Radar Training System
8097-00

LabVolt Series

Datasheet

* The product images shown in this document are for illustration purposes; actual products may vary. Please refer to the Specifications section of each product/item for all details. Festo Didactic reserves the right to change product images and specifications at any time without notice.

Festo Didactic
en
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Table of Contents

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.

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

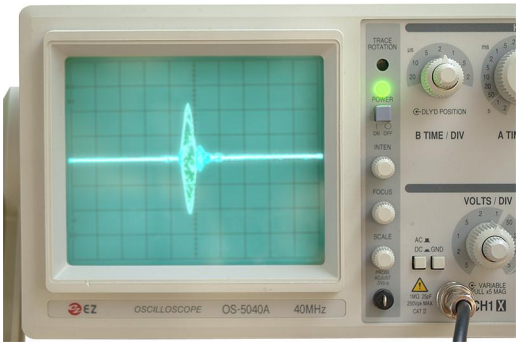
Qty	Description	Model number
1	Basic Radar Training System	8112495 (8097-10)
1	Radar Processor/Display (add-on to the Basic Radar Training System)	8112498 (8097-20)
1	Radar Tracking Training System (add-on to the Radar Processor/Display)	8112501 (8097-30)
1	Radar Active Target Training System (add-on to the Radar Tracking Training System)	8112504 (8097-40)
1	Radar Phased Array Antenna Training System (add-on to the Radar Processor/Display)	8112507 (8097-60)
1	RCS and ISAR Measurement Training System (add-on to the Radar Processor/Display)	8122693 (8097-A0)
1	Synthetic Aperture Radar (SAR) Training System (add-on to the RCS and ISAR Measurement Training System)	8163409 (8097-B0)
1	Radar Phase-Coded Pulse Compression Training System (add-on to the Radar Processor/Display)	8121494 (8097-C0)

Available Training Systems

Basic Radar Training System 8112495 (8097-10)

The Basic Radar Training System is a complete set of hardware, courseware, and all necessary accessories such as targets and interconnecting cables that allows the principles of pulse, CW Doppler, and FM-CW radar systems to be studied.

The Basic Radar Training System consists of a transmitter, a receiver, three instrumentation modules, an antenna with pedestal, a target positioning system, and a set of accessories. A comprehensive student manual and an instructor guide, which may be ordered separately, are also provided.



Radar echo of a moving target observed on an A-scope display obtained using a conventional oscilloscope.

An oscilloscope is required for target echo visualization on an A-scope display as well as time-domain observation of signals at outputs and test points (the Model 797 Dual Trace Oscilloscope is recommended).

List of Equipment

Qty	Description	Model number
1	Principles of Radar Systems (Student Manual)	580402 (38542-00)
1	Radar Training System (Instructor Guide)	580405 (38542-10)
1	Horn Antenna	581847 (9535-00)
1	Power Supply / Antenna Motor Driver	8084743 (9601-20)
1	Radar Synchronizer / Antenna Controller	595986 (9602-20)
1	Rotating-Antenna Pedestal	8112383 (9603-10)
1	Radar Antenna	581936 (9604-00)
1	Dual-Channel Sampler	595989 (9605-10)
1	Target Positioning System	8121782 (9607-30)
1	Radar Transmitter	595172 (9620-20)
1	Radar Receiver	595990 (9621-20)
1	Accessories for the Basic Radar Training System	8112515 (9688-00)

List of Manuals

Description	Manual number
Principles of Radar Training System (Workbook)	580402 (38542-00)
Principles of Radar Training System (Workbook (Instructor))	580405 (38542-10)
Radar Training System (User Guide)	8112390

Table of Contents of the Manual(s)

Principles of Radar Training System (Workbook) (580402 (38542-00))

- 1-1 Basic Principles of Pulsed Radar
- 1-2 The Range-Delay Relationship
- 1-3 Radar Antennas
- 1-4 The Radar Equation
- 2-1 Pulsed Radar Transmitter and Receiver
- 2-2 Antenna Driving System
- 3-1 CW Radar and the Doppler Effect
- 3-2 Frequency-Modulated CW Radar
- 4-1 Troubleshooting a CW Radar
- 4-2 Troubleshooting an FM-CW Radar
- 4-3 Troubleshooting a Pulsed Radar: The RF Section

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Dual-Trace Digital Storage Oscilloscope	585695 (798-10)

System Specifications

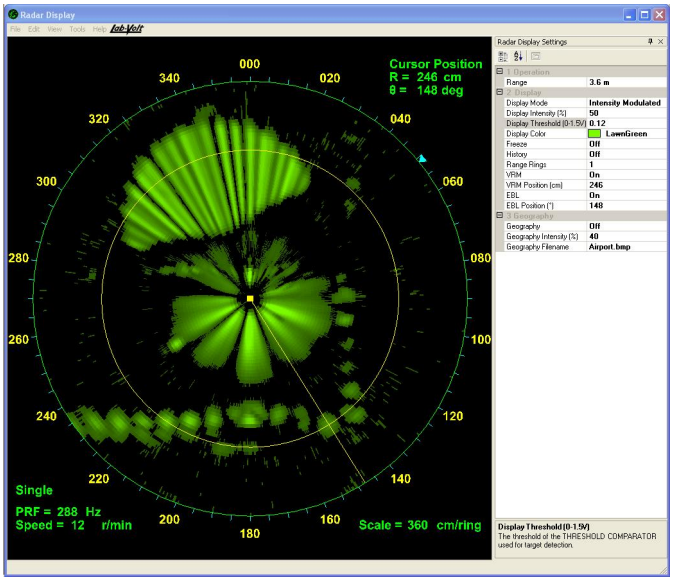
Parameter	Value
Power Requirement	
Current	10 A (for 120V)
Frequency Range	8-10 GHz
Output Power Density at Horn	
CW Mode	0.02 mW/cm²
Maximum Range (Equiv. RCS of Target: 1 m²)	Typically more than 8 m (26 ft)
Range	1.8 m (5.9 ft), 3.6 m (11.8 ft), 7.2 m (23.6 ft), switch selectable
Range Resolution	Typically 15 cm (6 in)
Physical Characteristics	
Dimensions	About 8 m² (86 ft²)
Net Weight	TBE

Radar Processor/Display (add-on to the Basic Radar Training System) 8112498 (8097-20)

The Radar Processor/Display is used in conjunction with the Basic Radar Training System to form a complete and modern pulse radar system. The Radar Processor/Display adds the following elements to the Basic Radar Training System: radar echo signal processing functions, PPI display functions, on-screen block diagrams of the complete radar and radar processor/display subsystem, and computer-based (i.e., on-screen) instruments (oscilloscope and data monitoring system). Two major types of radar echo signal processing function are available: Moving Target Indication (MTI) and Moving Target Detection (MTD). The Radar Processor/Display also provides computer-controlled generation of clutter and interference to allow study of the MTI processing function. The following types of clutter and interference can be generated: sea clutter, rain clutter, second-trace echo, noise, and pulse interference.

The Radar Processor/Display consists of a reconfigurable training module (RTM), a power supply for the RTM, three interface modules, a set of accessories including the Radar Training System Software, two comprehensive

student manuals, and a user guide. A Windows® based host computer (to be purchased separately) is required with the RTM. The Festo Radar Host Computer is recommended.



Example of a PPI display obtained with the Radar Processor/Display.

Model 8096-3.

The RTM is the cornerstone of the Radar Processor/Display. This module, which uses state-of-the-art digital signal processor (DSP) technology, can be programmed to act as either an analog pulse radar (i.e., a pulse radar with MTI processing) or a digital pulse radar (i.e., a pulse radar using MTD, correlation and interpolation, and surveillance processing). Interface modules that students install in the RTM allow connection of the various signals coming from the Basic Radar Training System, as shown in Figure 1. The RTM can also be programmed to act as a tracking radar when used with the Radar Tracking Training System,

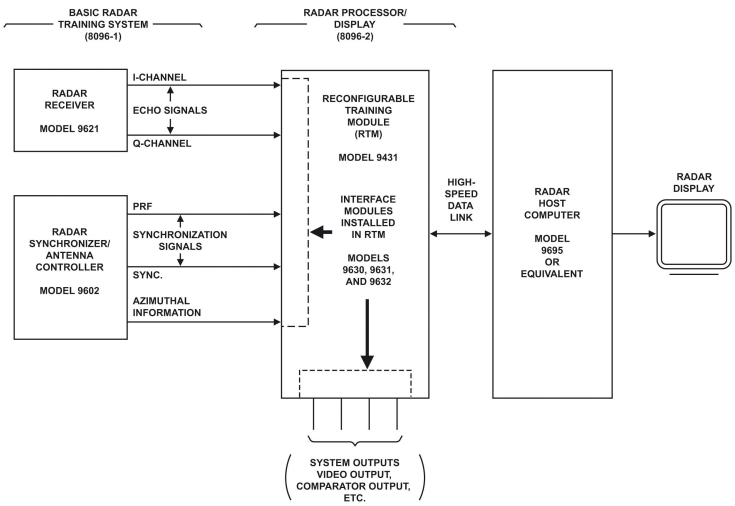


Figure 1. Simplified connection diagram of the Basic Radar Training System and Radar Processor/Display.

The RTM processes the signals from the Basic Radar Training System to detect targets, and sends data to the radar host computer via a high-speed data link (Ethernet link with TCP/IP protocol). The RTM can also generate clutter and interference which are added to the I- and Q-channel echo signals from the radar receiver, before signal processing takes place. The radar host computer, which runs the LVRTS software, uses the data produced by the RTM to display the detected targets on a PPI display. The LVRTS software is a Windows®-based application used to download programs into the DSP memory of the RTM, to select the type of radar which is implemented (see Figure 2). It also has an intuitive user interface to:

- Select the radar processing functions and adjust other parameters of the radar, such as the video gain, detection threshold, etc. (see Figure 3)
- Control the radar display functions such as the PPI display mode selection, Variable Range Marker (VRM), Electronic Bearing Line (EBL), etc. (see Figure 4)
- Display diagrams that show how to connect the equipment (see Figure 5).
- Display the functional block diagrams of the complete radar and radar processor/display subsystem (see Figure 6).
- Connect virtual probes to test points in the aforementioned block diagrams to observe real signals using the built-in oscilloscope (see Figure 7).
- Use the Data Monitor to observe and analyze the signal processing sequence involved in Moving Target Detection (see Figure 8).
- Insert faults in the system (password-protected feature) for troubleshooting purposes (see Figure 9).
- Set the parameters that control the generation of clutter and interference (see Figure 10).
- Obtain on-line help screens (see Figure 11).

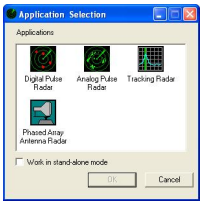


Figure 2. On-screen selection of the type of radar which is implemented.

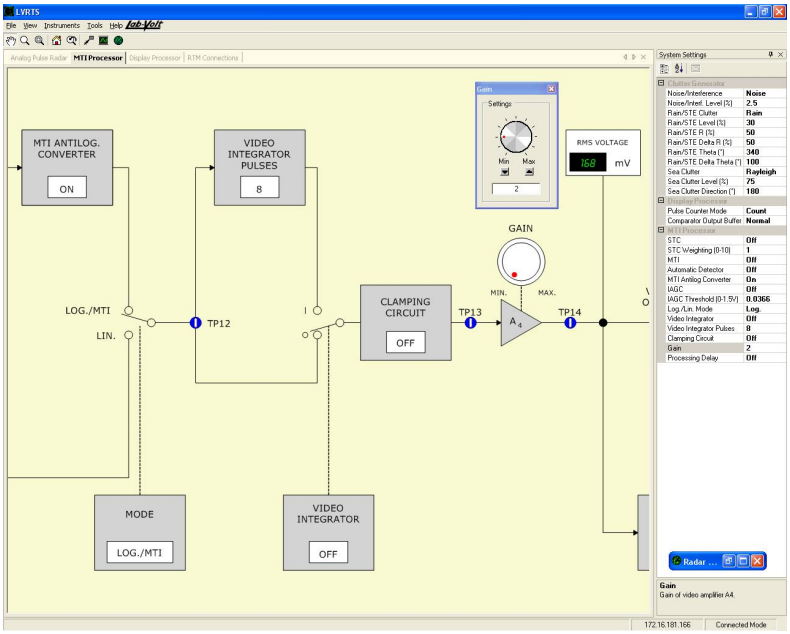


Figure 3. Computer-based control of the radar processing functions and operating parameters.

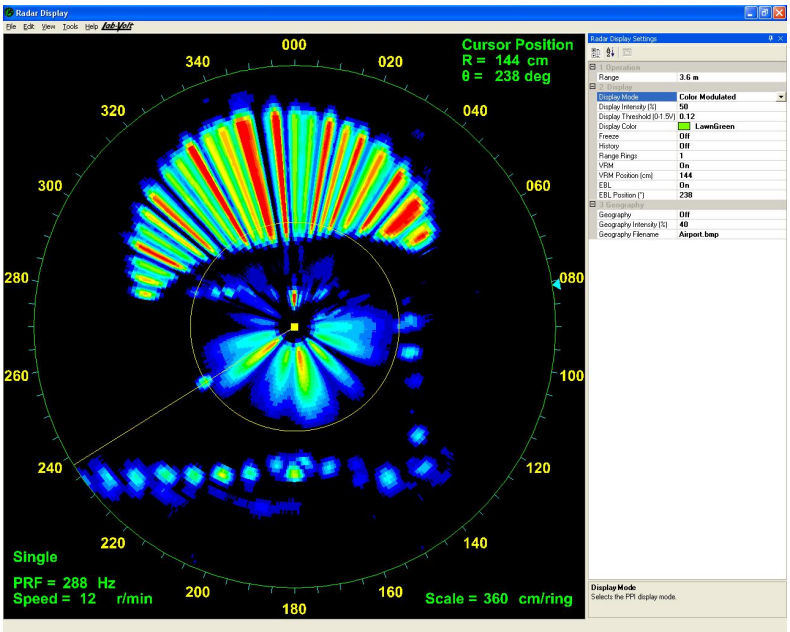


Figure 4. Computer-based control of the radar display functions.

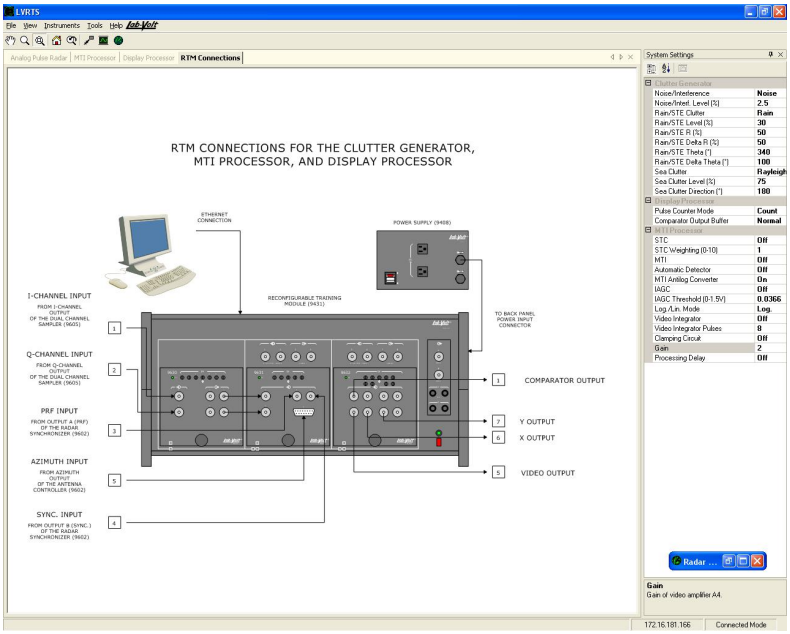


Figure 5. Window showing the interconnections to the RTM.

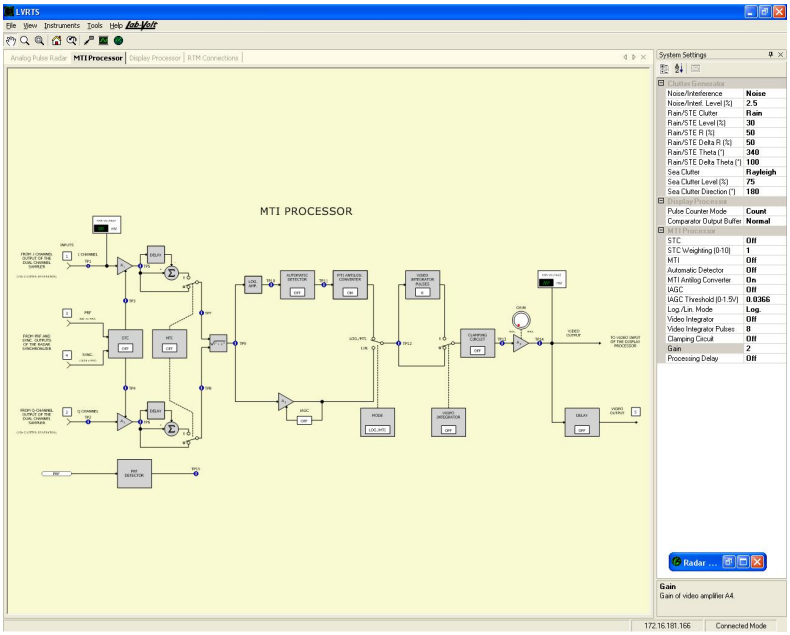


Figure 6. On-screen block diagram of the Moving Target Indicator (MTI) processor.

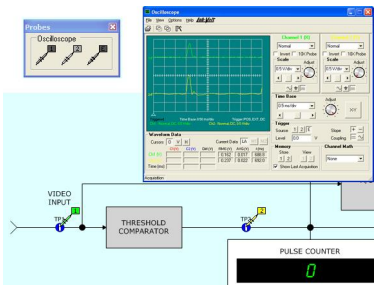


Figure 7. Real signals can be observed on the built-in oscilloscope by connecting virtual probes to test points in the on-screen block diagrams.

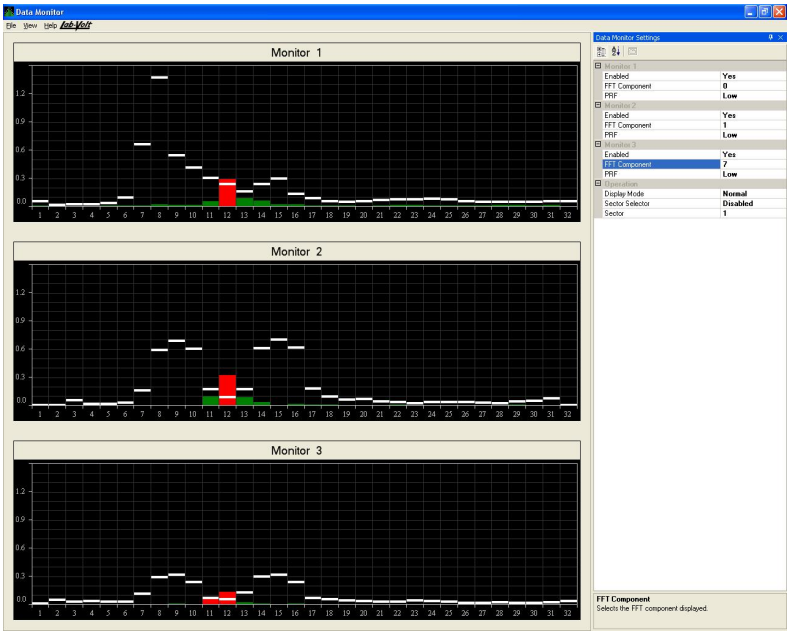


Figure 8. The Data Monitor is a powerful tool designed to study the various stages (FFT Doppler filtering, thresholding, alarm generation) of Moving Target Detection (MTD).

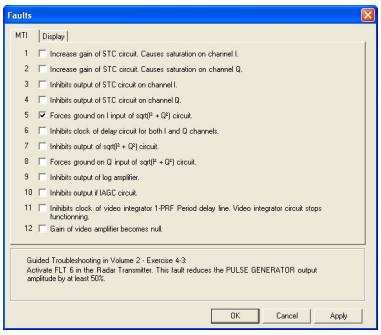


Figure 9. Faults window in the LVRTS software.

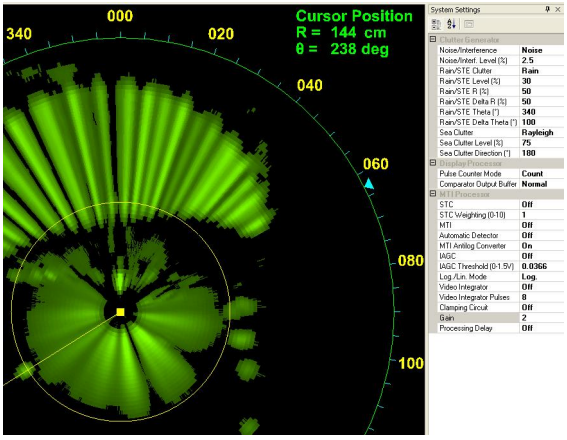


Figure 10. Computer-based control of clutter and interference generation.

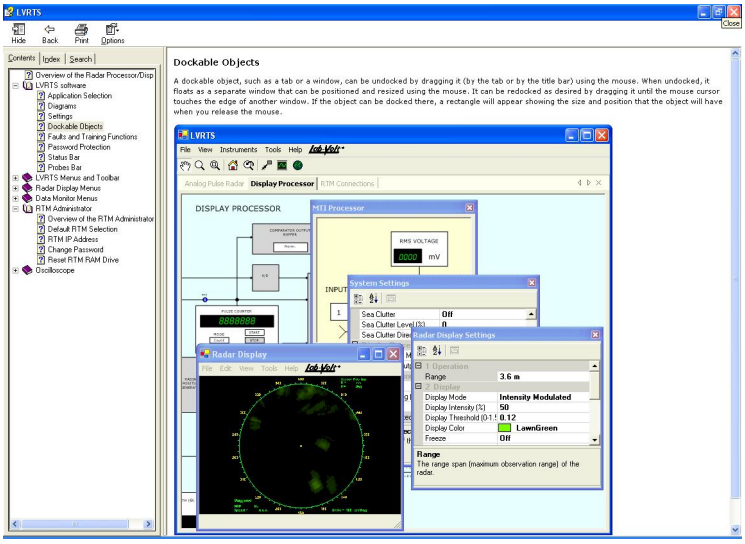


Figure 11. On-line help screens are available through a few clicks of the mouse button.

List of Equipment

Qty	Description	Model number
1	Analog MTI Processing (Student Manual)	580412 (38543-00)
1	Radar Processor/Display (User Guide)	580414 (38543-E0)
1	Digital MTD Processing (Student Manual)	580418 (38544-00)
1	RTM Power Supply	8112514 (9408-2X)
1	Reconfigurable Training Module (RTM)	8094635 (9431-30)
1	Analog/Digital Signal Combiner	8112776 (9630-10)
1	Data Acquisition Interface	8112777 (9631-10)
1	Radar Analog/Digital Output Interface	8093433 (9635-00)
1	Accessories for the Radar Processor/Display	8112516 (9688-A0)

List of Manuals

Description	Manual number
Analog MTI Processing (Workbook)	580412 (38543-00)
Radar Processor/Display (User Guide)	580414 (38543-E0)
Digital MTD Processing (Workbook)	580418 (38544-00)
Radar Training System (User Guide)	8112390

Table of Contents of the Manual(s)

Analog MTI Processing (Workbook) (580412 (38543-00))

- 1-1 Familiarization with the Analog Pulse Radar
- 1-2 The PPI Display
- 2-1 Phase-Processing MTI
- 2-2 Vector-Processing MTI
- 2-3 Staggered PRF
- 2-4 MTI Limitations
- 3-1 Threshold Detection
- 3-2 Pulse Integration

- 3-3 Sensitivity Time Control
- 3-4 Instantaneous Automatic Gain Control
- 3-5 The Log-FTC Receiver
- 3-6 Constant False-Alarm Rate
- 4-1 Troubleshooting the MTI Processor
- 4-2 Troubleshooting the Display Processor
- 4-3 Troubleshooting an MTI Radar System

Digital MTD Processing (Workbook) (580418 (38544-00))

- 1-1 Familiarization with the Digital Pulse Radar
- 1-2 The PPI Display
- 2-1 Cell Mapping
- 2-2 Fast Fourier Transform (FFT) Processing
- 2-3 Constant False-Alarm Rate (CFAR)
- 3-1 Correlation and Interpolation (CI) Processing
- 3-2 Surveillance (Track-While-Scan) Processing
- 4-1 Troubleshooting the Digital MTD/PPI Processor

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	Function Generator 5 MHz / Frequency Counter	8125246 (9409-00)
1	Radar Host Computer	587465 (9695-00) [1]

System Specifications

Parameter	Value
MTI Processor (Analog)	
Functions	Functions Sensitivity Time Control (STC), moving target cancellation, logarithmic amplification, Fast Time Constant (FTC), Constant False-Alarm Rate (CFAR), Instantaneous Automatic Gain Control (IAGC), antilog conversion, 4- and 8-pulse video integration (non-coherent)
I- and Q-Channel Input Voltage Range	-1.5 to +1.5 V
Video Output Voltage Range	-10 to +10 V
On-Screen Test Points	15
Faults	12
Display Processor (Analog)	
PPI Outputs X and Y, Voltage Range	-8 to +8 V
PPI Output Z	TTL
Azimuth Input	TTL
On-Screen Test Points	8
Faults	4
MTD Processor (Digital)	
Functions	Moving Target Detection (MTD), Correlation and Interpolation, Surveillance
Coherent Processing Intervals (CPI)	2, 4/3 ratio, synchronized in azimuth
Target Tracking Capability	up to 8 targets simultaneously
I- and Q-Channel Input Voltage Range	-1.5 to +1.5 V
PPI Outputs X and Y, Voltage Range	-8 to +8 V
PPI Output Z	TTL
Azimuth Input	TTL
On-Screen Test Points	15
Faults	13
PPI Display (Digital)	
Number of Sectors	60
Sector Width	6°

[1] Comes with the software pre-installed. Can be replaced by a PC running Windows with a Ethernet port and 2 screens.

Parameter	Value
Number of Range Segments	16, 32, and 64 on 1.8-m (5.9-ft), 3.6-m (11.8-ft), and 7.2-m (23.6-ft) ranges, respectively
Range Segment Length	11.25 cm (4.4 in)
Number of Cells	960, 1920, and 3840 on 1.8-m (5.9-ft), 3.6-m (11.8-ft), and 7.2-m (23.6-ft) range, respectively

Radar Tracking Training System (add-on to the Radar Processor/Display) 8112501 (8097-30)

The Radar Tracking Training System adds on to the pulse radar implemented with the Basic Radar Training System and the Radar Processor/Display to form a continuous tracking radar. This radar can track a passive target that moves in the classroom laboratory.

The Radar Tracking Training System includes an interface module to be installed in the RTM of the Radar Processor/Display, a special dual-feed parabolic antenna, a joystick-type hand controller, a set of accessories, and a student manual.

* WARNING: This equipment is subject to export control. Please contact your sales representative to know if this product can be imported in your region.

The tracking radar can operate in three different modes (Scan, Manual, and Lock), which are selected through the hand-controller buttons. In scan mode, the antenna rotates at constant speed, allowing observation of targets on the PPI display. In manual mode, the operator can isolate a fixed or moving target of his or her choice, using the hand controller to control the antenna beam angle and to position an electronic marker (range gate) over the target echo signal. A computer-based O-scope display is used to monitor the position of the range gate relative to the echo signal of the target to be acquired. When the range gate straddles the target echo signal, the lock mode can be activated and the target is automatically tracked in range and azimuth by the system.

Range tracking is achieved by means of the split range-gate technique, whereas angle tracking is accomplished using lobe switching (sequential lobing). In addition to the fully automatic tracking mode, several useful ECCM features are available, such as a switchable lobing rate, a range tracking rate limiter in the range loop, manual control of either the range loop or the azimuth loop while the system is locked onto a target, and leading-edge range tracking. The computer-based interface of the tracking radar allows control of these functions and offers the same other possibilities as for the pulse radar system (visualization of the system's block diagrams, connection of virtual probes in the onscreen block diagrams, observation of signals on the built-in oscilloscope, fault insertion, etc.)

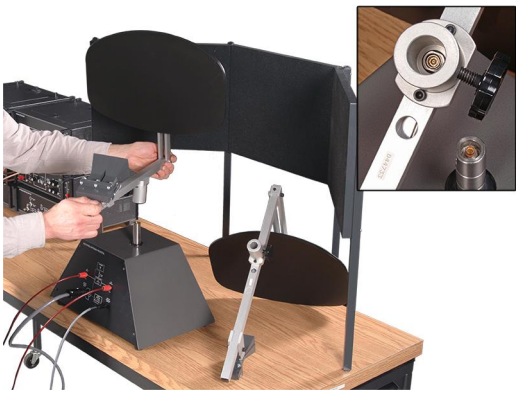


Figure 12. Antenna replacement is quick and easy thanks to miniature plug-in connectors in the antenna frame and antenna pedestal's shaft.

Installation of the Radar Tracking Training System is very simple: insert the interface module in the RTM, modify a few connections, connect the hand controller to a USB port of the host computer, and replace the conventional parabolic antenna with the dual-feed parabolic antenna. These two antennas come with a miniature plug-in connector to facilitate replacement, as shown in Figure 12.

List of Equipment

Qty	Description	Model number
1	Tracking Radar (Student Manual)	580422 (38545-00)
1	Dual Feed Parabolic Antenna	581937 (9604-A0)
1	Radar Target Tracking Interface	8112778 (9633-10)
1	Accessories for the Tracking Radar	581984 (9690-B0)
1	Radar Tracker Hand Controller (USB)	581992 (9694-10)

List of Manuals

Description	Manual number
Tracking Radar (Workbook)	580422 (38545-00)
Radar Training System (User Guide)	8112390

Table of Contents of the Manual(s)

Tracking Radar (Workbook) (580422 (38545-00))

System Specifications

Parameter	Value
Lobe Switch Control Input, Voltage Range	-5 to +5 V
Antenna Rotation Command Input, Voltage Range	-5 to +5 V
Lobe Switch Control Output, Voltage Range	-5 to +5 V
Antenna Rotation Command Output, Voltage Range	-5 to +5 V
PPI Display	
X- and Y-Output Voltage Range	-8 to +8 V
Z Output Voltage Range	TTL
O-Scope Display	
Video Output Voltage Range	-10 to +10 V
Time Base Output Voltage Range	0 to +10 V
Maximum Range Tracking Rate	>35 cm/s (>14 in/s)
Maximum Angle (Azimuth) Tracking Rate	>6°/s
On-Screen Test Points	24
Faults	12

Radar Active Target Training System (add-on to the Radar Tracking Training System) 8112504 (8097-40)

Radar Active Target (RAT) Training System is used in conjunction with the three previous subsystems to train students in the principles and scenarios of EW. This is a truly unique system that places real-time, safe, and unclassified EW demonstrations into the hands of students. The RAT Training System consists of an active jamming pod trainer, an elaborate set of accessories, and a comprehensive student manual.

* WARNING: This equipment is subject to export control. Please contact your sales representative to know if this product can be imported in your region.

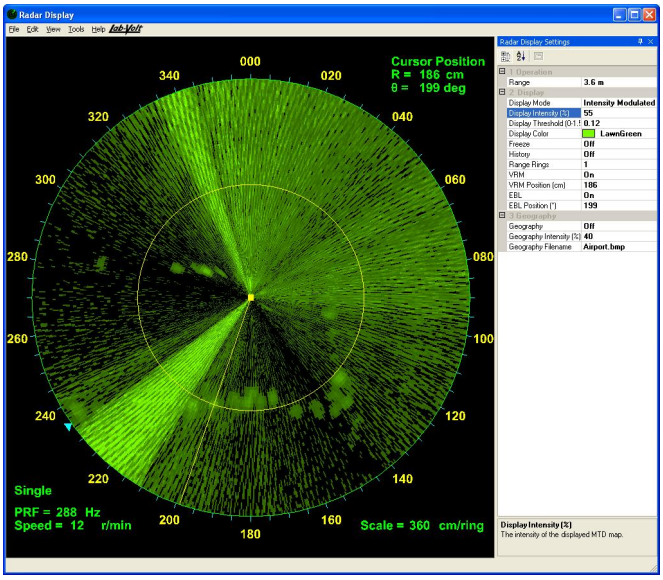
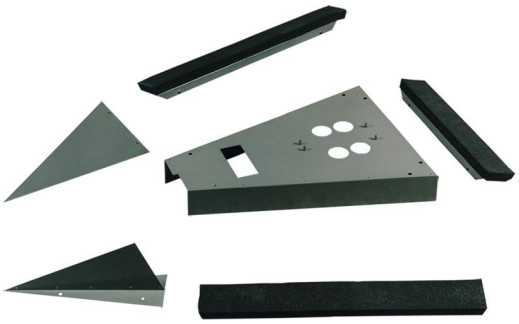


Figure 13. Effect of barrage noise jamming produced by the jamming pod trainer of the RAT Training System as observed on the Radar PPI display.

The jamming pod trainer is a Self-Screening Jammer (SSJ) target that can perform direct or modulated noise jamming (see Figure 13) as well as repeater jamming. It includes a remote controller to select the type of jamming and set the jamming parameters. The jamming pod trainer and the included accessories are designed for use with the Radar to implement real EW situations. This provides an effective means of introducing students to a real-time jamming situation that necessitates a response, that is, the use of an appropriate ECCM to prevent losing track of the target.



Stealth accessories in the RAT Training System allow reduction of the jamming pod trainer's radar cross section.

List of Equipment

Qty	Description	Model number
1	Electronic Warfare (Reference Book)	580343 (32254-80)
1	Radar in an Active Target Environment (Student Manual)	580425 (38546-00)
1	Horn Antenna	581847 (9535-00)

Qty	Description	Model number
1	Radar Jamming Pod Trainer Support	581916 (9595-10)
1	Radar Jamming Pod Trainer	581949 (9608-10)
1	Power Supply (Radar Electronic Warfare)	8095962 (9609-10)
1	Accessories for the Radar Active Target Training System	581985 (9690-C0)

List of Manuals

Description	Manual number
Electronic Warfare (User Guide)	580343 (32254-80)
Radar in an Active Target Environment (Workbook)	580425 (38546-00)
Radar Training System (User Guide)	8112390

Table of Contents of the Manual(s)

Radar in an Active Target Environment (Workbook) (580425 (38546-00))

- 1-1 Familiarization with the Radar Jamming Pod Trainer
- 1-2 Spot Noise Jamming and Burn-Through Range
- 1-3 Frequency Agility and Barrage Noise Jamming
- 1-4 Video Integration and Track-On-Jamming
- 1-5 Antennas in EW: Sidelobe Jamming and Space Discrimination
- 2-1 Deception Jamming Using the Radar Jamming Pod Trainer
- 2-2 Range Gate Pull-Off
- 2-3 Stealth Technology: The Quest for Reduced RCS
- 3-1 Deceptive Jamming Using Amplitude-Modulated Signals
- 3-2 Cross-Polarization Jamming
- 3-3 Multiple-Source Jamming Techniques
- 4-1 Chaff Clouds
- 4-2 Chaff Clouds used as Decoys

Radar Phased Array Antenna Training System (add-on to the Radar Processor/Display) 8112507 (8097-60)

The Radar Phased Array Antenna Training System is specifically designed to be used with the complete, pulse radar system that can be implemented with the Basic Radar Training System and the Radar Processor/Display. The training system includes a phased array antenna, a beam-steering control module, the necessary cables, and a comprehensive student manual that deals with the principles of electronically steered antennas.

* WARNING: This equipment is subject to export control. Please contact your sales representative to know if this product can be imported in your region.

Beam steering in the Radar Phased Array Antenna Training System is achieved using a microwave switch coupled to a Rotman lens and microstrip tapered slot array antennas. Beam steering control can be manual, continuous or radar PRF dependent. Scan speeds of up to 1080 scans/min can be achieved, thereby allowing the PPI display (sector scan) of the radar system to be refreshed at much higher rates than with a conventional mechanically rotated parabolic antenna. Targets can thus be followed in near real time.

The Radar Phased Array Antenna Trainer is fully compatible with the Radar Training System. It allows sector-scan operation with no antenna motion.

List of Equipment

Qty	Description	Model number
1	The Phased Array Antenna (Student Manual)	580428 (38547-00)
1	Phased Array Antenna	581966 (9612-00)
1	Phased Array Antenna Controller	581968 (9613-00)
1	Accessories for the Radar Phased Array Antenna	581987 (9690-E0)

List of Manuals

Description	Manual number
The Phased Array Antenna (Workbook)	580428 (38547-00)
Radar Training System (User Guide)	8112390

Table of Contents of the Manual(s)

The Phased Array Antenna (Workbook) (580428 (38547-00))

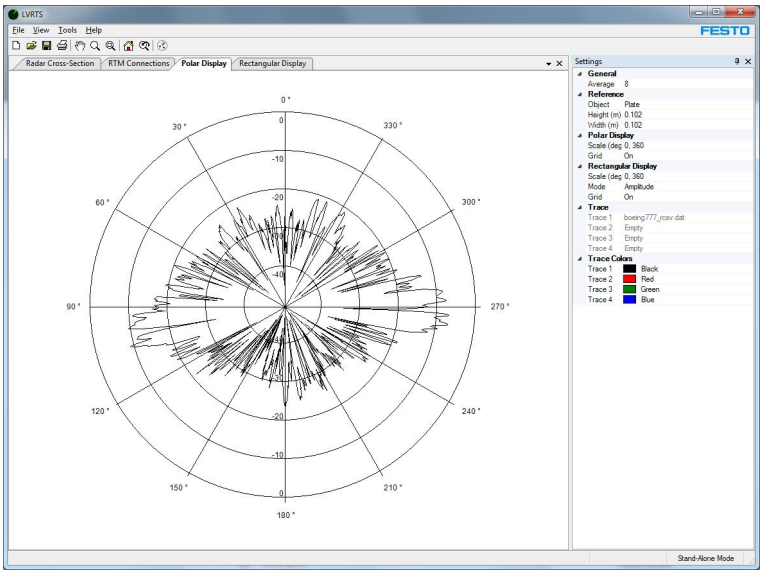
RCS and ISAR Measurement Training System (add-on to the Radar Processor/Display) 8122693 (8097-A0)

The RCS and ISAR Measurement Training System adds on to the Radar Processor/Display to form a computer-based, pulse-mode system that can measure the radar cross section (RCS) of targets and produce inverse synthetic-aperture radar (ISAR) images of targets.

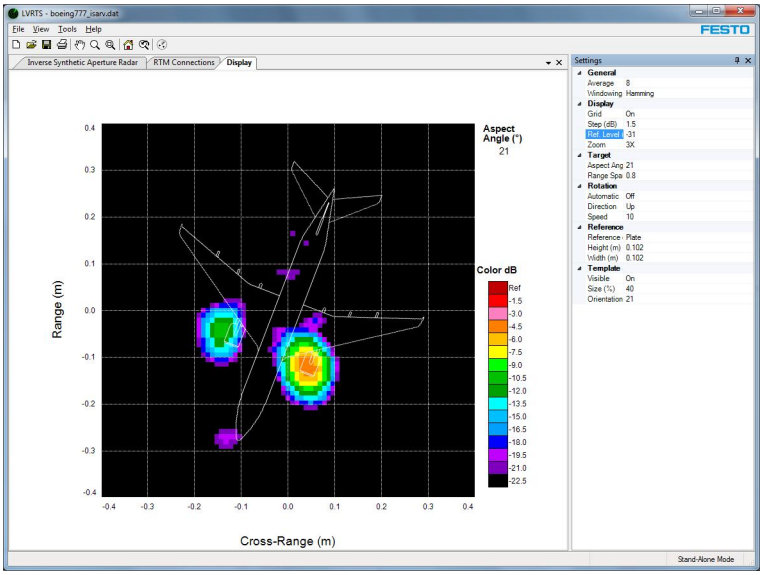
* WARNING: This equipment is subject to export control. Please contact your sales representative to know if this product can be imported in your region.

The system can generate RCS patterns of targets of up to 75 cm (30 in) in length when the longest pulse width is used. The system can also generate high-resolution ISAR images of much larger targets when the shortest pulse width is used. Because the system is based on pulse operation, it does not need to be operated in an anechoic chamber or in an outdoor range. Background clutter is rejected using time-gating and subtraction techniques during the measurement process.

The RCS and ISAR Measurement Training System includes a low-RCS target support to achieve precise RCS measurements; an RCS/ISAR data acquisition interface; an RCS measurement/ISAR imagery software included in the LVRTS software; an RCS/ISAR measurement interface module; a set of accessories including a reflective scale model of a 777 Boeing aircraft; and a system user guide. Note that RTM 9431-2 (or newer) from the Radar Processor/Display add-on is required to use this add-on. Other reflective scale models are optionally available.



RCS pattern of a scale model of a 777 Boeing aircraft obtained using the RCS and ISAR Measurement Training System.



In the ISAR imagery mode, the RCS and ISAR Measurement Training System can produce images that show the shape of a target (view of a 777-Boeing aircraft shown).

The RCS pattern of an actual aircraft can be obtained by placing a reflective scale model on top of the low-RCS rotating support of the RCS and ISAR Measurement Training System.

Accessories for 8096-A.

List of Equipment

Qty	Description	Model number
1	RCS and ISAR Measurement Training System (User Guide)	593911 (52792-E0)
1	RCS/ISAR Measurement Interface	581960 (9610-00)
1	RCS/ISAR Data Acquisition Interface	8122692 (9634-10)
1	Accessories for RCS and ISAR Measurement	8129037 (9688-D0)

Manual

Description	Manual number
RCS and ISAR Measurement Training System (User Guide)	593911 (52792-E0)

Table of Contents of the Manual(s)

RCS and ISAR Measurement Training System (User Guide) (593911 (52792-E0))

System Specifications

Parameter	Value
Frequency Range	8 to 10 GHz
Antennas	Pyramidal horn, 73 x 91 mm (2.9 x 3.6 in) aperture, 18 dB; offset feed parabolic reflector, 30cm (11.8 in), 27 dB
Selectable Pulse Width	1, 2 and 5 ns
Variable Pulse Width	0.6 to 5.5 ns
Maximum Peak Power	200 mW
Angular Accuracy	0.25°

Synthetic Aperture Radar (SAR) Training System (add-on to the RCS and ISAR Measurement Training System)
8163409 (8097-B0)

The Synthetic-Aperture Radar (SAR) Training System adds on to the RCS and ISAR Measurement Training System 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).

* WARNING: This equipment is subject to export control. Please contact your sales representative to know if this product can be imported in your region.

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 included in the Basic Radar Training System and an 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 data acquisition interface, the necessary accessories, and a system user guide. Note that RTM 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.

List of Equipment

Qty	Description	Model number
1	Synthetic-Aperture Radar (SAR) (User Guide)	593946 (54269-E0)
1	SAR Data Acquisition Interface	8136301 (9636-00)
1	Accessories for Synthetic Aperture Radar (SAR)	8171243 (9688-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))

System Specifications

Parameter	Value
Radar Frequency	8 to 10 GHz
Real Aperture Beamwidth	30°
Down (slant) Range Resolution	15 cm

Parameter	Value
Azimuth Resolution	ff 6.5 cm at 3 m (-3 dB points, Kaiser window applied)
Platform Velocity	ff 9 cm/s
Look Angle	20° to 90°
Squint Angle	0° (side-looking mode)
Maximum Aperture Lenght	89.7 cm
Range Span	3.6 m and 7.2 m
Maximum Processed Area	0.9 m x Range Span in standard mode
Extended Mode	2 m x Range Span
Sensitivity	32 dBsm at 2 m (S/N = 12 dB)
SAR Processing Gain	ff 28 dB

Radar Phase-Coded Pulse Compression Training System (add-on to the Radar Processor/Display) 8121494 (8097-C0)

Radar Pulse Compression is a signal processing technique used to increase the range resolution and signal-to-noise ratio of any pulse radar. The design of a radar is usually a question of compromise. In many cases, a trade-off must be made between desirable characteristics. For only a modest increase in cost and complexity, pulse compression improves the range resolution without sacrificing the signal-to-noise ratio. This is why all modern radars use pulse compression.

The Phase-Coded Pulse Compression System is an add-on to the Basic Radar and Radar Processor/Display Training Systems.

* WARNING: This equipment is subject to export control. Please contact your sales representative to know if this product can be imported in your region.

The system includes the Phase-Coded Pulse Compression Processor that encodes the radar pulses before transmission and compresses the received pulses. It also includes the Pulse Compression Parabolic Dish Antenna, which is designed to prevent internal reflections from interfering with the radar signal, and two attenuators (4 dB and 10 dB) used to facilitate measurements. The LVRTS software with the Phase-Coded Pulse Compression application is also included. (Note that the LVRTS software is also included with the Radar Processor / Display add-on and can be downloaded from Festo Didactic's website.)

Features & Benefits

- FPGA-based signal processing.
- Seamless integration with the Series Radar Training System.
- User-configurable Pulse Compression Processors for wide topic coverage.
- Multiple test-points for complete learning experience.
- Turnkey solution, including high quality student and instructor manuals.

List of Equipment

Qty	Description	Model number
1	Phase-Coded Pulse Compression (Student Manual)	593926 (52919-00)
1	Phase-Coded Pulse Compression (Instructor Guide)	593927 (52919-10)
1	Pulse Compression Radar Antenna	592570 (9604-B0)
1	Phase-Coded Pulse Compression Processor	592571 (9615-00)
1	Accessories Pulse Compression	8092757 (9690-G0)

List of Manuals

Description	Manual number
Phase-Coded Pulse Compression (Workbook)	593926 (52919-00)
Phase-Coded Pulse Compression (Workbook (Instructor))	593927 (52919-10)
Radar Training System (User Guide)	8112390

Table of Contents of the Manual(s)

Phase-Coded Pulse Compression (Workbook) (593926 (52919-00))

Equipment Description

RTM Power Supply 8112514 (9408-2X)

The RTM Power Supply is the power source for the Reconfigurable Training Module (RTM) used in the radar training systems. It has a multi-pin connector output, located on the back panel, that provide regulated dc voltages. Hiccup mode protection protects the outputs of the RTM Power Supply against short-circuits.

Front View

Rear View

Specifications

Parameter	Value
Power Requirements	
Service Installation	Standard single-phase ac outlet
Voltage	100-240 V ac
Current	2.5 A
Frequency	50/60 Hz
Rating of DC Power Outputs	
+5 V	2 A
+3.3 V	2.5 A
+12 V - A	1.25 A
+12 V - B	1.25 A
-12 V	0.85 A
-5 V	1 A
Physical Characteristics	
Dimensions (H x W x D)	165 x 250 x 250 mm (6.5 x 9.8 x 9.8 in)
Net Weight	5.6 kg (12.2 lb)

Reconfigurable Training Module (RTM) 8094635 (9431-30)

The Reconfigurable Training Module (RTM) consists mainly of a powerful digital signal processor (DSP), with three slots on the module front panel for installing interface modules. An Ethernet port (RJ-45) connector, located on the back panel, allows connection of the RTM to the host computer. The functionality of the training system is determined by downloading a program into the DSP memory using the host computer that runs the software. Electrical power is supplied to the RTM by the Power Supply, Model 9408, through a multipin cable that connects to the back panel.

Specifications

Parameter	Value
Interface Card Slots	
Analog/Digital	2
Digital	1
Data Link	
Data Link to Host Computer	10 Mb/s (Ethernet) or 100 Mb/s (Fast Ethernet), TCP/IP Protocol
Physical Characteristics	
Dimensions (H x W x D)	215 x 430 x 280 mm (8.5 x 16.9 x 11.0 in)
Net Weight	9.8 kg (21.6 lb)

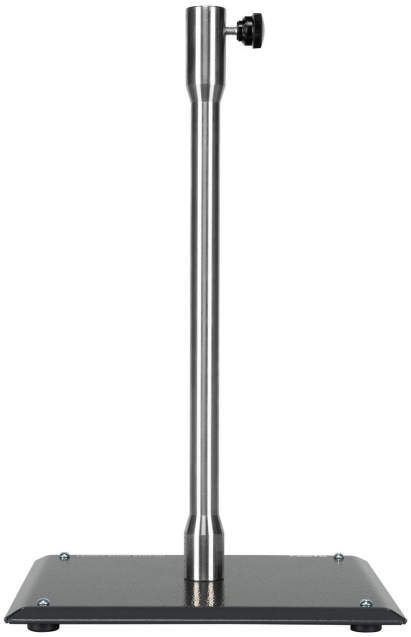
Horn Antenna 581847 (9535-00)

The Horn Antenna is used to perform experiments related to a variety of topics, such as FM-CW radar, antenna gain, and microwaves. When used in conjunction with the Radar Antenna, the Horn Antenna allows separate transmission and reception of RF signals. It is also used in certain EW demonstrations.

Specifications

Parameter	Value
Gain	14.5 dB
Distance	Between the transmitting and receiving horn antennas: 40 cm (16 in).

Radar Jamming Pod Trainer Support 581916 (9595-10)



This support is a mast designed to support the Radar Jamming Pod Trainer when it is used to perform electronic jamming against the Radar. The large base of the mast provides stable support of the Radar Jamming Pod Trainer. Soft pads attached under the base allow the mast to glide softly over the surface of the Target Positioning System.

Power Supply / Antenna Motor Driver 8084743 (9601-20)

The Power Supply / Antenna Motor Driver is the physical base for the Basic Radar Training System. Several modules of the system are designed to be stacked on top of it, side-by-side. The power supply distributes three unregulated dc voltages to the stacked modules through self-aligning connectors. These voltages are regulated within each module to provide the required voltages. Three regulated dc voltage outputs are also available through miniature banana jacks on the front panel of the power supply.

The antenna motor driver supplies power to the Rotating-Antenna Pedestal. It is a Pulse-Width-Modulated (PWM) motor driver that uses a four-quadrant chopper requiring a command signal from the antenna controller or radar target tracking system. It is equipped with front-panel test points for training purposes.

Specifications

Parameter	Value
Power Requirement	
Current	
Service Installation	Standard single-phase ac outlet
Power Supply	
Unregulated DC Outputs	-25 V typ. -3 A max.; +11 V typ. - 5 A max. (two separate outputs); +25 V typ. - 3 A max.
Regulated DC Outputs	-15 V at 0.5 A; +5 V at 1 A; + 15 V at 0.5 A
AC Line Protection	
Regulated DC Output Protection	
Unregulated DC Output Protection	
Antenna Motor Driver	
Input Voltage Range	-10 to +10 V
PWM Output Voltage Range	-24 V to +24 V max.
Physical Characteristics	
Dimensions (H x W x D)	104 x 687 x 305 mm (4.1 x 27 x 12 in)

Parameter	Value
Net Weight	

Radar Synchronizer / Antenna Controller 595986 (9602-20)

The Radar Synchronizer / Antenna Controller is used for Pulse Repetition Frequency (PRF) generation and synchronization of the radar system. It also controls the operating parameters of the radar antenna.

The synchronizer includes a PRF generator equipped with push buttons to select the PRF and either single or staggered mode. Two sets of outputs are used for synchronization, one at the selected PRF and one at 1024 times the selected PRF.

The antenna controller provides three control modes for the radar antenna: manual mode, where speed (clockwise or counterclockwise) is manually controlled; PRF locked mode, which synchronizes the rotation of the antenna to the system PRF; and SCAN/TRACK mode for 120-degree scanning. A three-digit display that can be switched to show antenna position or speed is provided. The controller accepts feedback signals from the encoder on the rotating antenna pedestal and generates a command signal for output to the antenna motor driver. The controller also generates azimuth information required by other system modules.

Unregulated dc power is automatically supplied to the Radar Synchronizer / Antenna Controller through self-aligning connectors when it is installed on the Power Supply / Antenna Motor Driver.

Specifications

Parameter	Value
Radar Synchronizer	
PRF	12, 18, 144, 216, 288 Hz
Mode	Single, Staggered
Outputs	A & B TTL
Antenna Controller	
Antenna Rotation Speed Range	0 to 15 r/min.
Azimuth Output	10-bit TTL
Output Voltage Range	-15 to +15 V max.

Rotating-Antenna Pedestal 8112383 (9603-10)

The Rotating-Antenna Pedestal is the mount and drive motor for the radar antenna. It provides the RF connection between the antenna and the radar transmitter and receiver. Antenna position feedback is obtained from an incremental optical shaft encoder, the output of which may be monitored through front-panel test points. The RF section includes a circulator for simultaneous transmission and reception. A rotary joint provides RF coupling to the rotating antenna mount.

Specifications

Parameter	Value
Rating	
RF Input and Output Impedance	50 Ω
Shaft Encoder	Incremental, 1024 steps
Shaft Encoder Outputs (A, B, Index)	TTL
Rotation	360°
Physical Characteristics	
Dimensions (H x W x D)	240 x 385 x 250 mm (9.4 x 15.2 x 9.8 in)
Net Weight	8.1 kg (17.8 lb)

Radar Antenna 581936 (9604-00)

The Radar Antenna mounts on the rotating-antenna pedestal and has a miniature plug-in connector for quick RF coupling. It uses an offset-feed design to reduce masking effects. A screen of microwave-radiation-absorbing material is also supplied, which, although not required due to the low level of RF power radiated by the system, provides training in microwave safety techniques.

Specifications

Parameter	Value
Type	Offset Feed
Feed Type	Single Horn
Beamwidth (at -3 dB)	6°
Gain	27 dB (typical)
Impedance	50 Ω
Polarization	Linear, vertical
Physical Characteristics	
Dimensions (H x W x D)	425 x 375 x 515 mm (16.8 x 14.8 x 20.3 in)
Net Weight	1.5 kg (3.3 lb)

Dual Feed Parabolic Antenna 581937 (9604-A0)

The Dual Feed Parabolic Antenna mounts on the rotating antenna pedestal and is fully compatible with the miniature plug-in RF quick connector. The dual-feed horns are connected to a microwave SPDT switch that allows alternating transmission and reception of the signal from each horn through the single rotary joint of the antenna pedestal. Switch control is achieved by superimposing a DC bias on the transmitted RF signal. The antenna beams formed by each horn are squinted in azimuth to allow lobe switching (sequential lobing) target tracking.

* WARNING: This equipment is subject to export control. Please contact your sales representative to know if this product can be imported in your region.

Specifications

Parameter	Value
Crossover Level of Antenna Beams (at 6 m)	3.2 dB (typical)
Antenna beam Squint (at 6 m)	±3.2° (typical)
Physical Characteristics	
Dimensions (H x W x D)	425 x 375 x 515 mm (16.8 x 14.8 x 20.3 in)
Net Weight	1.9 kg (4.2 lb)

Pulse Compression Radar Antenna 592570 (9604-B0)

The Radar Pulse Compression Antenna mounts on the rotating antenna pedestal and is fully compatible with the miniature plug-in RF quick connector. It uses an offset-feed design to reduce masking effects. It also comprises a low-lost cable for adding delay in pulse-compression exercises.

* WARNING: This equipment is subject to export control. Please contact your sales representative to know if this product can be imported in your region.

Specifications :

Dimensions 114 X 110 X 209 mm (4.5 X 4.3 X 8.2 in)

Net Weight 0.6 kg (1.4 lb)

Specifications

Parameter	Value
Type	Offset Feed
Feed Type	Single Horn
Beamwidth (at -3 dB)	6°
Gain	21 dB (typical)
Impedance	50 Ω
Polarization	Linear, vertical
Physical Characteristics	
Dimensions (H x W x D)	425 x 375 x 515 mm (16.8 x 14.8 x 20.3 in)
Net Weight	2.56 kg (5.63 lb)

Dual-Channel Sampler 595989 (9605-10)

The Dual-Channel Sampler performs time expansion of the I- and Q-channel baseband signals from the radar receiver in order to allow further processing and display. It has three switches to select the system observation range, as well as control knobs for adjusting the system range origin, the balance of the I- and Q-channel output signals, and the DC offsets at the I- and Q-channel outputs. A time base output is provided to obtain an A-scope display on a conventional oscilloscope.

Unregulated DC power is automatically supplied to the Dual-Channel Sampler through self-aligning connectors when it is installed on the Power Supply / Antenna Motor Driver

Specifications

Parameter	Value
I-, Q-Channel Input Voltage Range	-1 V to +1 V
Pulse Input Impedance	50 Ω
Trigger Inputs	TTL
Range	Selectable, 1.8, 3.6, and 7.2 m (5.9, 11.8, and 23.6 ft)
A-Scope Time-Base Output Level	2 V

Target Positioning System 8121782 (9607-30)

The Target Positioning System positions a passive radar target accurately. The system consists of a mobile target table, a remote target controller module connected to the table via a multiway cable, and four types of targets (a sphere, a cylinder, a 90-degree reflector, three metal plates and a plexiglass plate). The surface of the target table measures 90 by 90 cm (35.1 x 35.1 in) and is marked with a 1-cm (0.39-in) grid.

The system provides closed-loop DC servo control of the position and speed of the target in X and Y. On the target controller, either manual control of target position and speed or one of four preprogrammed trajectories can be selected. Two three-digit displays give a readout of the X and Y position or speed of the target. The target position can be controlled externally using rear panel inputs.

Radar Jamming Pod Trainer
581949 (9608-10)

The Radar Jamming Pod Trainer is a Self-Screening Jammer (SSJ) target in a compact enclosure. It is designed to be placed on the Target Positioning System to electronically attack the Radar Training System by masking the target echo signal with noise or causing either range or angle deception. The Radar Jamming Pod Trainer mainly consists of an RF signal source, a variable attenuator, transmitting and receiving horn antennas, a signal repeater, an amplitude modulator, and a remote controller.

The RF signal source is a Voltage-Controlled Oscillator (VCO) whose frequency range is approximately twice that of the Radar Training System. The VCO frequency can be adjusted to perform radar jamming using spot noise. The VCO can also be modulated in frequency, either internally or externally, to produce barrage noise jamming. The variable attenuator decreases the VCO signal level before it is sent to the transmitting horn antenna. This allows the amount of noise introduced in the victim radar (i.e., the Radar) to be adjusted. The maximum transmitted power is low, thereby providing safe operation in a laboratory environment.

The receiving horn antenna intercepts the pulse signal transmitted by the Radar. The repeater, which consists of an amplifier and a programmable delay line, amplifies and delays the intercepted signal. By transmitting this signal back to the radar and gradually increasing the delay, the range gate in the radar tracking system can be captured and pulled away from the target echo, thereby producing range deception. This technique is usually referred to as Range Gate Pull Off (RGPO).

The amplitude modulator consists of an electronic RF switch which can be controlled either internally or externally. It is used to modulate the amplitude of the VCO output signal or repeated signal (on-off modulation). The amplitude modulator allows implementation of AM noise jamming and asynchronous inverse gain jamming. It also allows blinking jamming when a second transmitting horn antenna is connected to an auxiliary RF output on the Radar Jamming Pod Trainer. These three jamming techniques are used to cause angle deception in the radar tracking system.

The remote controller is used to operate the Radar Jamming Pod Trainer. Communication between the remote controller and the Radar Jamming Pod Trainer is through an infra-red link. Buttons and an LCD display on the remote controller provide access to the various functions of the Radar Jamming Pod Trainer.

The Radar Jamming Pod Trainer can be tilted 90° to perform cross-polarization jamming, another technique used to cause angle deception in the radar tracking system. It can also be used with accessories to demonstrate other jamming techniques such as sidelobe jamming, formation jamming, and jammer illuminated chaff (JAFF), as well as the fundamentals of stealth technology.

The Radar Jamming Pod Trainer operates from unregulated DC voltages. A cable allows the Radar Jamming Pod Trainer to be connected to a standard unregulated DC power bus (available on the Power Supply / Antenna Motor Driver and the Power Supply).

* WARNING: This equipment is subject to export control. Please contact your sales representative to know if this product can be imported in your region.

Specifications

Parameter	Value
Frequency Range	8 to 12 GHz
Output Power	-30 to +10 dBm, adjustable in 1 dB steps
Internal Frequency Modulation	
Waveform	Selectable, 980-Hz synthesized triangular wave or 30-kbps pseudo-random bit sequence

Parameter	Value
Deviation	Selectable, 50 MHz, 1, 2, 3, and 4 GHz
Frequency Modulation Input	
Voltage Range	-10 to +10 V (to cover 8 to 12 GHz)
Modulating Frequency Range	DC to 130 kHz
Impedance	10 kΩ
Internal Amplitude Modulation	
Type	On-Off
Frequency	Selectable, 0.25, 0.5, 1, 2, 3, 4, 5, 140, 141, 142, 143, 144, 145, 146, 147, and 148 Hz
Amplitude Modulation Input (on-off modulation)	
Level	TTL
Delay Time / Transition Time	150 ns / 50 ns
Auxiliary RF Output	
Frequency Range	8 to 12 GHz
Output Power	-30 to +10 dBm, adjustable in 1 dB steps
Impedance	50 Ω
Signal Repeater (Programmable Delay Line)	
Maximum Input Power	+10 dBm
Range of Delay	2.66 to 5.60 ns (40 to 84.2 cm), adjustable in 7 steps of 0.42 ns (6.3 cm)
RGPO Walk-Off Time	Selectable, 0.8, 1.6, 4.0, and 8.0 s
Physical Characteristics	
Dimensions (H x W x D)	150 x 170 x 440 mm (5.9 x 6.7 x 17.3 in)
Net Weight	3.4 kg (7.5 lb)

Power Supply (Radar Electronic Warfare) 8095962 (9609-10)

The Power Supply can be installed under the surface of the Target Positioning System to provide power to the Radar Jamming Pod Trainer. It provides the same unregulated DC voltages as the Power Supply / Antenna Motor Driver through a multi-pin connector located on its top panel. This connector is identical to the power connector used on several other modules of the system and has the same pin configuration.

Specifications

Parameter	Value
Power Requirement	
Current	1.5 A (for 120 V)
Service Installation	Standard single-phase ac outlet
Unregulated DC Outputs	-25 V typ. -1.0 A max.; +11 V typ. -1.5 A max.; +25 V typ.-1.0 A max.
Line Input Protection	2 A / 1 A circuit breaker
Unregulated DC Output Protection	1.0 A and 1.5 A circuit breaker
Physical Characteristics	
Dimensions (H x W x D)	112 x 330 x 300 mm (4.4 x 13 x 11.8 in)
Net Weight	6.7 kg (14.8 lb)

RCS/ISAR Measurement Interface 581960 (9610-00)

The RCS/ISAR Measurement Interface contains additional RF circuitry that allows RCS and ISAR measurements to be performed using the Basic Radar Training System. This RF circuitry also allows the Basic Radar Training System to be converted into a synthetic aperture radar (SAR). The additional RF circuitry in the RCS/ISAR Measurement Interface consists of a

time-gated, variable-gain amplifier; a circulator; and two limiters. The time-gated, variable-gain amplifier increases the peak RF power transmitted. It also maintains the average RF power transmitted to a level that allows the system to be operated safely in a classroom laboratory. The circulator is used for simultaneous transmission and reception using the same antenna. The limiters prevent saturation in the I and Q channels of the receiving section of the system (i.e., the Radar Receiver and the Dual-Channel Sampler).

* WARNING: This equipment is subject to export control. Please contact your sales representative to know if this product can be imported in your region.

Specifications

Parameter	Value
Frequency Range	8 to 10 GHz
RF Amplifier	
Maximum Gain	22 dB
On Time per Pulse	~150 ns
Limiters	
Type	Diodes
Voltage Limits	±1 V
RF Input and Output Impedance	50 Ω
Sync. Input	TTL
Physical Characteristics	
Dimensions (H x W x D)	112 x 330 x 300 mm (4.4 x 13.0 x 11.8 in)
Net Weight	3.2 kg (7.1 lb)

Phased Array Antenna 581966 (9612-00)

The Phased Array Antenna is specifically designed to be used with the Radar Training System. It allows an horizontal sector to be scanned (azimuthal scanning) without any antenna motion. The antenna can be tilted 90° to demonstrate elevation scanning. The Phased Array Antenna consists of a microwave switch coupled to a Rotman lens and microstrip tapered slot array antennas. A built-in circulator allows simultaneous transmission and reception.

* WARNING: This equipment is subject to export control. Please contact your sales representative to know if this product can be imported in your region.

Specifications

Parameter	Value
Scan Width	±35°
Number of Beams	16
Horizontal Beam Width	5 to 6°
Gain	20 to 22 dBi
RF Input and Output Impedance	50 Ω
Control Input	TTL
Physical Characteristics	
Dimensions (H x W x D)	450 x 370 x 490 mm (17.7 x 14.6 x 19.3 in)

Parameter	Value
Net Weight	7.5 kg (16.5 lb)

Phased Array Antenna Controller 581968 (9613-00)

The Phased Array Antenna Controller is used for beam steering control of the Phased Array Antenna (PAA). It allows the PAA to be operated in the following three different scan modes: manual, continuous, and PRF locked (radar PRF dependent). The beam sequence (i.e., the order in which the beams are scanned) can be either linear or pseudo-random, or consists of even-numbered beams only (skips over every second beam). A 3-digit display on the front panel of the Phased Array Antenna Controller indicates the number of the selected beam, the angular position of the beam or the scan speed.

* WARNING: This equipment is subject to export control. Please contact your sales representative to know if this product can be imported in your region.

Specifications

Parameter	Value
Scan Mode	Manual, Continuous, and PRF Locked
Scan Speed (Continuous Scan Mode)	Selectable, 54, 90, 135, 270, 540, 810, and 1080 scans/min
Beam Sequence	Incremental, Pseudo-Random, and Even
Trigger Inputs	TTL
Azimuth Output	10-bit TTL
Control Output	TTL
Physical Characteristics	
Dimensions (H x W x D)	112 x 330 x 300 mm (4.4 x 13.0 x 11.8 in)
Net Weight	3.2 kg (7.1 lb)

Phase-Coded Pulse Compression Processor 592571 (9615-00)

The Phase-Coded Pulse Compression Processor allows to experiment pulse compression with the radar training system. It is divided into three sections: Dual-Channel Sampler, Pulse Compressor and Pulse Generator.

The Dual-Channel Sampler samples the I- and Q-Channel baseband signals from the receiver and stretch these signals in time in order to facilitate observation and measurement. It also allows to set the origin (radar display "window") and select the range span. A time base output is available to trig an oscilloscope when displaying the A-Scope.

The Pulse Compressor compresses the pulses by correlating the digital data with the selected code using one or two compressor stages. It allows to select the sample rate of the A/D converter, select the filter mode (matched or optimum mismatched). Test points are also available to monitor the different signals using an oscilloscope.

The PRF and Sync. signals need to be inputted into the module. Note that only the 288 Hz PRF mode is supported.

The Pulse Generator allows to select the pulse compression code used to encode the baseband pulse.

A switch at the back of the module allows to inject noise into the system to experiment real-life conditions.

* WARNING: This equipment is subject to export control. Please contact your sales representative to know if this product can be imported in your region.

Additional Equipment Required to Perform the Exercises (Purchased separately)

Qty	Description	Model number
1	IEC Power Cable, straight - CEE 7/VII (Type F)	789182 (93992-05) [2]
1	IEC Power Cable, straight - NEMA (Type B)	789405 (95451-00) [3]
1	IEC Power Cable, straight - AS 3112 (Type I)	789406 (95451-0A) [4]

Specifications

Parameter	Value
Pulse Inputs	
Level	-1V to +1V
Impedance	50 Ω
Connector Type	SMA
A-Scope Time Base Output	
Level	-1V to +1V
Connector Type	BNC
Ranges	Selectable, 1.8m, 3.6m, 7.2m or 12.6m (5.9 ft, 11.8 ft, 23.6 ft or 41.3 ft)
Pulse Generator	
Output Impedance	50 Ω
Connector Type	SMA
Pulse Generator / Code and Length	
Barker	4*, 5*, 7*, 13*, 5X7 ns (* normalized or non-normalized)
PRBS	15, 31 ns
Near Perfect	15, 31 ns
Golay	8 ns
Other	Rectangular: 1, 5 ns, Golay: 32 ns
Trigger Inputs	
Connector Type	BNC
Voltage Level	TTL
Pulse Compressor	
Sample Rate	1, 3 samples / ns
Filters	Optimum Mismatch, Matched
Outputs	-1V to +1V
Test Point Monitors	
Outputs	2
Test Points	6
Connector Type	BNC
Level	-1V to +1V
Power Requirements	
From DC Source	15V (60 VA max.)
External Power Adapter	100-240 V AC, 50-60 Hz, 2A
Service Installation	Standard single-phase outlet
Physical Characteristics	

[2] The power cord line is not included with stand-alone Phase-Coded Pulse Compression Processor. Please add the right power cord line for the region. Note that when ordering a system, all power cord lines are included.

[3] The power cord line is not included with stand-alone Phase-Coded Pulse Compression Processor. Please add the right power cord line for the region. Note that when ordering a system, all power cord lines are included.

[4] The power cord line is not included with stand-alone Phase-Coded Pulse Compression Processor. Please add the right power cord line for the region. Note that when ordering a system, all power cord lines are included.

Parameter	Value
Dimensions (H x W x D)	305 x 330 x 305 mm (12 x 13 x 12 in.)
Net Weight	6.7 kg (14.7 lb)

Radar Transmitter 595172 (9620-20)

The Radar Transmitter is an instructional module designed to provide training in system- and module-level troubleshooting. It has switches that the instructor can use to insert faults. These switches, as well as the circuit boards and test points, are accessed through the hinged door on top of the module.

The Radar Transmitter generates an RF signal that can be either frequency modulated or amplitude modulated. It includes an RF oscillator, a pulse generator, and an amplitude modulator.

The RF oscillator has a frequency modulator with variable modulation frequency and deviation. It also has a variable output frequency, which is indicated on 2½ digit display. An RF power switch allows the RF output to be disabled.

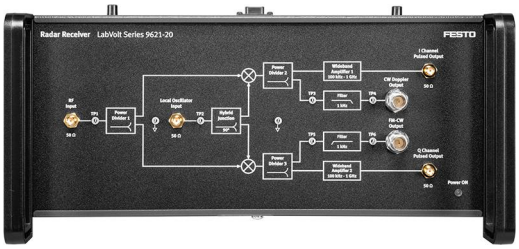
The pulse generator produces the pulses required by the system. It provides discrete and continuous variation of the pulse width. The pulse generator output signal controls the amplitude modulator to produce the pulsed (amplitude-modulated) RF signal.

Unregulated dc power is automatically supplied to the Radar Transmitter through self-aligning connectors when it is installed on the Power Supply / Antenna Motor Driver.

Specifications

Parameter	Value
RF Oscillator	
Frequency Range	8 to 10 GHz
Output Power	+10 dBm (typical)
Output Impedance	50 Ω
CW/FM-CW RF Output	
Power	+0.5 dBm (typical)
Impedance	50 Ω
Pulse Generator	
Pulse Width Ranges	1, 2, 5, 1 to 5 ns
Trigger Input	TTL
Output Level	300 mV
Output Impedance	50 Ω
Faults	10, switch-insertable
Test Points	10
Physical Characteristics	
Dimensions (H x W x D)	162 x 330 x 300 mm (6.4 x 13 x 11.8 in)
Net Weight	5 kg (11 lb)

Radar Receiver
595990 (9621-20)



The Radar Receiver is an instructional module designed to provide training in system- and module-level troubleshooting. It has switches that the instructor can use to insert faults. These switches, as well as the circuit boards and test points, are accessed through the hinged door on top of the module.

The Radar Receiver down-converts the received RF signal to baseband directly (homodyne receiver) for the three types of radar that can be implemented (CW, FM-CW, and pulse radars). Direct CW Doppler and FM-CW outputs are provided. Quadrature detection (I- and Q-channel outputs) is used for the pulse radar. Wideband amplifiers are used in the I- and Q-channels to ensure faithful baseband reproduction of the received RF signals.

Unregulated DC power is automatically supplied to the Radar Receiver through self-aligning connectors when it is installed on the Power Supply / Antenna Motor Driver.

Specifications

Parameter	Value
Type	Direct Conversion - DC-IF
Detector Type	Quadrature
RF Input Frequency Range	8 to 12.4 GHz
Bandwidth	600 MHz
Sensitivity	Noise Figure better than 18 dB
Local Oscillator Input Power	+11 dBm (+13 dBm maximum)
I- and Q-Channel Pulsed Output Voltage Range	-700 to +700 mV
CW Doppler Output Voltage Range	-15 to +15 V
FM-CW Output Voltage Range	-15 to +15 V
Faults	6, switch-insertable
Test Points	10
Physical Characteristics	
Dimensions (H x W x D)	162 x 330 x 300 mm (6.4 x 13 x 11.8 in)
Net Weight	4.8 kg (10.6 lb)

Analog/Digital Signal Combiner
8112776 (9630-10)

The Analog/Digital Signal Combiner is a compact module designed to be installed into one of the slots on the RTM of the Radar Processor/Display. This module converts the clutter and interference generated by the DSP of the RTM to analog format, and adds it to the I- and Q-channel echo signals coming from the Radar Receiver.

The Analog/Digital Signal Combiner has two BNC-connector inputs to receive the I- and Q-channel echo signals. It also has four BNC-connector outputs. Two outputs provide the clutter and interference signals added to the I- and Q-channel echo signals. The other two outputs provide the I- and Q-channel, perturbed echo signals. All these inputs and outputs are protected from misconnections within the system. Test points are available on

the module's front panel to observe all these signals using a conventional oscilloscope.

DC power is automatically supplied to the Analog/Digital Signal Combiner when it is installed into the RTM.

Specifications

Parameter	Value
Analog Inputs (2)	
Voltage Range	-10 to +10 V
Impedance	10 kΩ
Analog Outputs 3 and 4	
Voltage Range	-1 to +1 V
Impedance	600 Ω
Analog Outputs 5 and 6	
Voltage Range	-11 to +11 V
Impedance	600 Ω
Tests Points	
Test Points	6
Physical Characteristics	
Dimensions (H x W x D)	114 x 110 x 209 mm (4.5 x 4.3 x 8.2 in)
Net Weight	0.6 kg (1.4 lb)

Data Acquisition Interface 8112777 (9631-10)

The Data Acquisition Interface is a compact module designed to be installed into one of the slots on the RTM of the Radar Processor/Display. This module receives the I- and Q-channel echo signals of the radar, perturbed or not, and converts them to digital format. It also receives the PRF and synchronization signals as well as azimuth information from the Radar Synchronizer / Antenna Controller. All these signals are then routed to the RTM for digital signal processing.

The Data Acquisition Interface has two BNC-connector analog inputs to receive the I- and Q-channel echo signals. It also has two BNC-connector digital inputs where the PRF and synchronization signals are injected. A DB15 connector is provided as a digital input for the azimuth information. All these inputs are protected from misconnections within the system. Test points are available on the module's front panel to observe the input signals using a conventional oscilloscope.

DC power is automatically supplied to the Data Acquisition Interface when it is installed into the RTM.

Specifications

Parameter	Value
Analog Inputs (2)	
Voltage Range	-1.5 to +1.5 V
Impedance	10 kΩ
Digital Inputs (2)	
Parallel Digital Input	TTL, 10 bits
Test Points	4
Physical Characteristics	
Dimensions (H x W x D)	114 x 110 x 209 mm (4.5 x 4.3 x 8.2 in)
Net Weight	0.6 kg (1.4 lb)

Radar Target Tracking Interface 8112778 (9633-10)

The Radar Target Tracking Interface is a compact module designed to be installed into one of the slots on the RTM of the Radar Processor/Display. The module provides the lobe switching control signal and the RF circuitry (bias tee and DC blocking capacitor) required to perform lobe switching with the Dual Feed Parabolic Antenna. To allow manual or automatic control of the radar antenna rotation, the Radar Target Tracking Interface is also used to intercept the rotation command signal produced by the antenna controller before it reaches the antenna motor driver.

The Radar Target Tracking Interface is provided with four SMA connectors that provide access to the lobe switching RF circuitry. It also has two BNC-connector inputs (lobe switch control input and antenna rotation command input) and two BNC-connector outputs (lobe switch control output and antenna rotation command output). All these inputs and outputs are protected from misconnections within the system. Test points are available on the module's front panel to observe the signals on the BNC-connector inputs and outputs using a conventional oscilloscope.

DC power is automatically supplied to the Radar Target Tracking Interface when it is installed into the RTM.

* WARNING: This equipment is subject to export control. Please contact your sales representative to know if this product can be imported in your region.

Specifications

Parameter	Value
RF Inputs and Outputs	
Impedance	50 Ω
Frequency Range	8 to 10 GHz
Lobe Switch Control Input	
Voltage Range	-5 to +5 V
Impedance	1.5 kΩ
Lobe Switch Control Output	
Voltage Range	-5 to +5 V
Impedance	1.0 kΩ
Antenna Rotation Command Input	
Voltage Range	-10 to +10 V
Impedance	10 kΩ
Antenna Rotation Command Output	
Voltage Range	-10 to +10 V
Impedance	600 Ω
Test Points	4
Physical Characteristics	
Dimensions (H x W x D)	114 x 110 x 209 mm (4.5 x 4.3 x 8.2 in)
Net Weight	0.7 kg (1.6 lb)

RCS/ISAR Data Acquisition Interface 8122692 (9634-10)

The Data Acquisition Interface is a compact module designed to be installed into one of the slots on the RTM of the Radar Processor/Display. This module receives the I- and Q-channel echo signals of the radar and converts them to digital format. It also receives the PRF and synchronization signals as well as azimuth information from the Radar Synchronizer / Antenna Controller. All these signals are then routed to the RTM for digital signal processing. A digital output allows to route the synchronization signal to another module.

The Data Acquisition Interface has two BNC-connector analog inputs to receive the I- and Q-channel echo signals. It has two BNC-connector digital inputs where the PRF and synchronization signals are injected and one BNC-connector digital output to route the synchronization signal to another module. A DB15 connector is provided as a digital input for the azimuth information. All these inputs are protected from misconnections within the system. Test points are available on the module's front panel to observe the input signals using a conventional oscilloscope.

DC power is automatically supplied to the RCS/ISAR Data Acquisition Interface when it is installed into the RTM.

* WARNING: This equipment is subject to export control. Please contact your sales representative to know if this product can be imported in your region.

Specifications

Parameter	Value
Analog Inputs (2)	
Voltage Range	-1.5 to +1.5 V
Impedance	10 kΩ
Digital Inputs (2)	
Parallel Digital Input	TTL, 10 bits
Test Points	4
Physical Characteristics	
Dimensions (H x W x D)	114 x 110 x 209 mm (4.5 x 4.3 x 8.2 in)
Net Weight	0.6 kg (1.4 lb)

Radar Analog/Digital Output Interface 8093433 (9635-00)

The Analog/Digital Output Interface is a compact module designed to be installed into one of the slots on the RTM of the Radar Processor/Display. This module provides analog and digital output signals generated by the RTM. The nature of the signals generated depends on the type of radar processing that the RTM performs.

The Analog/Digital Output Interface has four BNC-connector analog outputs and four BNC-connector digital outputs. All these outputs are protected from misconnections within the system. Test points are available on the module's front panel to observe the output signals using a conventional oscilloscope.

DC power is automatically supplied to the Analog/Digital Output Interface when it is installed into the RTM.

Specifications

Parameter	Value
Analog Outputs (4)	
Voltage Range	-10 to +10 V
Impedance	600 Ω
Digital Outputs (4)	TTL
Test Points	8
Physical Characteristics	
Dimensions (H x W x D)	114 x 110 x 209 mm (4.5 x 4.3 x 8.2 in)
Net Weight	0.6 kg (1.4 lb)

SAR Data Acquisition Interface 8136301 (9636-00)

The Synthetic-Aperture Radar (SAR) Training System adds on to the RCS and ISAR Measurement Training

System 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).

It includes the SAR Measurement Interface and required accessories: cables and hardware.

* WARNING: This equipment is subject to export control. Please contact your sales representative to know if this product can be imported in your region.

Specifications :

Dimensions 114 X 110 X 209 mm (4.5 X 4.3 X 8.2 in)

Net Weight 0.6 kg (1.4 lb)

Specifications

Parameter	Value

Accessories for the Basic Radar Training System 8112515 (9688-00)

The Accessories for the Basic Radar Training System contain all the cables and accessories necessary for the operation of the Basic Radar Training System. These include: SMA flexible cables, BNC cables, a DB9 cable, an antenna motor driver cable, BNC tees, SMA attenuators, an SMA 50 Ω load, a measuring tape, a level, a waveguide-to-coax adapter, a horn antenna support, and quick-lock fasteners.

Accessories for the Radar Processor/Display 8112516 (9688-A0)

The Accessories for the Radar Processor/Display contains a DB15 cable, a USB port cable, an RJ-45 connector crossover cable, an Ethernet adapter (network card) to be installed in the radar host computer, two semi-circular targets, a multiple target holder to be used with the Target Positioning System and the LVRTS software CD-ROM.

Accessories for RCS and ISAR Measurement 8129037 (9688-D0)

The Accessories for RCS and ISAR Measurement contain a low-RCS target support with a storage stand, an adjustable base and long interconnection cables for the Rotating-Antenna Pedestal, additional BNC and SMA cables, a tripod with an antenna mast, a large horn antenna, a small metal plate target, a small metal plate target with radar absorbing material (RAM) on one side, and a reflective aircraft target (777-Boeing scale model).

Accessories for Synthetic Aperture Radar (SAR)
8171243 (9688-F0)

The Accessories for Accessories for Synthetic Aperture Radar (SAR) set contains a two-axis adjustable antenna support and a radiation absorbing material (RAM) panel.

Accessories for the Tracking Radar
581984 (9690-B0)

The Accessories for the Tracking Radar contains a cylinder target, two zigzag targets, and a BNC connector-to-miniature banana jack cable.

Accessories for the Radar Active Target Training System
581985 (9690-C0)

The Accessories for the Radar Active Target Training System contain a chaff cloud simulation device, a multifunction stand, a triangular (stealth) shield to cover the Radar Jamming Pod Trainer, Radiation Absorbing Material (RAM), a set of microwave components and cables, and a sample of actual chaff.

Accessories for the Radar Phased Array Antenna
581987 (9690-E0)

The Accessories for the Radar Phased Array Antenna contain two short SMA cables with built-in passive limiters, two low-loss long SMA cables, a 30 dB SMA attenuator, a DB25 cable, and a microwave absorbing pen.

Accessories Pulse Compression
8092757 (9690-G0)

Accessories for the Phase-Coded Radar Pulse Compression. Includes two attenuators (4dB and 10 dB), longer limiter cables, and a SMA adaptor.

Radar Tracker Hand Controller (USB)
581992 (9694-10)

The Radar Tracker Hand Controller (USB) is a joystick-type device designed to be connected to a USB port of a personal computer. It is used to select specific targets when the tracking radar is in the manual mode of operation. Fore and aft motion of the handle allows range positioning of a tracking cursor (range gate). Left-right motion of the handle controls the direction of the antenna's rotation, thereby allowing the antenna to be rotated to a particular azimuth. Mode control of the tracking radar is achieved with the trigger buttons on the handle of the Hand Controller.

Specifications

Parameter	Value
Physical Characteristics	
Dimensions (H x W x D)	190 x 165 x 165 mm (7.5 x 6.5 x 6.5 in)
Net Weight	0.8 kg (1.8 lb)

Optional Equipment Description

Dual-Trace Digital Storage Oscilloscope (Optional)
585695 (798-10)

The Dual trace digital storage oscilloscope enables students to measure, observe, and display results to perform the courses.

The Dual-Trace Digital Storage Oscilloscope is a affordable oscilloscope that is ideally suited for general purpose use in any classroom laboratory.

Two low-capacitance probes are included with the unit.

Specifications:

- Input Channels: 2
- Bandwidth: 50 MHz (at input BNC)
- Maximum Input Voltage: 400 V CATII
- Auto Measure System
- Display: Color TFT 17.8 cm (7 in)
- Interfaces: USB host, USB devices, pass/fail output

Features & Benefits

- Color, 17.8 cm (7 in) TFT
- Multi-language, on-display menu
- 50 MHz bandwidth
- 1 GSa/s maximum sampling rate
- 2 ns/div to 100 s/div time base

- 1 mV/div to 10V/div vertical sensitivity
- ±3% accuracy
- USB ports
- Compact design
- Light weight

Function Generator 5 MHz / Frequency Counter (Optional) 8125246 (9409-00)

Direct digital synthesized arbitrary function generator with an embedded frequency counter, perfect to complement telecommunication or radar training systems.

Radar Host Computer (Optional) 587465 (9695-00)

The Radar Host Computer is a Windows® based computer with the LVRTS software installed, two monitors, and a dual-output display adapter (video card) compatible with Microsoft DirectX® version 9 or later.

The Radar Host Computer is used to run the LVRTS software and is linked to the RTM of the Radar Processor/Display through a high-speed data link (Ethernet link with TCP/IP protocol). It provides the radar's PPI display and allows control of the radar processing and display functions, and much more as described in the General Description of the Radar Processor/Display.

The Radar Host Computer is not included in the Radar Processor/Display. It must be purchased separately or replaced with an equivalent personal computer. The Windows® 7 or later operating system is required to run the LVRTS software.

Reflecting the commitment of Festo Didactic to high quality standards in product, design, development, production, installation, and service, our manufacturing and distribution facility has received the ISO 9001 certification.

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