

Radar Training System

8096-00

FESTO

LabVolt Series

Datasheet



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General Description

The Radar Training System is still the only real radar trainer that operates safely inside a classroom or lab, demonstrating that the technical advancement achieved by this system has been unequalled since. The computer-based control of the radar's processing and display functions ensures it will continue to be a leading-edge pedagogical product for many years to come.

The system uses patented technology to provide students with real — not simulated — hands-on experience in the use of radar to detect and track passive targets at very short range in the presence of noise and clutter. The very low transmitter power allows for safe operation in a variety of training environments.

Many features make this a unique training system. A powerful, computer-based data monitoring system allows for easy study of the first stage in Moving Target Detection (MTD) processing. Students work with a realistic, high-gain parabolic antenna for high azimuth (angular) resolution. The system includes all necessary instrumentation tools.

The Radar Training System consists of seven subsystems (Models 8096-1 to 8096-8). Subsystems 8096-1 to 8096-3 provide students with hands-on training in the principles and operation of analog and digital radar, as well as radar tracking systems. Subsystem 8096-4 adds an active jamming pod trainer to the system to train students in the principles and scenarios of Electronic Warfare (EW). Subsystem 8096-5 is a sophisticated pulse-mode, radar cross-section (RCS) measurement training system with inverse synthetic-aperture radar (ISAR) imagery capability that is specifically designed for operation at close range. Subsystem 8096-6 provides students with training in the principles of electronically steered antennas. Finally, subsystem 8096-8 introduces students to the basic principles and operation of synthetic aperture radar (SAR).

Topic Coverage

- Principles of Radar Systems
- Analog MTI Processing
- Digital MTD Processing
- Tracking Radar
- Radar in an Active Target Environment
- The Phased Array Antenna

Features & Benefits

- Real radar training system that operates safely inside a classroom or lab
- Innovative design combining real-world radar with the power of modern surveillance technology
- Computer-based control of the radar's processing and display functions

- Comprehensive courseware and system level training with lab exercises
- Fault-insertion capability for the teaching of troubleshooting
- Turnkey, cost-effective training solution including instrumentation
- Powerful DSP, FPGA, and Data Acquisition System for Digital Analysis
- Realistic, high-gain parabolic antenna for high azimuth (angular) resolution
- Several subsystems allow delving into specific topics to expand knowledge and skills
- Can expand and complete existing telecommunication programs (satellite, antenna, microwave, etc.)
- Total program duration: more than 195 hours (all subsystems)

List of Available Training Systems

Qty	Description	Model number
1	Synthetic Aperture Radar (SAR) Training System – Add-On to 8096-A _____	592583 (8096-B0)

Additional Equipment Required to Perform the Exercises

Qty	Description	Model number
1	Dual Trace Oscilloscope _____	580849 (797-20) ¹
1	Dual Function Generator _____	581549 (9402-10) ²
1	Frequency Counter _____	581552 (9403-00) ³

Optional Equipment

Qty	Description	Model number
1	Radar Training System (Manuals on CD-ROM) _____	580408 (38542-A0)

Available Training Systems

Synthetic Aperture Radar (SAR) Training System – Add-On to 8096-A 592583 (8096-B0)



The Synthetic-Aperture Radar (SAR) Training System adds on to the RCS and ISAR Measurement Training System, Model 8096-A, to form a synthetic aperture radar that can produce high-resolution images. This system introduces students to the basic principles and operation of synthetic aperture radar (SAR).

The SAR Training System synthesizes a large aperture antenna through motion of a small-aperture (low-directivity) horn antenna. Motion of the horn antenna is achieved using the

Target Positioning System, Model 9607-1, included in the Basic Radar Training System, Model 8069-1, and an

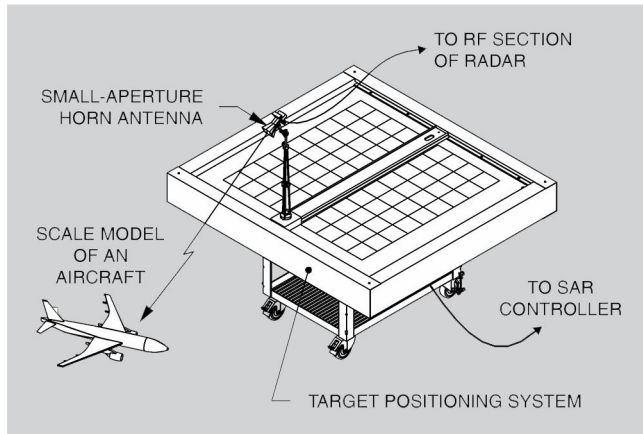
¹ Required for Volumes 1 and 2.

² Required for Volume 2.

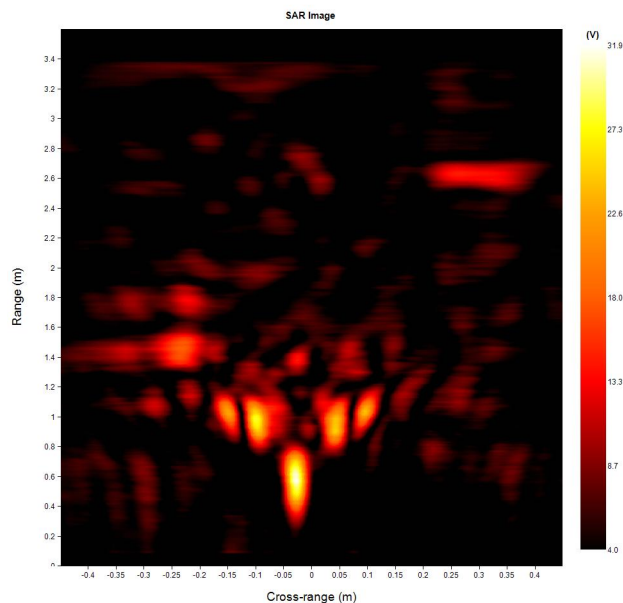
³ Required for Volume 2.

antenna-motion control module (SAR controller). Target radar echoes produced during a complete antenna scan are sampled and stored in the SAR processor then processed using a range Doppler algorithm to obtain high-resolution SAR images.

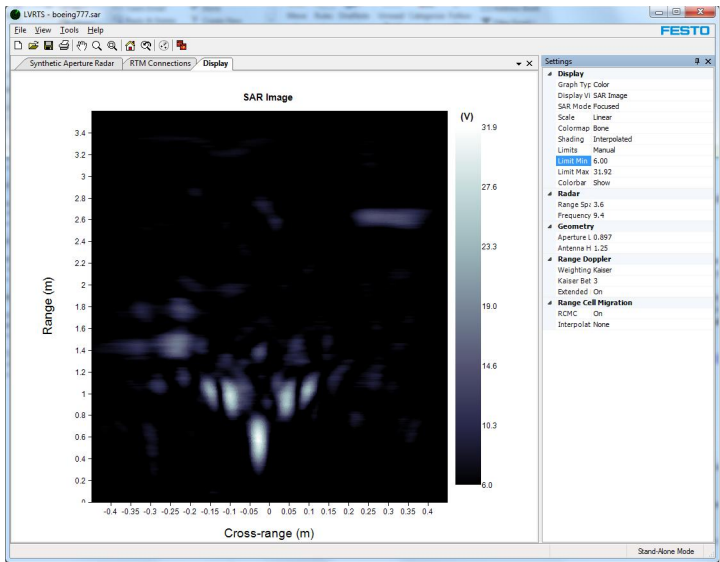
The SAR Training System consist of SAR processing and imagery software included in the LVRTS software, a SAR controller module, the necessary cables and accessories, and a system user guide. Note that RTM 9431-2 from the Radar Processor/Display add-on is required to use this add-on. Reflective scale models of aircraft that can be used with the SAR Training System are optionally available. See Optional Equipment for Models 8096-A and 8096-B.



The SAR Training System synthesizes a large aperture antenna through motion of a small-aperture horn antenna installed on the movable carriage of the Target Positioning System, Model 9607-1.



SAR image of a 777-Boeing aircraft reflective scale model obtained with the SAR Training System.



SAR image of a 777-Boeing aircraft reflective scale model obtained with the SAR Training System.

List of Equipment

Qty	Description	Model number
1	SAR Controller _____	581970 (9614-00)
1	Accessories for 8096-B _____	581988 (9690-F0)

Manual

Description	Manual number
Synthetic-Aperture Radar (SAR) (User Guide) _____	593946 (54269-E0)

Table of Contents of the Manual(s)

Synthetic-Aperture Radar (SAR) (User Guide) (593946 (54269-E0))

- 1 Introduction to SAR
- 2 Hardware Setup
- 3 SAR Processor Overview
- 4 System Description
- 5 System Operation
- 6 Processing Examples
- 7 Specifications

Optional Equipment

Qty	Description	Model number
1	B2 Bomber RCS Scale Model _____	587493 (39208-02)
1	F-117A Stealth Fighter RCS Scale Model _____	587494 (39209-02)

System Specifications

Parameter	Value
Operating Frequency	9.4 GHz
Actual Aperture Beamwidth	24°

Parameter	Value
Range Resolution	15 cm
Azimuth Resolution	6.5 cm at 3 m (equivalent to 1.25° SAR beamwidth)
Descent Angle	25°
Range Swath	90 cm
Processed Area	4 m ² (2 m x 2 m)

Equipment Description

SAR Controller 581970 (9614-00)



The SAR Controller allows motion control of the small-aperture horn antenna installed on the moveable carriage of the Target Positioning System (Model 9607-1) when the Basic Radar Training System (Model 8096-1) is used as a synthetic aperture radar. Antenna motion commands are received from the SAR Processor (RCS/ISAR Processor, Model 9611 equipped with the LVSAR software) via a USB port connection. The SAR controller also ensures that the radar echo signal acquisition is

properly synchronized with the horn antenna motion. The SAR Controller is provided with an LED indicator that lights up when faulty operating conditions are detected in the Target Positioning System. A reset button on the SAR Controller allows normal operating conditions to be restored.

Synthetic Aperture Radar Software

The Synthetic Aperture Software is a Windows®-based application that implements a powerful SAR processing unit that produces SAR images from the target echo signals acquired during a scan of the small-aperture horn antenna over the complete aperture length. The Software is also an intuitive user interface that provides all the controls and settings required to operate the Synthetic Aperture Radar as well as to display fine SAR images.

Specifications

Parameter	Value
PRF Input	TTL
Trigger Output	TTL
X and Y Outputs	-5 V to +5 V
Interface to SAR Processor	USB
Physical Characteristics	
Dimensions (H x W x D)	8 x 14 x 19 mm (3.2 x 5.5 x 7.5 in)
Net Weight	1.1 kg (2.4 lb)

Accessories for 8096-B 581988 (9690-F0)



The Accessories for 8096-B set contains two medium-length BNC cables, two long BNC cables, a low-loss long SMA cable, a short multiway cable (to connect the SAR Controller to the Target Controller of the Target Positioning System), a long USB-port cable, a two-axis adjustable antenna support, and a radiation absorbing material (RAM) panel.

Optional Equipment Description

Dual Trace Oscilloscope (Optional) 580849 (797-20)



The Dual Trace Oscilloscope is an economical and highly reliable solid-state instrument, ideal for general-purpose use in laboratory and training applications. Students can measure phase difference between waveforms using the X-Y operation mode, and video signals can be measured quickly with the special TV sync separation circuit. The Dual Trace Oscilloscope

includes CH 1, CH 2, CHOP, and ALT display modes. An operating instruction manual, one fuse, one line cord, and two low-capacitance probes are provided with the oscilloscope.

Features & Benefits

- 15 cm (6 inch) width, high luminance CRT with internal graticule, 8 x 10 divisions
- Wide dynamic range even at high frequencies of -3 dB
- Fast rise time with low overshoot
- Flat frequency response up to half of -3 dB frequency
- Alternate and chopping display
- Polarity inversion and algebraic sum of CH1 and CH2
- Maximum sweep rates of 20 ns/div.
- Variable scale illumination
- Delayed sweep function with minimum delay time jitter of 1/20,000 or less
- Jitterless and superb trigger sensitivity
- TV sync separation and hold-off circuit useful for video signal observation
- Brightness modulation available with Z-axis input
- Low drift with compensation circuitry
- Signal delay with delay line useful for observation of signal leading edge
- X-Y phase difference measurement up to 50 kHz

Specifications

Parameter	Value
Power Requirements	
Current	0.4 A
Service Installation	Standard single-phase ac outlet
CRT Display	
Type	15.24 cm (6 in) rectangular, internal graticule, scale illumination
Effective Area	8 x 10 div (1 div = 1 cm)
Acceleration Potential	12 kV
Vertical Deflection	
Sensitivity	5 mV/div to 5 V/div in 10 calibrated steps $\pm 3\%$
	1 mV/div to 1 V/div $\pm 5\%$ when using x5 magnifier
	Uncalibrated continuous control between steps 1: $\times 2.5$
Bandwidth	DC to 40 MHz (-3 dB); dc to 7 MHz (-3 dB) when using x5 magnifier
Rise Time	Less than 8.8 ns
Maximum Input	300 V (dc + ac peak) or 500 V p-p ac at 1 kHz or less
Input Coupling	AC, GND, DC
Input Impedance	1 meg in parallel with 25 pF
Operating Modes	CH1, CH2 (INVERT), ADD, DUAL (CHOP: Time/div sw 0.2 s - 5 ms; ALT: Time/div sw 2 ms - 0.2 μ s)
X-Y Operation	CH1: X-axis, CH2: Y-axis
Horizontal Deflection	
Display	A, A int B, B, B triggered, X-Y
Time Base A	0.2 μ s/div to 0.2 s/div in 19 calibrated steps $\pm 3\%$ uncalibrated continuous control between steps at least 1: $\times 2.5$
Time Base B	0.2 μ s/div to 20 μ s/div in 7 calibrated steps $\pm 3\%$
Trigger	
Modes	Auto, Norm, TV-V, TV-H
Coupling	AC
Sources	CH 1, CH 2, LINE, EXT
Sensitivity (Internal Source)	0.5 div (20 Hz to 2 MHz), 1.5 div (2 MHz to 40 MHz)
Sensitivity (External Source)	200 mV (20 Hz to 2 MHz), 800 mV (2 MHz to 20 MHz)
Slope	+ or -
TV Sync	Polarity: TV (-)
Calibrator	
	1 kHz, square wave, 0.5 $\pm 3\%$, duty cycle: 50%
Accessories	
	Power cable, fuse, operation manual, 2 probes
Physical Characteristics	
Dimensions (H x W x D)	140 x 320 x 430 mm (5.5 x 12.6 x 16.9 in)
Net Weight	5.7 kg (12.57 lb)

Dual Function Generator (Optional) 581549 (9402-10)



The Dual Function Generator consists of two independent function generators (A and B), each capable of generating a sine-wave signal, a square-wave signal, a triangular-wave signal, a sawtooth-wave signal, and a pulse signal with variable pulse-width. The signal frequency can be varied from 10 Hz to 100 kHz through four

ranges. A digital display is pushbutton-selectable between generators A and B to monitor the frequency of each generator. Each generator output signal level is continuously variable and may be attenuated by push button-selected switch attenuators. TTL output signals are provided to synchronize external equipment, such as an oscilloscope. Generator A may be frequency-modulated by a signal from generator B or from an external source.

The module is fully protected against short circuits and misconnections. Students use the instruments to make measurements in laboratory experiments performed on AM, FM, and digital communications systems.

Specifications

Parameter	Value
Power Requirement	± 25 V typ. – 3 A max; -25 V typ. – 3 A max.; $+11$ V typ. – 5 A max.
Generators (A & B) Rating	
Waveforms	Sine, triangle, square, sawtooth, or pulse
Pulse Duty Cycle	10 to 90 %
Frequency Ranges	10-100 Hz, 100-1000 Hz, 1-10 kHz, 10-100 kHz
Frequency Display (switchable between A & B)	4 digits
Output Impedance	50 Ω
Output Level (open circuit)	10 mV p-p to 10 V p-p
Attenuator	0, 20, or 40 dB
Synchronization Outputs	One for each channel (SYNC/TTL)
Frequency Modulation (Channel A only)	
Input Impedance	100 k Ω
Maximum Frequency Deviation	50 % of each side of the rest frequency
Input Level for Maximum Deviation	10 V p-p
Physical Characteristics	
Dimensions (H x W x D)	162 x 330 x 300 mm (6.4 x 13 x 11.8 in)
Net Weight	4.4 kg (9.7 lb)

Frequency Counter (Optional) 581552 (9403-00)



The Frequency Counter is a direct-counting frequency counter with an 8-digit display. The frequency counter has three functions: it determines the frequency of the input signal and displays the frequency in Hz, kHz, or MHz, it determines the period of the

input signal and displays the period in s or ms, and it works as an event counter when the counter function is selected. The frequency/period resolution is switch-selectable from 0.1 to 100 Hz (0.1 to 100 ns). As an event counter, each negative-going transition of the input signal adds one to the cumulative count displayed. The input signal may be attenuated by a switch attenuator.

The module is fully protected against short circuits and misconnections. Students use the instruments to make measurements in laboratory experiments performed on AM, FM, and digital communications systems.

Specifications

Parameter	Value
Power Requirement	$+25$ V – 425 mA; -25 V – 325 mA
Rating	
Input Frequency Range	10 Hz - 10 MHz, 10 MHz - 200 MHz
Input Period Range	0.1 s – 4 μ s (10 Hz-2.5 MHz)
Count Range	1 - 99 999 999
Input Impedance	1 M Ω
Sensitivity (Sine Wave RMS Value)	10 Hz - 100 MHz: 25 mV; 100 MHz-200 MHz: 60 mV
Attenuator	0, 20 or 40 dB
Resolution	0.1, 1, 10, 100 Hz (ns)
Frequency Display	8 digits
Physical Characteristics	
Dimensions (H x W x D)	112 x 330 x 300 mm (4.4 x 13 x 11.8 in)
Net Weight	3.2 kg (7 lb)

Radar Training System (Manuals on CD-ROM) (Optional) 580408 (38542-A0)

List of Manuals

Description	Manual number
Electronic Warfare (Reference Book) _____	590706 (32254-80)
Principles of Radar Systems (Student Manual) _____	591283 (38542-00)
Radar Training System (Instructor Guide) _____	591286 (38542-10)
Analog MTI Processing (Student Manual) _____	591289 (38543-00)
Radar Processor/Display (User Guide) _____	591292 (38543-E0)
Digital MTD Processing (Student Manual) _____	591295 (38544-00)
Tracking Radar (Student Manual) _____	591298 (38545-00)
Radar in an Active Target Environment (Student Manual) _____	591300 (38546-00)
The Phased Array Antenna (Student Manual) _____	591302 (38547-00)
RCS and ISAR Measurement Training System (User Guide) _____	591336 (39102-E0)
Synthetic-Aperture Radar (SAR) Training System (User Guide) _____	591677 (85300-E0)
RCS and ISAR Measurement Training System (User Guide) _____	594228 (52792-E0)
Phase-Coded Pulse Compression (Student Manual) _____	594242 (52919-00)
Phase-Coded Pulse Compression (Instructor Guide) _____	594243 (52919-10)
Synthetic-Aperture Radar (SAR) (User Guide) _____	594262 (54269-E0)

B2 Bomber RCS Scale Model (Optional) 587493 (39208-02)



Scale model of a B2 bomber for RCS measurement. Note that color may vary.

Specifications

Parameter	Value
Size	
Scale	1/100
Dimensions	50.8 X 20.3 cm (20½" X 8")

F-117A Stealth Fighter RCS Scale Model (Optional) 587494 (39209-02)

Scale model of a F-117A stealth jet fighter for RCS measurement. Note that color may vary.

Specifications

Parameter	Value
Size	
Scale	1/48

Parameter	Value
Dimensions	25.4 X 15.2 cm (10" X 16½")

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Festo Didactic SE

Rechbergstrasse 3
73770 Denkendorf
Germany

P. +49(0)711/3467-0
F. +49(0)711/347-54-88500

Festo Didactic Inc.

607 Industrial Way West
Eatontown, NJ 07724
United States

P. +1-732-938-2000
F. +1-732-774-8573

Festo Didactic Ltée/Ltd

675 rue du Carbone
Québec QC G2N 2K7
Canada

P. +1-418-849-1000
F. +1-418-849-1666

www.labvolt.com

www.festo-didactic.com