal Delay	200 nsec
Calibrated Scan	6 cm
Amplitude Calibrator	
Voltage Range	0.2 mv to 100 v
Special Output	0.1 v into 50 Ω
Horizontal Deflection	
Time Base A	
Time/cm Range	5 sec/cm to 0.1 μsec/cm
Variable	2.5:1
Trigger Modes	DC, AC, AC LF Reject, Auto
Trigger Slope	+ or -
Trigger Source	Internal, External, Line

Horizontal Deflection (cont.)

Time Base B	
Time/cm Range	1 sec/cm to 2 µsec/cm
Trigger Modes	DC, AC, Auto
Trigger Slope	+ or -
Trigger Source	Internal, External, Line
Sweep Magnification	5X (extends fastest sweep rate to 20 nsec/cm)
Variable Time Delay	1 µsec to 10 sec, calibrated
External Horizontal Amplifier	
Deflection Factor	0.15 v/cm, variable 10:1
Input Attenuation	1X or 10X
Frequency Response	DC to 450 kc

Output Signal Amplitude	
Vertical Signal Out	1.5 v/cm CRT deflection
Time Base A Sawtooth	0 to +140 v
Time Base A + Gate	0 to +30 v
Time Base B + Gate	0 to + 30 v
Delay Trigger	6 v

Power Source	
Regulation	115 v ±10% or 230 v ±10%
Watts	600 maximum
Line Frequency	50-60 cps (400 cps available as a mod)

CRT Circuit	
Tube Type	T5470-31-2 standard
Accelerating Potential	10 kv
Internal Graticule	Illuminated risetime type, 6 x 10 cm

Environment	
Storage	-40°C to +65°C, to 50,000 ft.
Operating Temperature	0°C to +50°C
Operating Altitude	To 15,000

Maximum Overall Dimensions	
Type 545B	16.750"H x 12.875"W x 23.812" L
Type RM545B*	Front panel: 13.984"H x 19.016"W Depth behind front panel: 22.688" *See outline drawing at rear of this specification

Weight	
Type 545B	65 lbs maximum, without plug-in unit
Type RM545B	86 lbs maximum, without plug-in unit

SECTION 1

1.0 Performance Requirements

1.1 Electrical

The following electrical characteristics are valid throughout the environment specified in Section 1.2 unless there is a modifying statement to the contrary.

Tests and measurements are performed according to Sections 3 and 4.

VERTICAL AMPLIFIER				
Characteristic	Customer Performance Requirement		Factory Test Limit	Supplemental Information
	Major	Minor		
Input DC Level				+67.5 v, trace centered
Deflection Factor		Adjustable to 0.1 v/cm, push-pull ±3%	0.1 v/cm ±1%	
Gain Control Range		±5% of calibrated value	±10%	
Risetime	≤ 10 nsec		≤ 10 nsec	See Section 3.1.1
Frequency Response	DC to 30% down @ ≥ 35 mc (Calculated from risetime)		≥ 33 mc with standard 1A2	See Section 3.1.2
DC (Thermal) Shift		≤ 1.25%	≤ 1%	Thermal bal. adj. to zero
Transient Response	≤ 1.25% overshoot, rolloff, ringing, or tilt		≤ 1%	See Section 3.1.3
Positioning Effect on Transient Response		≤ 1.25% change in transient response	≤ 1%	See Section 3.1.4
Low-Frequency Linearity	≤1.5mm compression or expansion		≤ 1.5 mm	See Section 3.1.5

1.1 Continued	VERTICAL AMPLIFIER (Continued)			
Characteristic	Customer Performance Requirement		Factory Test Limit	Supplemental Information
	Major	Minor		
Signal Delay				200 nsec delay line
Output DC Level				+300 v, nom.
DC Balance		±5 mm	±2 mm	Adj. to zero
DC Balance Range		±2 cm of center	±2 cm	
Trace Drift with Line Voltage Change		≤ 5 mm, 103.5 to 126.5 v	≤ 5 mm	
Positioning Indicators		One on, one off before spot reaches graticule limit	One on, one off within 2 cm of graticule center	
Gain Change with Line Voltage Change	≤ ±1%, 103.5 to 126.5 v		≤ ±1%	See Section 3.1.6
AMPLITUDE CALIBRATOR				
Voltage Range	0.2 mv to 100 v in 1, 2, 5 sequence			
Accuracy	±3%		±1% 100 v output ±2% all other output voltages	See Section 3.2.1
Symmetry (Duty Cycle)		50% ±10%	50% ±10%	See Section 3.2.2
Rep Rate				1 kc ±25%
Risetime				1 µsec typical
Special Output	0.1 v ±3% into 50Ω		±2%	See Section 3.2.3

1.1 Continued	SWEEP AND TRIGGER			
Characteristic	Customer Performance Requirement		Factory Test Limit	Supplemental Information
	Major	Minor		
TIME BASE A				
Calibrated Sweep Range	0.1 µsec/cm to 5 sec/cm in 1, 2, 5 sequence			
Accuracy	±3%		±2% 0.1 µsec to 0.5 sec; ±2.5% 1 sec to 5 sec	See Section 3.3.1
Uncalibrated Variable Range	≥ 2.5:1. Extends slowest sweep to about 12 sec/cm		≥ 2.5:1	
Sweep Length		10.5 ±0.3 cm	Set to 10.5 ±0.3 cm	
Triggering Level — Int — AC	2 mm deflection 150 c/s to 10 mc, increasing to 1 cm at 30 mc (< 1 mm display jitter). Will trigger below 150 c/s with increased deflection.		1 mm Calibrator signal, increasing to 1 cm at 30 mc sine wave (< 1 mm display jitter)	See Section 3.3.2
Int — AC LF REJECT	2 mm deflection 30 kc to 10 mc, increasing to 1 cm at 30 mc (< 1 mm display jitter). Will trigger below 30 kc with increased deflection			
Int — DC	6 mm deflection to 10 mc		4 mm Calibrator signal, centered ±2 mm	
Int — AUTO	2 mm deflection 150 c/s to 10 mc. Will trigger to 50 c/s with increased deflection.		1 mm Calibrator signal	

1.1 Continued	SWEEP AND TRIGGER (Continued)			
Characteristic	Customer Performance Requirement		Factory Test Limit	Supplemental Information
	Major	Minor		
TIME BASE A (cont.)				
Ext — AC	0.2 v 150 c/s to 10 mc, increasing to 1 v at 30 mc (< 1 mm display jitter). Will trigger below 150 c/s with increased signal.		0.1 v Calibrator signal, increasing to 1 v at 30 mc sine wave (< 1 mm display jitter)	See Section 3.3.2
Ext — AC LF REJECT	0.2 v 30 kc to 10 mc, increasing to 1 v at 30 mc (< 1 mm display jitter). Will trigger below 30 kc with increased signal.			
Ext — DC	0.2 v to 10 mc, increasing to 1 v at 30 mc (< 1 mm display jitter)		0.1 v Calibrator signal	
Ext — AUTO	0.2 v 150 c/s to 10 mc. Will trigger to 50 c/s with increased signal.			
External Trigger Input R and C				Typically 1 meg (except 91 k at AC LF REJECT), and 25 pf
No Signal Auto Trigger Rep Rate		40 c/s ±20%	Set to 40 c/s ±10%	
Single Sweep		Must operate at same triggering level as normal sweep	Must trigger internal AC on 1 mm Calibrator signal	

1.1 Continued	SWEEP AND TRIGGER (Continued)			
Characteristic	Customer Performance Requirement		Factory Test Limit	Supplemental Information
	Major	Minor		
TIME BASE B				
Calibrated Sweep Range	1 sec/cm to 2 μsec/cm in 1, 2, 5 sequence			
Accuracy	±3%		±2% 2 μsec to 0.5 sec; ±2.5% @ 1 sec	See Section 3.3.1
Sweep Length Adjustment		Variable from 4 to 10 cm	From 3.2 to 3.8 cm to 10.2 to 10.8 cm.	
Triggering Level				
Int — AC	2 mm deflection 300 c/s to 5 mc, increasing to 1 cm at 10 mc (< 1 mm display jitter). Will trigger below 300 c/s with increased deflection.		1 mm Calibrator signal, increasing to 1 cm at 10 mc sine wave (< 1 mm display jitter)	See Section 3.3.2
Int — DC	6 mm deflection to 5 mc		4 mm Calibrator signal, centered display ±2 mm	
Int — AUTO	2 mm deflection 300 c/s to 5 mc. Will trigger to 50 c/s with increased deflection.		1 mm Calibrator signal	
Ext — AC	0.2 v 300 c/s to 5 mc, increasing to 1 v at 10 mc (< 1 mm display jitter). Will trigger below 300 c/s with increased signal.		0.1 v Calibrator signal, increasing to 1 v at 10 mc sine wave (< 1 mm display jitter)	
Ext — DC	0.2 v to 5 mc, increasing to 1 v at 10 mc (< 1 mm display jitter)			
Ext — AUTO	0.2 v 300 c/s to 5 mc. Will trigger to 50 c/s with increased signal.		0.1 v Calibrator signal	

1.1 Continued	SWEEP AND TRIGGER (Continued)			
Characteristic	Customer Performance Requirement		Factory Test Limit	Supplemental Information
	Major	Minor		
TIME BASE B (cont.) External Trigger Input R and C				Typically 1 meg, 40 pf
No Signal Auto Trigger Rep Rate				40 c/s typical
B Intensified By A Unblanking Pulse Amplitude Differential				5 v typical
VARIABLE TIME DELAY Delay Time Range	1 µsec to 10 sec, calibrated, continuously variable			
Accuracy Delay Range	1%		0.6% for B ranges from 2 µsec/cm to 0.1 sec/cm; 1% from 0.2 sec/cm to 1 sec/cm	See Section 3.3.3
Incremental	0.2%		0.2%	
Delay Pickoff Jitter	< 1/20,000 for entire sweep duration		Delay Time Mult. ≤ 1/50,000 @ 1 ≤ 1/25,000 @ 9	See Section 3.3.4
Fixed Delay in System				200 nsec typical

1.1 Continued	SWEEP AND TRIGGER (Continued)			
Characteristic	Customer Performance Requirement		Factory Test Limit	Supplemental Information
	Major	Minor		
HORIZONTAL AMPLIFIER Sweep Magnification	X5 (Sweep accuracy remains ±3%). Extends fastest calibrated sweep rate to 0.02 µsec/cm.		X5 (Sweep accuracy remains ±2%)	
Sweep/Mag Registration		±2 mm	±1 mm	See Section 3.3.5
Positioning Indicators		One on, one off before spot reaches ±4.5 cm of center	One on, one off before spot reaches ±4 cm of center	
EXTERNAL HORIZONTAL AMPLIFIER Deflection Factor	≤ 0.2 v/cm, variable ≥ 10:1		X1 @ max gain: 1 v in must produce ≥ 5.6 cm deflection. Variable ≥ 10:1	
10:1 Attenuator Accuracy	±3%		±2%	See Section 3.3.6
X10 Attenuator Compensation	≤ 5% aberration or tilt referenced to X1		±3%	
Input R and C				Typically 1 meg, 55 pf
X1 DC Balance		±5 mm	±2 mm	Adj. to zero
Frequency Response	DC to 30% down @ ≥ 350 kc at maximum gain		≥ 350 kc	See Section 3.3.6

1.1 Continued	OUTPUT SIGNAL AMPLITUDE			
Characteristic	Customer Performance Requirement		Factory Test Limit	Supplemental Information
	Major	Minor		
Vertical Signal Out	≥ 1.2 v/cm CRT deflection		≥ 1.2 v/cm	
Sawtooth A	0 ±5 v to ≥ +130 v		Amplitude ≥ 130 v	
+ Gate A	0 to ≥ + 20 v		Amplitude ≥ 20 v	
+ Gate B	0 to ≥ + 20 v		Amplitude ≥ 20 v	
Delay Trigger	≥ 5 v		Amplitude ≥ 5 v	
POWER SOURCE				
Line Voltage Range	115 v ±10% or 230 v ±10%, 50 to 60 c/s or 400 c/s, single ϕ			Sine wave distortion should not exceed 2% for proper operation at lower line voltages
Power Input				600 w typical (high line, *maximum load) *TU-7 set to HIGH LOAD
Regulation, 115 v ±10% or 230 v ±10% Supply -150 v +100 v +225 v +350 v +500 v		Tolerance / Max. p-p Ripple ±3% / 5 mv ±3% / 10 mv ±3% / 5 mv ±3% / 20 mv ±5% / 20 mv	±2%, 5 mv ±2%, 10 mv ±2%, 5 mv ±2%, 20 mv ±3%, 20 mv	See Section 3.4.1

1.1 Continued	POWER SOURCE (Continued)			
Characteristic	Customer Performance Requirement		Factory Test Limit	Supplemental Information
	Major	Minor		
DC Change with Line Voltage Change, 103.5 to 126.5 or 207 to 253 v. Supply -150 v +100 v +225 v +350 v +500 v				0.05% maximum 0.5% maximum 0.1% maximum 0.5% maximum 0.5% maximum
Time Delay		≥ 15 sec	≥ 15 sec	
Thermal Cutout Operation				52°C ambient typical
CRT CIRCUIT				
Tube Type				T5470-31-2
Accelerating Potential		10,000 v ±5%	-1700 set ±2%	(-1700, +8300)
Visual Writing Rate	Visible trace in darkened room with no bright spot at start of trace. Sweep rate: 0.02 µsec/cm Trigger rate: 10 c/s			
HV Oscillator Freq.				50 kc typical
Trace Rotation Range	≥ 6°		≥ 6°	See Section 3.5.1

1.1 Continued	CRT CIRCUIT (Continued)			
Characteristic	Customer Performance Requirement		Factory Test Limit	Supplemental Information
	Major	Minor		
Z Axis Modulation				
Voltage		≤ 20 v for intensity modulation	≤ 10 v	See Section 3.5.2
Low Frequency Cutoff				~~390~~ 600 c/s typical
Input R and C				Typically 1 meg, 10 pf
Geometry				
Vertical	≤ 1.5 mm tilt or bowing		≤ 1 mm	See Section 3.5.3
Horizontal	≤ 2 mm tilt or bowing		≤ 1.5 mm	
Focus				
Vertical	1 horizontal line/mm distinguishable over entire 6 cm of graticule		Same	
Horizontal	1 time marker/mm distinguishable over middle 8 cm of graticule		1 mark/mm over middle 8.8 cm	

1.2 Environmental

The Types 545B and RM545B are laboratory instruments. Only the following environmental limits are applicable.

1.2.1 Storage

No visible damage or electrical malfunction after storage at -40°C to +65°C and 50,000 ft., as described in Sections 4.1 and 4.2. Adjustments may be performed to meet required accuracy after storage tests.

1.2.2 Temperature

The instrument will perform to limits indicated in Section 1.1 over a range from 0°C to 50°C when tested according to Section 4.1 Thermal cutout is incorporated to protect instrument from overheating.

1.2.3 Altitude

The instrument will perform to limits indicated in Section 1.1 to 15,000 ft.

1.2.4 Vibration

The instrument will perform to limits indicated in Section 1.1 following vibration tests described in Section 4.3.

1.2.5 Transportation

The instrument will be so packed that it will meet the National Safe Transit requirements described in Section 4.4.

SECTION 2

2.0 Miscellaneous Information

2.1 Ventilation

Safe operating temperature is maintained by filtered, forced-air ventilation. A minimum of 2" unobstructed clearance around the instrument is recommended for adequate ventilation. Thermal cutout protects instrument from overheating.

2.2 Finish

Front panel has an anodized finish; the cabinet is finished in a blue vinyl paint.

2.3 Maximum Overall Dimensions

Type 545B	16.750"H x 12.875"W x 23.812"L
Type RM545B*	Front panel: 13.984"H x 19.016"W Depth behind front panel: 22.688" *See outline drawing at rear of this specification.

2.4 Weight

Type 545B	65 lbs maximum, without plug-in unit
Type RM545B	86 lbs maximum, without plug-in unit

2.5 Connectors

A TRIGGER INPUT, B TRIGGER INPUT, and CAL OUT are BNC type. HORIZ INPUT, DLY'D TRIG, +GATE B, +GATE A, and SAWTOOTH A are 5-way binding posts.

2.6 Warm-up Time

Twenty minutes for rated accuracies at 25°C ±5°C

2.7 Accessories

2.7.1 Type 545B Accessories

2	070-428	Instruction Manuals
2	010-127	P6006 Probes
2	103-033	BNC to Binding Post Adapters
1	012-031	Test Lead
1	161-010	Power Cord
1	103-013	3-Wire to 2-Wire Adapter
1	012-076	50Ω Cable, BNC to BNC, 18"
1	103-015	Adapter, BNC to UHF
1	387-918	CRT Protector Plate

2.7.2 Type RM545B Accessories

2	070-438	Instruction Manuals
2	010-127	P6006 Probes
2	103-033	BNC to Binding Post Adapters
1	012-031	Test Lead
1	161-010	Power Cord
1	103-013	3-Wire to 2-Wire Adapter
1	012-076	50Ω Cable, BNC to BNC, 18"
1	103-015	Adapter, BNC to UHF
1	387-918	CRT Protector Plate
12	212-533	10-24 x 5/16 THS Screws
12	212-535	10-32 x 5/16 THS Screws

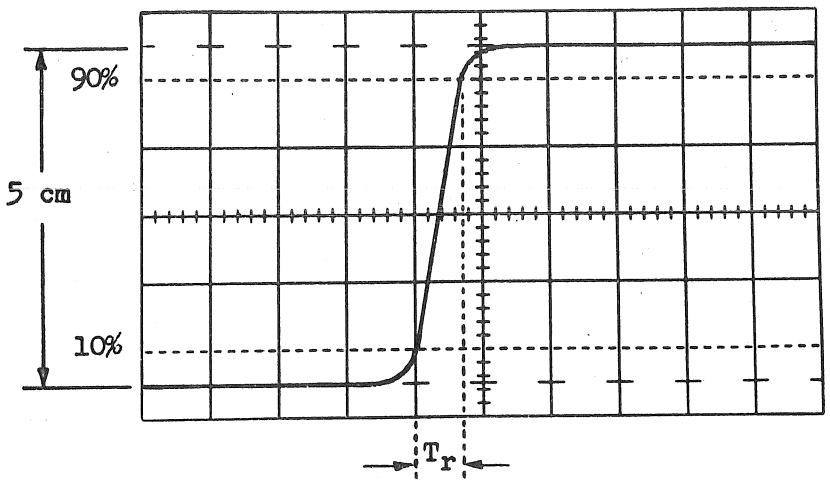
SECTION 3

3.0 Method of Measurement of Electrical Performance

3.1 Vertical Amplifier

3.1.1 Risetime

Risetime is measured using a pulse from the TU-7. Risetime is the time interval between the 10% and 90% amplitude points on the leading edge of the pulse. Using exactly a 5-cm pulse positioned as shown in the following illustration, the 10% and 90% amplitude points occur at the dotted lines. The oscilloscope time base should be within calibration requirements before risetime is measured.



3db

3.1.2 High-Frequency Response

The 30%-down high frequency is calculated from the risetime according to $f = \frac{0.35}{T_r}$, where T_r is the risetime.

3.1.3 Transient Response

Transient response is measured with the same setup used for risetime. Transient response is calculated by measuring the maximum peak-peak pulse aberration in the form of overshoot, rolloff, ringing, or tilt along the entire pulse top. It is generally expressed in percentage of pulse amplitude.

3.1.4 Positioning Effect on Transient Response

To measure the effect of positioning on transient response, the pulse is positioned down 5 cm so that the pulse top occurs at the lower dashed graticule line.

3.1.5 LF Linearity

Linearity is measured using a low repetition rate pulse from the TU-7, exactly 2 cm amplitude, centered vertically on the graticule. Positioning the display vertically + and - 2 cm from center, linearity is the maximum change in pulse amplitude occuring at the defined limits.

3.1.6 Gain Change With Line Voltage Change

Amplifier regulation is checked by observing for a change in gain with line voltage. With the TU-7 set to GAIN SET, a 100-volt signal from a precision voltage calibrator (0.25%) will produce 4 cm of deflection at 115-volt (design-center) line. With the line voltage varied between the specified limits (103.5 and 126.5 volts), regulation is the change in deflection expressed as a percentage of 4 cm.

3.2 Amplitude Calibrator

3.2.1 Accuracy

Calibrator accuracy is checked by applying each output voltage to a precision (0.25%) mixing-type voltage calibrator, and comparing the outputs on an oscilloscope. The deviation at any calibrator voltage cannot exceed 2.75% for the Amplitude Calibrator to remain within its 3% specification.

3.2.2 Symmetry (Duty Cycle)

Calibrator waveform symmetry or duty cycle is determined by measuring the dc voltage at the Calibrator Test Point jack, when the Calibrator is set to any output voltage. Symmetry or duty cycle is defined as the ratio of the voltmeter reading to 100 volts, expressed as a percentage.

3.2.3 Special Output Accuracy

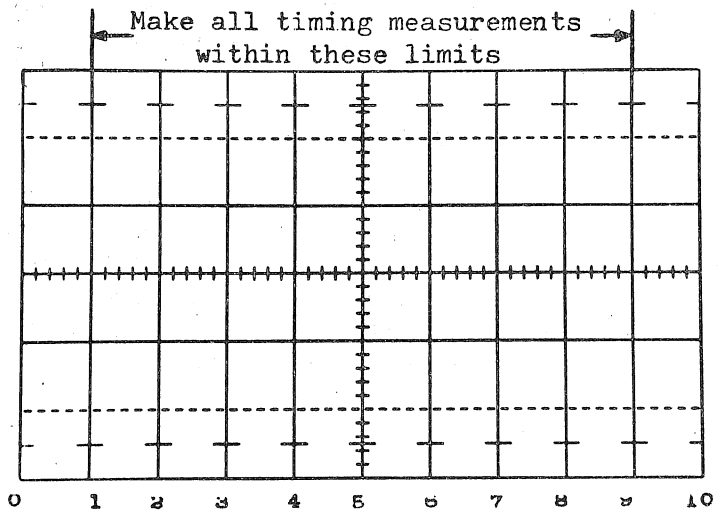
The accuracy of the 0.1 volt into 50 Ω output is determined by applying this output voltage to a standard 50 Ω ±0.1% resistor, and measuring the voltage across the resistor with a precision voltmeter. Accuracy is defined as any deviation from 0.1 v, expressed as a percentage of 0.1 v.

3.3 Sweep and Trigger

3.3.1 Sweep Accuracy

Sweep accuracy is determined by applying time markers from a 180A through a TU-7 (or other plug-in). Time markers should be selected so that there is 1 mark/cm at all "1, 5, 10" ranges, and 2 marks/cm at all "2" ranges (exception: At 0.5 µsec/cm sweep rate, 1 mark/2 cm will be obtained with 1-µsec markers, or 2½ cycles/cm with 5-mc signal). All timing measurements are made over the middle 8 centimeters of the graticule, as shown in the illustration. The first and last centimeters should not be included in the measurement because of CRT nonlinearity.

Sweep accuracy is defined as the amount of any deviation between the 9th-cm graticule mark and the corresponding timing marker in mm, expressed as a percentage of 80 mm.



3.3.2 Triggering Level

Triggering level is measured with the following signals: Below 5 mc, use square wave pulse from Amplitude Calibrator; above 5 mc, use sine wave signal from Type 190B.

3.3.3 Time Delay Accuracy

Delay range and incremental accuracy are measured with time markers from a Type 180A and the DELAY-TIME MULTIPLIER dial. A "B" INTENSIFIED by "A" display is first obtained, with the A sweep time/cm chosen to be at least 1/10 that of B sweep. The timing check is then made in the "A" DLY'D by "B" mode. Delay range accuracy is the deviation in a total of 800 minor divisions, from approximately 1.00 to 9.00 on the DELAY-TIME MULTIPLIER dial. A 1% accuracy is equivalent to an 8-division deviation in 800. Incremental accuracy is the percent deviation from periodic major divisions. Since the beginning and ending major divisions are seldom even numbers (1.00 and 9.00), the procedure for obtaining percentage deviation is a little involved. Essentially, it is a matter of first determining the periodic major divisions, then calculating the deviation that exists at each setting of the dial.

For example, suppose a time marker were exactly aligned with a reference graticule mark at the following DELAY-TIME MULTIPLIER dial readings.

1.000	5.980
1.995	6.970
2.995	7.995
3.990	8.960
4.990	

Then 8.960 - 1.000 = 7.960 or 796.0 minor divisions. And $\frac{796.0}{8}$ = 99.5 minor divisions between each periodic major division for perfect linearity.

Periodic Major Divisions	Delay-Time Multiplier Readings	Deviation in Minor Divisions
1.000	1.000	0
1.000 + 0.995 = 1.995	1.995	0
1.995 + 0.995 = 2.990	2.995	+0.5
2.990 + 0.995 = 3.985	3.990	+0.5
3.985 + 0.995 = 4.980	4.990	+1.0
4.980 + 0.995 = 5.975	5.980	+0.5
5.975 + 0.995 = 6.970	6.970	0
6.970 + 0.995 = 7.965	7.960	-0.5
7.965 + 0.995 = 8.960	8.960	0

Each eviation at the major dial points is within 1.6 minor divisions, or within 0.2% of 800.

3.3.4 Delay Pickoff Jitter

Jitter is measured by setting up B sweep at 1 msec/cm and A sweep at 1 μsec/cm, free running. This effectively produces a 1000:1 magnification. In the "A" DLY'D by "B" mode, 5 mm represents 1 part in 20,000. The first major division and ninth major division of the DELAY-TIME MULTIPLIER dial are check points.

3.3.5 Sweep/Magnifier Registration

Magnifier registration is checked by positioning a timing marker to the exact center of the graticule with the 5X magnifier on, then switching the magnifier off. Registration is the amount of any deviation between the timing marker and the center graticule mark.

3.3.6 External Horizontal Amplifier

10:1 attenuator accuracy is checked by applying an approximate 1-kc square wave from a voltage calibrator to the External Horizontal Input connector. The overall deflection should not exceed 8 cm. A sweep voltage may be applied to the vertical deflection system if desired, but it is not necessary. Attenuator accuracy is defined as any deviation from an exact 10:1 ratio, between X1 and X10, expressed as a percentage of the reference deflection.

Attenuator compensation is checked by applying an approximate 1-kc square wave, having a risetime of from 1 to 5 μsec.

High-frequency response is measured by applying a 50-kc reference signal from a Type 190B. Using exactly 6 cm of deflection, the frequency is then increased until the deflection decreases to 4.2 cm.

3.4 Power Source

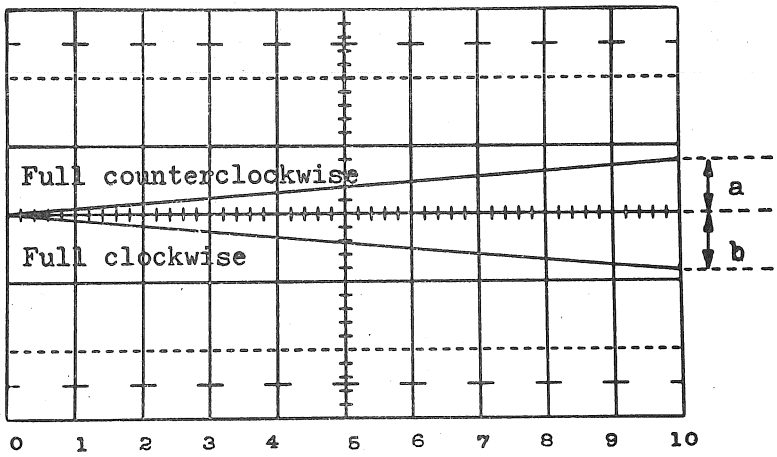
3.4.1 Regulation

Regulation is checked by monitoring each output voltage with a 20,000 Ω/v voltmeter while varying the line voltage between 103.5 and 126.5 v, or 207 and 253 v. Regulation is the maximum change in any supply voltage, expressed as a percentage of that voltage. Ripple is measured at the same time with an oscilloscope, preferably with a 1X probe.

3.5 CRT Circuit

3.5.1 Trace Rotation Range

Trace rotation range is checked by turning the Trace Rotation control fully counterclockwise, positioning the start of the trace as shown in the following illustration, and measuring the vertical deflection "a" at the 10th graticule mark. Then turn the control fully clockwise, position the trace as shown, and measure "b". The total deflection (a + b) must be at least 1 cm.



3.5.2 Z Axis Modulation

Z axis modulation voltage is checked by free-running the sweep at about 1 msec/cm, connecting a 20-volt (performance requirement) or a 10-volt (factory test limit) Calibrator signal to the External CRT Cathode connector, and observing for intensity modulation at some setting of the Intensity control.

3.5.3 Geometry

Vertical geometry is checked by applying a Calibrator signal of sufficient amplitude to exceed the graticule height, at a triggered sweep rate of 2 msec/cm.

Horizontal geometry is checked by positioning a 0.5 msec/cm free-running sweep trace to the top and bottom of the graticule.

SECTION 4

4.0 Environmental Test Methods

4.1 Temperature

4.1.1 Non-operating

Store for 4 hours at -40°C and 4 hours at +65°C. One cycle only.

4.1.2 Operating

Perform complete electrical checks at room ambient. Turn off instrument and store at 0°C for 4 hours. After 20 minutes, check the following electrical characteristics: Risetime, thermal shift, transient response, vertical amplifier gain, triggering, time-base timing, and power supply voltages.

Raise ambient temperature to 50°C with instrument operating. Hold for 4 hours and again check above characteristics.

Return instrument to room temperature and after 4 hours (or temperature stabilization) perform complete electrical checks.

4.1.3 Failure Criteria

Non-operating

Instrument and components must meet performance requirements before and after storage. (Adjustments may be performed if necessary to meet required accuracies).

Cracking, warping, and significant color discoloration or deformation which interferes with the normal mechanical function will not be permitted.

Operating

Instrument must be within indicated performance characteristics at each step of the operating temperature check. Controls and switches shall be checked for ease of operation.

4.2 Altitude

4.2.1 Non-operating

Store at -40°C and 50,000 feet altitude for 4 hours. This may be performed along with the storage tests.

4.2.2 Operating

The instrument while operating will be maintained at an altitude of 15,000 feet for 4 hours and with the necessary thermal derating. At the end of this period and while the above conditions are maintained, the most important electrical checks will be performed. When necessary, the vacuum chamber may be opened and the necessary switching performed as rapidly as possible. The instrument will then be allowed to stabilize for 1 hour at the above conditions before completing the electrical checks.

4.2.3 Failure Criteria

Non-operating

Instrument will meet performance requirements before and after the 50,000 feet storage test.

Operating

Instrument will meet performance requirement during operation at altitude. Any evidence of malfunction will constitute failure, i.e., random trace modulation, noise, corona, etc.

4.3 Vibration

4.3.1 Non-operating

4.3.1.1 Type 545B

Perform resonant searches along all 3 axes at 0.015" ±.003" total displacement from 10-50 cps. All major resonances should be above 50 cps and no amplification factor of more than 2½ to 1 should be permitted.

4.3.1.2 Type RM545B

Perform resonant searches along all 3 axes at 0.010" ±.003" total displacement at the instrument center of gravity, from 10-50 cps. All major resonances should be above 50 cps and no amplification factor of more than 2½ to 1 should be permitted.

4.3.2 Operating

4.3.2.1 Type 545B

Vibrate for 15 minutes along each of the 3 axes at a total displacement of 0.015" (1.9 g at 50 cps) with the frequency varied from 10-50-10 cps in 1 minute cycles. Hold at resonant points for 3 minutes. If no resonances are present vibrate at 50 cps for 3 minutes in each axis. Total vibration time about 55 minutes. Sporadic output will be permitted during vibration.

4.3.2.2 Type RM545B

Vibrate for 15 minutes along each of the 3 axes at a total displacement of 0.010" at the instrument center of gravity (1.25 g at 50 cps) with the frequency varied from 10-50-10 cps in 1 minute cycles. Hold at resonant points for 3 minutes. If no resonances are present vibrate at 50 cps for 3 minutes in each axis. Total vibration time about 60 minutes. Sporadic output will be permitted during vibration.

4.3.3 Failure Criteria

Non-operating

Broken leads, chassis or other components, loose parts, excessive wear or component fatigue. Change in value of any component outside its normal rated tolerance. Deformation which interferes with the normal mechanical function.

Operating

Includes all failures listed in non-operating and the test will be completely re-run after repairing any of these failures.

Tube failures will be permitted during test and when replaced the test will be continued from that point - CRT's or transistors will not be included in this.

Instrument must meet performance requirements before and after the operating vibration test.

Engineering tests will be performed with the instrument "dogged" to the table. Tests on completed instruments will be performed with panels removed when possible and straps used for hold downs.

4.4 Transportation

The instrument when packaged must meet the National Safe Transit type of test.

4.4.1 Vibration

One hour on the vibration platform with an amplitude slightly in excess of 1 g and causing the package to just leave the vibration surface.

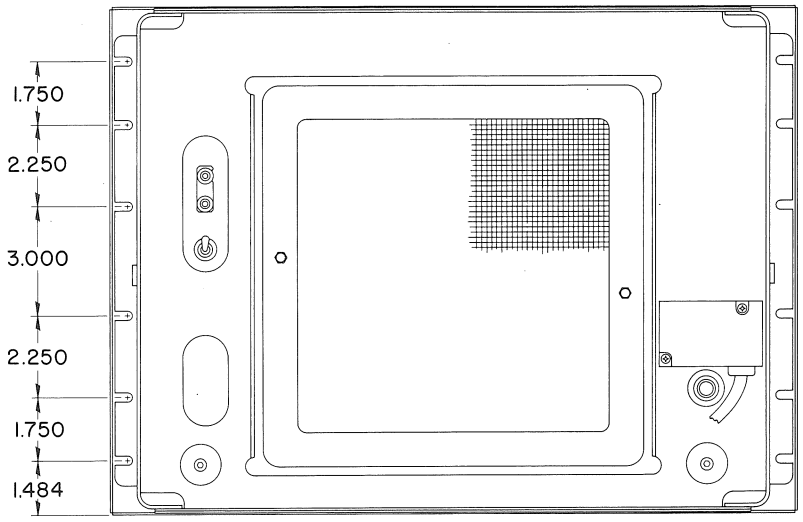
4.4.2 Drop Test

Drop from a height of 30 inches on all corners, edges, and flat surfaces.

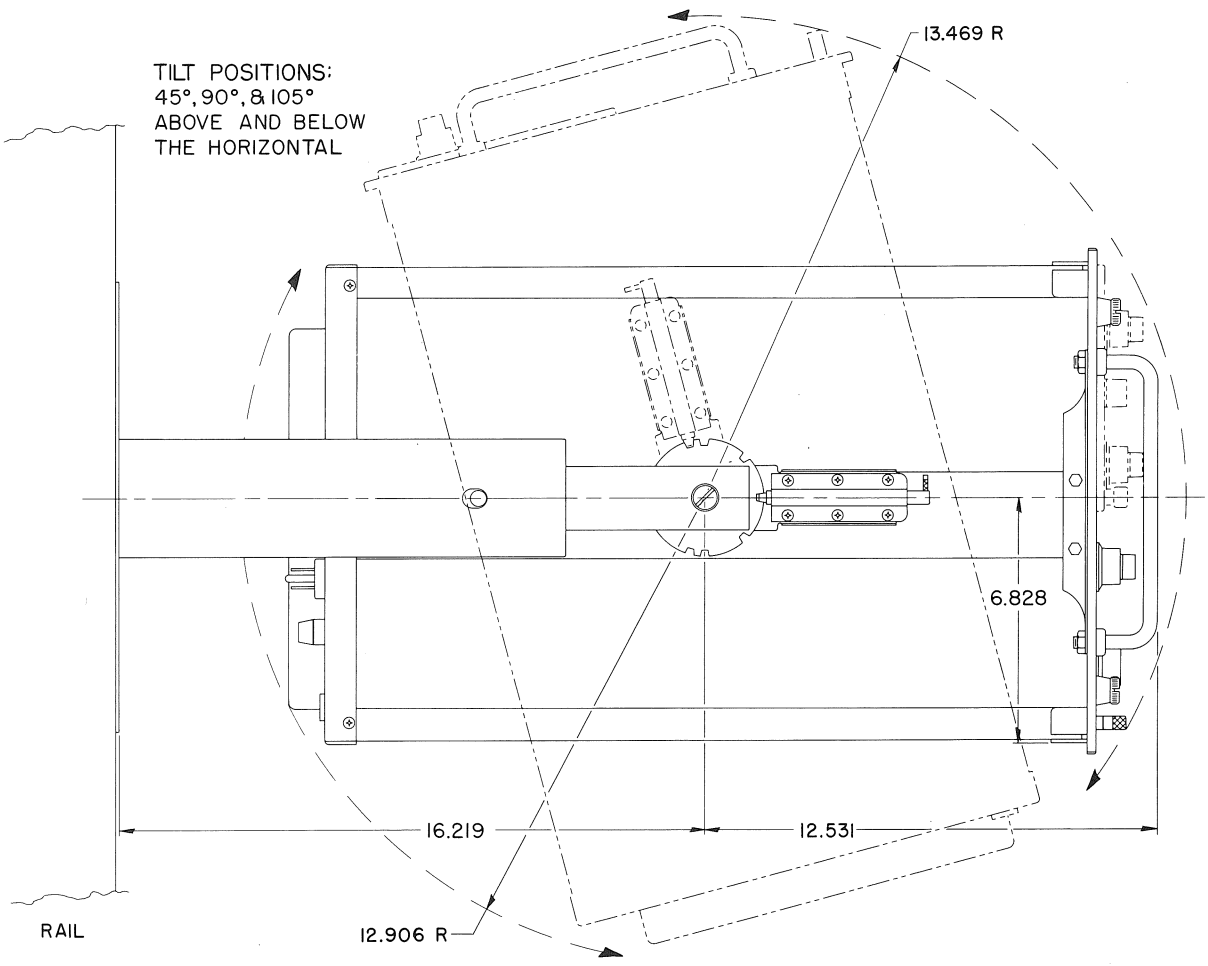
4.4.3 Failure Criteria

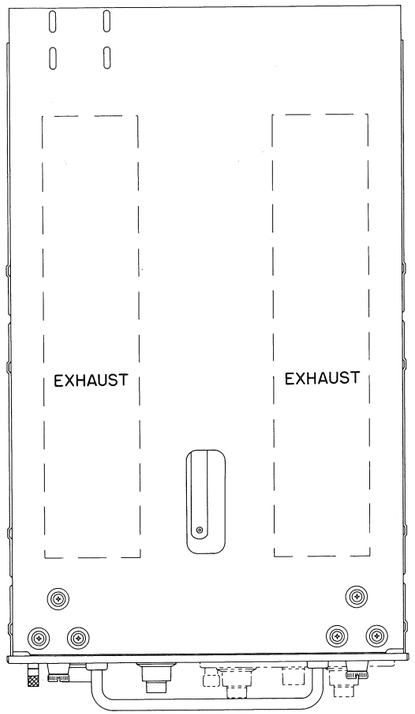
Instrument must meet performance requirements before and after the transportation tests.

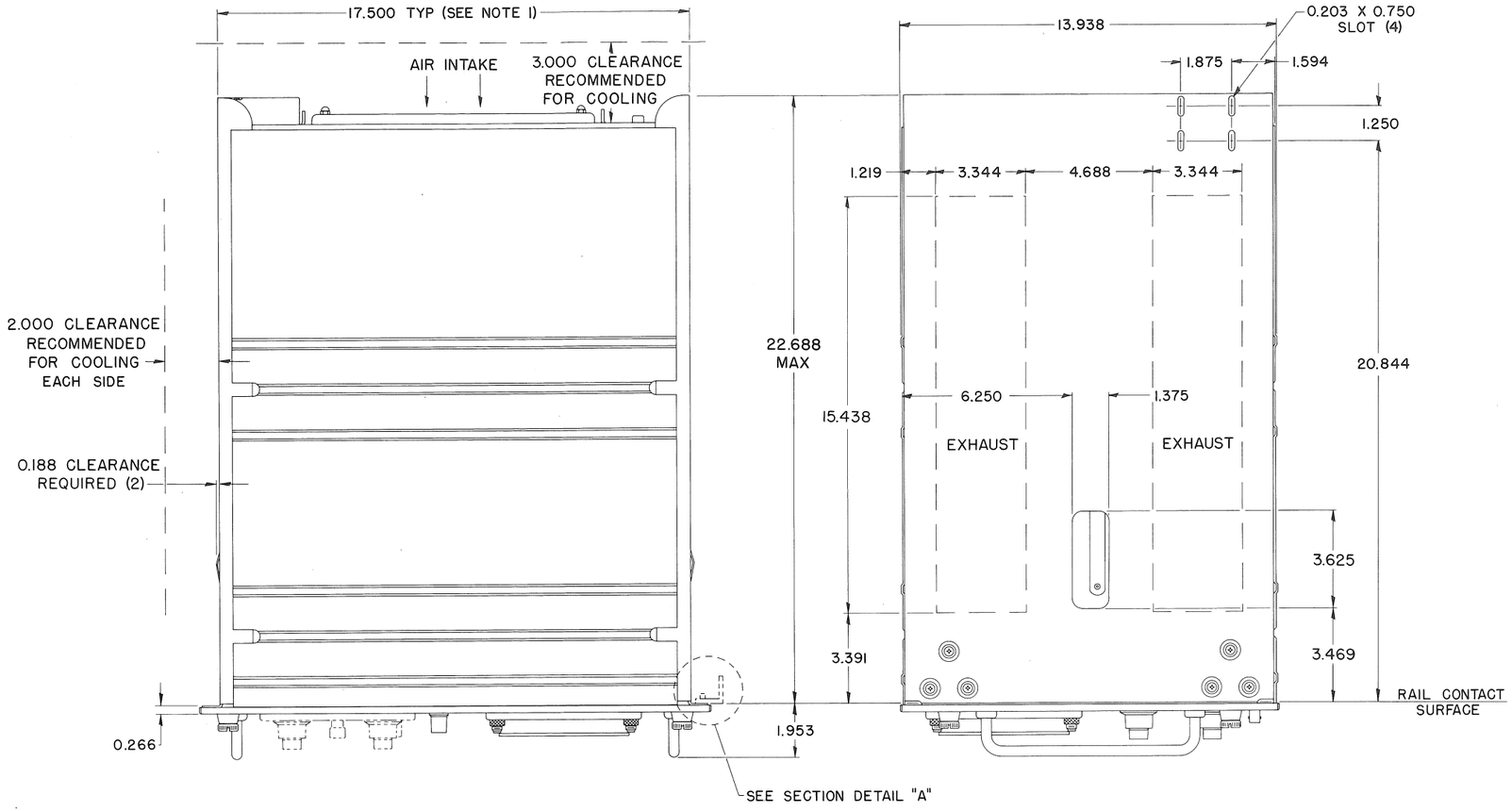
There must be no serious damage such as broken components, leads or chassis, and no deformation of components or chassis in excess of 0.100". Deformation which interferes with normal mechanical function will not be permitted.

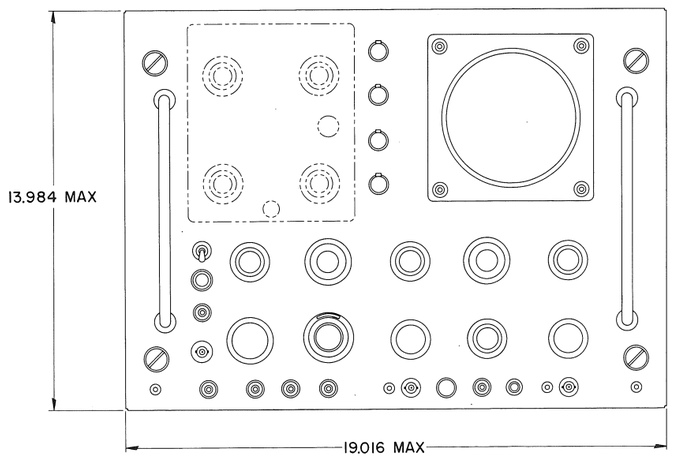

1.750
2.250
3.000
2.250
1.750
1.484

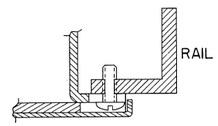
REAR VIEW


TILT POSITIONS:
45°, 90°, & 105°
ABOVE AND BELOW
THE HORIZONTAL
13.469 R
6.828
16.219
12.531
12.906 R
RAIL







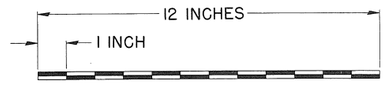


SECTION DETAIL "A"

RECOMMENDED MOUNTING

NOTES:
1. SUBJECT TO APPROXIMATELY ±0.047 DEVIATION
2. ALL DIMENSIONS ARE REFERENCE DIMENSIONS EXCEPT AS NOTED

TYPE RM545B



A_1