

# Basic Radar Training System 8112495 (8097-10)

**FESTO**

LabVolt Series

Datasheet



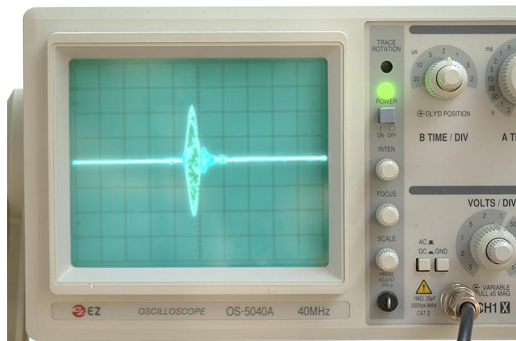
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## General Description

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.



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).

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

## List of Equipment

Qty	Description	Model number
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 8097-1 _____	8112515 (9688-00)

## List of Manuals

Description	Manual number
Principles of Radar Systems (Student Manual) _____	580402 (38542-00)
Radar Training System (Instructor Guide) _____	580405 (38542-10)

## Table of Contents of the Manual(s)

### Principles of Radar Systems (Student Manual) (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

Qty	Description	Model number
1	Dual-Trace Digital Storage Oscilloscope _____	585695 (798-10) <sup>1</sup>
1	Dual-Trace Digital Storage Oscilloscope _____	585696 (798-15) <sup>2</sup>
1	Dual-Trace Digital Storage Oscilloscope _____	585694 (798-1A) <sup>3</sup>
1	Frequency Counter (0.1Hz - 2.4 GHz) _____	8112877 (9416-00) <sup>4</sup>

## System Specifications

Parameter	Value
<b>Power Requirement</b>	
Current	10 A (for 120V)
Frequency Range	8-10 GHz
<b>Output Power Density at Horn</b>	
CW Mode	0.02 mW/cm <sup>2</sup>
Maximum Range (Equiv. RCS of Target: 1 m <sup>2</sup> )	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)
<b>Physical Characteristics</b>	
Dimensions	About 8 m <sup>2</sup> (86 ft <sup>2</sup> )
Net Weight	TBE

<sup>1</sup> Only one oscilloscope is required to perform the experiments. Please select the right one based on your AC network.

<sup>2</sup> Only one oscilloscope is required to perform the experiments. Please select the right one based on your AC network.

<sup>3</sup> Only one oscilloscope is required to perform the experiments. Please select the right one based on your AC network.

<sup>4</sup> A frequency counter is required to perform the experiments.

## Equipment Description

### 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).

### 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 Model 9603 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
<b>Power Requirement</b>	
Current	
Service Installation	Standard single-phase ac outlet
<b>Power Supply</b>	
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	
<b>Antenna Motor Driver</b>	
Input Voltage Range	-10 to +10 V
PWM Output Voltage Range	-24 V to +24 V max.

Parameter	Value
<b>Physical Characteristics</b>	
Dimensions (H x W x D)	104 x 687 x 305 mm (4.1 x 27 x 12 in)
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
<b>Radar Synchronizer</b>	
PRF	12, 18, 144, 216, 288 Hz
Mode	Single, Staggered
Outputs	A & B TTL
<b>Antenna Controller</b>	
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
Power Requirement	+25 V – 425 mA; -25 V – 325 mA
<b>Rating</b>	

Parameter	Value
Input Frequency Range	10 Hz - 10 MHz, 10 MHz - 200 MHz
Input Period Range	0.1 s – 4 $\mu$ s (10 Hz-2.5 MHz)
Count Range	1 - 99 999 999
Input Impedance	1 M $\Omega$
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
<b>Physical Characteristics</b>	
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 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
<b>Type</b>	Offset Feed
<b>Feed Type</b>	Single Horn
<b>Beamwidth (at -3 dB)</b>	6°
<b>Gain</b>	27 dB (typical)
<b>Impedance</b>	50 $\Omega$
<b>Polarization</b>	Linear, vertical
<b>Physical Characteristics</b>	
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-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 $\Omega$
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 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.

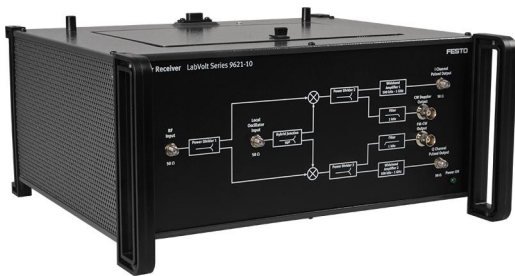
Unregulated dc power is automatically supplied to the Radar Transmitter through self-aligning connectors when it is installed on the Power Supply / Antenna Motor Driver.

## Specifications

Parameter	Value
<b>RF Oscillator</b>	
Frequency Range	8 to 10 GHz
Output Power	+10 dBm (typical)

Parameter	Value
Output Impedance	50 $\Omega$
<b>CW/FM-CW RF Output</b>	
Power	+0.5 dBm (typical)
Impedance	50 $\Omega$
<b>Pulse Generator</b>	
Pulse Width Ranges	1, 2, 5, 1 to 5 ns
Trigger Input	TTL
Output Level	300 mV
Output Impedance	50 $\Omega$
Faults	10, switch-insertable
Test Points	10
<b>Physical Characteristics</b>	
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
<b>Physical Characteristics</b>	
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)



## Accessories for 8097-1 8112515 (9688-00)



The Accessories for 8097-1 set contains all the cables and accessories necessary for the operation of the Basic Radar Training System, Model 8097-1. These include: SMA flexible cables, BNC cables, a DB9 cable, an antenna motor driver cable, BNC tees, SMA attenuators, an SMA 50  $\Omega$  load, a measuring tape, a level, a waveguide-to-coax adapter, a horn antenna support, and quick-lock fasteners.

## Optional Equipment Description

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



The Dual-Trace Digital Storage Oscilloscope is a low-cost oscilloscope that is ideally suited for general purpose use in any classroom laboratory. Two low capacitance probes are included with the unit.

### Features & Benefits

- Color, 17.8 cm (7 in) liquid crystal display
- Multi-language, on-display menu
- 50 MHz bandwidth
- 1 GSa/s maximum sampling rate
- 10 ns/div to 50 s/div time base
- 2 mV/div to 10V/div vertical sensitivity
- $\pm 3\%$  accuracy
- USB and RS 232 ports
- Compact design
- Light weight

### Dual-Trace Digital Storage Oscilloscope (Optional) 585696 (798-15)



The Dual-Trace Digital Storage Oscilloscope is a low-cost oscilloscope that is ideally suited for general purpose use in any classroom laboratory. Two low capacitance probes are included with the unit.

#### Features & Benefits

- Color, 17.8 cm (7 in) liquid crystal display
- Multi-language, on-display menu
- 50 MHz bandwidth
- 1 GSa/s maximum sampling rate
- 10 ns/div to 50 s/div time base
- 2 mV/div to 10V/div vertical sensitivity
- $\pm 3\%$  accuracy
- USB and RS 232 ports
- Compact design
- Light weight

### Dual-Trace Digital Storage Oscilloscope (Optional) 585694 (798-1A)



The Dual-Trace Digital Storage Oscilloscope is a low-cost oscilloscope that is ideally suited for general purpose use in any classroom laboratory. Two low capacitance probes are included with the unit.

#### Features & Benefits

- Color, 17.8 cm (7 in) liquid crystal display
- Multi-language, on-display menu
- 50 MHz bandwidth
- 1 GSa/s maximum sampling rate
- 10 ns/div to 50 s/div time base
- 2 mV/div to 10V/div vertical sensitivity
- $\pm 3\%$  accuracy

- USB and RS 232 ports
- Compact design
- Light weight

**Frequency Counter (0.1Hz - 2.4 GHz) (Optional)**  
**8112877 (9416-00)**



2.4 GHz frequency counters that is microprocessor controlled. Its LED displays can provide up to nine digits of resolution using an external time base with a 10 s gate time. The high accuracy, sensitivity, and versatility of these counters make them an extremely valuable instrument to complement telecommunication and radar training systems.

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.

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