PACE® TR-48 TRANSISTORIZED ANALOG COMPUTER SPECIFICATIONS

I. TR-48 SYSTEM SPECIFICATIONS

1. Computer Power Requirements

Voltage	110/120 VAC - 220/240 VAC
Frequency	50/60 CPS
Power	100 Watts, Typical

2. Mechanical

Size	20" Wide, 25-3/8" High, 34-3/16" Long
Weight	330 Pounds

3. Reference System

Output Voltages	+10V, -10V, Nominal
Output Current	+250 MA, -250 MA
Balance Resolution	Better than 0.02% Typically 0.01%

4. Repetitive Operation

Compute Time	20, 50, 100 and 200 Millisecond Steps +5.0% Vernier Scale Expansions of 2.5 to 1.0 Minimum
Reset Time	10 Milliseconds, ±5%
Integrator Start Time Coincidence	200 Microseconds, Differential, Maximum 100 Microseconds, Differential, Typical

II. TR-48 COMPUTING COMPONENTS SPECIFICATIONS

1. Dual DC Amplifier 6.514 (Characteristics identical for both sections)

Output Voltage Range	±10V, Minimum. Up to ±13V, depending on load.
Output Current at ±10 Volts DC	±20 MA, Minimum
Cut-Off Frequency (3 db down) of unity gain inverter with 10K resistors. 30 MV p-p Input	250 KC, Minimum 300 KC, Typical

TR-10, TR-20, AND TR-48 ARE TRADEMARKS OF ELECTRONIC ASSOCIATES, INC., LONG BRANCH, N.J.

PRINTED IN U.S.A.

With 100K Resistors	30 KC, Minimum 50 KC, Typical
Dynamic Amplitude Error (unity-gain inverter) 10K resistors. 10 volt p-p input at 1 KC	0.1% Maximum
Phase Shift (unity-gain inverter, 20 volt p-p input at 100 cycles) with 100K resistors	0.01°, Typical
Phase Shift (unity-gain inverter, 20 volt p-p input at 1 KC) with 100K resistors	0.15°, Maximum
Output Impedance (unity-gain inverter at 100 cycles/second) with 10K resistors	0.01 Ohms, Maximum
Open Loop DC Gain	3×10^7, Typical
Gain at 100 CPS	25,000, Typical
Gain at 1 KC	3500, Typical
Peak Noise and Ripple from DC to 300 KC with 100K Resistors	500 Microvolts RMS, Maximum
Offset (at summing junction when amplifiers are balanced by the standard procedure using control panel meter) with 10K resistors	±30 Microvolts, Maximum
With 100K Resistors	±50 Microvolts, Maximum
Amplifier Offset Temperature Coefficient (unity-gain inverter) with 10K resistors	±0.5 Microvolts Per Degree Fahrenheit
Inverter Resistor Tolerance Gain 1	±.01% at 25° C
Temperature Coefficient Zero Minus	+5 PPM/°C

NOTE

The amplifier has functional stability with any value feedback capacitor or a feedback resistor from 0 ohms to 5 megohms. The amplifier has functional stability with input resistance from 500 ohms to infinity. The amplifier has functional stability with capacitive load up to 0.03 mfd. The amplifier has functional stability with up to 0.005 microfarads mfd.

2. Dual Integrator Network 12.764 (Characteristics identical for both sections)

Integrating Capacitor

Value	10 MFD ±0.05%
Voltage	25 VDC
Dielectric	Polystyrene

Integrator Drift

Network operated with Dual DC Amplifier 6.514, with 100K input resistor. Input grounded, output essentially zero volts, computer in operate mode.

	25 Microvolts/Second, Typical 50 Microvolts/Second, Maximum

Fast Time-Scale Capacitor

Value	0.02 MFD Adjustable
Voltage	25 VDC
Dielectric	Polystyrene

NOTE

The 10 mfd capacitor is made up of 2 capacitors such that a real-time time-scale change of 10 may be accomplished by removal of the bottle plug. The time scale in repetitive operation has also to be increased by a factor of 10 by removing a bottle plug.

3. Multiplier 7.099 (Operated with Dual DC Amplifier 6.514)

Input Voltage	+10V to -10V
Output Voltage	+10V to -10V
Total Error when Multiplying ±10 VDC by 20V p-p at 5.0 CPS	±0.2% FS, Typical ±0.4% FS, Maximum
Phase Shift when Multiplying ±10 VDC by 20V p-p at 1 KC	0.26°, Maximum

4. Coefficient Setting Potentiometer Group (Type 2.440 consists of 1 each Network 42.283 and 1 each Attenuator Group 42.291)

Type	Wirewound
Rotation	10 Turn
Resistance	5,000 Ohms ±5%
Independent Linearity	±0.5%
Resolution	0.02% or Better

5. Function Switch Group (Type 2.462 consists of 1 each Network 12.766 and 1 each Group 2.441 Function Switches)

Function Switches	5
Contact Rating	120V, 1 Ampere

6. Trunk Installations (Type 2.426 consists of 2 each Network 12.762 and 1 each Cable 19.261)

Trunks Available	15

NOTE

Each computer normally has the 12.762 Module included. For adding a second TR-48, it will be necessary only to purchase Cable 19.261.

7. Comparator (Relay) 40.404

Sensitivity	1 MV, Typical 3 MV, Maximum
Operate Time for Step Function Input	7 Milliseconds, Typical 10 Milliseconds, Maximum
Switch Contact Rating	30V at 2A
Input Impedance	
Input 1	12K ±1.0%
Input 2	10K ±1.0%

8. Comparator (Electronic) 40.488

Switching Sensitivity	1 MV, Maximum
Switching Time	5 Microseconds, Typical
Analog Input Range	0 to ±10V
Latch and Unlatch Impedance	100K
Output . . . Complementary Digital Level	0, +5 Volts
Switches (Electronic)	
Input, and Feedback Impedance	10K
Switching Time	1 Microsecond, Typical
DC Offset	±500 Microvolts, Maximum

NOTE

Typical total switching time is about 5 microseconds. Switching time is measured with a step function input whose rise time is less than 2 microseconds, and does not include the rise time of the output function.

9. Dual X^2 DFG 16.275

Input Voltage	
Minus-input Generator	0.0V to -10V
Plus-input Generator	0.0V to +10V

Output Voltage

Minus-input Generator	0.0V to +10V
Plug-input generator	0.0V to -10V
Segments	Seven Per Generator
Total Error at 5.0 CPS	±0.2% FS, Typical ±0.4% FS, Maximum
Frequency Response	Compatible with Associated Amplifier+

10. Log X DFG 16.276

Input Voltage	0.0V to ±10V
Output Voltage	0.0V to ±10V
Segments	Seven

Static Error

Antilog X	±0.5% FS, Typical ±1.0% FS, Maximum
Log X (Actual input deviation from theoretical input for a given output)	±0.5% FS, Typical ±1.0% FS, Maximum
Frequency Response	Compatible with Associated Amplifier+

11. 1/2 Log X DFG 16.281

Input Voltage	0.0V to ±10V
Output Voltage	0.0V to ±5.0V
Segments	Seven

Static Error

Antilog X	±0.5% FS, Typical ±1.0% FS, Maximum
Log X (Actual input deviation from theoretical input for a given output)	±0.5% FS, Typical ±1.0% FS, Maximum
Frequency Response	Compatible with Associated Amplifier+

12. Positive Input Variable Slope, Variable Breakpoint Diode Function Generator 16.304-2

Input Voltage	0.0 to +10 Volts

Output Voltage	0.0 to ±10 Volts
Segments	Ten
Maximum Slope	At Least 1 Volt/Volt*
Parallax Range	±10 Volts
Noise	<5 MV p-p
Frequency Response	Compatible with Associated Amplifier+
Input Impedance at +10 Volts	7000 Ohms

13. Negative Input Variable Slope, Variable Breakpoint Diode Function Generator 16.306-2

Input Voltage	0.0 to -10 Volts
Output Voltage	0.0 to ±10 Volts
Segments	Ten
Maximum Slope	At Least 1 Volt/Volt*
Parallax Range	±10 Volts
Noise	<5 MV p-p
Frequency Response	Compatible with Associated Amplifier+
Input Impedance at -10 Volts	7000 Ohms

14. Negative Input Variable Slope Diode Function Generator 16.154-2 (-VDFG)

Input Voltage	0.0V to -10V
Output Voltage	0.0V to ±10V
Segments	Ten
Maximum Slope	
Segment No. 1	At Least 2V/V*
Segment No. 2-10	At Least 1V/V*
Parallax Range	±10V
Noise	Less Than 1.5 MV p-p
Frequency Response	Compatible with Associated Amplifier+
Input Impedance at -10V Input	1000 Ohms ±10%

15. Positive Input Variable Slope Diode Function Generator 16.156-2 (+VDFG)

Input Voltage	0.0V to +10V
Output Voltage	0.0V to ±10V
Segments	Ten
Maximum Slope	
Segment No. 1	At Least 2V/V*
Segment No. 2-10	At Least 1V/V*
Parallax Range	±10V
Noise	Noise Less than 1.5 MV p-p
Frequency Response	Compatible with Associated Amplifier+
Input Impedance at +10V Input	1000 Ohms ±10V

16. Sine-Cosine DFG 16.314

Input	±10V = 180° Sine-Cosine = 18°/Volt
Static Error	±.2%, Typical ±.25%, Maximum
Phase Shift	5° at 1000 CPS
Frequency Response	12 KC, Typical
Zero Error	.1 MV
Noise	5 MV p-p, Typical 10 MV p-p, Maximum

III. ACCESSORY DISPLAY EQUIPMENT SPECIFICATIONS

1. Repetitive Operation Display 34.034

Display Area	4-1/8" × 6-1/4"
Accuracy of Display (Y Axis)	±1% of Full Scale
Linearity	±1/4% (Within 4-1/8" × 4-1/8" Square)
Writing Speed	Up to 20,000 Inch/Second
Inputs	Four
Input Voltage	±10 Volts DC

NOTES: **Maximum slope may be varied by use of potentiometer in feedback of output amplifier.*

+Units may be used with other amplifiers than those listed in this brochure. Frequency response is controlled by the amplifier characteristics.