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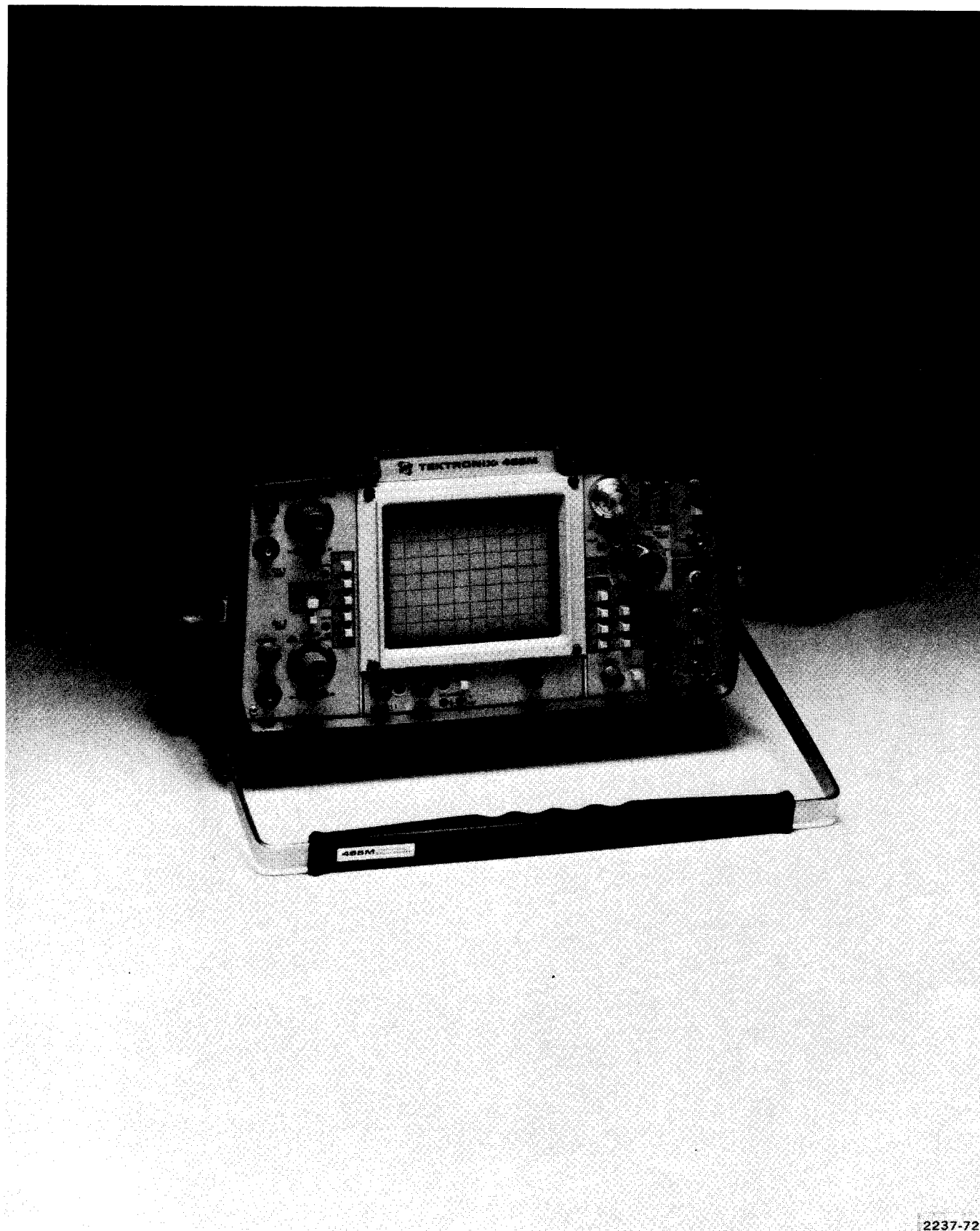
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465M with front cover.

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OPERATORS SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply, but may not appear in this summary.

Terms In This Manual

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

Terms As Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

Symbols As Marked on Equipment



DANGER — High voltage.



Protective ground (earth) terminal.



ATTENTION — refer to manual.

Power Source

This product is intended to operate from a power source that will not apply more than 264 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Grounding the Product

This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to

the product input or output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Danger Arising From Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating) can render an electric shock.

Use the Proper Power Cord

Use only the power cord and connector specified for your product.

Use only a power cord that is in good condition.

Refer cord and connector changes to qualified service personnel.

Use the Proper Fuse

To avoid fire hazard, use only the fuse of correct type, voltage rating and current rating as specified in the parts list for your product.

Refer fuse replacement to qualified service personnel.

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this product in an explosive atmosphere unless it has been specifically certified for such operation.

Do Not Remove Covers or Panels

To avoid personal injury, do not remove the product covers or panels. Do not operate the product without the covers and panels properly installed.

SECTION I

INTRODUCTION AND GENERAL INFORMATION

1-1. INTRODUCTION

a. Manual Purpose. This manual provides instructions for operation and maintenance of the 465M Oscilloscope and includes illustrated parts breakdown data. The 465M is also known as the military AN/USM-425(V)1.

b. Manual Scope. The instructions provided in this manual are intended to be performed at organizational or intermediate level maintenance activities using tools, test equipment, and spare parts authorized in their allowance lists and supply activities.

c. Manual Arrangement. This manual is separated into eleven sections as follows:

(1) Section I, Introduction and General Information. Contains the purpose, scope, and arrangement of the manual and a description of the instrument including its leading particulars and accessories.

(2) Section II, Special Tools and Test Equipment. Contains listing of tools, test equipment, and consumable materials needed to maintain the instrument.

(3) Section III, Preparation for Use and Shipment. Contains instructions for preparing the instrument for initial use and repackaging for shipment.

(4) Section IV, Operation Instructions. Contains instrument theory of operation; a description of controls, connectors, and indicators; special operating instructions; initial turn-on and adjustment procedures; normal operation familiarization procedures; and examples of instrument applications.

(5) Section V, Maintenance Instructions. Contains procedures to check out, perform routine maintenance, troubleshoot, repair, test, and adjust the instrument.

(6) Section VI, Diagrams. Contains schematic diagrams with associated data referenced in other sections of the manual.

(7) Section VII, Introduction to the Illustrated Parts Breakdown. Contains information on how to use the illustrated parts breakdown data in Sections VIII through X.

(8) Section VIII, Maintenance Parts List. Contains the illustrated parts breakdown illustrations and parts descriptions.

(9) Section IX, Numerical Index. Contains a part number to figure and index cross reference listing.

(10) Section X, Reference Designation Index. Contains a reference designator to figure and index, and part number cross reference listing.

(11) Section XI, Difference Data Sheets. Provides a section for inserting information about different models, custom modifications, other accessories, etc., that may not be provided as part of the manual.

1-2. USE OF WARNING, CAUTION, AND NOTE SYMBOLS. Symbols are used throughout the manual text to highlight personnel safety warnings, precautions to prevent damage to the instrument, and special notes. These symbols are as follows:

WARNING

Personnel Safety Warnings

CAUTION

Equipment Damage Precautions

NOTE

Special Notes

1-3. GENERAL INFORMATION

a. Equipment Description. The 465M is a solid state, dual channel, 100 megahertz bandwidth, delayed sweep, general purpose oscilloscope. Each vertical channel has ten calibrated deflection factors from 5 millivolts/division to 5 volts/division selected in a 1-2-5 sequence. The horizontal deflection system has calibrated sweep rates of 0.5 seconds/division to 0.05 microseconds/division in 22 steps. It also has delayed sweep rates of 50 milliseconds/division to 0.05 microseconds/division in 19 steps. A ten times magnifier expands each horizontal sweep rate to a maximum of 5 nanoseconds/division. An X-Y display mode is provided through vertical mode and horizontal sweep speed selection.

Introduction and General Information—465M

b. Accessories Supplied. Figure 8-2 illustrates and lists the accessories that are shipped with the instrument.

c. Performance Conditions. Tables 1-1 through 1-3 list the electrical, environmental, and physical characteristics of the 465M. The electrical characteristics are valid under these conditions: (1) the instrument has been calibrated (adjusted) as described in Section V at an ambient temperature between +20°C and +30°C (+68° to +86°F), (2) the instrument is operating in an ambient temperature

between -15°C and +55°C (+5°F to +131°F) and (3) the instrument has warmed-up for 20 minutes below 0°C, or 5 minutes if above 0°C (+32°F).

d. Electrical Characteristics. Electrical characteristics are divided into two categories: Characteristics shown in the performance requirement column are instrument specifications and can be verified by the Operational Checkout (Performance Check) in Section V. Information in the Supplemental Information column is provided for reference or clarification.

Table 1-1. Electrical Characteristics

Characteristics	Performance Requirements	Supplemental Information
POWER SOURCE		
Line Voltage Range (ac, rms) 116 V 232 V	100 V to 132 V 200 V to 264 V	
Line Frequency		48 Hz to 440 Hz.
Maximum Power Consumption		60 watts at 115 V, 60 Hz.
CALIBRATOR		
Output Voltage into 1 MΩ and 22 pF -15°C to +55°C	1.0 V within 1%.	
Repetition Rate	1 kHz within 10%.	
Symmetry	Within ±25%.	
Risetime	<1 microsecond.	
Output Resistance		Typically 190 Ω.
CRT DISPLAY		
CRT Graticule Display Area	8 div vertical by 10 div horizontal. Each div equals 1 cm.	
Vertical Resolution		At least 15 lines in 1 div.
Horizontal Resolution		At least 15 lines in 1 div.
Geometry		0.1 div or less.
Trace Rotation Range		Adequate to align trace with horizontal center line.
CRT Phosphor		P31
Raster Distortion		0.1 div or less.
Accelerating Potential		Nominally 12,000 volts.

Table 1-1. Electrical Characteristics—Continued

Characteristics	Performance Requirements	Supplemental Information
VERTICAL DEFLECTION SYSTEM		
Deflection Factor		
Calibrated Range	5 mV/div to 5 V/div in 10 steps in a 1-2-5 sequence.	
Variable Range	Continuously variable between calibrated steps and at least 2.5 to 1 range.	Extends deflection factor to at least 12.5 V/div.
DC Accuracy		
0°C to +40°C	±2%	With GAIN set at 5 mV/div.
-15°C to 0°C and +40°C to +55°C	±3%	
Low-frequency linearity		Typically 0.1 div or less of compression or expansion as a 2 div signal is positioned anywhere within the graticule limits.
Frequency Response		
DC Coupled Bandwidth	DC to at least 100 MHz (-3 dB)	5 division reference signal centered vertically from a 25 Ω source with VAR V/DIV in the calibrated position.
AC LF Response	10 Hz or less with ac coupling	1 Hz or less with X10 probe.
Step Response		5 div reference centered vertically, DC coupled at all deflection factors from a 25 Ω source with VAR V/DIV in calibrated position.
Risetime		
-15°C to +55°C	3.5 nanoseconds or less	Measured between 10% and 90% points indicated on the graticule.
Positive-going step (Excluding ADD mode)		
Aberrations		
+15°C to +35°C		Less than +3%, -3%, 3% peak-to-peak.
+35°C to +55°C and 0°C to +15°C		Less than +4%, -4%, 4% peak-to-peak. (AF 82-PD-332 Paragraph 3.8.3.2.2 does not specify aberrations below 0°C.)
Position Effect		Aberrations less than +6%, -6%, not to exceed 6% peak-to-peak.

Table 1-1. Electrical Characteristics—Continued

Characteristics	Performance Requirements	Supplemental Information
VERTICAL DEFLECTION SYSTEM—Cont.		
INVERT Trace Shift		Typically less than 2 div when switching from normal to inverted.
Input Gate Current		
−15°C to +30°C		Typically 0.5 nA or less (0.1 div at 5 mV/div).
+30°C to +55°C		Typically 4.0 nA or less (0.8 div at 5 mV/div).
Channel Isolation		
To 10 MHz	100:1	
10 to 20 MHz	50:1	
20 to 50 MHz	25:1	
50 to 100 MHz	15:1	
Position Range		Typically greater than +12 and −12 div from graticule center.
Chopped Mode Repetition Rate		Typically 250 kHz.
Common Mode Rejection Ratio (ADD Mode with CH 2 Inverted)		
To 10 MHz		Greater than 25:1
10 MHz to 50 MHz		Greater than 10:1
DC Stability		
Step Atten Balance		0.2 div or less.
DC Drift		
0°C to +55°C		Less than 0.1 div/hour.
−15°C to 0°C		Less than 0.5 div/hour.
CH 1 and CH 2 Input Impedance		1 M Ω \pm 2%, paralleled nominally by 20 pF.
Maximum Input Voltage		
At 20 kHz		\pm 250 V (dc + peak ac)
At 1 MHz		\pm 10 V (dc + peak ac)
At 100 MHz		\pm 5 V (dc + peak ac)
Channel 2 Signal Output (Through Main Module CH 2 OUT Connector)		
Bandwidth		DC to at least 40 MHz into 50 Ω .

Table 1-1. Electrical Characteristics—Continued

Characteristics	Performance Requirements	Supplemental Information
HORIZONTAL DEFLECTION SYSTEM—Cont.		
Mixed Sweep Accuracy A Portion B Portion		Within 4% Within 2%
B Sweep must be at least 1 sweep rate faster than A sweep. Exclude first div or 0.5 μ s (whichever is greater) after sweep start. Also exclude first 0.2 div or 0.1 μ s (whichever is greater) after the transition from A to B sweep.		
Variable Range (A only)	At least 2.5:1	Continuously variable between calibrated settings. Extends slowest A sweep rate to at least 1.25 s/div.
Trigger Holdoff Variable	Increases A sweep holdoff time to at least 3X the time/div settings, except at .2 s/div and .5 s/div.	
Magnifier Registration		Within 0.25 division from graticule center (MAG on to MAG off).
Position Range	Start of sweep must position to right of graticule center. End of sweep must position to the left of graticule center (TIME/DIV at 1.0 ms/div).	
Position Drift at any given temperature 0°C to +55°C -15°C to 0°C		≤ 0.1 div/hour. ≤ 0.5 div/hour.
Differential Time Measurement Accuracy for measurements of two or more major dial divisions (exclude delayed operation when knobs are locked at any sweep rate or when A TIME/DIV is at 0.5 μ s/div). +15°C to +35°C 0°C to +55°C Below 0°C	1% +0.1% of full scale. Additional 1% allowed. Additional 4% allowed.	

Table 1-1. Electrical Characteristics—Continued

Characteristics	Performance Requirements	Supplemental Information
HORIZONTAL DEFLECTION SYSTEM—Cont.		
Delay Time Jitter	One part or less in 20,000 (0.005%) of ten times the A TIME/DIV setting.	
Calibrated Delay Time (VAR control in CAL)	Continuous from 0.1 μ s to at least 5 sec after the start of the delaying (A) sweep.	
X-Y Operation		TIME/DIV set to extreme ccw position. CH 2 or X-Y VERT MODE button must be pushed.
Sensitivity	Same as vertical system deflection factor calibrated range (with X10 MAG off).	
Variable Range	Same as vertical system variable range.	
X-Axis Bandwidth	DC to at least 4 MHz.	6 division reference signal.
Input Impedance	Same as for the vertical system.	
X-Axis Linearity		≤ 0.2 div compression or expansion when a 2 div X-Axis signal at center screen is positioned to right or left extreme of the graticule area.
Maximum Usable Input voltage	Same as for the vertical system.	
Phase Difference between X and Y Axes Amplifiers	Within 3° from dc to 50 kHz.	
X-Axis Deflection Accuracy		Within 4% with VAR control in the CAL position.
TRIGGERING		
Trigger Sensitivity		In EXT \div 10, multiply trigger voltage requirements by 10.
AC Coupled	0.3 div internal or 50 mV external from 30 Hz to 25 MHz increasing to 1.0 div internal or 150 mV external at 100 MHz.	
LF REJ Coupled	0.3 div internal or 50 mV external from 50 kHz to 25 MHz increasing to 1.0 div internal or 150 mV external at 100 MHz.	Attenuates signals below about 15 kHz.
HF REJ Coupled	0.3 div internal or 50 mV external from 60 Hz to 5 kHz.	Attenuates signals below about 30 Hz and above about 50 kHz.

Table 1-1. Electrical Characteristics—Continued

Characteristics	Performance Requirements	Supplemental Information
TRIGGERING—Cont.		
Trigger Sensitivity cont. DC Coupled Trigger Jitter (at 100 MHz and 5 ns/div) -15°C to +55°C Auto Free Run Freq. External Trigger Input Impedance Maximum Input Voltage Trigger LEVEL range EXT EXT ÷ 10 Trigger View Deflection Factor EXT EXT ÷ 10	0.3 div internal or 50 mV external from dc to 25 MHz increasing to 1.0 div internal or 150 mV external at 100 MHz. 0.5 ns or less. At least + and -1 V, 2 V p-p.	Less than 40 Hz. 1 MΩ ±15% paralleled nominally by 20 pF. 100 V (dc + peak ac); 100 V p-p ac at 1 kHz or less. At least + and -10 V, 20 V p-p. Typically 100 mV/div AC or DC trigger coupling only. Typically 1 V/div, AC or DC trigger coupling only.
Z AXIS INPUT		
Sensitivity Polarity of Operation Usable Frequency Range Input Resistance at dc Maximum Input Voltage	5 V p-p or more signal provides noticeable modulation at normal intensity. Positive-going signal decreases trace intensity. DC to 15 MHz.	Approximately 1.6 kΩ. 50 V (dc + peak ac).
SIGNAL OUTPUTS		
A Gate Output Voltage (Positive-going pulse) Output resistance	5 V ±20%	Starts at approximately 0 V. Approximately 1.5 kΩ.

Table 1-1. Electrical Characteristics—Continued

Characteristics	Performance Requirements	Supplemental Information
SIGNAL OUTPUTS—Cont.		
B Gate		
Output Voltage (positive)	5 V \pm 20%	Starts at approximately 0 V.
Output Resistance		Approximately 500 Ω .

Table 1-2. Environmental Characteristics

Characteristics	Description
Temperature	
Non-operating	−62°C to +85°C
Operating	−15°C to +55°C
Humidity	5 cycles (120 hours) referred to MIL-T-28800B.
Altitude	
Non-operating	To 50,000 feet.
Operating	To 15,000 feet; maximum operating temperature decreased 1°C/1000 feet above 5000 feet.
Vibration	
Operating and Non-operating	With the instrument complete and operating, and vibration frequency swept from 10 to 55 to 10 Hz at 1 minute per sweep. Vibrate 15 minutes in each of the three major axes at 0.015-inch total displacement. Hold 10 minutes at any major resonance, or if none, at 55 Hz. Total time 75 minutes.
Shock	30 g's 1/2 sine, 11 ms duration, 3 shocks in each direction along 3 major axes, for a total of 18 shocks.
Transportation	Qualified under National Safe Transit Committee Test Procedure 1A-B-1 and 2.
Transit Drop (non-operating)	Drop unboxed instrument 8-inches on each corner and face, a total of 14 drops. Drop test performed on a rigid wooden surface. Per MIL-T-28800B as modified by US Government purchase description AF82-PD-332 configuration B.
Drip-proof (Front cover on, non-operating)	Spray from 3-feet above instrument with instrument tilted 15° away from horizontal plane in each of 4 directions and horizontal. Per MIL-T-28800B Style C.
Bench Handling (operating)	Edge lifts and drops on work bench on bottom and rear faces, total of 8 drops. Per MIL-T-28800B.

Table 1-3. Physical Characteristics

Characteristics	Description
Weight	
465M with Panel cover, modules, and accessories	27.0 lbs (12.2 kg).
Without Panel Cover and accessories	24.0 lbs (10.9 kg).
Domestic Shipping Weight	34.2 lbs (15.5 kg).
Height	
With Feet	7.05 inches (179.1 mm).
Width	
With Handle	13.65 inches (346.7 mm).
Without Handle	12.5 inches (317.5 mm).
Depth	
Including Panel Cover	21.45 inches (544.8 mm).
Handle Extended	24.1 inches (612.1 mm).
Construction	Plastic cabinet, aluminum alloy chassis and panel, with glass laminate etched wiring circuit boards.
Finish	Anodized front panel and textured cabinet.