Radar Training System

Communication and Radar Technology

User Guide



Festo Didactic
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User Guide

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Safety symbols and procedures

The following table lists the safety and common symbols that may be used in this document and on the equipment. Before performing procedures with the equipment, you should read all sections regarding safety in the User Guide accompanying the equipment. Additional safety procedures are given before any task requiring specific safety precautions.

Symbol	Description
	**DANGER** indicates a hazard with a high level of risk, which, if not avoided, will result in death or serious injury.
	**WARNING** indicates a hazard with a medium level of risk, which, if not avoided, could result in death or serious injury.
	**CAUTION** indicates a hazard with a low level of risk, which, if not avoided, could result in minor or moderate injury.
	**NOTICE** indicates a hazard with a potentially hazardous situation, which, if not avoided, may result in property damage.
	Caution, risk of danger. Consult the relevant user documentation.
	Caution, risk of electric shock.
	Caution, lifting hazard.
	Caution, hot surface.

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Symbol	Description
	Caution, risk of fire.
	Caution, risk of explosion.
	Caution, belt drive entanglement hazard.
	Caution, chain drive entanglement hazard.
	Caution, gear entanglement hazard.
	Caution, hand crushing hazard.
	Static sensitive contents. Observe precautions for handling electrostatic discharge sensitive devices.
	Notice, non-ionizing radiation.
	Consult the relevant user documentation.
	Radio Equipment Directive (RED) geographical restrictions – consult the relevant user documentation.

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Symbol	Description
	Direct current.
	Alternating current.
	Both direct and alternating current.
	Three-phase alternating current.
	Earth (ground) terminal.
	Protective conductor terminal.
	Frame or chassis terminal.
	Equipotentiality.
	On (supply).
	Off (supply).
	Equipment protected throughout by double insulation or reinforced insulation.

Symbol	Description
	In position of a bi-stable push control.
	Out position of a bi-stable push control.

About this document

The operator should familiarize himself/herself with the contents of this document before installing and operating the equipment.

The Safety Symbols table at the beginning of this document lists safety symbols that may be present in this document or on the equipment.

This document is freely available for download from the Festo Didactic website.

Upon request, printed copies of this document are freely available. Contact your Festo Didactic sales representative.



Important. In this document, "the equipment" and/or "the training system" specifically refers to the Radar Training System and all its add-ons.



The total time required to perform this course is: 6.0 hour(s)

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General Requirements for Operating the Equipment

General requirements for safe operation of electrical equipment:

- National regulations for operating electrical systems and equipment must be observed in commercial facilities.
- The laboratory or classroom must be overseen by a supervisor.
    - A supervisor is a qualified electrician or a person who has been trained in electrical engineering, knows the respective safety requirements and regulations, and whose training has been documented accordingly.
- Installation and commissioning of the equipment must be performed as directed in the accompanying documentation before any person can use the equipment for its intended purpose.
- Damaged or defective equipment must never be used.
    - Damaged devices must be barred from further use and removed from the laboratory or classroom.

Regulation in certain countries requires that the laboratory or classroom is equipped with the following devices:

- The ac power outlets in the laboratory or classroom must be protected by residual current devices (RCDs).
    - Electrical equipment (e.g., power supply units, compressors, hydraulic power units, etc.) may only be operated in training rooms which are equipped with residual current devices (RCDs).
    - Type A or type B residual current circuit breakers with a residual current set in accordance with the local regulation (generally ≤ 30 mA) must be used to protect the ac power outlets in the laboratory or classroom.
- The ac power outlets in the laboratory or classroom must be protected by overcurrent protection devices.
    - Circuit breakers or fuses.

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For additional safety, the laboratory or classroom can also be equipped with the following devices:

- One or several energy-off devices can be provided.
    - An emergency-off device can be provided to turn electric power off for the whole laboratory or classroom.
    - An emergency-off device can be provided at each workstation to turn electric power off at the workstation only.
- The laboratory or classroom can be secured so that operating voltage and compressed air supply cannot be activated by unauthorized persons, for example by means of:
    - Lockable power-on switches.

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Use for Intended Purpose

The equipment may only be used:

- For its intended purpose in teaching and training applications.
- When its safety functions are in flawless condition.

The components of the equipment are designed in accordance with the latest technology and recognized safety rules. However, life and limb of the user and third parties may be endangered and the equipment may be impaired if it is used improperly.

The learning program from Festo Didactic has been developed and produced exclusively for training purposes. To ensure the safety of the trainees during their training, the training company and/or supervisors must make sure that all trainees use the equipment as directed in the accompanying Festo Didactic training manuals, and observe the safety instructions and precautions in the present document.



⚠ WARNING

Risk of danger from using the equipment in a way other than prescribed by Festo Didactic!

- Using the equipment in a way other than directed in the accompanying Festo Didactic training manuals, or using the equipment with equipment from other manufacturers, may increase the risk of danger for the users of the equipment.
- To minimize the risk of danger related to the situation described above, always respect the specifications marked on the equipment as well as the specifications in the Festo Didactic data sheet of the equipment.
- If the equipment includes a third-party component, always respect the specifications and directives provided in the user document on this component to minimize the risk of danger related to the situation described above.

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Guarantee and Liability

Our "general terms and conditions of sale and delivery" are always applicable. These are made available to the operating company no later than on conclusion of the sales contract. Guarantee and liability claims resulting from personal injury and/or property damage are excluded if they can be traced back to one or more of the following causes:

- Use of the equipment for anything other than its intended purpose.
- Improper commissioning and/or operation of the equipment.
- Use of the equipment with defective safety equipment, or with improperly attached or non-functional safety and protective equipment.
- Non-compliance with instructions included in the core documentation about commissioning and operation.
- Unauthorized modifications to the equipment.
- Improperly executed repairs.
- Disasters resulting from the influence of foreign bodies and acts of nature.

Festo Didactic hereby excludes any and all liability for damages suffered by trainees, the training company, and/or any third parties, which occur during use of the equipment in situations which serve any purpose other than training and/or vocational education, unless such damages have been caused by Festo Didactic due to malicious intent or gross negligence.

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For Your Safety

Important information

Fundamental prerequisites for safe use and trouble-free operation of the equipment include knowledge of basic safety precautions and safety regulations. This document includes important instructions for safe use of the equipment.

In particular, the safety precautions must be adhered to by all persons who work with the equipment. In addition, all pertinent accident prevention rules and regulations, which are applicable at the respective place of use, must be adhered to.

Obligations of the operating company

The operating company only permits those who meet the following qualification to work with the equipment:

- Persons that are familiar with the basic regulations regarding work safety and accident prevention, and have been trained in the use of the equipment.
- Persons that have read and understood the chapter concerning safety and the warnings in this manual.

Personnel should be tested at regular intervals for safety-conscious work habits.

Obligations of the trainees

All persons who have been entrusted to work with the equipment must complete the following steps before beginning work.

- Read the chapter concerning safety and the warnings in this manual.
- Familiarize themselves with the basic regulation regarding work safety and accident prevention.

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Work and Safety Instructions

General



⚠ WARNING

Presence of dangerous voltage!

The equipment conducts voltages which may be dangerous. Disregard of the warnings and/or non-observance of the safety instructions in this document may result in life-threatening danger, severe injury, or major damage to property.



⚠ CAUTION

- Trainees should only work with the equipment under the supervision of a qualified supervisor.
- Always use the equipment as directed in the accompanying Festo Didactic training documents.
- Observe the specifications included in the technical data for the individual components, and in particular, all safety instructions.
- Set the equipment up so that activation of switches and disconnectors is not made difficult.
- Any equipment malfunction which may impair safety must be eliminated immediately.

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⚠ CAUTION

Risk of body injury when handling heavy equipment!

- Heavy equipment is identified with the symbol shown to the left.
- To minimize the risk of injury mentioned above, use care when manipulating heavy equipment.
- Refer to section Handling and installing modules of this document for safety guidelines related to the manipulation of heavy equipment.



⚠ CAUTION

Mechanical hazard – Stab or puncture

- Keep a safe distance from moving equipment.
- Wear safety glasses.

Mechanical hazard – Loss of stability/tipping

- Do not apply excessive force when using the equipment, especially when multiple modules are stacked together.
- Do not lean on a stack of modules.
- Respect the setup presented in courses; do not stack modules higher than mentioned in the exercises.

Electrical system



⚠ CAUTION

Hazard-free operation of the equipment is no longer possible in the case of visible damage, malfunction, incorrect storage, or incorrect transport. In any of these situations, turn electric power off immediately and protect the equipment against inadvertent use.

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NOTICE

- When laying cables and leads, make sure that they are not kinked or pinched.
- Always pull on the plug when disconnecting cables or leads. Never pull on the cable or lead itself.
- Ventilation slots on the equipment must never be covered! The equipment is cooled primarily by convection.
- Make sure that connection cables and leads are not subjected to continuous tensile loads.
- Make sure that you use detachable mains supply cords with adequate rating.
- The equipment may generate high-frequency interference in residential areas, which may make it necessary to implement interference suppression measures.

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Safety Precautions

Preliminary warning

Even though the equipment has been carefully designed to ensure trainees' safety, there are residual risks that cannot be reduced via technical solutions without impairing the learning process. The first and foremost safety measure that must be enforced at all times is the proper supervision of the trainees.

Nothing can replace the supervision and guidance of a qualified instructor. Trainees have an incomplete mastery of the subject. They can make mistakes and most certainly will. That is an essential part of the learning process.

The role of the instructor is to let trainees make mistakes that have no consequences on their safety, while protecting them from mistakes that can have unfortunate consequences.



⚠ CAUTION

Nothing can replace the supervision and guidance of a qualified instructor.

Indication of conformity

The following EU directives are relevant for the CE marking of the equipment:

- Low-Voltage Directive
  - The Low-Voltage Directive requires that products do not cause electrical hazards.
- Electromagnetic Compatibility (EMC) Directive
  - The EMC Directive requires that electric devices must only influence one another to a limited extent.
- Restriction of the Use of Certain Hazardous Substances (RoHS) Directive
  - The RoHS Directive requires a limit to hazardous substances such as lead, mercury, cadmium, or chrome.
- Radio Equipment Directive (RED)
  - The Radio Equipment Directive establishes a regulatory framework to make radio equipment available on the market and its commission in the EU.

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The following is the list of compliance documents related to this system. They are attached at the end of the present user guide.

CE compliance documents

- **Festo Didactic CE declaration of conformity (PDF_CRT DoC0026_CE_2022-03-11.pdf)**
- **CKC Certification Services – EU Type Examination Certificate for the Radar Training System (PDF_CRT DoC0026_Radar 105599-01-EURED TEC-Final.pdf)**
- **CKC Certification Services – EU Type Examination Certificate for the Jamming Pod (PDF_CRT DoC0026_JamPOD 105599-03-EURED TEC-Final.pdf)**
- **CKC Certification Services – EU Type Examination Certificate for the SAR / RCS / ISAR (PDF_CRT SAR 106560-01-EURED Certificate-Final.pdf)**

UKCA compliance documents

- **Festo Didactic UKCA declaration of conformity (PDF_CRT DoC0026_UKCA_2022-03-11.pdf)**
- **CKC Certification Services – UK Type Examination Certificate for the Radar Training System (PDF_CRT DoC0026_Radar 105599-02-UKRE TEC-Final.pdf)**
- **CKC Certification Services – UK Type Examination Certificate for the Jamming Pod (PDF_CRT DoC0026_JamPOD 105599-04-UKRE TEC-Final.pdf)**
- **CKC Certification Services – UK Type Examination Certificate for the SAR / RCS / ISAR (PDF_CRT SAR 106560-02-UKRE Certificate-Final.pdf)**

Degrees of ingress protection (IP)

The equipment is rated IP20.

NOTICE

The equipment is not protected against liquid infiltration or immersion. Keep it away from all types of liquids. Failure to do so could damage the equipment.

Equipment modification

Do not modify the equipment without prior written permission of Festo Didactic. The equipment uses complex industrial components and modifications could have undesired consequences on product integrity and safety.

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Safety with RF fields

In normal operation, the radiation levels in the Radar Training System are too low to be dangerous. The maximum continuous power radiated by the system is at the antenna horn in CW (continuous wave) mode. This is typically 2 mW or less from 8 to 10 GHz (except for the Jamming Pod, see Appendix A). The maximum power density in this case is 0.08 mW/cm² from 8 to 10 GHz.

The following figure shows how the maximum power density of the Radar Training System (RTS) in different modes compares with radiation standards established by three regulatory organizations: the American Federal Communications Commission (FCC), the International Commission on Non-Ionizing Radiation Protection (ICNIRP), and Health Canada. There are two traces for each standard, one for people classed as RF and microwave exposed workers (solid line) and one for people who are not so classed, including the general public (broken line).

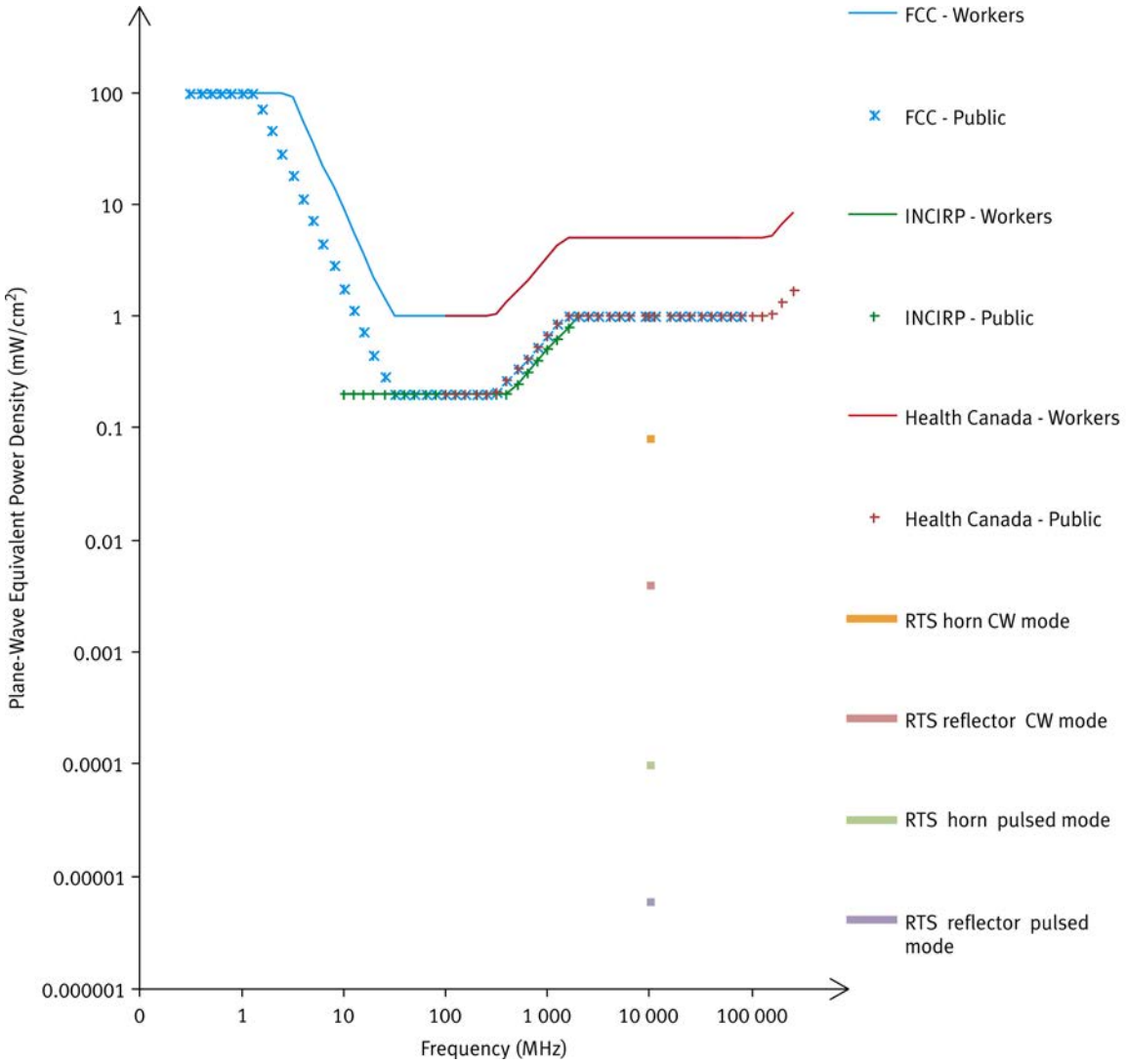


Figure 1: Radiation safety standards and maximum power densities of the Radar Training System (RTS).

In order to develop good safety habits, students are advised to set the RF Power switch to the STANDBY position, whenever possible, before placing themselves in from of the transmitting antenna, and to avoid looking directly at a transmitting antenna. In addition, a microwave-absorbing parapet is provided with the Radar Antenna in order to protect the operator(s) of the Radar Training System against long-time exposure to microwave radiation, and to encourage good safety habits.

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Equipment Description

Equipment Description (Radar Training System)

This section identifies the main components (connectors, controls, displays, indicators, etc.) on the equipment. It also provides operating instructions specific to certain pieces of equipment.



All information required for the operation of the equipment is provided in the Student Manuals.

The following points apply to the equipment descriptions in this section:

- All inputs and outputs are protected against misconnections within the system.
- For input connectors designed for connecting external equipment, the acceptable voltage range is indicated on the equipment near the connector.
- All SMA connector inputs and outputs have a 50 Ω impedance.
- Test points (TPs) are provided on some modules to allow observing signals on an oscilloscope.

Systems and add-ons

The **Basic Radar Training System** is a complete set of hardware and accessories designed for studying the principles of pulse, CW Doppler, and FM-CW radar systems. It does not use a computer but requires the use of an oscilloscope.

The **Radar Processor/Display** is used in conjunction with the Basic Radar Training System and a computer to form a complete and modern pulse radar system.

The **Radar Tracking Training System** is an add-on to the Basic Radar and Radar Processor/Display Training Systems to form a continuous tracking radar.

The **Radar Active Target (RAT) Training System** is used in conjunction with the above three systems to train students in the principles and scenarios of electronic warfare (EW).

The **Radar Phased Array Antenna Training System** is an add-on to the Basic Radar and Radar Processor/Display Training Systems for studying electronically steered antennas.

The **Radar Phase-Coded Pulse Compression Training System** is an add-on to the Basic Radar and Radar Processor/Display Training Systems for studying pulse-compression signal processing.

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Basic Radar Training System

Power Supply / Antenna Motor Driver

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 regulated dc voltages to the stacked modules through self-aligning DB9 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.

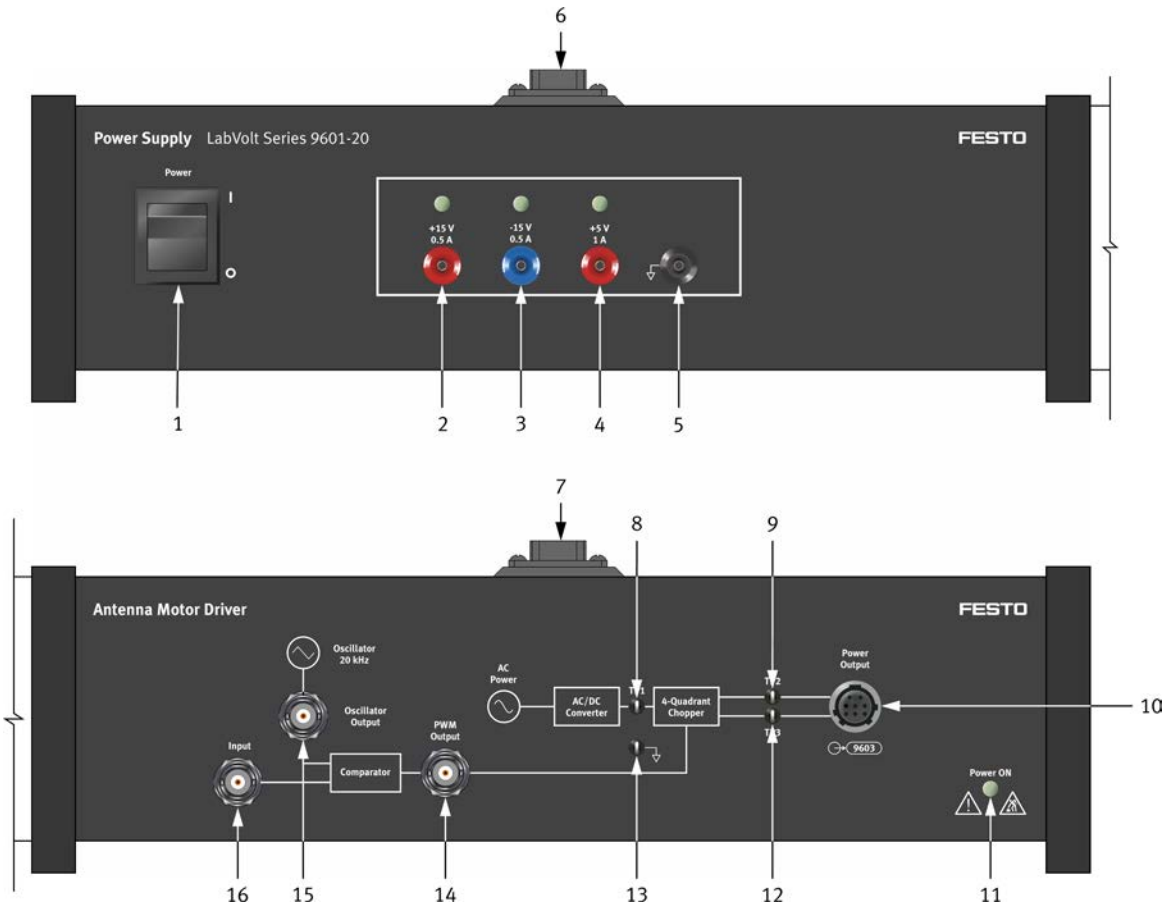


Figure 2: Front panel of the Power Supply / Antenna Motor Driver.

Table 1: Description of the Power Supply / Antenna Motor Driver (front panel).

Number	Type	Component name
1	rocker switch	Power on/off switch
2	jack 2 mm	Supply voltage +15 V 0.5 A

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Number	Type	Component name
3	jack 2 mm	Supply voltage -15 V 0.5 A
4	jack 2 mm	Supply voltage +5 V 1 A
5	jack 2 mm	Ground
6	DB9	Connector for supplying dc voltages to other modules
7	DB9	Connector for supplying dc voltages to other modules
8	test point	TP1 - AC/DC Converter output
9	test point	TP2 - 4-Quadrant Chopper output
10	M12	Power Output
11	LED	Power ON indicator
12	test point	TP3 - 4-Quadrant Chopper output
13	test point	Ground
14	BNC	PWM Output
15	BNC	Oscillator Output
16	BNC	Input to Comparator

Table 2: DB9 connector outputs on top and front of the Power Supply / Antenna Motor Driver.

Outputs	Specifications
Unregulated DC Outputs	–24 V typical 2.5 A max. +12 V typical 5 A max. +24 V typical 2.5 A max.
Regulated DC Outputs	+15 V 0.5 A –15 V 0.5 A +5 V 1 A

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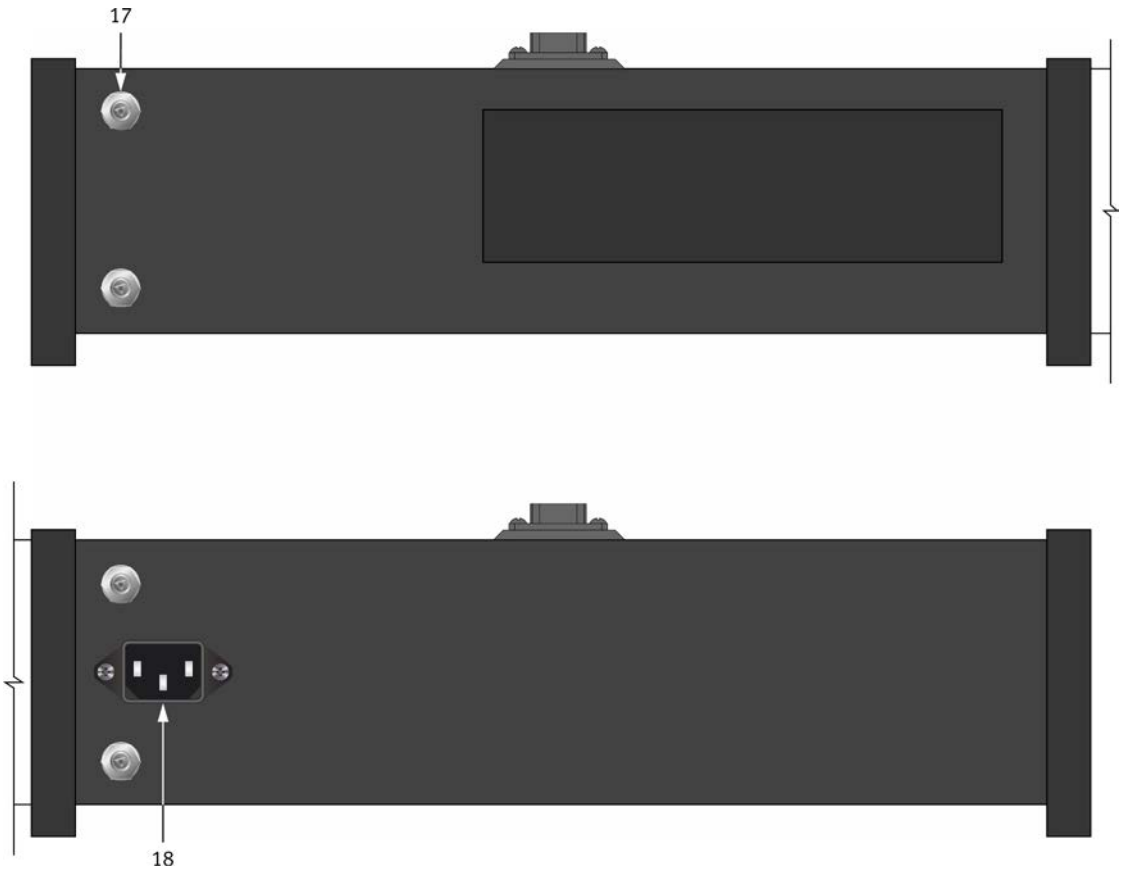


Figure 3: Rear panel of the Power Supply / Antenna Motor Driver.

Table 3: Description of the Power Supply / Antenna Motor Driver (rear panel).

Number	Type	Component name
17	POAG	Protective earthing (PE) terminal
18	IEC C14	Power inlet [100-240 V 240 W 50/60 Hz]

Radar Synchronizer / Antenna Controller

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.

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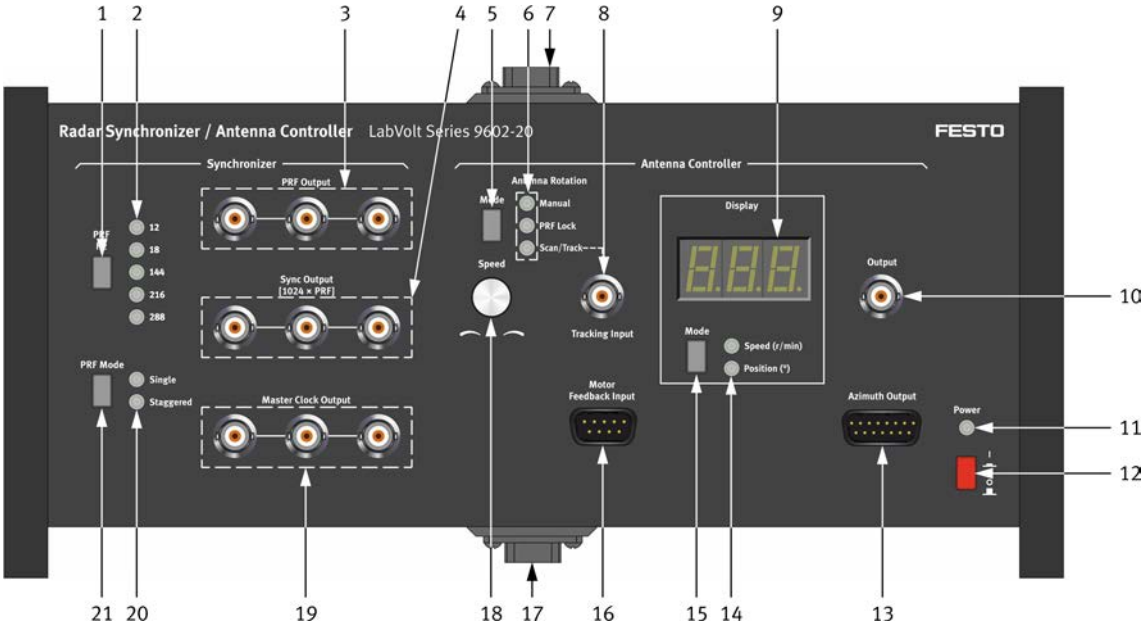


Figure 4: Front panel of the Radar Synchronizer / Antenna Controller.

Table 4: Description of the Radar Synchronizer / Antenna Controller (front panel).

Number	Type	Component name
1	push button	PRF selector
2	LEDs	PRF indicator [12 | 18 | 144 | 216 | 288 Hz]
3	BNC (3)	PRF Outputs
4	BNC (3)	Sync Outputs [1024 x PRF]
5	push button	Antenna Rotation Mode selector
6	LEDs	Antenna Rotation Mode indicator [Manual | PRF Lock | Scan/Track]
7	DB9	Connector for dc voltages from the Power Supply / Antenna Motor Driver
8	BNC	Tracking Input for Scan/Track mode
9	multi-segment display	Display for Speed (revolutions/min) or Position (°)
10	BNC	Antenna Controller Output

Number	Type	Component name
11	LED	Power indicator
12	push button	Power on/off switch
13	DB15	Azimuth Output
14	LEDs	Display Mode indicator [Speed | Position]
15	push button	Display Mode selector
16	DB9	Motor Feedback Input
17	DB9	Connector for dc voltages from the Power Supply / Antenna Motor Driver
18	knob	Antenna Rotation Speed control (for Manual mode)
19	BNC (3)	Master Clock Outputs
20	LEDs	PRF Mode indicator [Single | Staggered]
21	push button	PRF Mode switch

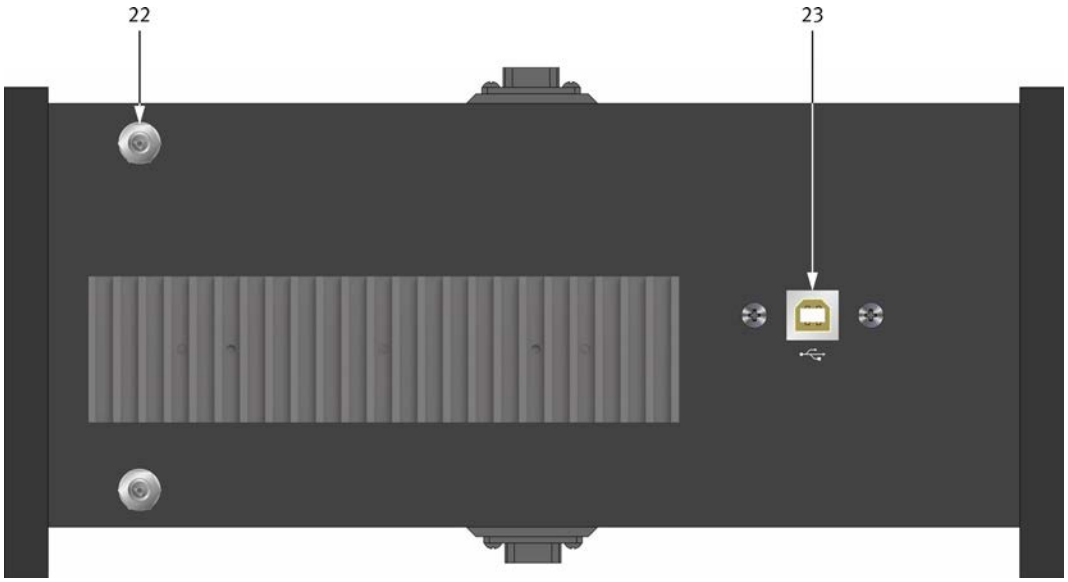


Figure 5: Rear panel of the Radar Synchronizer / Antenna Controller.

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Table 5: Description of the Radar Synchronizer / Antenna Controller (rear panel).

Number	Type	Component name
22	POAG	Protective earthing (PE) terminal
23	USB-B	USB connector

Radar Transmitter

The Radar Transmitter generates an RF signal in the range of 8 GHz to 10 GHz that can be either frequency modulated or amplitude modulated. It includes an RF oscillator, a pulse generator, and an amplitude modulator. This module has fault switches (located under a cover on the rear panel) for troubleshooting exercises.

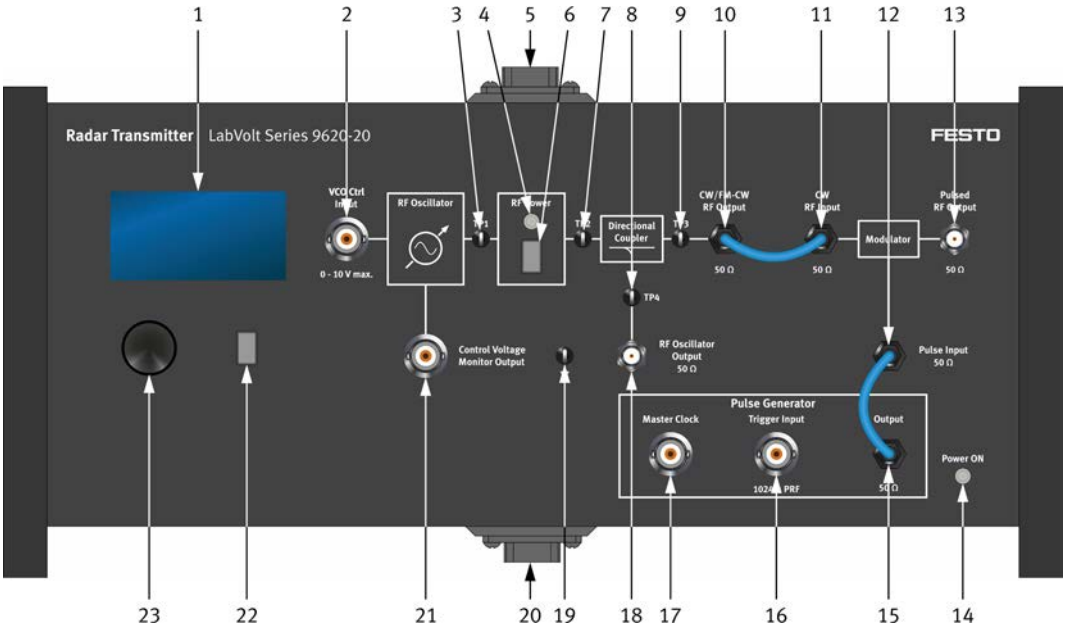


Figure 6: Front panel of the Radar Transmitter.

Table 6: Description of the Radar Transmitter (front panel).

Number	Type	Component name
1	LCD	Display for the parameters menu
2	BNC	VCO Control Input [0 - 10 V max.] to RF Oscillator
3	test point	TP1 - RF Oscillator output

Number	Type	Component name
4	LED	RF Power indicator (flashes when on)
5	DB9	Connector for dc voltages from the Power Supply / Antenna Motor Driver
6	push button	RF Power on/off switch
7	test point	TP2 - RF Power output
8	test point	TP3 - Directional Coupler output
9	test point	TP4 - Directional Coupler output
10	SMA	CW/FM-CW RF Output
11	SMA	CW RF Input (to Modulator)
12	SMA	Pulse Input (to Modulator)
13	SMA	Pulsed RF Output
14	LED	Power ON indicator
15	SMA	Pulse Generator Output
16	BNC	Pulse Generator Trigger Input [1024 x PRF]
17	BNC	Pulse Generator Master Clock Input
18	BNC	RF Oscillator Output (50 Ω)
19	test point	Ground for test points
20	DB9	Connector for dc voltages from the Power Supply / Antenna Motor Driver
21	BNC	Control Voltage Monitor Output (provides a voltage proportional to the carrier frequency)
22	push button	Select button for the parameters menu
23	knob	Browse knob for the parameters menu

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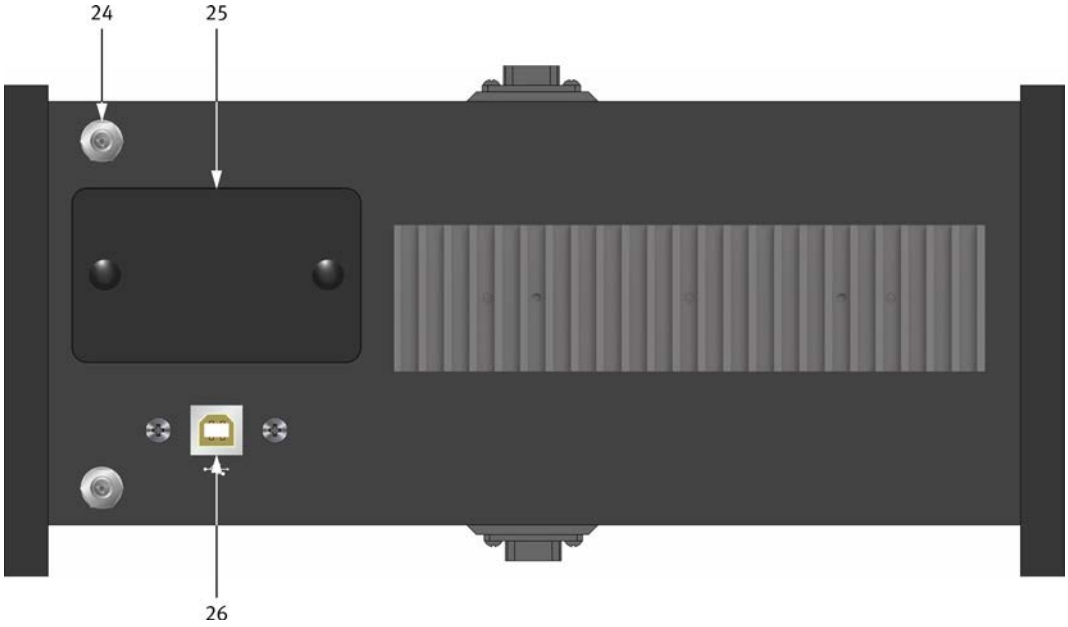


Figure 7: Rear panel of the Radar Transmitter.

Table 7: Description of the Radar Transmitter (rear panel).

Number	Type	Component name
24	POAG	Protective earthing (PE) terminal
25	cover	Fault switches access cover
26	USB-B	USB connector

Rotating-Antenna Pedestal

The Rotating-Antenna Pedestal provides the mount and drive motor for the radar antenna. A miniature connector inside the antenna mounting shaft ensures RF coupling between the antenna and the radar transmitter and receiver.

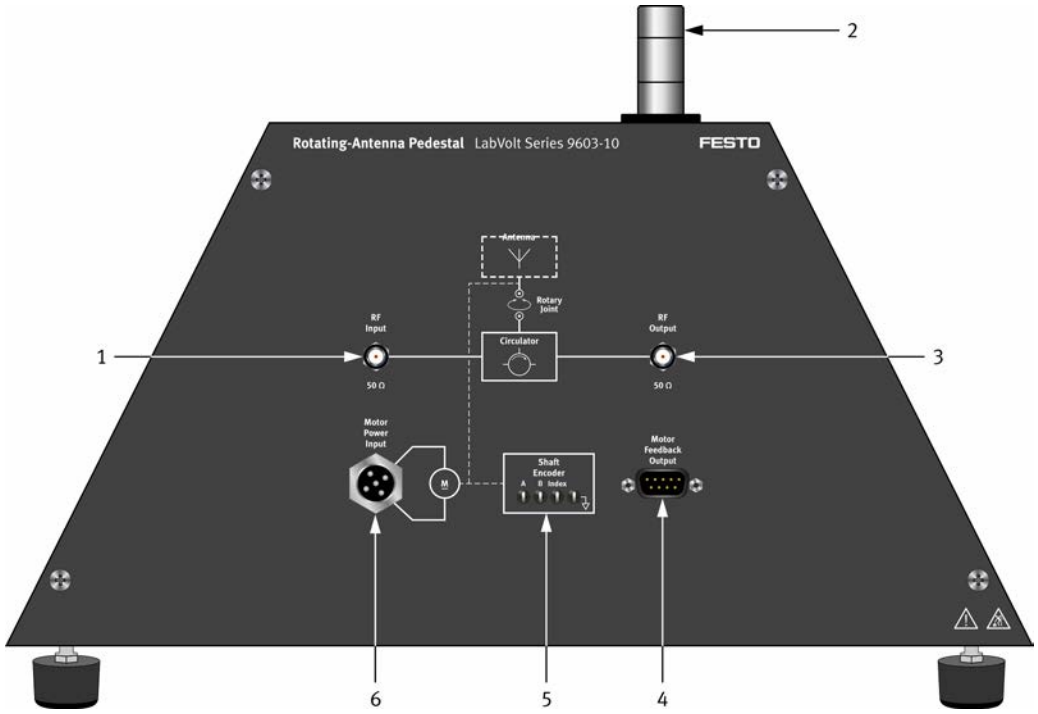


Figure 8: Rotating-Antenna Pedestal.

Table 8: Description of the Rotating-Antenna Pedestal.

Number	Type	Component name
1	SMA	RF Input
2	shaft	Antenna mounting shaft with internal RF connector
3	SMA	RF Output
4	DB9	Motor Feedback Output
5	test point	Shaft Encoder test points
6	M12	Motor Power Input

Radar Antenna

The Radar Antenna mounts on the antenna mounting shaft of the Rotating-Antenna Pedestal. The antenna has a miniature connector that mates with the connector in the shaft for RF coupling.

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Figure 9: Radar Antenna.

Horn Antenna

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.



Figure 10: Horn Antenna.

Radar Receiver

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). This module has fault switches (located under a cover on the rear panel) for troubleshooting exercises.

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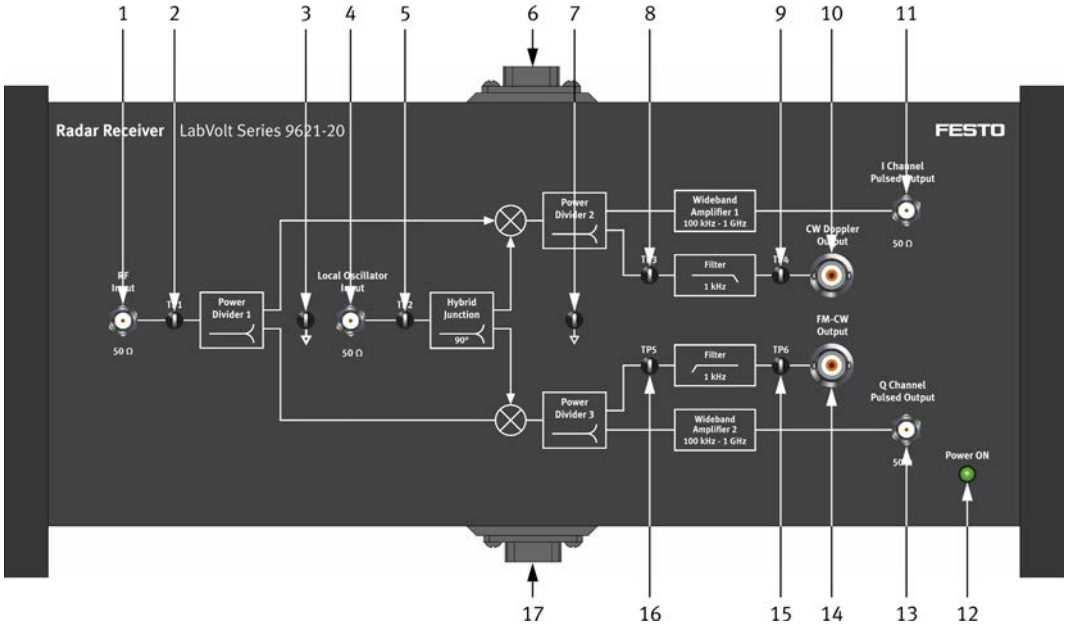


Figure 11: Front panel of the Radar Receiver.

Table 9: Description of the Radar Receiver (front panel).

Number	Type	Component name
1	SMA	RF Input
2	test point	TP1 - RF Input
3	test point	Ground for test points
4	SMA	Local Oscillator Input
5	test point	TP2 - Local Oscillator Input
6	DB9	Connector for dc voltages from the Power Supply / Antenna Motor Driver
7	test point	Ground for test points
8	test point	TP3 - Lowpass filter input
9	test point	TP4 - Lowpass filter output
10	BNC	CW Doppler Output
11	SMA	I Channel Pulsed Output

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Number	Type	Component name
12	LED	Power ON indicator
13	SMA	Q Channel Pulsed Output
14	BNC	FM-CW Output
15	test point	TP6 - Highpass filter output
16	test point	TP5 - Highpass filter input
17	DB9	Connector for dc voltages from the Power Supply / Antenna Motor Driver

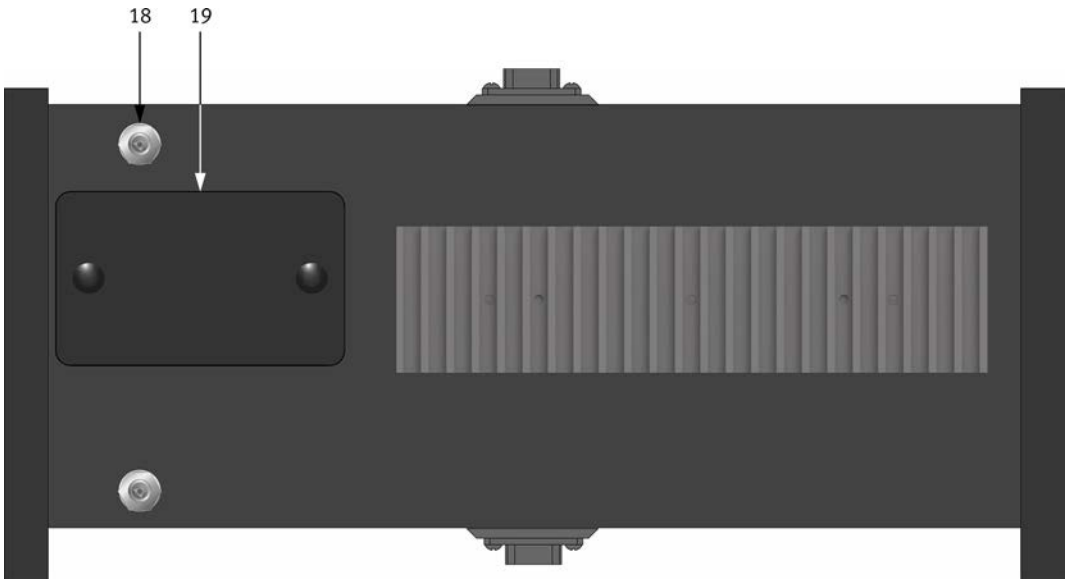


Figure 12: Rear panel of the Radar Receiver.

Table 10: Description of the Radar Receiver (rear panel).

Number	Type	Component name
18	POAG	Protective earthing (PE) terminal
19	cover	Fault switches access cover

Dual-Channel Sampler

The Dual-Channel Sampler samples the I- and Q-Channel baseband signals from the radar receiver and performs time expansion of these signals in order to allow further processing and display.

The Phase-Coded Pulse Compression Processor has an integrated Dual-Channel Sampler.

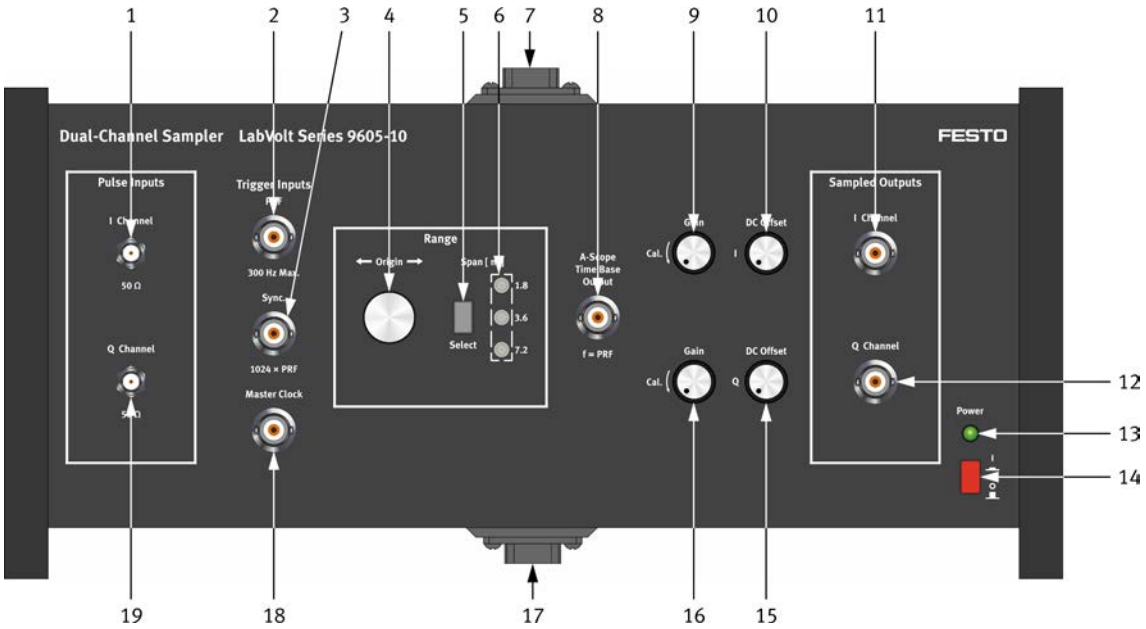


Figure 13: Front panel of the Dual Channel Sampler.

Table 11: Description of the Dual Channel Sampler (front panel).

Number	Type	Component name
1	SMA	I Channel Pulse Input
2	BNC	PRF Trigger Input [300 Hz Max.]
3	BNC	Sync. Trigger Input [1024 x PRF]
4	knob	Range Origin control
5	push button	Range Span selector
6	LEDs	Range Span indicator [1.8 m | 3.6 m | 7.2 m]
7	DB9	Connector for dc voltages from the Power Supply / Antenna Motor Driver

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Number	Type	Component name
8	BNC	A-Scope Time Base Output [f = PRF]
9	knob	I Channel Gain control
10	knob	I Channel DC Offset control
11	BNC	I Channel Sampled Output
12	BNC	Q Channel Sampled Output
13	LED	Power indicator
14	push button	Power on/off switch
15	knob	Q Channel DC Offset control
16	knob	Q Channel Gain control
17	DB9	Connector for dc voltages from the Power Supply / Antenna Motor Driver
18	BNC	Master Clock trigger Input
19	SMA	Q Channel Pulse Input

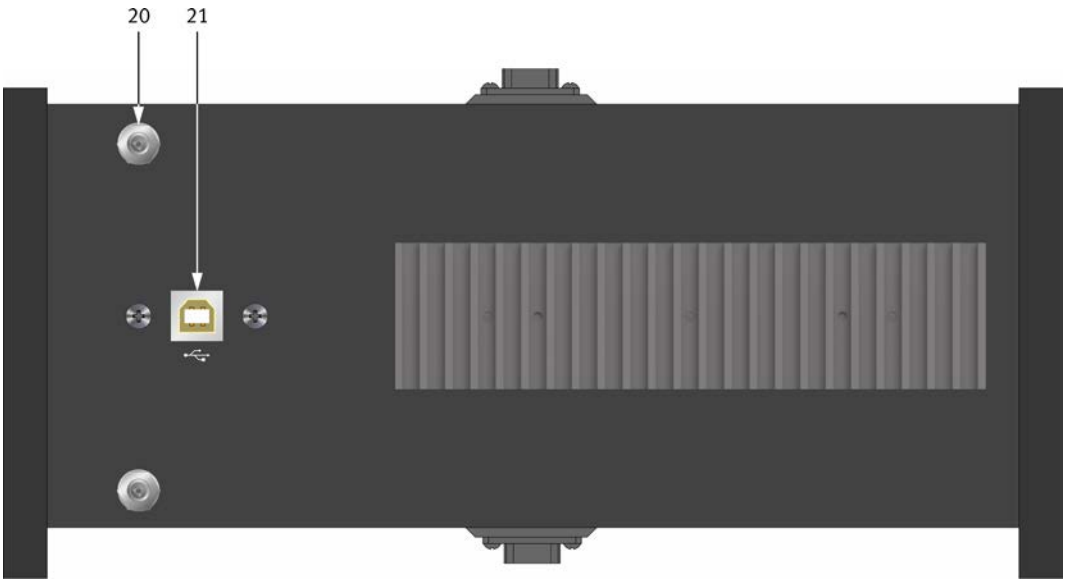


Figure 14: Rear panel of the Dual Channel Sampler.

Table 12: Description of the Dual Channel Sampler (rear panel).

Number	Type	Component name
20	POAG	Protective earthing (PE) terminal
21	USB-B	USB connector

Target Positioning System

The Target Positioning System accurately positions and moves a passive radar target. It consists of a Target Table with a 90 cm x 90 cm surface and a moveable mast to support the target, a Target Remote Controller, a Target Controller Base, as well as a Power Supply/Motor Drive.

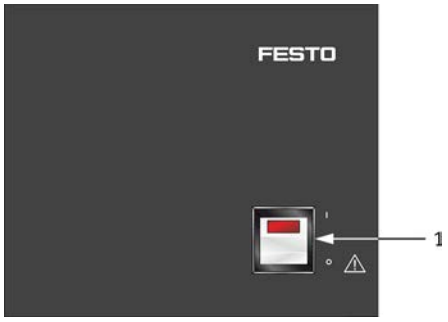


Figure 15: Front panel of the Target Table.

Table 13: Description of the Target Table (front panel).

Number	Type	Component name
1	rocker switch	Power on/off switch

Target Remote Controller

The Target Remote Controller is part of the Target Positioning System and is used to control the position, speed, and trajectory of the target over a wireless RF link.

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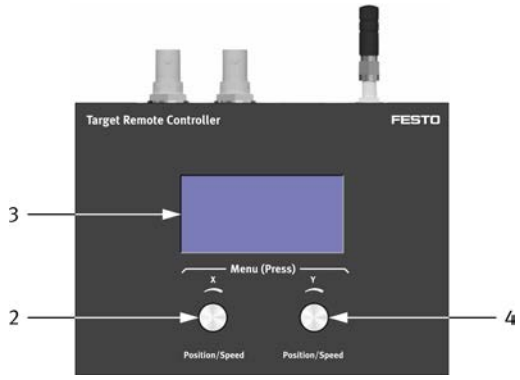


Figure 16: Front panel of the Target Remote Controller.

Table 14: Description of the Target Remote Controller (front panel).

Number	Type	Component name
2	knob	X-axis Position/Speed control
3	LCD	Parameters display
4	knob	Y-axis Position/Speed control

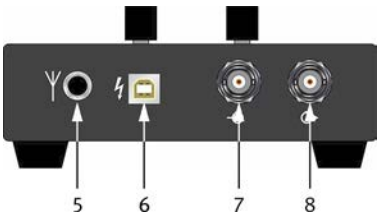


Figure 17: Rear panel of the Target Remote Controller.

Table 15: Description of the Target Remote Controller (rear panel).

Number	Type	Component name
5	SMA	Connector for antenna (2.4 GHz)
6	USB-B	USB connector
7	BNC	Serial input
8	BNC	Serial output

The serial input and output are for use with the SAR Data Acquisition Interface.

Target Controller Base

The Target Controller Base is part of the Target Positioning System. It is mounted on the Target Table and receives commands from the Target Remote Controller over a wireless RF link.

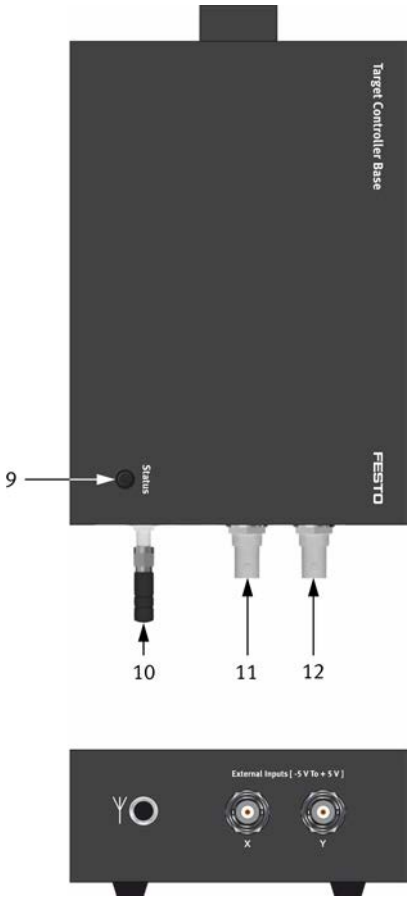


Figure 18: Top and front panels of the Target Controller Base.

Table 16: Description of the Target Controller Base (top and front panels).

Number	Type	Component name
9	LED	Status indicator
10	SMA	Connector for antenna (2.4 GHz)
11	BNC	X-axis external input [-5 V to +5 V]
12	BNC	Y-axis external input [-5 V to +5 V]

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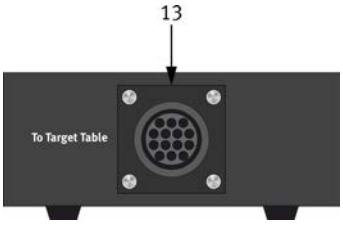


Figure 19: Rear panel of the Target Controller Base.

Table 17: Description of the Target Controller Base (rear panel).

Number	Type	Component name
13	CPC	Connector for cable to Target Table

Power Supply/Motor Drive

The Power Supply/Motor Drive is part of the Target Positioning System and supplies power to the motors.

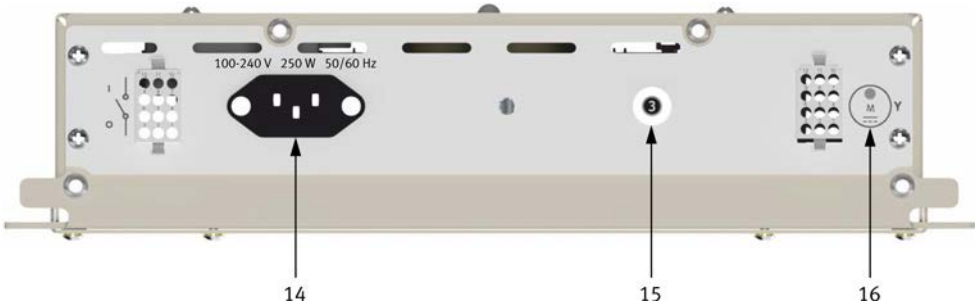


Figure 20: Front panel of the Power Supply/Motor Drive.

Table 18: Description of the Power Supply/Motor Drive (front panel).

Number	Type	Component name
14	IEC C14	Power inlet [100-240 V 250 W 50/60 Hz]
15	push to reset	Y-axis motor circuit breaker
16	LED	Y-axis motor status indicator (lit when normal)

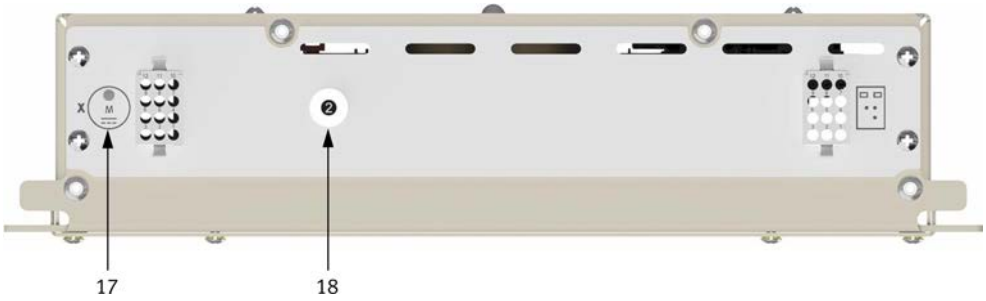


Figure 21: Rear panel of the Power Supply/Motor Drive.

Table 19: Description of the Power Supply/Motor Drive (rear panel).

Number	Type	Component name
17	LED	X-axis motor status indicator (lit when normal)
18	push to reset	Circuit breaker

Radar Processor/Display

Reconfigurable Training Module (RTM)

The Reconfigurable Training Module (RTM) is a multi-purpose module the functionality of which is determined by different programs downloaded to it using the host computer and the Radar Training System (LVRTS) software. The RTM contains a digital signal processor (DSP) and has three slots on the module front panel for installing compact interface modules.

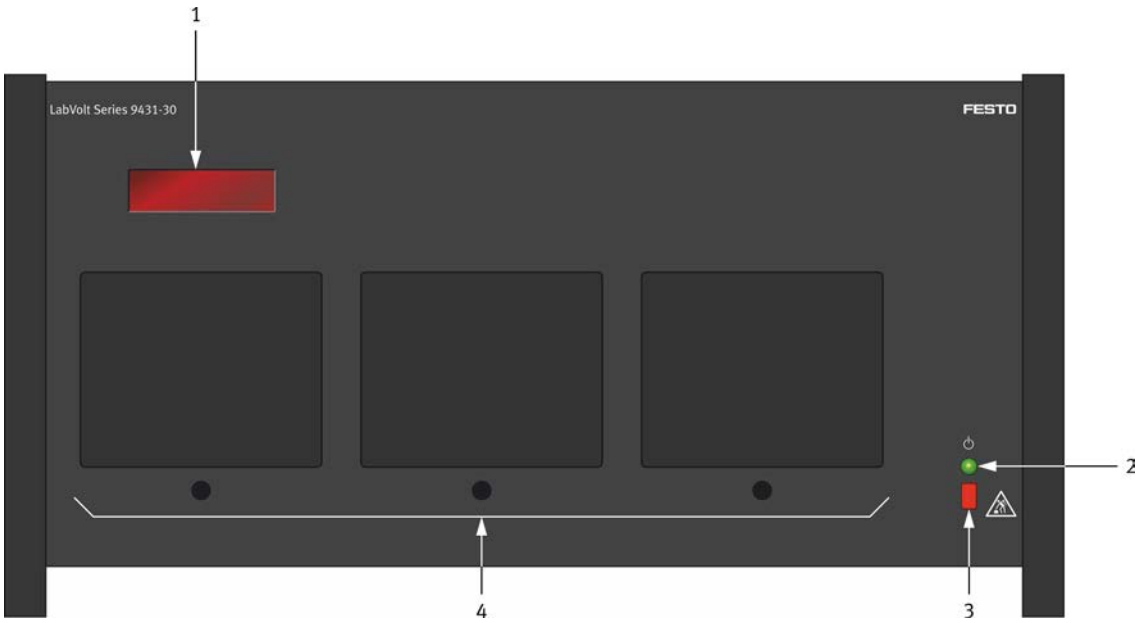


Figure 22: Reconfigurable Training Module (RTM).

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Table 20: Description of the Reconfigurable Training Module (RTM).

Number	Type	Component name
1	LCD	Display for IP address
2	LED	Power ON indicator
3	push button	Power on/off switch
4	slot (3)	For installing compact interface modules

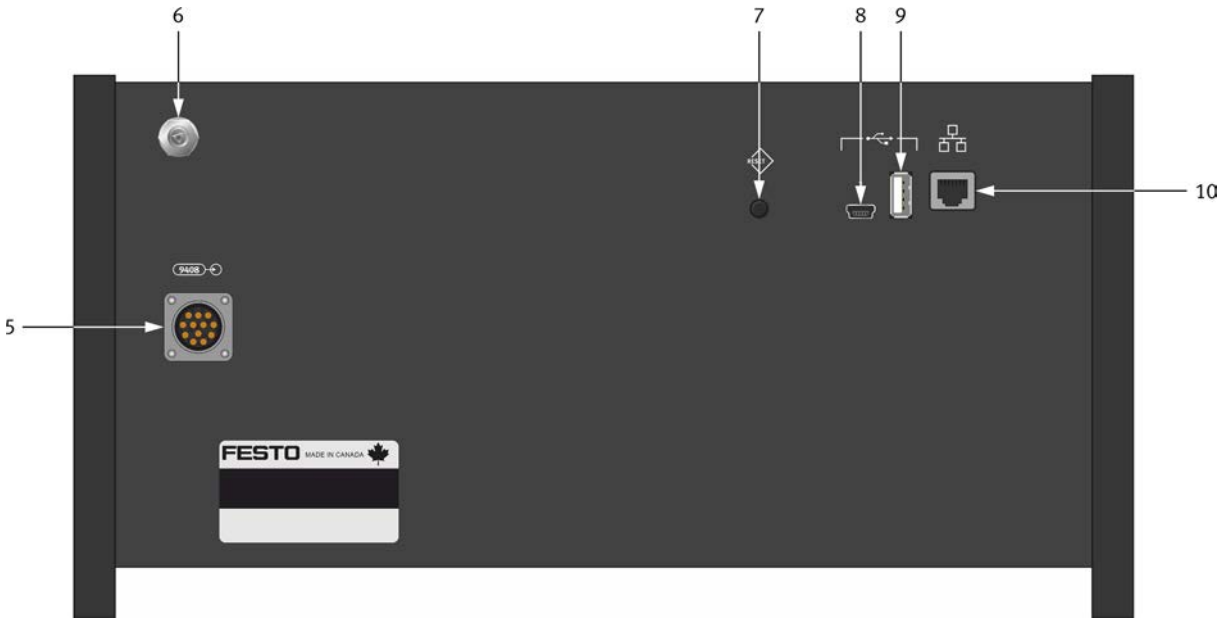


Figure 23: Rear panel of the Reconfigurable Training Module (RTM).

Table 21: Description of the Reconfigurable Training Module (RTM) (rear panel).

Number	Type	Component name
5	M23	Power connector (from RTM Power Supply)
6	POAG	Protective earthing (PE) terminal
7	button	Reset button
8	mini-AB	USB connector
9	USB-A	USB connector
10	RJ45	Ethernet connector

RTM Power Supply

The RTM Power Supply is the power source for the Reconfigurable Training Module (RTM) used in the radar training systems.

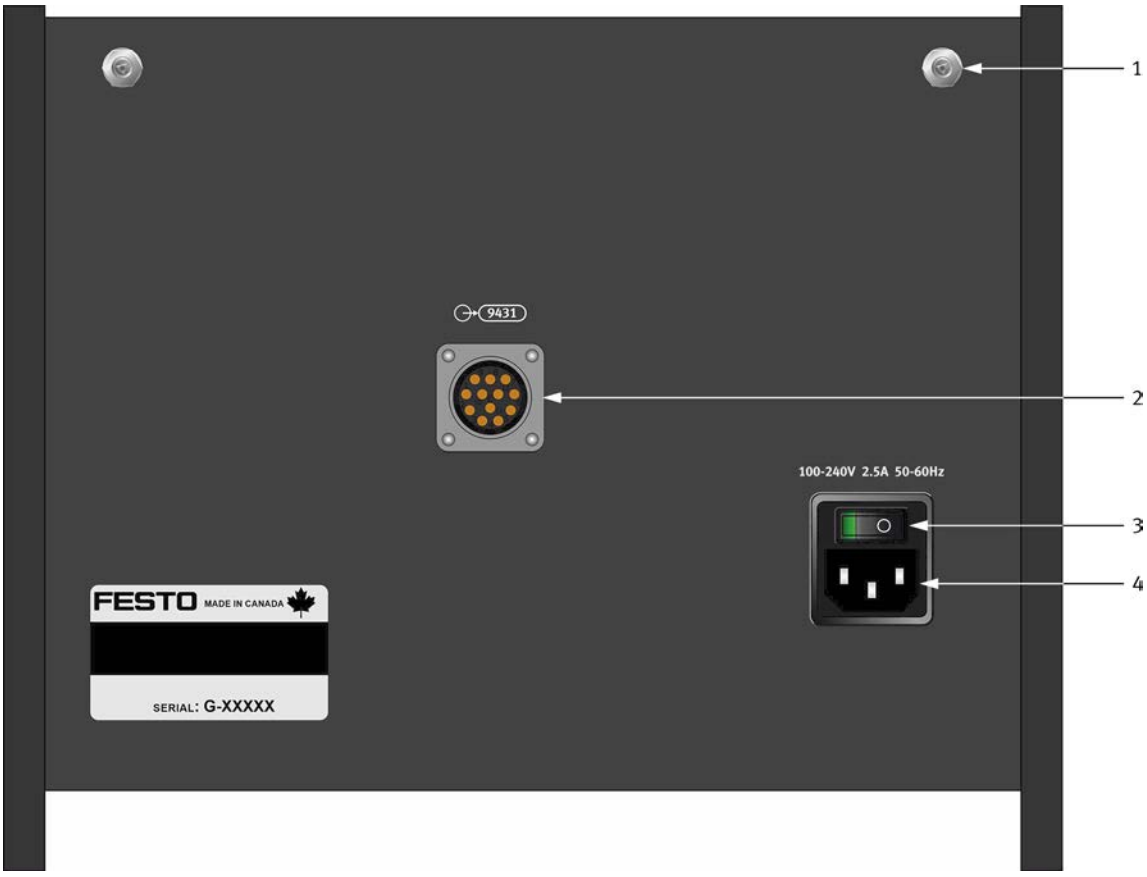


Figure 24: Rear panel of the RTM Power Supply.

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Table 22: Description of the RTM Power Supply (rear panel).

Number	Type	Component name
1	POAG	Protective earthing (PE) terminal
2	M23	Power connector (to RTM)
3	rocker switch	Power on/off switch
4	IEC C14	Power inlet [100-240 V 2.5 A 50/60 Hz]

Analog/Digital Signal Combiner (9630)

The Analog/Digital Signal Combiner interface module combines the I- and Q-Channel echo signals from the Dual-Channel Sampler with the clutter and interference generated digitally by the RTM to produce a two-channel analog signal.

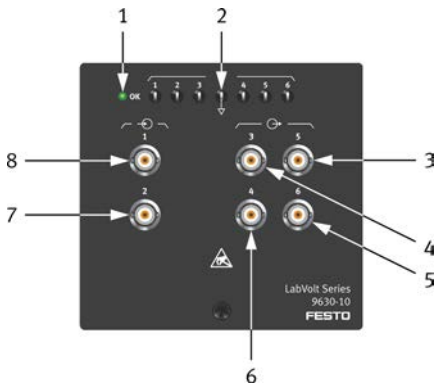


Figure 25: Front panel of the Analog/Digital Signal Combiner.

Table 23: Description of the Analog/Digital Signal Combiner.

Number	Type	Component name
1	LED	OK
2	test point	TP1 to TP6 and ground
3	BNC	I-Channel clutter added to signal output
4	BNC	I-Channel clutter output
5	BNC	Q-Channel clutter added to signal output
6	BNC	Q-Channel clutter output
7	BNC	Q-Channel Input
8	BNC	I-Channel Input

Data Acquisition Interface (9631)

The Data Acquisition Interface module receives the I- and Q-Channel analog echo signals, either directly from the Dual-Channel Sampler or from the Analog/Digital Signal Combiner, 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.

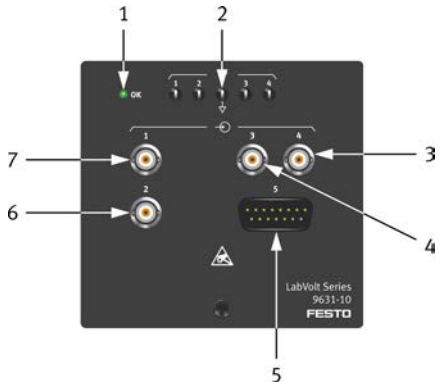


Figure 26: Data Acquisition Interface.

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Table 24: Description of the Data Acquisition Interface.

Number	Type	Component name
1	LED	OK
2	test point	TP1 to TP4 and ground
3	BNC	Sync. Input [1024 x PRF]
4	BNC	PRF Input
5	DB15	Azimuth Input
6	BNC	Q-Channel Input
7	BNC	I-Channel Input

Analog/Digital Output Interface (9635)

The Analog/Digital Output Interface 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.

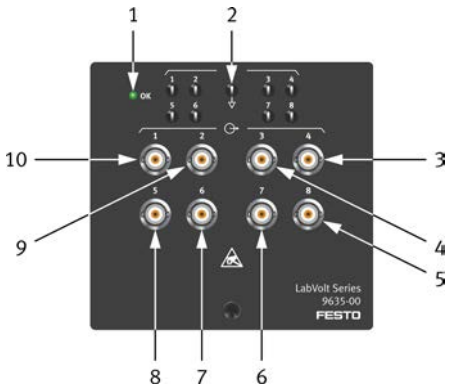


Figure 27: Radar Analog/Digital Output Interface.

Table 25: Description of the Radar Analog/Digital Output Interface.

Number	Type	Component name
1	LED	OK
2	test point	TP1 to TP8 and ground
3	BNC	Configurable output
4	BNC	Configurable output
5	BNC	Configurable output
6	BNC	Configurable output
7	BNC	Configurable output
8	BNC	Configurable output
9	BNC	Configurable output
10	BNC	Configurable output

Radar Tracking Training System

Radar Target Tracking Interface (9633)

The Radar Target Tracking Interface 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, this interface intercepts the rotation command signal produced by the Antenna Controller before it reaches the Antenna Motor Driver.

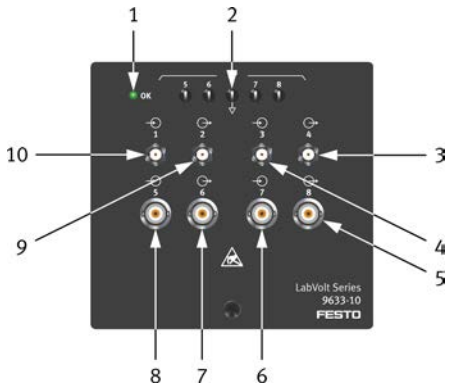


Figure 28: Radar Target Tracking Interface.

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Table 26: Description of the Radar Target Tracking Interface.

Number	Type	Component name
1	LED	OK
2	test point	TP5 to TP8 and ground
3	SMA	RF dc block output
4	SMA	RF dc block input
5	BNC	Lobe switch control output
6	BNC	Lobe switch control input
7	BNC	Antenna drive output
8	BNC	Antenna drive input
9	SMA	RF bias tee output
10	SMA	RF bias tee input

Dual Feed Parabolic Antenna

The Dual Feed Parabolic Antenna mounts on antenna mounting shaft of the Rotating-Antenna Pedestal. The antenna has a miniature connector that mates with the connector in the shaft for RF coupling. The dual-feed horns are connected to a microwave SPDT switch that allows alternating transmission and reception of the signal from each horn.

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Figure 29: Dual Feed Parabolic Antenna.

Radar Active Target Training System

Radar Jamming Pod Trainer

The Radar Jamming Pod Trainer is the main component of the Radar Active Target Training System add-on. It is a self-screening jammer (SSJ) target in a compact enclosure and 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 consists mainly of an RF signal source, a variable attenuator, transmitting and receiving horn antennas, a signal repeater, an amplitude modulator, and a remote controller.

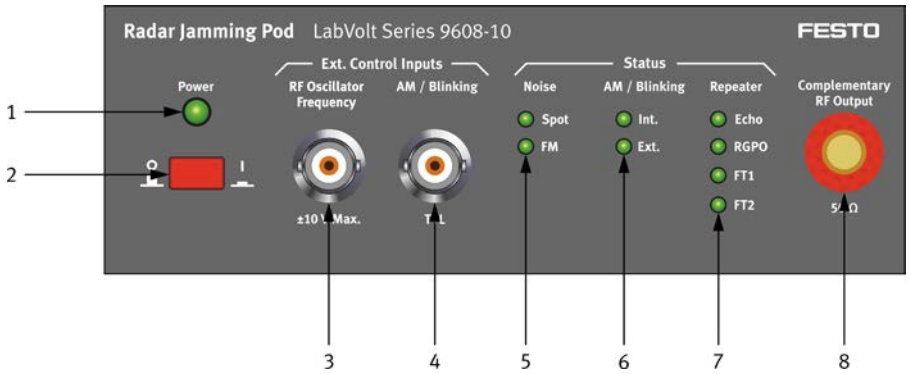


Figure 30: Rear panel of the Radar Jamming Pod Trainer.

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Table 27: Description of the Radar Jamming Pod Trainer (rear panel).

Number	Type	Component name
1	LED	Power
2	push button	Power on/off switch
3	BNC	RF Oscillator Frequency External Control Input [±10 V max.]
4	BNC	AM / Blinking External Control Input [TTL]
5	LEDs	Noise Status indicator [Spot | FM]
6	LEDs	AM / Blinking Status indicator [Int. | Ext.]
7	LEDs	Repeater Status indicator [Echo | RGPO | FT1 | FT2]
8	SMA	Complementary RF Output (shown with 50Ω load installed)

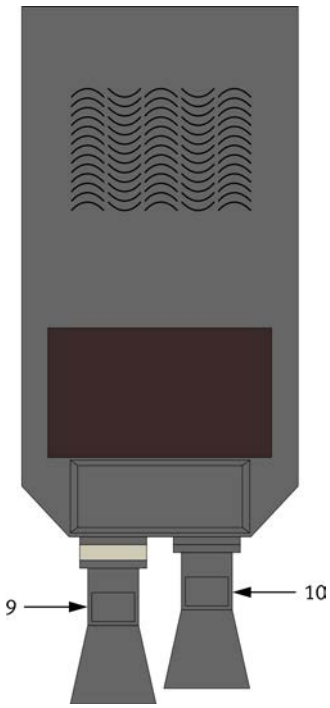


Figure 31: Radar Jamming Pod Trainer (top view).

Table 28: Description of the Radar Jamming Pod Trainer (top view).

Number	Type	Component name
9	horn	Receiving antenna
10	horn	Transmitting antenna
11 (not shown)	DB9	Cable and connector for dc voltages from the Power Supply (underneath)
12 (not shown)	Infrared	Receiver for communication with Remote Controller (underneath)

Radar Jamming Pod Trainer Remote Controller

The Radar Jamming Pod Trainer Remote Controller is part of the Radar Active Target Training System add-on and is used to control the Radar Jamming Pod Trainer over an infrared link.

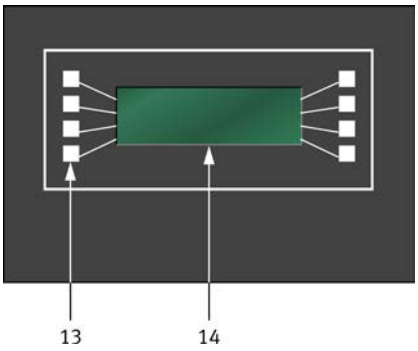


Figure 32: Radar Jamming Pod Trainer Remote Controller.

Table 29: Description of the Radar Jamming Pod Trainer Remote Controller.

Number	Type	Component name
13	push buttons	Menu select buttons
14	LCD	Menu display

Power Supply (Radar Electronic Warfare)

This Power Supply is part of the Radar Active Target Training System add-on and supplies power to the Radar Jamming Pod Trainer.

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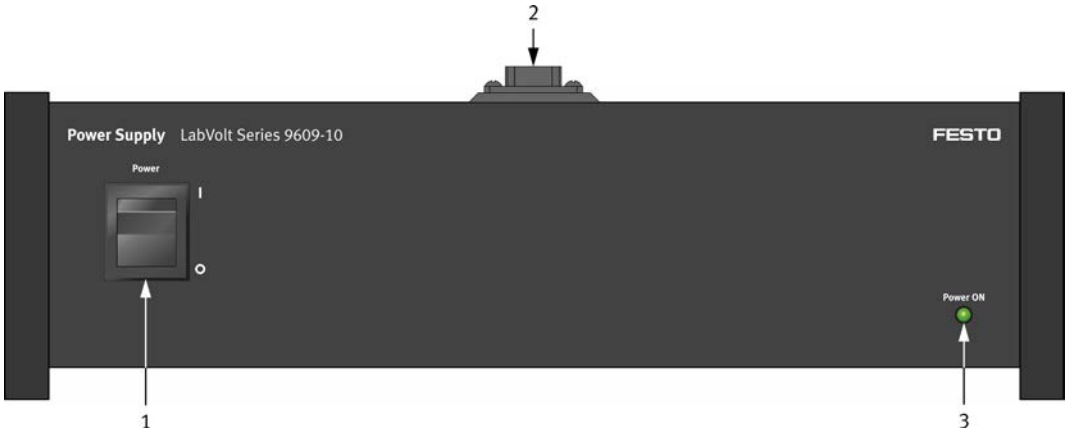


Figure 33: Power Supply (Radar Electronic Warfare).

Table 30: Description of the Power Supply (Radar Electronic Warfare).

Number	Type	Component name
1	rocker switch	Power on/off switch
2	DB9	Connector for dc voltages to the Jamming Pod Trainer
3	LED	Power ON indicator

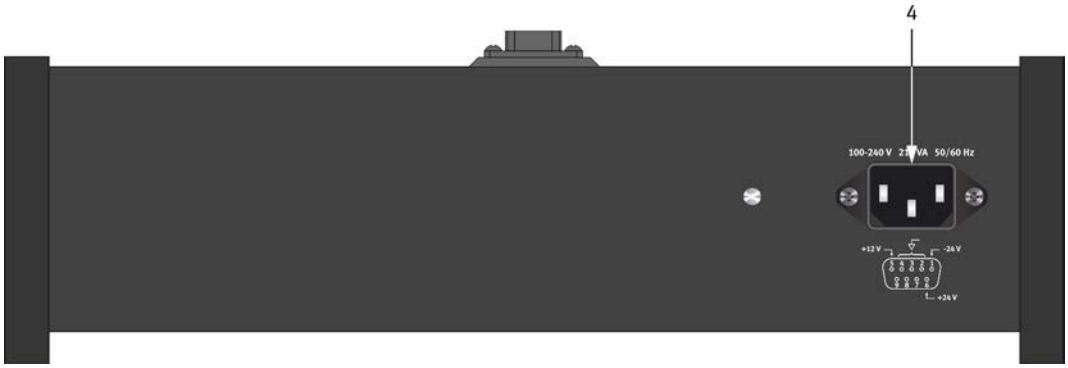


Figure 34: Rear panel of the Power Supply (Radar Electronic Warfare).

Table 31: Description of the Power Supply (Radar Electronic Warfare) (rear panel).

Number	Type	Component name
4	IEC C14	Power inlet [100-240 V 210 VA 50/50 Hz]

Radio Equipment Directive (RED) geographical restrictions

In CE Member States and other related states, do not use the Jamming Pod at frequencies higher than 10.6 GHz.

The Jamming Pod equipment is intended to be used in the allocated band for radiodetermination (8.0 GHz to 10.6 GHz), but to accommodate sales in every country, the Jamming Pod can emit at up to 12.0 GHz. Utilization of the Jamming Pod with frequencies higher than 10.6 GHz is forbidden within CEPT countries, under harmonized spectrum use (ECC/ERC decisions and recommendations).

The 10.6 GHz-12 GHz band is used by specific equipment types:

- Broadcasting satellites
- Earth-exploration satellites (passive)
- Earth-to-space and space-to-Earth satellites
- Space-research equipment (passive)
- Mobile devices except for aeronautical mobile communications and radio astronomy

The ISO codes below this pictogram identify the states where these restrictions apply.

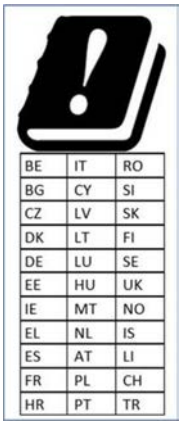


Figure 35: States where RED geographical restrictions apply.

Radar Phased Array Antenna Training System

Phased Array Antenna

The Phased Array Antenna (PAA) consists of a microwave switch coupled to a Rotman lens and microstrip tapered slot array antennas. It allows a horizontal sector to be scanned electronically (azimuthal scanning) without any antenna motion.

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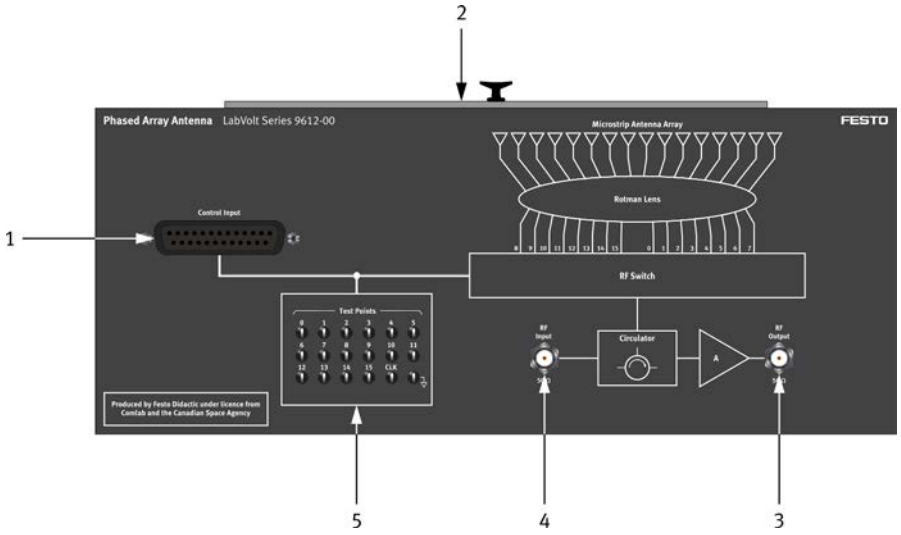


Figure 36: Front panel of the Phased Array Antenna.

Table 32: Description of the Phased Array Antenna (front panel).

Number	Type	Component name
1	DB25	Control Input
2	access door (on top)	access to the Rotman lens
3	SMA	RF Output
4	SMA	RF Input
5	test point	Test points 1 to 15, OK, and ground

Phased Array Antenna Controller

The Phased Array Antenna Controller is used for beam steering control of the Phased Array Antenna (PAA).

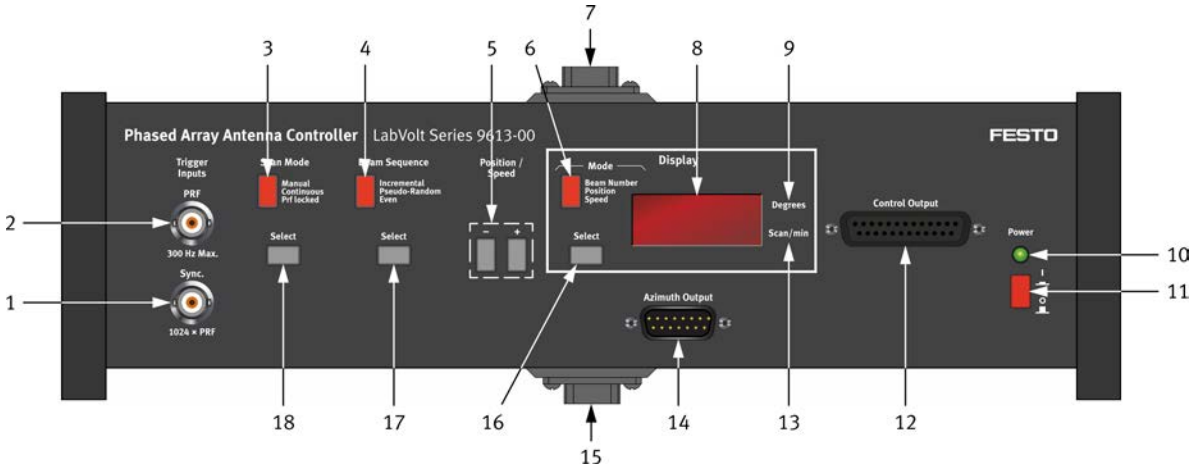


Figure 37: Front panel of the Phased Array Antenna Controller.

Table 33: Description of the Phased Array Antenna Controller (front panel).

Number	Type	Component name
1	BNC	Sync. Trigger Input [1024 x PRF]
2	BNC	PRF Trigger Input [300 Hz max.]
3	LED bar display	Scan Mode indicator [Manual | Continuous | PRF Locked]
4	LED bar display	Beam Sequence indicator [Incremental | Pseudo-Random | Even]
5	push buttons	Position / Speed control
6	LED bar display	Display Mode indicator [Beam Number | Position | Speed]
7	DB9	Connector for dc voltages from the Power Supply / Antenna Motor Driver
8	multi-segment display	Display [Beam Number | Position | Speed]
9	LED	Degrees unit indicator
10	LED	Power indicator
11	push button	Power on/off switch

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Number	Type	Component name
12	DB25	Control Output
13	LED	Scan/min unit indicator
14	DB15	Azimuth Output
15	DB9	Connector for dc voltages from the Power Supply / Antenna Motor Driver
16	push button	Display Mode selector
17	push button	Beam Sequence selector
18	push button	Scan Mode selector

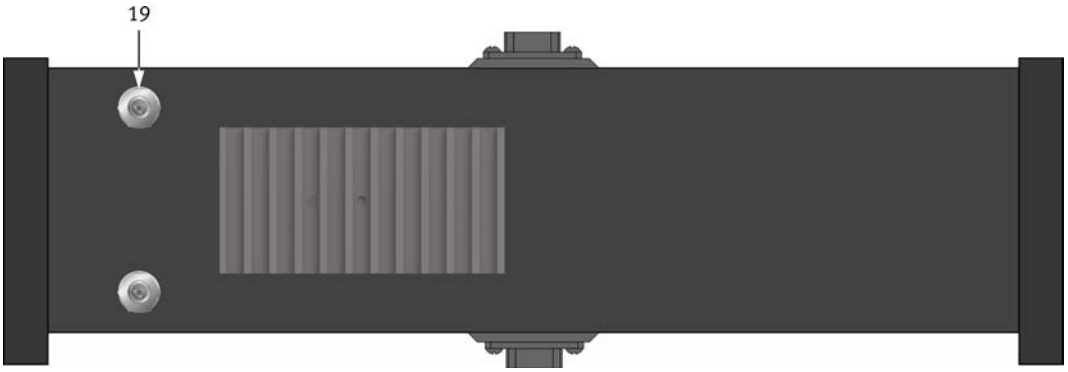


Figure 38: Rear panel of the Phased Array Antenna Controller.

Table 34: Description of the Phased Array Antenna Controller (rear panel).

Number	Type	Component name
19	POAG	Protective earthing (PE) terminal

RCS and ISAR Measurement Training System

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.

RCS/ISAR Measurement Interface

The RCS/ISAR Measurement Interface contains RF circuitry that allows RCS and ISAR measurements to be performed using the Basic Radar Training System. This circuitry includes a time-gated, variable-gain amplifier, a circulator, and two limiters. The time-gated amplifier increases the peak RF power transmitted while maintaining 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.

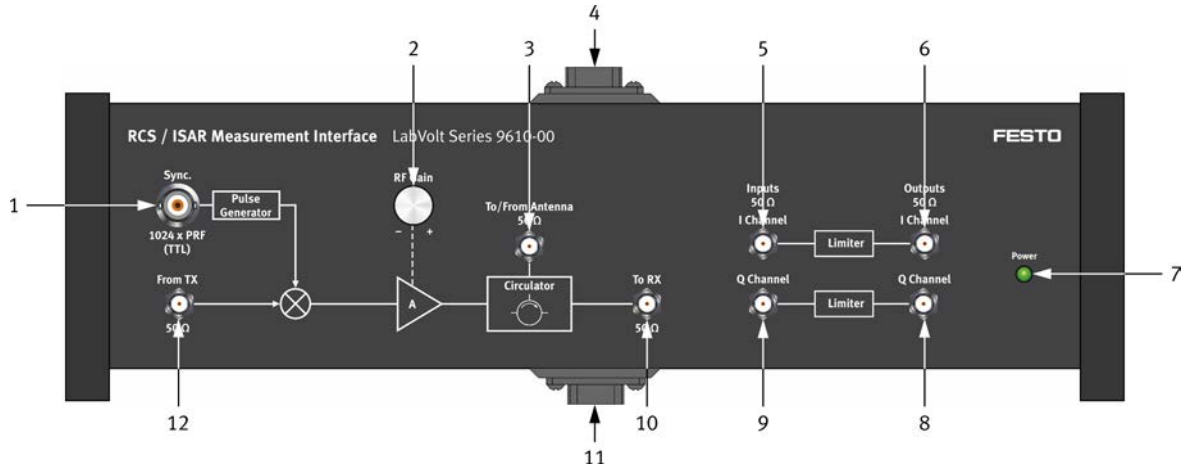


Figure 39: Front panel of the RCS/ISAR Measurement Interface.

Table 35: Description of the RCS/ISAR Measurement Interface (front panel).

Number	Type	Component name
1	BNC	Sync. input [1024 x PRF]
2	knob	RF Gain control
3	SMA	To/From Antenna (bidirectional)
4	DB9	Connector for dc voltages from the Power Supply / Antenna Motor Driver
5	SMA	I-Channel Limiter Input
6	SMA	I-Channel Limiter Output
7	LED	Power indicator
8	SMA	Q-Channel Limiter Output

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Number	Type	Component name
9	SMA	Q-Channel Limiter Input
10	SMA	To Rx (receiver) Output
11	DB9	Connector for dc voltages from the Power Supply / Antenna Motor Driver
12	SMA	From Tx (transmitter) Input

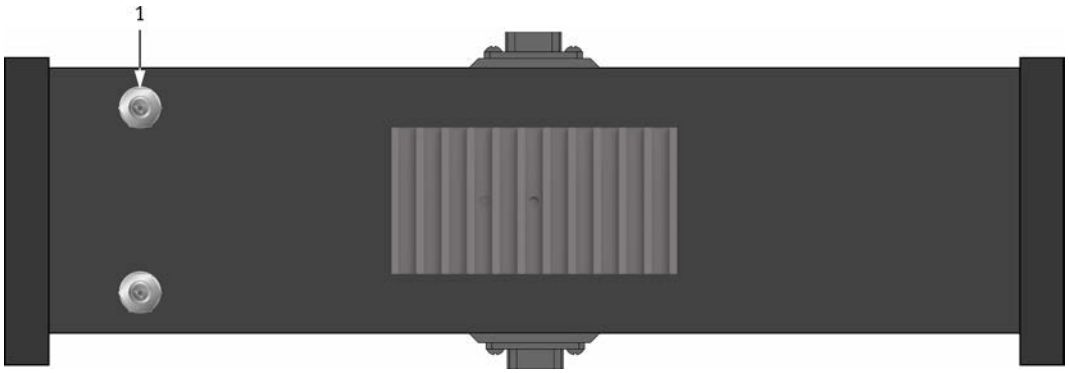


Figure 40: Rear panel of the RCS/ISAR Measurement Interface.

Table 36: Description of the RCS/ISAR Measurement Interface (rear panel).

Number	Type	Component name
1	POAG	Protective earthing (PE) terminal

RCS/ISAR Data Acquisition Interface

The RCS/ISAR Data Acquisition Interface 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 is provided to route the synchronization signal to another module.

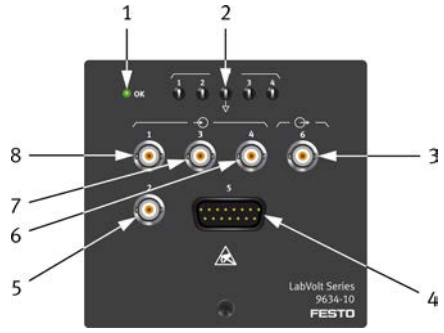


Figure 41: RCS/ISAR Data Acquisition Interface.

Table 37: Description of the RCS/ISAR Data Acquisition Interface.

Number	Type	Component name
1	LED	OK
2	test point	TP1 to TP4 and ground
3	BNC	Sync. Output [1024 x PRF]
4	DB15	Azimuth Input
5	BNC	Q-channel input
6	BNC	Sync. Input [1024 x PRF]
7	BNC	PRF input
8	BNC	I-channel input

Synthetic-Aperture Radar (SAR) Training System

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. Instead of having the entire radar system on a moving platform, as is usually the case with SAR, only the antenna is moved.

SAR Data Acquisition Interface

The SAR Data Acquisition Interface controls the movement of the small-aperture horn antenna installed on the moveable carriage of the Target Positioning System. The SAR Data Acquisition Interface communicates with the Target Remote Controller via two serial links and ensures that the radar echo signal acquisition is properly synchronized with the horn antenna motion.

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The SAR Data Acquisition Interface receives the I- and Q-channel echo signals from the radar and converts them into digital format. It also receives the PRF signal.



Figure 42: SAR Data Acquisition Interface.

Table 38: Description of the SAR Data Acquisition Interface.

Number	Type	Component name
1	LED	OK
2	test point	TP1 to TP3 and ground
3	BNC	Serial Output (to Target Remote Controller)
4	BNC	Serial Input (from Target Remote Controller)
5	BNC	Q-Channel Input
6	BNC	PRF Input
7	BNC	I-Channel Input

Radar Phase-Coded Pulse Compression Training System

Phase-Coded Pulse Compression Processor

The Phase-Coded Pulse Compression Processor is designed for the study of phase-coded pulse compression techniques used in pulse radar. It is divided into three sections: Dual-Channel Sampler, Pulse Compressor, and Pulse Generator.

The Pulse Generator generates phase-coded pulses used to modulate the RF signal at the Radar Transmitter. The Dual-Channel Sampler samples the I- and Q-channel baseband signals from the radar receiver and performs time expansion of these signals in order to allow further processing. The Pulse Compressor compresses the pulses.

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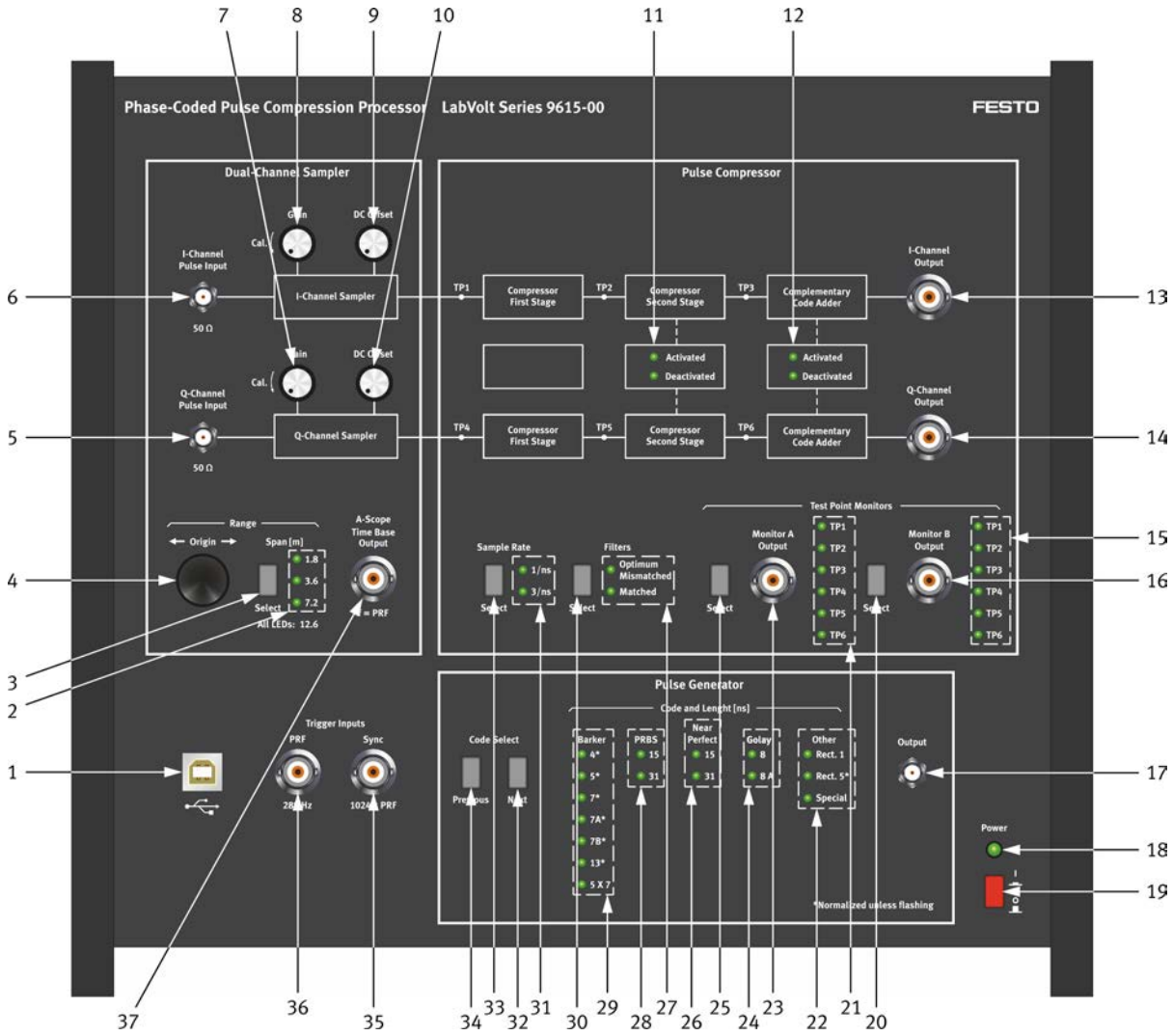


Figure 43: Front panel of the Phase-Coded Pulse Compression Processor.

Table 39: Description of the Phase-Coded Pulse Compression Processor (front panel).

Number	Type	Component name
1	USB-B	USB connector
2	LEDs	Range Span indicator [1.8 m | 3.6 m | 7.2 m]
3	push button	Range Span selector
4	knob	Range Origin control
5	SMA	Q-Channel Pulse Input
6	SMA	I-Channel Pulse Input

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Number	Type	Component name
7	knob	Q-Channel Sampler Gain control
8	knob	I-Channel Sampler Gain control
9	knob	I-Channel Sampler DC Offset control
10	knob	Q-Channel Sampler DC Offset control
11	LEDs	Compressor Second Stage status indicator [Activated | Deactivated]
12	LEDs	Complementary Code Adder status indicator [Activated | Deactivated]
13	BNC	I-Channel Output
14	BNC	Q-Channel Output
15	LEDs	Test Point Monitor B indicator [TP1 to TP6]
16	BNC	Test Point Monitor B Output
17	SMA	Pulse Generator Output
18	LED	Power indicator
19	push button	Power on/off switch
20	push button	Test Point Monitor B Output Select
21	LEDs	Test Point Monitor A indicator [TP1 to TP6]
22	LEDs	Other Code and Length indicator
23	BNC	Test Point Monitor A Output
24	LEDs	Golay Code and Length indicator
25	push button	Test Point Monitor A Output Select
26	LEDs	Near Perfect Code and Length indicator
27	LEDs	Filters Indicator [Optimum Mismatched | Matched]

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Number	Type	Component name
28	LEDs	PRBS Code and Length indicator
29	LEDs	Barker Code and Length indicator
30	push button	Filters selector
31	LEDs	Sample Rate indicator [1/ns | 3/ns]
32	push button	Next Code Select
33	push button	Sample Rate selector
34	push button	Previous Code select
35	BNC	Sync. Trigger Input [1024 x PRF]
36	BNC	PRF Trigger Input [288 Hz]
37	BNC	A-Scope Time Base Output

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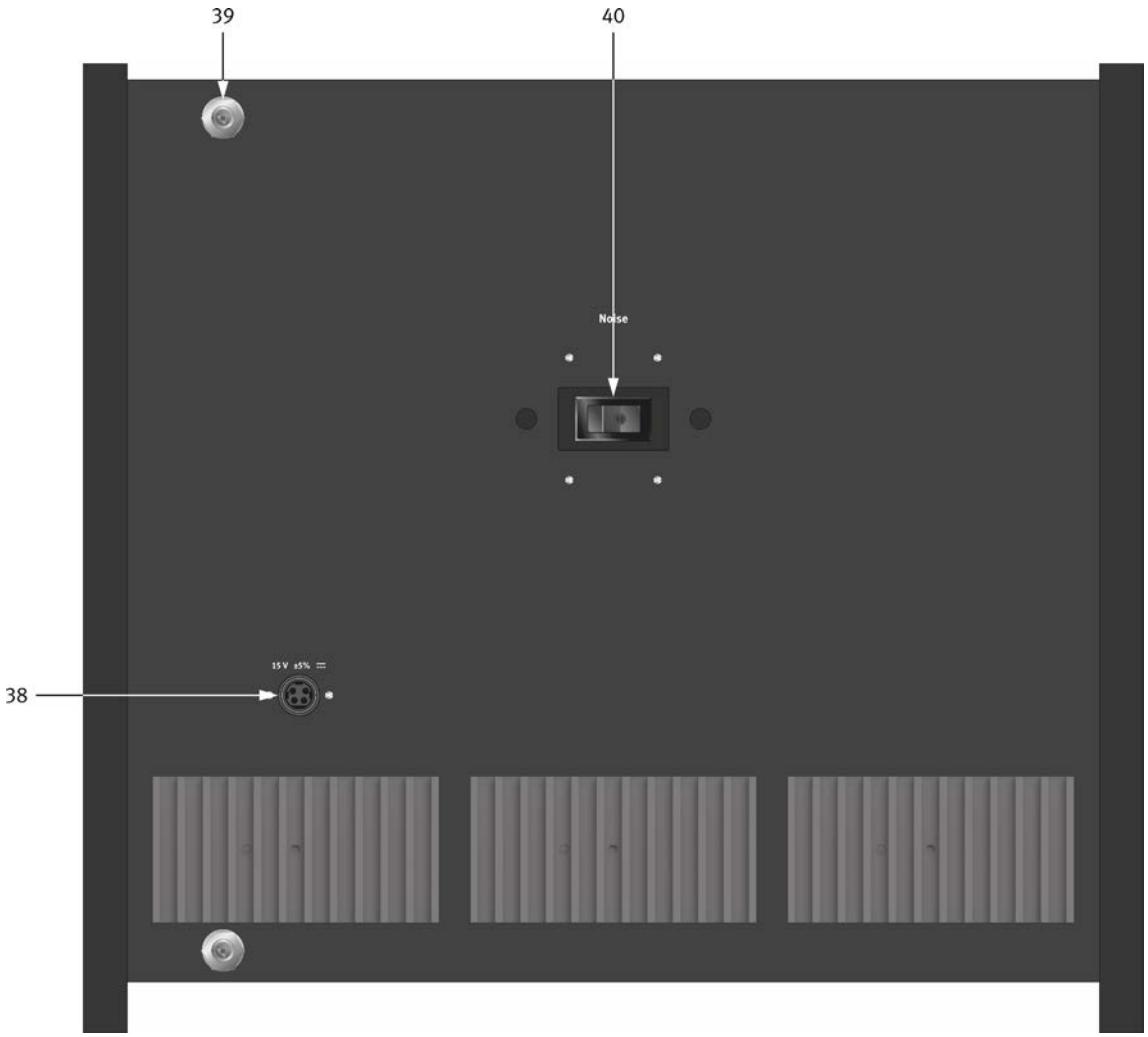


Figure 44: Rear panel of the Phase-Coded Pulse Compression Processor.

Table 40: Description of the Phase-Coded Pulse Compression Processor (rear panel).

Number	Type	Component name
38	DC connector	Power connector [15 V dc ±5%]
39	POAG	Protective earthing (PE) terminal
40	rocker switch (under removable cover)	Noise on/off switch

Pulse Compression Radar Antenna

The Pulse Compression Radar Antenna mounts on antenna mounting shaft of the rotating-antenna pedestal. The antenna has a miniature connector that mates with the connector in the shaft for quick RF coupling. The antenna includes a length of RF cable for adding a slight delay in order to prevent internal reflections from interfering with the longer pulses used with pulse compression.



Figure 45: Pulse Compression Radar Antenna.

Additional Equipment

Function generator

A function generator with sine-wave function in the audio band, such as the Festo Didactic Dual Function Generator, is required for some exercises. The amplitude of the sine wave must remain constant as the frequency is varied between 30 Hz and 1100 Hz.

Frequency counter

A frequency counter with at least 1-Hz resolution, such as the Festo Didactic Frequency counter, is required for some exercises.

Remote Control Settings

With the latest version of the radar training system (8097), some modules have a USB connector at the back. This USB connector allows the user to change the different parameters of the modules remotely. This can be done either by connecting the

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modules to the PC with a USB cable or by connecting the modules to the RTM with a USB cable. In both cases, the modules can be controlled using the Remote Control Settings panel of the LVRTS software.

A USB hub is required in order to connect all of the modules.

There are four modules that can be controlled remotely using the LVRTS software: the Radar Transmitter, the Radar Synchronizer / Antenna Controller, the Dual Channel Sampler, and Target Positioning System.

The settings that can be controlled remotely for each module are shown in this figure. All of these settings are direct mappings of the front-panel knobs and push buttons of each of these four modules.

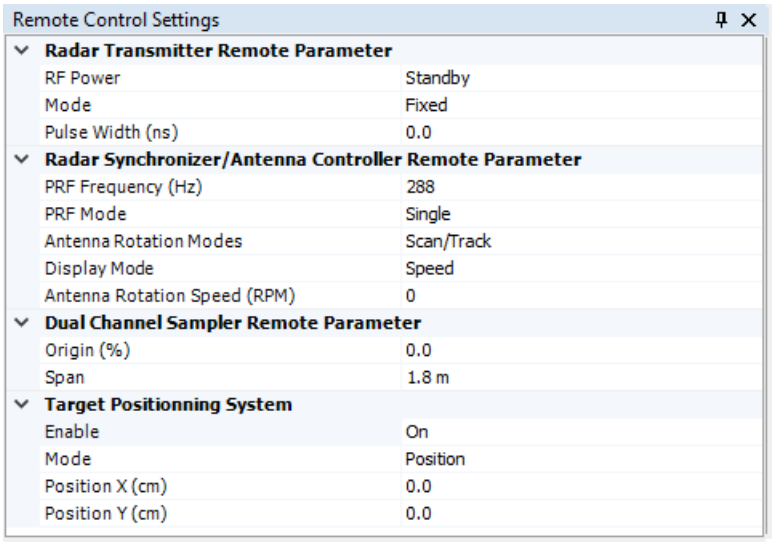


Figure 46: Remote Control Settings.

Radar Transmitter Controls

All parameters of the Radar Transmitter are displayed on the front-panel LCD. They can be edited using the browse knob and the select push button as follows:

- The LCD displays the current parameters and the screens used to edit them.
- The knob is used to browse through the screens.
- The push button is used to enter the edit mode of a parameter or to select the desired value.

Parameters Screen

The default screen of the LCD is referred to as the Parameters Screen. It shows the current mode and other parameters of the Radar Transmitter:



Figure 47: Example of the Parameters Screen.

The icons and text in the example above provide the following information:

Table 41: Information shown in the Parameters Screen.

Icon	Parameter
	Fixed Frequency mode (Refer to the following table for the icon corresponding to each mode)
	Carrier frequency: 9.400 GHz
	Pulse Width: 5.0 ns
	Modulating Frequency*: 0.22 kHz
	Frequency Deviation*: 20 MHz

*The Modulating Frequency and Frequency Deviation are always displayed but are used for the Frequency Modulated mode only.

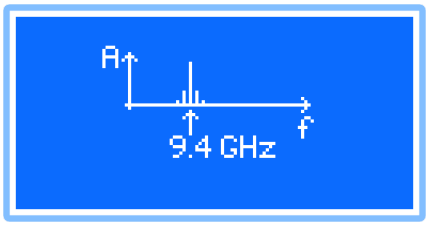
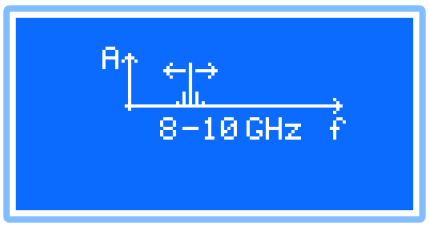
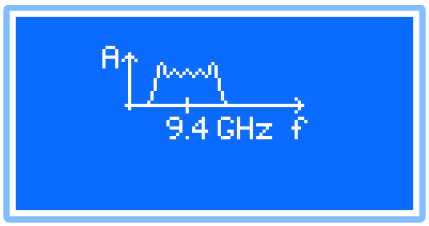
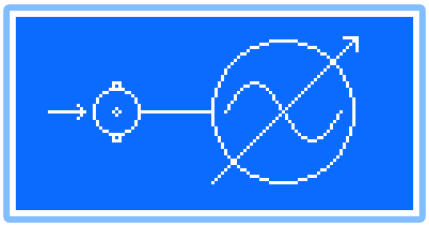
To emit a continuous wave (CW or FM-CW), the Pulse Generator and the Modulator are not connected and the Pulse Width parameter has no effect.

Turn the knob clockwise or counterclockwise to pass from the Parameters Screen through the available modes. As you do, each mode is represented by a different icon, as shown in the following table.

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A white border around a screen indicates that the knob is enabled for selecting the displayed mode or value.

Table 42: Selecting the mode.

Screen and mode icon	Mode
	Fixed Frequency
	Variable Frequency
	Frequency Modulated
	External

Fixed Frequency mode

In this mode, the frequency of the sine wave carrier signal generated by the RF Oscillator is fixed at 9.4 GHz. The Pulse Generator pulse width can be set by the user.

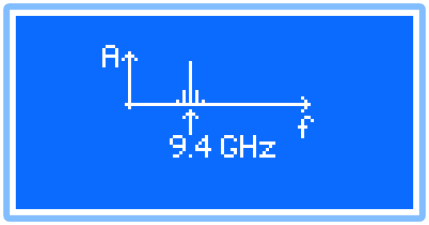


Figure 48: Selecting the Fixed Frequency mode.

Press the push button to select and edit this mode.

Fixed Frequency mode screen

This screen serves only to show that you have selected the Fixed Frequency mode:

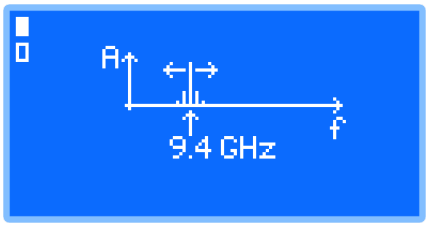


Figure 49: Fixed Frequency mode screen.

Pulse width

To change the pulse width, turn the knob until you see this screen:

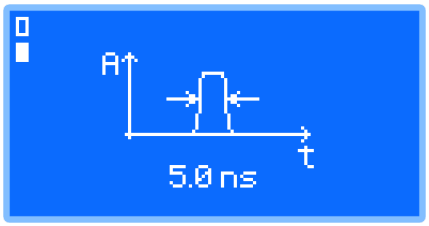


Figure 50: Pulse width screen.

Press the push button to enter the edit mode. The white border indicates that the pulse width can be changed by turning the knob.

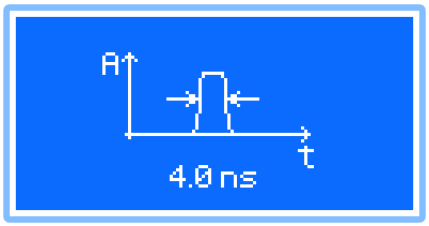


Figure 51: Editing the Pulse Width.

Turn the knob clockwise or counterclockwise until the desired pulse width is displayed, then press the push button to leave the edit mode.

When you have finished, turn the knob until the Parameters Screen appears and check the parameters.

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Variable Frequency mode

In this mode, the frequency of the sine wave carrier signal generated by the RF Oscillator can be set by the user. The Pulse Generator pulse width can also be set by the user.

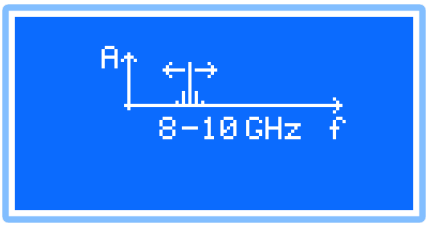


Figure 52: Selecting the Variable Frequency mode.

Press the push button to enter and edit this mode.

Variable Frequency mode screen

This screen serves only to show that you have selected the Variable Frequency mode:

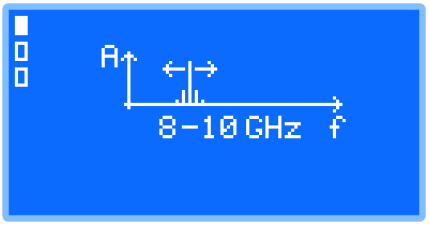


Figure 53: Variable Frequency mode screen.

Pulse Width

To change the pulse width, turn the knob until you see this screen:

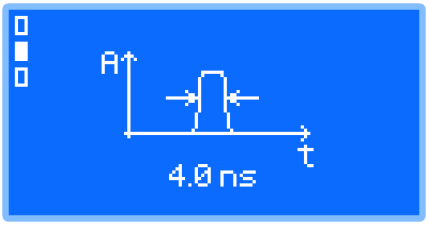


Figure 54: Pulse width screen.

Press the push button to enter the edit mode. Turn the knob clockwise or counterclockwise until the desired value is displayed, then press the push button to leave the edit mode.

Carrier Frequency

To change the carrier frequency, turn the knob until you see this screen:

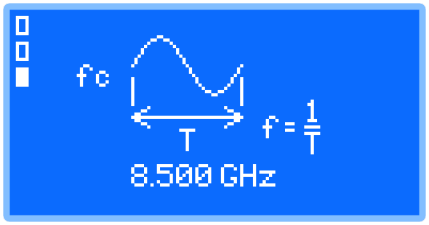


Figure 55: Carrier frequency screen.

Press the push button to enter the edit mode. Turn the knob clockwise or counterclockwise until the desired value is displayed, then press the push button to leave the edit mode.

Frequency Modulated mode

In this mode, the carrier signal generated by the RF Oscillator is a modulated sine wave, centered at 9.4 GHz, with the modulating frequency and frequency deviation set by the user. The Pulse Generator pulse width can also be set by the user.

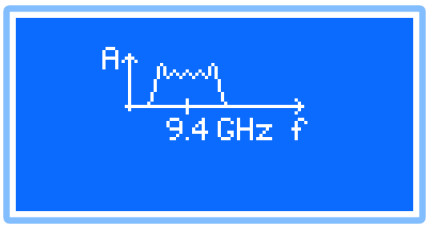


Figure 56: Selecting the Frequency Modulated mode.

Press the push button to enter and edit this mode.

Frequency Modulated mode screen

This screen serves only to show that you have selected the Frequency Modulated mode.

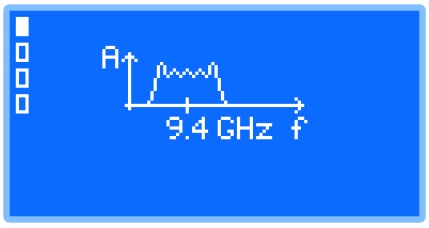


Figure 57: Frequency Modulated mode screen.

Pulse Width

To change the pulse width, turn the knob until you see this screen:

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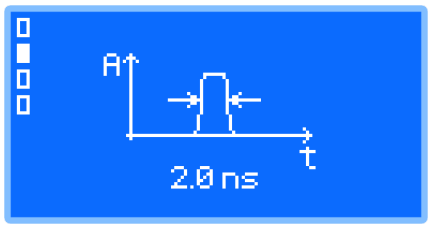


Figure 58: Pulse Width screen.

Press the push button to enter the edit mode. Turn the knob clockwise or counterclockwise until the desired value is displayed, then press the push button to leave the edit mode.

Modulating Frequency

To change the modulating frequency, turn the knob until you see this screen:

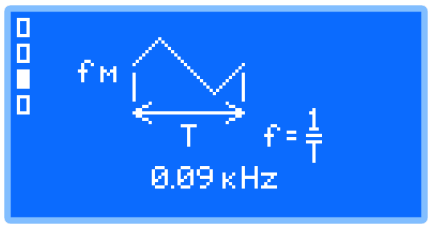


Figure 59: Modulating Frequency screen.

Press the push button to enter the edit mode. Turn the knob clockwise or counterclockwise until the desired value is displayed, then press the push button to leave the edit mode.

Frequency Deviation

To change the frequency deviation, turn the knob until you see this screen:

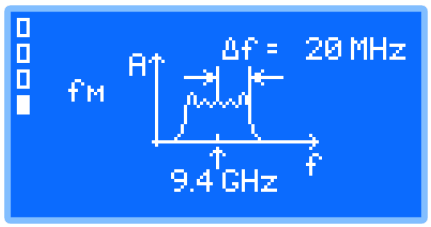


Figure 60: Frequency Deviation screen.

Press the push button to enter the edit mode. Turn the knob clockwise or counterclockwise until the desired value is displayed, then press the push button to leave the edit mode.

External mode

In this mode, the signal generated by the RF Oscillator is a sine wave with a frequency proportional to the voltage applied to the VCO Ctrl Input (0 - 10 V max.). The Pulse Generator pulse width can be set by the user.

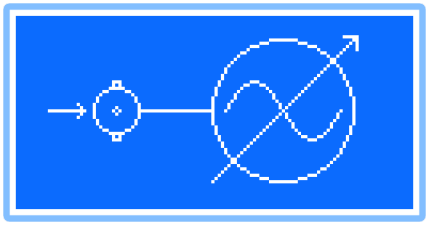


Figure 61: Selecting the External mode.

Press the push button to enter and edit this mode.

External Mode screen

This screen serves only to show that you have selected the External mode:

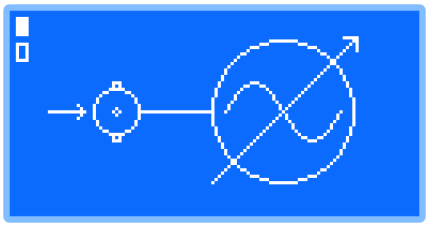


Figure 62: External mode screen.

Pulse width

To change the pulse width, turn the knob until you see this screen:

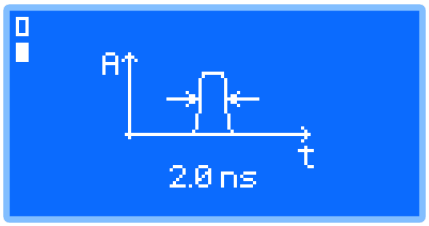


Figure 63: Pulse width screen.

Press the push button to enter the edit mode. Turn the knob clockwise or counterclockwise until the desired value is displayed, then press the push button to leave the edit mode.

Target Positioning System Controls

The Target Positioning System consists of the target table with a 90 cm x 90 cm surface and a moveable mast to support the target. The Target Remote Controller allows the user to control the position, speed, and trajectory of the target over a wireless link with the Target Controller Base which is installed on the target table.

An LCD on the Target Remote Controller displays a menu for selecting the mode and trajectory of the target and displays the target's position and speed. The X and Y Position/Speed push button knobs are turned in order to browse through the screens and are pushed to make a selection. These knobs are also used to adjust the position or speed of the target, depending on the selected mode.

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The Target Remote Controller is powered by a USB cable plugged into either a computer or the RTM. It turns on as soon as it is connected.

When necessary, the LCD displays a message, as shown in the example below.



Figure 64: LCD message displayed when the Target Controller Base is not detected.

Whenever a message is displayed, follow the instructions in order to begin using the system.

Mode selection

The Target Positioning System has five modes, as shown in the following figure. These modes are described in the table below. Turn the left knob to move the arrow to the desired mode, then press the knob to select that mode.

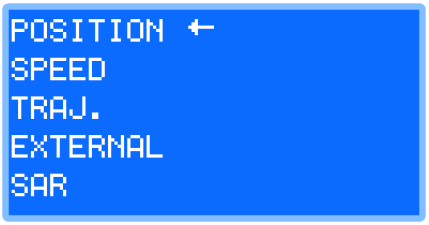


Figure 65: Mode menu.

Table 43: Target controller modes.

Mode	Description
Position	The target is stationary. The X and Y axis positions are controlled independently.
Speed	The X and Y speeds of the target are controlled independently.
Trajectory	The target follows one of the predefined trajectories at the selected speed.
External	The target is controlled via the external inputs on the Target Controller Base.
SAR	The target is controlled by the SAR (Synthetic Aperture Radar) Controller.

Position mode

In this mode, the target is stationary. Its position in cm along the X and Y axes is set manually using the X and Y Position/Speed knobs.



Figure 66: Typical display in the Position mode.

Speed mode

In this mode, the speeds along the X and Y axes are set independently using the X and Y Position/Speed knobs. The instantaneous X-Y position along each axis is displayed in cm and the speed is displayed in cm/s.



Figure 67: Typical display in the Speed mode.

While the speed is being adjusted, the display shows the speed setpoint; otherwise it displays the instantaneous speed along each axis in cm/s.

Trajectory Mode

In this mode, the target follows one of the four predefined trajectories: circle, square, figure 8, or diagonal. Turn the right knob to move the arrow to the desired trajectory, then press the knob to select that trajectory.

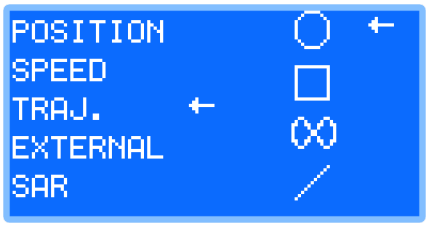


Figure 68: Selecting the trajectory.

Either knob can be used to adjust the speed. While the speed is being adjusted, a graph show how the set speed compares to the minimum and maximum speeds, as shown in the following figure.

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Figure 69: Adjusting the speed in the Trajectory mode.

Jamming Pod Remote Controller menus

The Jamming Pod is controlled using the Jamming Pod Remote Controller through menus displayed on an LCD and buttons on each side of the LCD. The function of each button depends on the screen displayed and is shown on the LCD. The menu system is illustrated in the figure below.

Communication between the Controller and the Jamming Pod

The Jamming Pod Remote Controller uses an infrared transmitter to communicate with the Jamming Pod. A pivoting infrared receiver is located on the underside of the Radar Jamming Pod. The window of the infrared receiver must be turned toward the Remote Controller. An LED within the infrared receiver window lights briefly to acknowledge the reception and execution of a command.

A Jamming Pod Remote Controller can be used to control more than one Radar Jamming Pod. Each command sent by a Remote Controller includes an ID number and each Radar Jamming Pod, when turned on, is assigned an ID which is 0 by default. A Radar Jamming Pod with an ID of 0 will accept all commands regardless of their ID. However, once the Radar Jamming Pod has been assigned an ID other than 0, it will only accept commands having the same ID. This makes it possible to control more than one Radar Jamming Pod using a single remote controller. All that is required is to use the Remote Controller to assign a different ID to each Jamming Pod.

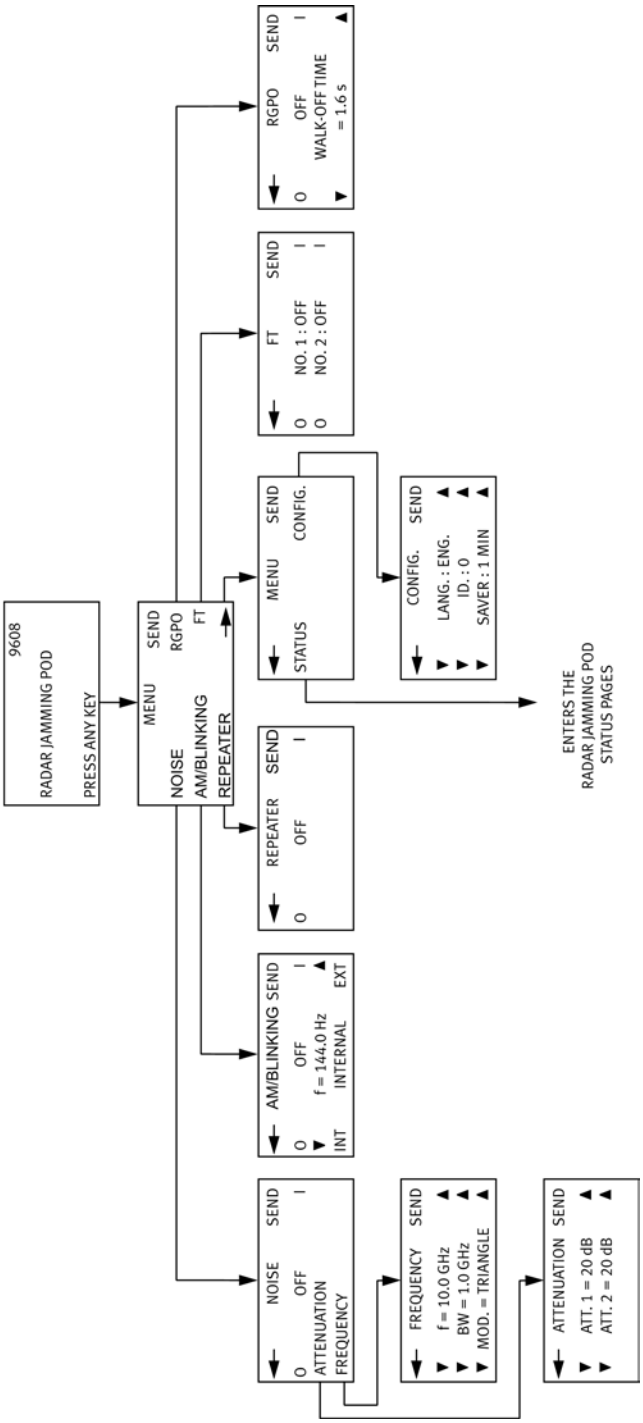


Figure 70: Jamming Pod Remote Controller menu.

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Equipment Maintenance

The equipment is designed to ensure user safety and long-term reliability. Nevertheless, care must be taken to ensure that the equipment remains in good operating condition and safe for the user.

This section provides directives and guidelines for the maintenance of the equipment.



⚠ WARNING

Instructors and/or the personnel in charge of laboratory equipment should transmit the following directions and guidelines to students because they play an important role in maintaining the equipment in good operating condition.

General maintenance

The equipment does not require any particular maintenance. However, it is very important to perform a visual inspection of the equipment before each laboratory exercise. If a piece of equipment appears damaged or shows wear, it must be replaced to ensure user safety and prevent further damage to the equipment.

There are no user serviceable parts inside the equipment, other than certain parts that may need to be replaced, such as fuses, button cells, batteries, etc. Opening or removing the equipment housing to replace parts may expose you to dangerous voltages. Do not try to open the equipment housing to replace parts. Have a qualified technician replace parts in the equipment.

Consumables and replacement parts

It is possible to replace certain pieces of equipment that are consumable or that have been damaged. Use only Festo Didactic parts and accessories to ensure compatibility and sustainability of the equipment. Available replacements parts and accessories are listed below.



The measuring tape, level, USB cables, and batteries can be replaced with generic items.

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Table 44: List of consumable pieces and damageable equipment.

Part	Type	Rating	Order no.
Basic Radar Accessories			
Adapter	Tee BNC, jack-plug-jack	50 Ω	769770
Support	Horn antenna support		770690
Coaxial cable	SMA	200 cm, 50 Ω	775653
Adapter	Antenna base to SMA		771321
Coaxial cable	SMA, with voltage limiter	42 cm, 50 Ω	775911
Load	SMA	50 Ω	770981
Coaxial cable	SMA	42 cm, 50 Ω	771062
Coaxial cable	SMA	400 cm, 50 Ω	771063
Clip	Microwave guide quick fastener		770771
Coaxial cable	SMA	75 cm, 50 Ω	771060
Measuring tape	Measuring tape 8 m	8 m	771278
Level	Cross check level		771279
Attenuator	SMA, jack-jack	10 dB, 2 W, 50 Ω	771283
Adapter	Tee BNC, jack-jack-jack	50 Ω	771900
Adapter	Microwave guide to SMA	50 Ω, WR90	771003
Adapter	SMA, plug-plug	50 Ω	775372
Attenuator	SMA, jack-jack	6 dB, 2 W, 50 Ω	771285
Attenuator	SMA, jack-jack	3 dB, 2 W, 50 Ω	771287

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Part	Type	Rating	Order no.
Protective earth lead	6 mm protective earthing lead (POAG)	100 mm, 4 mm^2 cross-section wire	793138
Cable	D9, female, shielded	2 m	8112455
Cable	M12, male to female, 5 conductor, shielded	2 m	8112517
Coaxial cable	BNC	75 cm, 50 Ω	8112518
Coaxial cable	BNC	122 cm, 50 Ω	8112519
Coaxial cable	BNC	46 cm, 50 Ω	8112520
Power Supply / Antenna Motor Driver			
Line cord	Detachable line cord, C13 to EF	250 V, 10 A, 2 m	789182
Radar Transmitter			
Coaxial cable	SMA, "U" formed	10 cm, 50 Ω	771098
Target Positioning System			
Support	Tripod target support		771211
Target	Corner reflector		771212
Target	Flat, reflective	20 cm X 20 cm	771213
Target	Flat, reflective	10 cm X 10 cm	771214
Target	Flat, plastic	20 cm X 20 cm	771215
Target	Sphere, reflective		771216
Target	Cylinder, reflective		771217
Support	Tripod independent target support		772409
Cable	USB 2.0, A/B	3 m	774966

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Part	Type	Rating	Order no.
Line cord	Detachable line cord, C13 to EF	250 V, 10 A, 3 m	780519
RTM Power Supply			
Line cord	Detachable line cord, C13 to EF	250 V, 10 A, 2 m	789182
Reconfigurable Training Module			
Cable	RTM custom power cable	1 m	8112869
Blank panel	RTM blank panel		8114467
Radar Processor/Display Accessories			
Target	Half cylinder		771218
Support	Double target bar		772016
Cable	USB 2.0, A/mini B	3 m	780035
Cable	D15, female, shielded	0.76 m	793854
Ethernet cable	RJ45, shielded	2 m	8112521
Radar Tracking Training System Accessories			
Coaxial cable	BNC to 2 mm plugs	190 cm, 50 Ω	769319
Target	Cylinder, reflective		771217
Target	Zigzag, small, reflective		771219
Target	Zigzag, large, reflective		771220
Radar Active Target Training System Accessories			
Support	Rod, short	11.6 cm	774651
Support	Rod, short	17.6 cm	774652
Target	Flat, reflective	15 cm X 15 cm	771221

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Part	Type	Rating	Order no.
Support	Tripod independent target support		772409
Support	Antenna support		770690
Power divider	RF power divider	50 Ω	774735
Chaff	Radar chaff sample		774725
Clip	Microwave guide quick fastener		770771
Coaxial cable	SMA	110 cm, 50 Ω	771064
Adapter	Radar antenna adapter		774681
Adapter	Rod support adapter		774682
Adapter	Chaff support adapter		774683
Chaff	Chaff band		774684
Stealth parts	Main cover		774686
Adapter	Interface support adapter		774685
Stealth parts	Flat wing		774670
Stealth parts	Wing cover		774673
Stealth parts	RF absorber panel short		774676
Stealth parts	RF absorber panel long		774677
Stealth parts	RF absorber panel rear		774678
Support	Chaff support		774680
Support	Jamming pod tripod		774707
Adapter	Microwave guide to SMA adapter	50 Ω, WR90	771003

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Part	Type	Rating	Order no.
Radar Jamming Pod			
Battery	AA	1.5 V	764761
Load	SMA	50 Ω	770981
Power Supply (Radar Electronic Warfare)			
Line cord	Detachable line cord, C13 to EF	250 V, 10 A, 2 m	789182
Radar Phased Array Antenna Training System Accessories			
Coaxial cable	SMA	200 cm, 50 Ω	775653
Coaxial cable	SMA, with voltage limiter	42 cm, 50 Ω	775911
Absorber pen	RF absorber pen		783466
Attenuator	SMA, jack-jack	30 dB, 2 W, 50 Ω	775640
Cable	D25, male	183 cm	775641
Phased Array Antenna			
Support	Phased array antenna support		775371
Radar Phase-Coded Pulse Compression Training System			
Adapter	SMA, jack-jack	50 Ω	772903
Attenuator	SMA, jack-plug	4 dB, 2 W, 50 Ω	792620
Attenuator	SMA, jack-plug	10 dB, 2 W, 50 Ω	792621
Coaxial cable	SMA, with voltage limiter	75 cm, 50 Ω	8092755
Phase-Coded Pulse Compression Processor			
Power supply	Power supply	15 V, 4 A	786383

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Equipment disposal

Do not discard the equipment with normal waste: it contains electrical and electronic components. A specialist must dismantle the product. Each component must be recycled or disposed of according to your local legislation.

It is the owner's responsibility to make provisions for the equipment recycling and safe disposal.

Waste from Electrical and Electronic Equipment (WEEE) directive:

- In accordance with European regulations, used electrical and electronics devices cannot be disposed of in unsorted municipal waste. The symbol of the waste bin on wheels indicates the necessity for separate collection. For environmental protection, make sure the equipment is disposed of in the waste sorting processes designed for this purpose. DIRECTIVE 2012/19/EU of the EUROPEAN PARLIAMENT AND OF the COUNCIL of 4 July 2012 on waste electrical and electronic equipment (WEEE).



The presence of this symbol on the equipment indicates the necessity of separate collection.

Cleaning

To clean the front panel(s) and housing(s) of the equipment, use a soft cloth and a mild solution of detergent and water. It is important not to apply the solution directly onto the surface of the module. Instead, apply the solution onto the soft cloth.

NOTICE
Unless specifically stated otherwise, do not use abrasive substances or solvents to clean any part of the equipment.

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Equipment Handling and Installation

Environmental requirements

The equipment is designed to be installed indoors and must be operated in the following environmental conditions to ensure user safety:

- an altitude up to 2000 m (6560 ft)
- a temperature between 5°C and 40°C (41°F and 104°F)
- a maximum relative humidity of 80% for temperatures up to 31°C (88°F), decreasing linearly to 50% relative humidity at 40°C (104°F)
- mains supply voltage fluctuations which do not exceed ±10% of the nominal voltage
- transient overvoltages up to the levels of overvoltage category II
- temporary overvoltage occurring on the mains supply: 1500 V for 120 V mains and 2500 V for 230 V mains
- a pollution degree of 2 in accordance with IEC 60664-1



The word pollution used above refers to any addition of foreign matter, solid, liquid, or gaseous (ionized gases), that may produce a reduction of dielectric strength or surface resistivity.

Make sure that the location where you want to install the equipment meets the environmental requirements listed above, and then follow the directives given in the next sections to safely install and use the equipment.

Power requirements

The Power Supply / Antenna Motor Driver has the following power requirements:

- Power: 240 W
- AC power network voltage and frequency: 100-240 V – 50/60 Hz

The Target Positioning System has the following power requirements:

- Power: 250 W
- AC power network voltage and frequency: 100-240 V – 50/60 Hz

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The Power Supply of the Reconfigurable Training Module (RTM) has the following power requirements:

- Current: 2.5 A
- AC power network voltage and frequency: 100-240 V – 50/60 Hz

The Power Supply of the of the Radar Jamming Pod Trainer has the following power requirements:

- Power: 210 VA
- AC power network voltage and frequency: 100-240 V – 50/60 Hz

Module handling

The equipment mostly consists of modules which are designed to be placed on a table. Many of the modules are stackable. The following safety guidelines assume that the modules are correctly installed in such environment.

Before handling any module, make sure of the following:

- You know where to install or move the module.
- No obstacle is in the way. The floor is not bumpy, obstructed, or slippery.
- You are strong enough to lift and carry the module to its intended location. Assess the module weight beforehand, if necessary.

When carrying any module, make sure of the following:

- Keep a good grip on the module.
- Keep the module as close as possible to the waist, with the shoulders level. Never hold the module at arm's length or away from the body.
- Move slowly while keeping the body and feet in a stable position.
- Turn by turning the feet, NOT the back.
- Always lift and carry one module at a time.



⚠ CAUTION

The Target Table of the Target Positioning System is very heavy (approximately 100 kg). Three people are required to install it and adjust the height. Always use proper lifting technique in order to avoid personal injury.

Module installation

There are several different configurations of the Radar Training System, depending on the optional add-ons purchased by the customer and on the courseware used by the students. A typical procedure for physically setting up the system is provided in a section below.

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Although the installation procedure is basically the same for each configuration of the Radar training System, some details differ. Each student manual contains detailed instructions for setting up the Radar Training System for the exercises in that course.

The Radar Processor/Display is an addition to the Basic Radar Training System. The Radar Processor/Display and the Basic Radar Training System are required to perform the exercises in the Radar series courses, with the exception of the course Principles of Radar Systems, which requires only the basic system.

The Radar Processor/Display consists of a Reconfigurable Training Module (RTM), a Power Supply, three plug-in modules, an accessory kit, and the LVRTS software. A host computer is also required.

Before using the Radar Processor/Display, it must be installed and configured. There are different possible configurations. Refer to the Radar Processor/Display user guide for complete information.

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Equipment Commissioning

Commissioning the Radar Training System involves verifying the operation of the Target Positioning System and calibrating the Radar Training System. Calibration is necessary to adjust the signal levels in both the I and Q channels of the system, and to adjust the range origin. Calibration ensures that the system is operating correctly, that is, that targets are detected and that range measurements are accurate.



Calibration should be performed during commissioning as well as at the beginning of each laboratory period.

Verifying the operation of the Target Positioning System

- On the Target Remote Controller, select the Position mode. Verify that the X and Y Position controls vary the position of the moveable carriage along the two axes.
- On the Target Remote Controller, select the Speed mode. Verify that the X and Y Speed controls vary the speed of displacement of the moveable carriage along the two axes.
- On the Target Remote Controller, select the Trajectory mode. Verify that different trajectories can be selected and the verify operation of the speed control.

Calibrating the Radar Training System

A typical procedure for calibrating the Radar Training System is presented in a section below.



Although the calibration procedure is basically the same for each configuration of the Radar training System, some details differ. Each student manual contains detailed instructions for calibrating the Radar Training System for the exercises in that course.

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Setting up the Radar Training System

Setting up the Radar Training System with Pulse Compression

As different system configurations require slightly different equipment, the appropriate set-up procedure is provided in each student manual. This section reproduces the appendix on setting up the system from one of the student manuals.

Introduction

The Radar Training System and host computer must be set up properly before beginning any exercise contained in this document. This appendix gives procedures, recommendations, and examples that facilitate setting up the various elements of the Radar Training System.

The first section of the appendix briefly describes the various elements of the Radar Training System. The second section describes how to mount the antenna on the pedestal. The third section deals with the positioning of the various elements in the laboratory classroom. This section provides useful recommendations and examples for setting up the Radar Training System. The fourth section gives the optimum height of the target table with respect to the antenna height. It also contains a procedure describing how to vary the height of the target table. The last section shows how to place the training modules and explains how to position the host computer and its monitors with respect to the training modules. These sections should normally be carried out in order when setting up the Radar Training System.

The main elements of the Radar Training System

The Rotating-Antenna Pedestal contains a driving mechanism for rotating an antenna, and a circulator for transmitting and receiving simultaneously with the same antenna.

The Pulse Compression Radar Antenna has an integrated cable that delays the signal by a few microseconds. This delay is necessary in order to prevent internal reflections from interfering with the longer pulses used with pulse compression.

For brevity, the Pulse Compression Radar Antenna is often referred to in this section as the “Radar Antenna”.

The Radar Antenna is of the offset-feed type, and is designed to be mounted on the Rotating-Antenna Pedestal. A microwave-absorbing parapet is provided with the Radar Antenna in order to protect the operator(s) of the Radar Training System against long-time exposure to microwave radiation, and to encourage good safety habits.

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The target table is the main element of the Target Positioning System. It is a 1 square-meter table mounted on wheels. A movable carriage holding a mast is mounted on the surface of this table. A target can be fixed to the upper end of the mast. The movable carriage is controlled by the Target Remote Controller, also part of the Target Positioning System.

The Radar Training System includes a set of training modules that are stackable over the Power Supply / Antenna Motor Driver. The system also includes the Reconfigurable Training Module (RTM), its power supply, and plug-in modules, as well as the LVRTS software. A host computer running Windows is required. The use of two monitors is recommended.

Mounting the Radar Antenna on the Rotating-Antenna Pedestal

The Radar Antenna is designed to be inserted onto the shaft located on top of the Rotating-Antenna Pedestal. There is a key slot on this shaft and a key inside the tubular part of the Radar Antenna frame. These must be properly aligned when inserting the Radar Antenna onto the shaft of the Rotating-Antenna Pedestal. The screw located on the Radar Antenna allows it to be secured to the shaft of the Rotating-Antenna Pedestal.

Positioning the various elements of the Radar Training System

The following recommendations are useful for positioning the various elements of the Radar Training System properly.

The Rotating-Antenna Pedestal, the training modules, the RTM and its power supply, the host computer, the monitor(s), and the microwave-absorbing parapet (if used) should all be placed on the same table.

The height of this table should be in the range of 0.6 to 0.95 m.

The Rotating-Antenna Pedestal should be placed near an edge of this table. This will allow a target to be brought very close to the Radar Antenna horn, using the target table.

The microwave-absorbing parapet should be placed between the Rotating-Antenna Pedestal and the training modules and host computer so that it shields the operator(s) of the Radar Training System from microwave radiation produced by the Radar Antenna.

A minimum free space of approximately 3.5 m, starting from the edge of the table where the Rotating-Antenna Pedestal is placed, should be allocated for moving the target table. This minimum free space is required in order to carry out the exercises contained in this document.



Any metallic object of relatively large size located beyond the free space allocated for moving the target table may be detected by the Radar Training System. This may be disturbing when performing certain exercises. If so, the object(s) should be moved, or hidden from the Radar Training System with microwave-absorbing material.

The following figure shows two examples of a suitable set-up. Because the instructions for connecting the module will be shown on the computer, it is best to place the monitors where you can easily see them as you make the connections.

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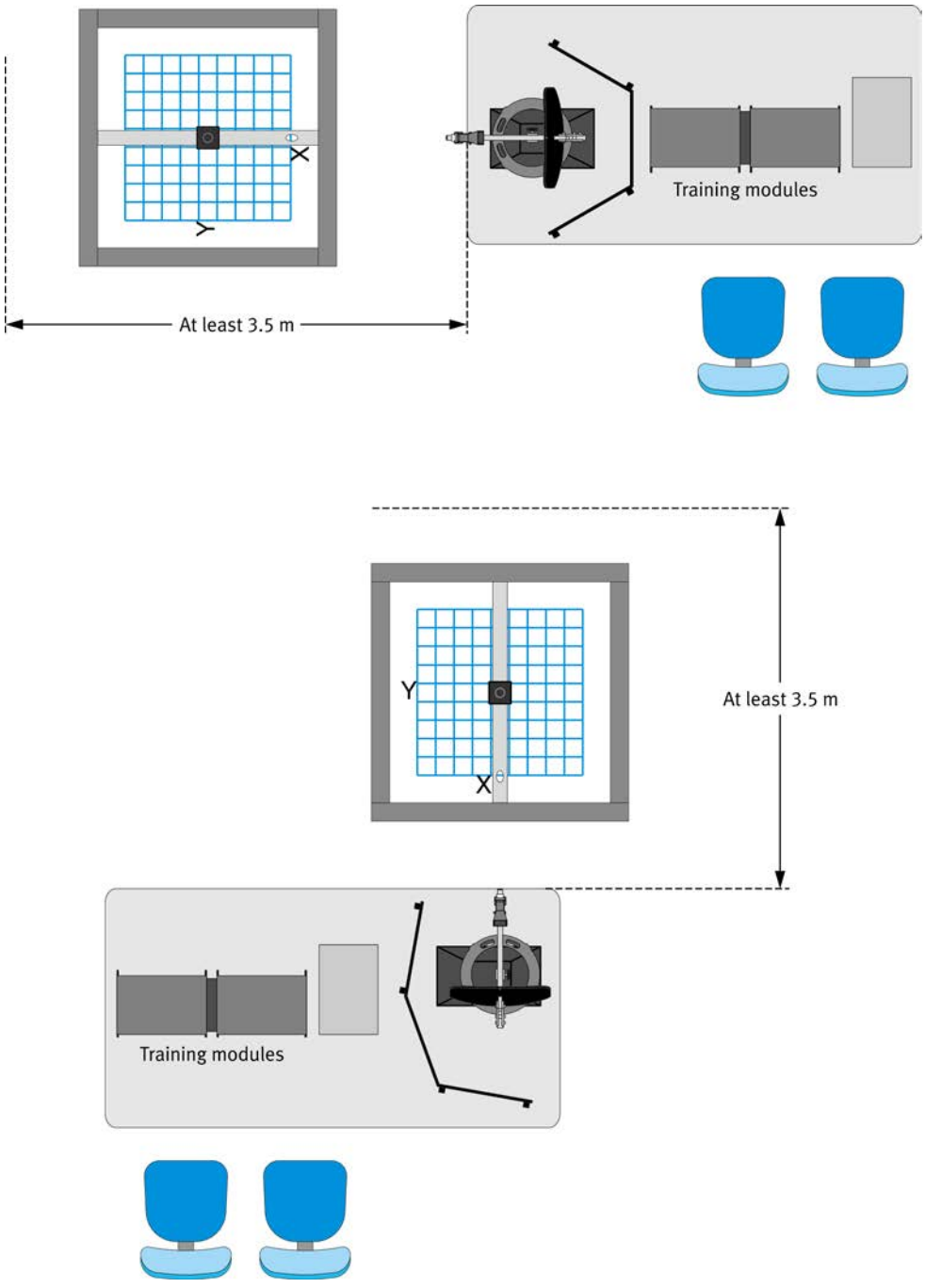


Figure 71: Positioning the elements of the Radar Training System.

Setting the height of the target table

To insure correct alignment of the targets with the Radar Antenna, the height of the target table should be adjusted so that the upper end of the mast is approximately 10 cm lower than the center of the parabolic reflector of the Radar Antenna. This occurs when the height of the target table and that of the table where the Rotating-Antenna Pedestal is placed are the same. This is illustrated in the following figure.

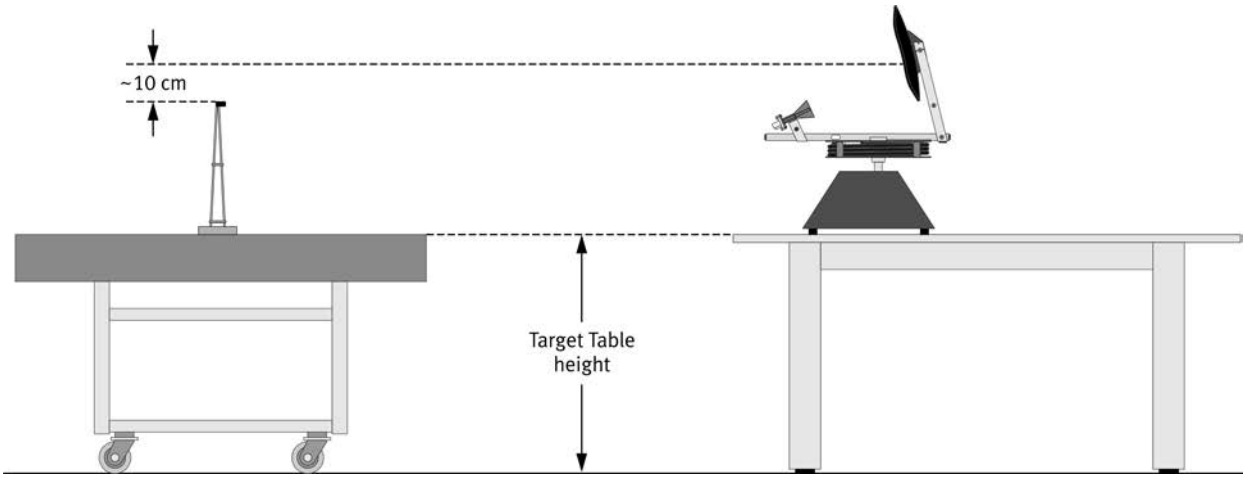


Figure 72: Appropriate height of the target table.

The following procedure describes how to vary the height of the target table. Note that three people are normally required to carry out most of this procedure.

1. Place the target table beside the table where the Rotating-Antenna Pedestal is placed.

2. Loosen the bolt on each leg of the target table. Before loosening these bolts, ask two people to hold the upper part of the target table to take the weight off the table legs.

3. Once these bolts have been loosened, the people helping you should raise or lower the upper part of the target table to the desired height.

4. Slide the adjustable part of each leg up or down so that it butts against the underside of the target table.

   It might be necessary to place the bolt in another of the holes drilled in the adjustable part of each leg, depending on the length of adjustment required.

5. Snugly tighten the bolt on each leg of the target table. The people holding up the upper part of the target table can now let go.

6. Using the level provided with the Radar Training System, verify if the target table is approximately level. If not, readjust the length of its legs as necessary, while two people support the upper part of the target table.

7. When the adjustments on the target table have been completed, firmly tighten the bolt on each of its legs.

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Placing the modules

1. Set up the modules on the table in a convenient arrangement. The following figure shows an arrangement that can be used where space is limited. The RTM power supply can be placed either to the left or to the right of the RTM.

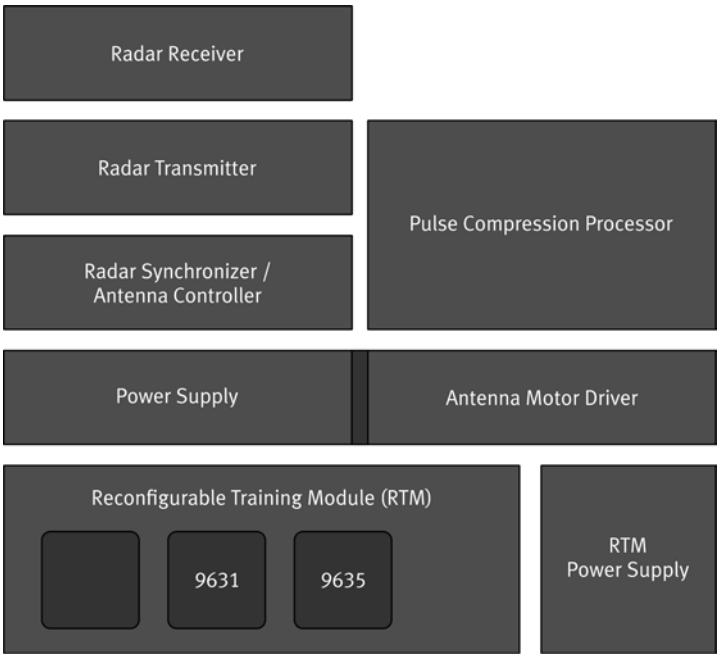


Figure 73: Typical arrangement of the training modules.

2. Make sure that the Radar Antenna has enough space to rotate freely.

   On the Radar Transmitter, make sure that the RF Power switch is in the Standby position (yellow LED).

   Install the plug-in modules, Models 9631 and 9635, in the RTM as shown in the preceding figure.

3. Connect the Target Remote Controller to a USB port on either the computer or the RTM.

Make sure that the surface of the target table is free of any objects before setting the Power switch of the Target Positioning System to the I (on) position.

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Earthing

Connecting the PE terminals

Some training module in the Radar Training System are provided with two protective earthing (PE) terminals on the rear panel. These terminals are provided to ensure that the modules share a common earth (ground). This is not for security reasons but rather to reduce electromagnetic interference (EMI). If EMI is a concern, connecting all of these terminals together using the leads provided will help reduce EMI to a minimum.

Connecting external devices to the RTM

Because the output connectors of the Power Supply, Model 9408, are grounded, the connectors on the modules powered by this power supply (that is, the RTM and the plug-in modules) are also grounded. To prevent damage to the equipment, any external device connected to the RTM or to a plug-in module must be properly grounded.

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Calibration

Calibration ensures that the system is operating correctly, that is, that targets are detected and that range measurements are accurate. As different system configurations requires slightly different equipment, the appropriate calibration procedure is provided in each student manual. This section reproduces the appendix on system calibration from one of the student manuals.

Introduction

This calibration procedure consists of the following sections:

- Connections and initial adjustments
- DC Offset adjustment, to eliminate dc offsets at the I- and Q-Channel Outputs of the Pulse Compression Processor
- Gain adjustment, to make sure that the amplitudes of the I- and Q-Channel Outputs of the Pulse Compression Processor are approximately equal
- Origin calibration, to ensure that target ranges are accurately indicated on the Radar Display

Connections and initial adjustments

Some of the following steps begin with “if not already done…”. If you have already done a similar step in the exercise you are doing, simply skip the corresponding step in this appendix.

1. If not already done, turn on all modules of the Radar Training System, the computer and the monitor. Then start the LVRTS software and select the desired radar application.

   For best results, it is preferable to let the system warm up for approximately 30 minutes before performing the calibration. During this time, you can complete the initial adjustments. For Radar Transmitters with revision 2 or later, no warm up period is required. The first digit following the hyphen in the identifier indicates the revision number (e.g. 9620-2X).

2. If not already done, make the connections shown in the Pulse Compression Radar tab of the LVRTS software.

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For details of connections to the Reconfigurable Training Module, refer to the RTM Connections tab of the software.

The Analog/Digital Output Interface (9635) plug-in module is only used if you wish to connect a conventional PPI display to the system. It is not required for calibration of the system.

3. Stop the antenna rotation.

   To stop the antenna from rotating and orient it manually, use any one of the following three methods:

   - Use the Manual Antenna Rotation Mode and the Speed control on the Antenna Controller. Select PRF Lock to resume antenna rotation.
   - Disconnect the cable at the Input of the Antenna Motor Driver and orient the antenna by hand. Reconnect the cable to resume antenna rotation.
   - Slightly unscrew the connector at the Power Output of the Antenna Motor Driver and orient the antenna by hand. Screw the connector back in to resume antenna rotation.

4. If not already done, position the target table within the desired observation range of the Rotating-Antenna Pedestal.

   In most set-ups, the aluminum rail on the target table is aligned with the antenna axis, as shown in the following figure. With this orientation, moving the target along the Y-axis changes the target range.

   In some cases, the table is turned so that the X axis is the range axis. This is useful when both a fixed target and a moveable target must be placed on the antenna boresight.

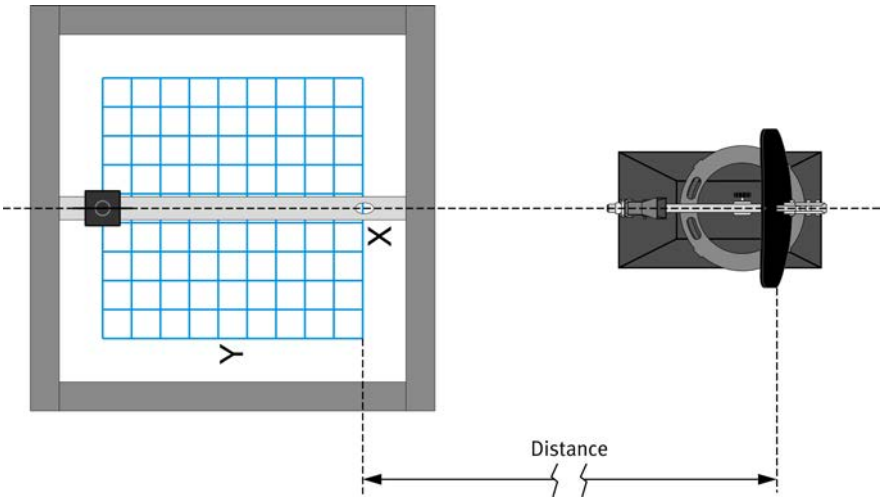


Figure 74: Position of the target table (Y axis is range axis).

5. On the Target Remote Controller, set the Mode to Position.

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If not already done, place a target on the target table mast. If no target is specified in the exercise procedure, use the half-cylinder target or the small plate target. Orient the target so that it faces the Radar Antenna, and then tighten the screw to secure the target to the mast.

Orientation is critical with a plate target. However, when it is perfectly perpendicular to the antenna boresight line, the small plate target provides a stronger return than does the half-cylinder target.

Align the antenna with the target.

6. If not already done, make adjustments to the modules:

   On the Radar Transmitter

RF Oscillator Frequency	9.4 GHz (calibrated)
RF Power	Standby (yellow LED)

   On the Radar Synchronizer / Antenna Controller

PRF	288 Hz
PRF Mode	Single
Antenna Rotation Mode	PRF Lock

   The Pulse Compression Processor is designed to operate with a 288 Hz single PRF.

   On the Pulse Compression Processor

Gain (I and Q)	Slightly above Cal.*
DC Offset (I and Q)	mid position*
Range Span	desired observation range
Sample Rate	3 / ns
Filters	Matched
Code	Rect. 1

   * If you are just checking to make sure the system is correctly calibrated, do not change the Gains and DC Offsets now. Instructions are provided below to check them and adjust them if necessary.

DC Offset checking and adjustment

DC Offset adjustment is necessary in order to reduce dc offsets at the I- and Q-Channel Outputs of the Pulse Compression Processor.

1. In the LVRTS software, show the Probes bar (click Probes Bar in the View menu, or click the probe icon in the main toolbar).

   Connect probes 1 and 2, respectively, to TP1 (I Channel) and TP2 (Q Channel) in the MTI Processor tab.

   Connect probe E to TP3 (PRF) in the Display Processor tab.

2. Show the Oscilloscope (click Oscilloscope in the Instruments menu or click the Oscilloscope icon) and adjust it as follows:

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Channel 1	200 mV/div (DC Coupling)
Channel 2	200 mV/div (DC Coupling)
Time Base	Custom, 0.347 ms/div
Trigger Level	2 V
Trigger Slope	Rising
Trigger Source	Ext

To use a Custom Time Base, set Time Base to Custom. Set Custom Time Base to the desired unit per division, and enter the desired value.

Since the PRF is 288 Hz, the inter-pulse period is 1/(288 Hz)=3.47 ms. With a Custom Time Base of 0.347 ms/division, the Oscilloscope always displays one complete Range Span.

3. The Avg reading for Ch1 and Ch2, displayed in the Waveform Data area on the Oscilloscope, indicates the I- and Q-channel offsets, respectively. When the RF Power is set to Standby (yellow LED), these offsets should normally be close to 0 V.

   If necessary, adjust the I and Q DC Offset controls on the Pulse Compression Processor so that the Avg reading for each channel is approximately 0.0 V. It is normal that these readings fluctuate slightly.

The offsets are first adjusted with no radar signal present. As you use the system in different modes and with different codes, there will often be a dc offset present in the traces. It may be necessary to readjust the DC Offsets so the trace baselines are at 0 V (in line with the ground points).

Gain checking and adjustment

Gain adjustment is required to ensure that the amplitudes of the I- and Q-Channel Outputs of the Pulse Compression Processor are approximately equal.

1. On the Radar Transmitter, turn on the RF Power. The RF Power LED should start to flash red. This indicates that RF power is being radiated by the Radar Antenna.

Since the radiation levels of the Radar Training System are very low, there is no danger to anyone standing near or in front of the antenna. Remember, however, that with a full-scale radar, you must always make sure that no one could be exposed to dangerous radiation levels before turning on the RF power.

2. On the Target Remote Controller, set both Position/Speed controls to minimum (fully counterclockwise). Then select the Speed mode.

   Turn the Position/Speed control of the range axis (this is the Y axis in Figure 74, but it may be the X axis in some cases) very slightly to make the target move towards and away from the antenna.

Set the Speed to 1 or 2 cm/s.

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3. If you do not see the moving-target blips on the Oscilloscope, turn the Origin control on the Pulse Compression Processor several turns clockwise. This will move the origin beyond the moving target. Then turn it counter-clockwise until you see the moving target blips.

   These settings were used for the following figure:

Pulse Compression Processor settings:	
Range Span	7.2 m
Monitor Outputs	TP1 and TP4
Software test points:	
MTI Processor	TP1 and TP2
Oscilloscope settings:	
Channel 1 Scale	200 mV/div
Channel 2 Scale	200 mV/div
Time Base	Custom, 0.347 ms/div
Trigger Source	Ext
Trigger Level	2 V
Trigger Slope	Rising
Persistence	8 Traces

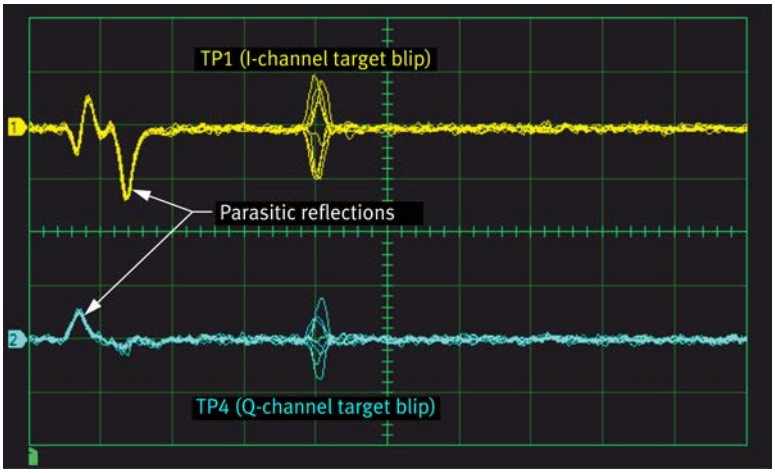


Figure 75: Moving target blips.

4. On the Target Remote Controller, select the Position mode.

   Use the Origin control on the Pulse Compression Processor to position the moving target blips in a convenient region of the screen.

   Turning the Origin control clockwise moves the imaginary window that contains the Range Span away from the antenna. This makes target blips appear to move towards the antenna (to the left on the Oscilloscope).

   Since the origin has not been calibrated, you may see parasitic reflections in the signal that are due to reflections in the antenna.

5. Check that the baseline (the part of the trace where only noise is present) of each trace is approximately at 0 V. If necessary, slightly adjust the DC Offset controls to remove the offset from each trace.

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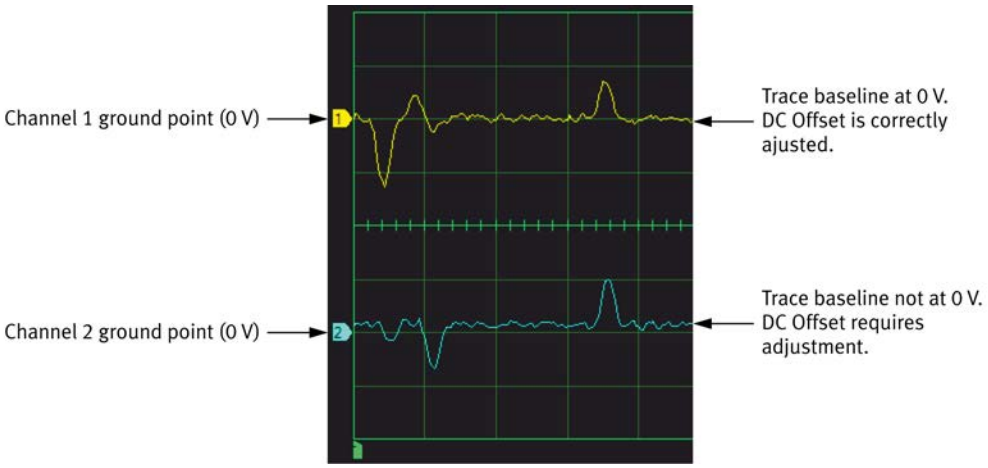


Figure 76: DC offset adjustments.

6. Using the Target Remote Controller, change the target range slightly so that the peak in the I-channel signal on the Oscilloscope (channel 1) is at a positive maximum and the Q-channel signal (channel 2) is approximately zero, as shown in the following figure.

Change the Oscilloscope Scale settings or ground points, if necessary, to view the waveform. Make sure the Channel 1 and Channel 2 Scale settings are the same.

Show the horizontal cursors. Using the mouse, position cursor 1 (red) at the peak of the I-channel signal, as shown in the following figure. Note the Ch 1 Cur 1 voltage in the waveform data at the bottom of the screen.

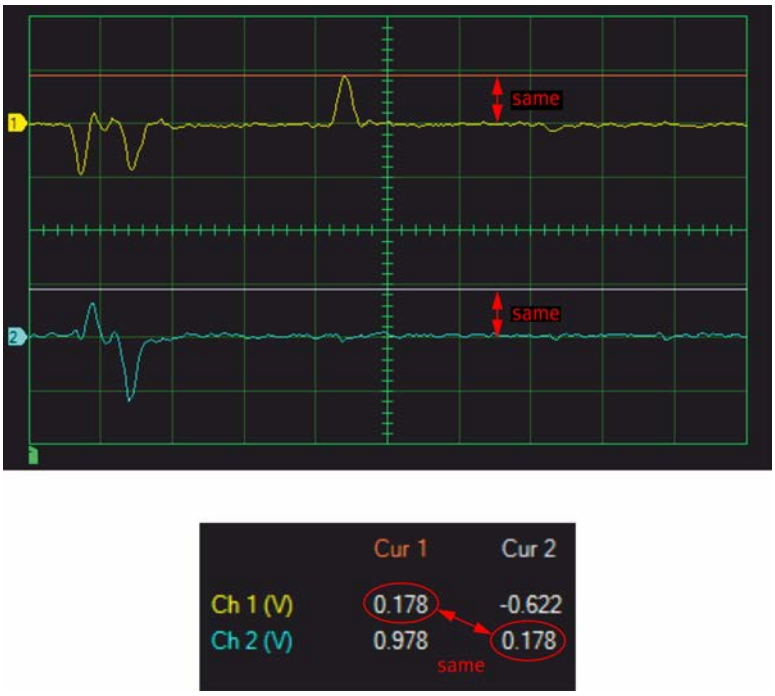


Figure 77: Positioning the horizontal cursors (Averaging: 4 Traces).

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7. On the Oscilloscope, move cursor 2 (white) to the position where the indicated Ch 2 Cur 2 voltage is the same as the Ch 1 Cur 1 voltage (refer to the data below the graticule, as shown in Figure 77). This places cursor 2 at the same voltage above the channel 2 ground point as cursor 1 is above the channel 1 ground point (see Figure 77).

8. Using the Target Remote Controller, slowly alter the target range so that the I-channel signal on the Oscilloscope reduces to approximately zero while the peak in the Q-channel signal increases to a maximum. If you go too far, back up to the optimal position.

   Once the optimal position is reached, adjust the Q-Channel Gain control on the Pulse Compression Processor, if necessary, so the peak of the pulse on channel 2 of the Oscilloscope just touches cursor 2, as shown in the following figure.

   In order to keep offsets low, try to set the Gains as close to the Cal. (minimum) position as possible.

   If you are going to calibrate the origin, note the peak amplitude of the pulse on the Oscilloscope.

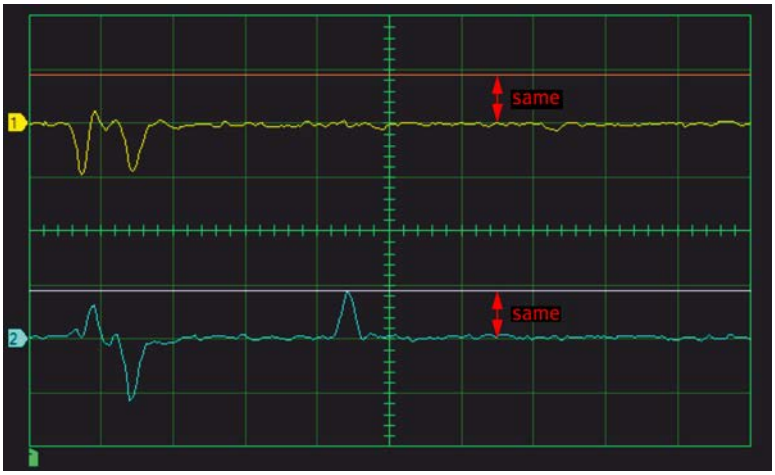


Figure 78: Adjusting the Q-Channel Gain.

Origin calibration

Origin calibration is required to ensure that target ranges are accurately indicated on the Radar Display.

1. On the Target Remote Controller, set the Mode to Speed. Set the appropriate Speed control so that the target moves along the range axis at a speed of roughly 5 to 10 cm/s.

   Make sure the Radar Antenna is rotating.

2. On the Radar Transmitter, make sure that the RF Power is on (flashing red LED).

3. In the LVRTS software, show the Radar Display (click Radar Display in the Instruments menu or click the Radar Display icon).

   In the Radar Display, make the following settings:

Range	Same as the Range Span on the Pulse Compression Processor
Display Threshold	Adjust as necessary to clearly display the moving target.

   Set the Display Threshold to approximately one-half the peak amplitude of the pulse observed on the Oscilloscope.

4. On the Target Remote Controller, set the Mode to Position. The target will move to the center of the table.

   Stop the antenna rotation and align the antenna with the target. Then use the measuring tape to determine the target range (in cm), measured from the back of the horn of the Radar Antenna.

   Start the antenna rotation again.

   Make sure the RF Power on the Radar Transmitter is on (flashing red LED).

5. In this step, you will place the VRM (Variable Range Marker) at the range where the target blip should be located, and then adjust the Origin control to move the blip close to that location.

   Set the Display Threshold in the Radar Display Settings to obtain a fairly small blip for the target.

   You may also find it helpful to increase the Display Intensity.

   Set VRM (Variable Range Marker) to On.

   In the Radar Display Settings, set VRM Position to the target range measured using the measuring tape (in cm).

6. On the Pulse Compression Processor, adjust the Origin control so that the target blip coincides with the VRM (see Figure 79). Once this is done, the Radar Display will display all visible targets at the correct range.

   Turning the Origin control clockwise moves the imaginary window that contains the Range Span away from the antenna. This makes target blips appear to move towards the antenna on the Radar Display.

   After each adjustment, wait until the antenna scans the target.

   Turn off the VRM.

   If you are not going to use the Radar Display immediately, you can close it. As long as you do not readjust the Origin control or turn off the Pulse Compression Processor, the origin will remain calibrated.

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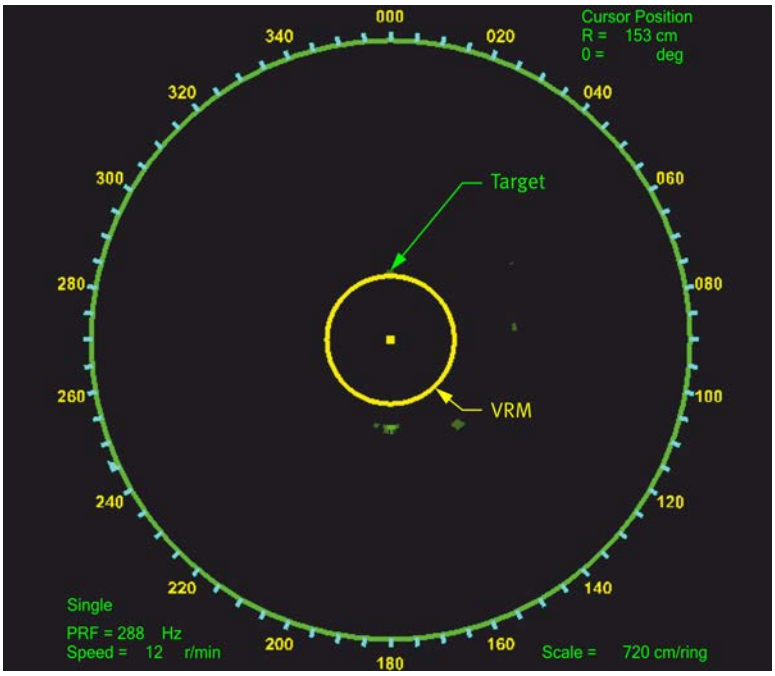


Figure 79: Origin calibration.

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Frequency and Power Specifications

The following two tables show the frequency and power specifications of the modules in the Radar Training System.

Table 45: Frequency and power specifications of the Radar Transmitter and Phase-Coded Pulse Compressor.

All modes	
Carrier	Sine wave
Frequency	8 to 10 GHz
Power	0.5 dBm
CW Mode	
Modulating signal	None
Total Width	Infinity
Duty Cycle	100%
FM-CW Mode	
Modulating signal	FM (freq.: 0.1 to 2.5 kHz, deviation: 0 to 600 MHz)
Total Width	Infinity
Duty Cycle	100%
Pulse	
Modulating signal	Pulse
Total Width	1 to 5 ns

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Duty Cycle	1 ns x 12.288 kHz (sync. min.) = 0.0012% to 5 ns x 294 kHz (sync. max.) = 0.15%
Phase-Coded Pulse Compressor	
Modulating signal	Binary Bipolar Code (length: 4 to 35)
Total Width	4 to 35 ns
Duty Cycle	4 ns x 294 kHz = 0.12% to 35 ns x 294 kHz = 1%

Table 46: Frequency and power specifications of the Jamming Pod.

All modes	
Carrier	Sine wave
Frequency	8 to 12 GHz
Power	-30 to 10 dBm
Total width	Infinity
FM	
Modulating signal	Triangular-wave (980 Hz)
Duty Cycle	100%
FM	
Modulating signal	Pseudo-random bit sequence (30 kbps)
Duty Cycle	100%
AM	
Modulating signal	Square-wave (0.25 to 148 Hz)
Duty Cycle	50% (internal AM mod), 1% to 99% (when using external AM input)
Aux	

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Modulating signal	User input (Triangular-wave or Pseudo-random bit sequence)
Duty Cycle	100%

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FESTO

(DE) Die alleinige Verantwortung für die Ausstellung dieser Konformitätserklärung trägt der Hersteller. Der beschriebene Gegenstand der Erklärung erfüllt die einschlägigen Harmonisierungsrechtsvorschriften der Union.

(EN) This declaration of conformity is issued under the sole responsibility of the manufacturer. The object of the declaration described is in conformity with the relevant Union harmonisation legislation.

(BG) Настоящата декларация за съответствие е издадена на отговорността на производителя. Предметът на описаната декларация отговаря на съответното законодателство на Съюза за хармонизация.

(CS) Toto prohlášení o shodě se vydává na výhradní odpovědnost výrobce. Popsaný předmět prohlášení je ve shodě s příslušnými harmonizačními právními před-pisy Unie.

(DA) Denne overensstemmelseserklæring udstedes på fabrikantens ansvar. Genstanden for erklæringen, som beskrevet, er i overensstemmelse med den relevante EU-harmoniseringslovgivning.

(EL) Η παρούσα δήλωση συμμόρφωσης εκδίδεται με αποκλειστική ευθύνη του κατασκευαστή. Ο περιγραφόμενος στόχος της δήλωσης είναι σύμφωνος με τη σχετική ενωσιακή νομοθεσία εναρμόνισης.

(ES) La presente declaración de conformidad se expide bajo la exclusiva responsabilidad del fabricante. El objeto de la declaración descrita es conforme con la legislación de armonización pertinente de la Unión.

(ET) Käesolev vastavusdeklaratsioon on välja antud tootja ainuvastutusel. Kirjeldatud deklareeritav toode on kooskõlas asjaomaste liidu ühtlustamisaktidega.

(FI) Tämä vaatimustenmukaisuusvakuutus on annettu valmistajan yksinomaisella vastuulla. Kuvattu vakuutuksen kohde on asiaa koskevan unionin yhdenmukaistamislainsäädännön vaatimusten mukainen.

(FR) La présente déclaration de conformité est établie sous la seule responsabilité du fabricant. L'objet décrit de la déclaration est conforme à la législation d'harmonisation de l'Union applicable.

(HU) Ezt a megfelelőségi nyilatkozatot a gyártó kizárólagos felelőssége mellett adják ki. Az ismertetett nyilatko-zat tárgya megfelel a vonatkozó uniós harmonizációs jogszabályoknak.

(IT) La presente dichiarazione di conformità è rilasciata sotto la responsabilità esclusiva del fabbricante. L'oggetto della dichiarazione descritto è conforme alla pertinente normativa di armonizzazione dell'Unione.

(LT) Ši atitikties deklaracija išduota tik gamintojo atsakomybe. Aprašytas deklaracijos objektas atitinka susijusius derinamuosius Sąjungos teisės aktus.

(LV) Šī atbilstības deklarācija ir izdota vienīgi uz ražotāja atbildību. Aprakstītais deklarācijas objekts atbilst attiecīgajam Savienības saskaņošanas tiesību aktam.

(NL) Deze conformiteitsverklaring wordt verstrekt onder volledige verantwoordelijkheid van de fabrikant. Het beschreven voorwerp is in overeenstemming de desbetreffende harmonisatiewetgeving van de Unie.

(PL) Niniejsza deklaracja zgodności wydana zostaje na wyłączną odpowiedzialność producenta. Wymieniony przedmiot niniejszej deklaracji jest zgodny z odnośnymi wymaganiami unijnego prawodawstwa harmonizacyjnego.

(PT) A presente declaração de conformidade é emitida sob a exclusiva responsabilidade do fabricante. O objeto da declaração descrito está em conformidade com a legislação aplicável de harmonização da União.

(RO) Prezenta declarație de conformitate este emisă pe răspunderea exclusivă a producătorului. Obiectul descris al declarației este în conformitate cu legislația relevantă de armonizare a Uniunii.

(SK) Toto vyhlásenie o zhode sa vydáva na vlastnú zodpovednosť výrobcu. Uvedený predmet vyhlásenia je v zhode s príslušnými harmonizačnými právnymi predpismi Únie.

(SL) Za izdajo te izjave o skladnosti je odgovoren izključno proizvajalec. Opisani predmet izjave je v skladu z ustrezno zakonodajo Unije o harmonizaciji.

(SV) Denna försäkran om överensstämmelse utfärdas på tillverkarens eget ansvar. Föremålet för försäkran överensstämmer med den relevanta harmoniserade unionslagstiftningen.

(TR) Bu Uygunluk Belgesi tamamen üreticinin sorumluluğu altındadır. Belgede açıklanan obje, Birliğin ilgili uyum mevzuatına uygundur.

EG-Konformitätserklärung
EU Declaration of Conformity
Декларация за съответствие на ЕС
Prohlášení o shodě ES
EF-overensstemmelseserklæring
Δήλωζη ζσμμόρθωζης ΕΚ
Declaración de conformidad CE
EÜ vastavusdeklaratsioon
EY-vaatimustenmukaisuusvakuutus
Déclaration CE de conformité
EK megfelelőségi nyilatkozat
Dichiarazione di conformità EU
EB atitikties deklaracija
EK atbilstības deklarācija
EG-verklaring van overeenstemming
Deklaracja zgodności WE
Declaração de conformidade CE
Declarație de conformitate CE
Vyhlásenie o zhode ES
Izjava ES o skladnosti
EG-försäkran om Överensstämmelse

The installation instructions according to the manual have to be followed. The person authorized to compile the technical documents is Philippe Drolet, Product conformity, Festo Didactic Ltée/Ltd. Canada.

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FESTO

2021-10-05

8097 RADAR TRAINING SYSTEM (EMCD)

Description	Model number			
	OLD (*)	ENGLISH	FRENCH	SPANISH
Dual Function Generator	9402-1X	581549	581550	581551
Frequency Counter	9403-0X	581552	581553	581554
RTM Power Supply	9408-2X	8112514	8112514	8112514
Reconfigurable Training Module (RTM)	9431-3X	8094635	8094635	8094635
Power Supply / Antenna Motor Driver	9601-2X	8084743	8104276	8104277
Radar Synchronizer / Antenna Controller	9602-2X	595986	595987	595988
Rotating Antenna Pedestal	9603-1X	8112383	8112384	8112385
Radar Antenna	9604-0X	581936	581936	581936
Dual Feed Parabolic Antenna	9604-AX	581937	581937	581937
Pulse Compression Radar Antenna	9604-BX	592570	592570	592570
Dual Channel Sampler	9605-1X	595989	8087048	8087049
Power Supply (Radar Electronic Warfare)	9609-1X	8095962	8101570	8101571
Phased Array Antenna Controller	9613-0X	581968	581969	587461
Phase-Coded Pulse Compression Processor	9615-0X	592571	8108337	N/A
Radar Pulse Comp FM	9616-0X	592572	592572	592572
Analog/Digital Signal Combiner	9630-1X	8112776	8112776	8112776
Data Acquisition Interface	9631-1X	8112777	8112777	8112777
Anal/Dig Output	9632-0X	581980	581980	581980
Radar Target Tracking Interface	9633-1X	8112778	8112778	8112778
Radar Analog/Digital Output Interface	9635-0X	8093433	8093433	8093433

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2014/35/EU	**EN 61010-1: 2010-10** **EN 61010-1/A1:2019-02** **ISO 12100:2010** **ISO TR 14121-2:2013**
2014/30/EU	**EN 61326-1: 2013-01**
2011/65/EU	**IEC 63000:2016-10**

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2021-10-05

8097 RADAR TRAINING SYSTEM (RED)

Description	Model number			
	OLD (*)	ENGLISH	FRENCH	SPANISH
Target Positioning System	9607-3X	8121782	8121783	8121784

2014/53/EU: 3.1(a) - 2014/35/EU	**EN 61010-1: 2010-10** **EN 61010-1/A1:2019-02** **EN 62479:2010-09**
2014/53/EU: 3.1(b) - 2014/30/EU	**EN 61326-1: 2013-01** **Draft EN 301 489-1 V2.2.0 (2017-03)** **Draft EN 301 489-17 V3.2.0 (2017-03)**
2014/53/EU: 3.2	**ETSI EN 303 213-6-1 V3.1.0 (2019-03)** **Draft EN 300 328 V2.2.0 (2017-11)**
2014/53/EU: 3.3 (e) (i)	**ISO 12100:2010** **ISO TR 14121-2:2013**
2011/65/EU	**IEC 63000:2016-10**

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2021-10-05

8097 RADAR TRAINING SYSTEM (RED)

Description	Model number			
	OLD (*)	ENGLISH	FRENCH	SPANISH
Horn Antenna	9535-0X	581847	581847	581847
Phased Array Antenna	9612-0X	581966	581967	587460
Radar Transmitter	9620-2X	595172	8087390	8087391
Radar Receiver	9621-2X	595990	8086689	8086690

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2014/53/EU: 3.1(a) - 2014/35/EU	**EN 61010-1: 2010-10 EN 61010-1/A1:2019-02 EN 62479:2010-09**
2014/53/EU: 3.1(b) - 2014/30/EU	**EN 61326-1: 2013-01**
2014/53/EU: 3.2	**EU-type examination certificate**
2014/53/EU: 3.2	**ETSI EN 303 213-6-1 V3.1.1 (2019-07)**
2014/53/EU: 3.3 (e) (i)	**ISO 12100:2010 ISO TR 14121-2:2013**
2011/65/EU	**IEC 63000:2016-10**

The notified body CKC Certification Services, LLC NB0976 performed assessment under 2014/53/EU Annex III module B and issued the EU-type examination certificate: 105599-01-EURED

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2021-10-05

8097 RADAR TRAINING SYSTEM (RED)

Description	Model number			
	OLD (*)	ENGLISH	FRENCH	SPANISH
Jamming Pod	9608-1X	581949	581950	581951

2014/53/EU: 3.1(a) - 2014/35/EU	**EN 61010-1: 2010-10** **EN 61010-1/A1:2019-02** **EN 62479:2010-09**
2014/53/EU: 3.1(b) - 2014/30/EU	**EN 61326-1: 2013-01**
2014/53/EU: 3.2	**EU-type examination certificate**
2014/53/EU: 3.2	**ETSI EN 303 213-6-1 V3.1.1 (2019-07)**
2014/53/EU: 3.3 (e) (i)	**ISO 12100:2010** **ISO TR 14121-2:2013**
2011/65/EU	**IEC 63000:2016-10**

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The notified body CKC Certification Services, LLC NB0976 performed assessment under 2014/53/EU Annex III module B and issued the EU-type examination certificate: 105599-03-EURED

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Domestic Fax: 1 866-779-9776
International Phone: +1 209-966-5240
International Fax: +1 858-300-5341

TYPE EXAMINATION CERTIFICATE
2014/53/EU Radio Equipment

Certificate Issued to:

Certificate Holder: **Festo Didactic Ltée/Ltd.**
675 Rue du Carbone
Québec QC G2N 2K7
Canada

Application ID: **105599-01-EURED**
Renewal of 102512-05-EURED

Product Identification:

This certificate applies to the following components of the 8096 Radar Training System:

Model Number(s):				*Device Name(s):*
Old	English	French	Spanish	
9535-0x	**581847**	**581847**	**581847**	**Horn Antenna**
9612-0x	**581966**	**581967**	**587460**	**Phased Array Antenna**
9620-2x	**595172**	**8087390**	**8087391**	**Radar Transmitter**
9621-2x	**595990**	**8086689**	**8086690**	**Radar Receiver**

Assessment Scope and Summary:

Essential Requirements:	*Applied Standard(s)*	*Type of Standard(s)*	*Deviations*	*Assessment Result*
Article 3.2, Radio Spectrum	**EN 303 213-6-1 v3.1.1**	**Harmonized, Product Out of Scope**	**See Annex A**	**Conforms**

Conditions / Restrictions:

Equipment is required to be installed indoors. Marketing is restricted for educational purposes only.

This certificate is issued in accordance with Annex III, Module B of Council Directive 2014/53/EU and the mutual recognition of their conformity, by CKC Certification Services, LLC., Notified Body 0976, who asserts the above determination regarding only the scope of assessment and the equipment as identified herein.

Acceptance Date: **October 29, 2021**
Expiration Date: **October 29, 2023**

Steve Behm, Authorized Signatory

This certificate is issued based on the evidence presented in the supporting technical documentation provided at time of review and is only valid in conjunction with attached Annex(es). This certificate cannot usurp the Directive; in legal disputes the Directive, or its implementation in National legislation takes precedence.

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ANNEX A

Equipment Specifications:

Frequency Range (MHz)	*Carrier Output (dBm EIRP)*	*Emission Type(s)*	*Protocol Specifications*
8000-10600	*20.3*	*CW / Pulse*	*Radar*

Assessment Comments:

Harmonized Standard applied represents the current state of the art (RED Whereas #10) with respect to fulfillment of essential requirement RED Article 3.2.

Deviations:
Measured Bandwidth Clause 4.2.1.3. Due to similarities in operational design and purpose, the permitted bandwidth is extended to include frequencies also addressed under EN 303 135 v2.1.1. Spectrum allocations for radio determination and/or radio location exist between 7.9 GHz to 10.6 GHz. Standards permit power levels up to 80dBm; equipment operates at very low power levels minimizing interference potential.

Assessment does not include evaluation of receiver performance. The purpose of the equipment is to facilitate training for radar systems. Equipment is utilized by trained professionals in an educational environment. Marketing is targeted only to specific types of entities engaged in educational activities. Performance of the system is intended to be modified and altered throughout use of the equipment.

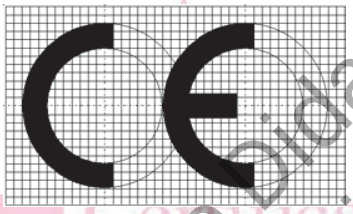
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ANNEX B – Certificate Conditions

This certificate relates only to the assessment of conformity with the essential requirements of the Directive, not to acceptability of CE marking. It remains the responsibility of the manufacturer or their authorized representative to satisfy all requirements of this and other applicable Directives prior to placement of the CE mark[1].

Placement of the CE mark is addressed within Radio Equipment Directive Articles 19 and 20. The CKC CS Notified Body Number is not permitted to be placed with the CE mark. The CE mark must be constructed according to the following relative dimensions:



This certificate remains valid for and applicable to the equipment identified herein during the validity period of this certificate. Changes affecting conformity assessment including but not limited to modification of the equipment, antennas, accessories or software which have not been approved by CKC CS may invalidate this certificate.

All conditions of the CKC CS application form Exhibit A remain applicable to this certificate.

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[1] Refer to 765/2008/EC Article 30, General principles of CE marking.

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CKC Certification Services, LLC
NB 0976
5046 Sierra Pines Dr.
Mariposa, CA 95338
USA

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International Fax: +1 858-300-5341

TYPE EXAMINATION CERTIFICATE
2014/53/EU Radio Equipment

Certificate Issued to:

Certificate Holder: **Festo Didactic Ltée/Ltd.**
675 Rue du Carbone
Québec QC G2N 2K7
Canada

Application ID: **105599-03-EURED**
Renewal of 102512-06-EURED

Product Identification:

This certificate applies to the following components of the 8096 Radar Training System:

Model Number(s):				*Device Name(s):*
Old	English	French	Spanish	
9608-1x	**581949**	**581950**	**581951**	**Jamming Pod**

Assessment Scope and Summary:

Essential Requirements:	*Applied Standard(s)*	*Type of Standard(s)*	*Deviations*	*Assessment Result*
Article 3.2, Radio Spectrum	**EN 303 213-6-1 v3.1.1**	**Harmonized, Product Out of Scope**	**See Annex A**	**Conforms**

Conditions / Restrictions:

Equipment is required to be installed indoors. Marketing is restricted to educational purposes only. Certain operational configurations are not permitted within EU. Equipment is restricted to operations within allocated spectrum 8-10.6 GHz, or user is required to obtain spectrum authorization prior to use of equipment. Manufacturer shall retain records of installation location when equipment is sold.

This certificate is issued in accordance with Annex III, Module B of Council Directive 2014/53/EU and the mutual recognition of their conformity, by CKC Certification Services, LLC., Notified Body 0976, who asserts the above determination regarding only the scope of assessment and the equipment as identified herein.

Acceptance Date: **October 29, 2021**
Expiration Date: **October 29, 2023**

Steve Behm, Authorized Signatory

This certificate is issued based on the evidence presented in the supporting technical documentation provided at time of review and is only valid in conjunction with attached Annex(es). This certificate cannot usurp the Directive; in legal disputes the Directive, or its implementation in National legislation takes precedence.

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ANNEX A

Equipment Specifications:

Frequency Range (MHz)	*Carrier Output (dBm EIRP)*	*Emission Type(s)*	*Protocol Specifications*
8000-10600	*23.2*	*CW / Pulse*	*Radar*

Assessment Comments:

Harmonized Standard applied represents the current state of the art (RED Whereas #10) with respect to fulfillment of essential requirement RED Article 3.2.

Deviations:
Measured Bandwidth Clause 4.2.1.3. Due to similarities in operational design and purpose, the permitted bandwidth is extended to include frequencies also addressed under EN 303 135 v2.1.1. Spectrum allocations for radio determination and/or radio location exist between 7.9 GHz to 10.6 GHz. Standards permit power levels up to 80dBm; equipment operates at very low power levels minimizing interference potential. Spurious emissions limits relaxed at second harmonic, consistent with radiolocation allocation. The low operational power, high directivity of antenna, very limited quantities of product released, and limited duration of use minimize the equipment's interference potential of spurious emissions.

Assessment does not include evaluation of receiver performance. The purpose of the equipment is to facilitate training for radar systems. Equipment is utilized by trained professionals in an educational environment. Marketing is targeted only to specific types of entities engaged in educational activities. Performance of the system is intended to be modified and altered throughout use of the equipment.

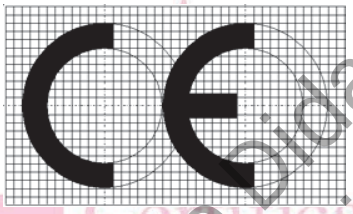
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ANNEX B – Certificate Conditions

This certificate relates only to the assessment of conformity with the essential requirements of the Directive, not to acceptability of CE marking. It remains the responsibility of the manufacturer or their authorized representative to satisfy all requirements of this and other applicable Directives prior to placement of the CE mark[1].

Placement of the CE mark is addressed within Radio Equipment Directive Articles 19 and 20. The CKC CS Notified Body Number is not permitted to be placed with the CE mark. The CE mark must be constructed according to the following relative dimensions:



This certificate remains valid for and applicable to the equipment identified herein during the validity period of this certificate. Changes affecting conformity assessment including but not limited to modification of the equipment, antennas, accessories or software which have not been approved by CKC CS may invalidate this certificate.

All conditions of the CKC CS application form Exhibit A remain applicable to this certificate.

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[1] Refer to 765/2008/EC Article 30, General principles of CE marking.

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2021-10-04

UK Declaration of Conformity

This declaration of conformity is issued under the sole responsibility of the manufacturer. The object of the declaration described is in conformity with the relevant statutory requirements.

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Festo Didactic Ltd

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www.festo-didactic.com

Francis Larrivée
Head of Engineering and Instructional Design

Philippe Drolet
Product Compliance

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FESTO

2021-10-04

8097 RADAR TRAINING SYSTEM (EMCD)

Description	Model number			
	OLD (*)	ENGLISH	FRENCH	SPANISH
Dual Function Generator	9402-1X	581549	581550	581551
Frequency Counter	9403-0X	581552	581553	581554
RTM Power Supply	9408-2X	8112514	8112514	8112514
Reconfigurable Training Module (RTM)	9431-3X	8094635	8094635	8094635
Power Supply / Antenna Motor Driver	9601-2X	8084743	8104276	8104277
Radar Synchronizer / Antenna Controller	9602-2X	595986	595987	595988
Rotating Antenna Pedestal	9603-1X	8112383	8112384	8112385
Radar Antenna	9604-0X	581936	581936	581936
Dual Feed Parabolic Antenna	9604-AX	581937	581937	581937
Pulse Compression Radar Antenna	9604-BX	592570	592570	592570
Dual Channel Sampler	9605-1X	595989	8087048	8087049
Power Supply (Radar Electronic Warfare)	9609-1X	8095962	8101570	8101571
Phased Array Antenna Controller	9613-0X	581968	581969	587461
Phase-Coded Pulse Compression Processor	9615-0X	592571	8108337	N/A
Radar Pulse Comp FM	9616-0X	592572	592572	592572
Analog/Digital Signal Combiner	9630-1X	8112776	8112776	8112776
Data Acquisition Interface	9631-1X	8112777	8112777	8112777
Anal/Dig Output	9632-0X	581980	581980	581980
Radar Target Tracking Interface	9633-1X	8112778	8112778	8112778
Radar Analog/Digital Output Interface	9635-0X	8093433	8093433	8093433

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S.I. 2016/1101	**EN 61010-1: 2010-10** **EN 61010-1/A1:2019-02** **ISO 12100:2010** **ISO TR 14121-2:2013**
S.I. 2016 No. 1091	**EN 61326-1: 2013-01**
S.I. 2012 No. 3032	**IEC 63000:2016-10**

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2021-10-04

8097 RADAR TRAINING SYSTEM (RED)

Description	Model number			
	OLD (*)	ENGLISH	FRENCH	SPANISH
Target Positioning System	9607-3X	8121782	8121783	8121784

S.I. 2017/1206: 6.1a	**EN 61010-1: 2010-10** **EN 61010-1/A1:2019-02** **EN 62479:2010-09** **ISO 12100:2010** **ISO TR 14121-2:2013**
S.I. 2017/1206: 6.1b	**EN 61326-1: 2013-01** **Draft EN 301 489-1 V2.2.0 (2017-03)** **Draft EN 301 489-17 V3.2.0 (2017-03)**
S.I. 2017/1206: 6.2	**ETSI EN 303 213-6-1 V3.1.0 (2019-03)** **Draft EN 300 328 V2.2.0 (2017-11)**
S.I. 2012 No. 3032	**IEC 63000:2016-10**

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2021-10-04

8097 RADAR TRAINING SYSTEM (RED)

Description	Model number			
	OLD (*)	ENGLISH	FRENCH	SPANISH
Horn Antenna	9535-0X	581847	581847	581847
Phased Array Antenna	9612-0X	581966	581967	587460
Radar Transmitter	9620-2X	595172	8087390	8087391
Radar Receiver	9621-2X	595990	8086689	8086690

S.I. 2017/1206: 6.1a	**EN 61010-1: 2010-10** **EN 61010-1/A1:2019-02** **EN 62479:2010-09** **ISO 12100:2010** **ISO TR 14121-2:2013**
S.I. 2017/1206: 6.1b	**EN 61326-1: 2013-01**
S.I. 2017/1206: 6.2	**ETSI EN 303 213-6-1 V3.1.1 (2019-07)**
S.I. 2012 No. 3032	**IEC 63000:2016-10**

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The approved body CKC Certification Services, LLC AB0976 performed assessment under SI 2017/1206 Schedule 3 Module B and issued the UK-type examination certificate: 105599-02-UKRE.

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2021-10-04

8097 RADAR TRAINING SYSTEM (RED)

Description	Model number			
	OLD (*)	ENGLISH	FRENCH	SPANISH
Jamming Pod	9608-1X	581949	581950	581951

S.I. 2017/1206: 6.1a	**EN 61010-1: 2010-10** **EN 61010-1/A1:2019-02** **EN 62479:2010-09** **ISO 12100:2010** **ISO TR 14121-2:2013**
S.I. 2017/1206: 6.1b	**EN 61326-1: 2013-01**
S.I. 2017/1206: 6.2	**ETSI EN 303 213-6-1 V3.1.1 (2019-07)**
S.I. 2012 No. 3032	**IEC 63000:2016-10**

The approved body CKC Certification Services, LLC AB0976 performed assessment under SI 2017/1206 Schedule 3 Module B and issued the UK-type examination certificate: 105599-04-UKRE.

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International Fax: +1 858-300-5341

UK TYPE EXAMINATION CERTIFICATE
SI 2017/1206 Radio Equipment Regulations

Certificate Issued to:

Certificate Holder: **Festo Didactic Ltée/Ltd.**
675 Rue du Carbone
Québec QC G2N 2K7
Canada

Application ID: **105599-02-UKRE**

Product Identification:
This certificate applies to the following components of the 8096 Radar Training System:

Model Number(s):				*Device Name(s):*
Old	English	French	Spanish	
9535-0x	**581847**	**581847**	**581847**	**Horn Antenna**
9612-0x	**581966**	**581967**	**587460**	**Phased Array Antenna**
9620-2x	**595172**	**8087390**	**8087391**	**Radar Transmitter**
9621-2x	**595990**	**8086689**	**8086690**	**Radar Receiver**

Assessment Scope and Summary:

Essential Requirements:	*Applied Standard(s)*	*Type of Standard(s)*	*Deviations*	*Assessment Result*
Section 6.2, Radio Spectrum	**EN 303 213-6-1 v3.1.1**	**Designated, Product Out of Scope**	**See Annex A**	**Conforms**

Conditions / Restrictions:

Equipment is required to be installed indoors. Marketing is restricted for educational purposes only.

This certificate is issued in accordance with Schedule 3, Module B of BEIS SI 2017/1206 and the mutual recognition of their conformity, by CKC Certification Services, LLC., Approved Body 0976, who asserts the above determination regarding only the scope of assessment and the equipment as identified herein.

Acceptance Date: **October 29, 2021**
Expiration Date: **October 29, 2023**



Steve Behm, Authorized Signatory

This certificate is issued based on the evidence presented in the supporting technical documentation provided at time of review and is only valid in conjunction with attached Annex(es). This certificate cannot usurp the Directive; in legal disputes the Directive, or its implementation in National legislation takes precedence.

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ANNEX A

Equipment Specifications:

Frequency Range (MHz)	*Carrier Output (dBm EIRP)*	*Emission Type(s)*	*Protocol Specifications*
8000-10600	*20.3*	*CW / Pulse*	*Radar*

Assessment Comments:

Designated Standard applied represents the current state of the art with respect to fulfilling of essential requirement RER SI 2017/1206 Part 2, Chapter 1, Section 6.2.

Deviations:
Measured Bandwidth Clause 4.2.1.3. Due to similarities in operational design and purpose, the permitted bandwidth is extended to include frequencies also addressed under EN 303 135 v2.1.1. Spectrum allocations for radio determination and/or radio location exist between 7.9 GHz to 10.6 GHz. Standards permit power levels up to 80dBm; equipment operates at very low power levels minimizing interference potential.

Assessment does not include evaluation of receiver performance. The purpose of the equipment is to facilitate training for radar systems. Equipment is utilized by trained professionals in an educational environment. Marketing is targeted only to specific types of entities engaged in educational activities. Performance of the system is intended to be modified and altered throughout use of the equipment.

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ANNEX B – Certificate Conditions

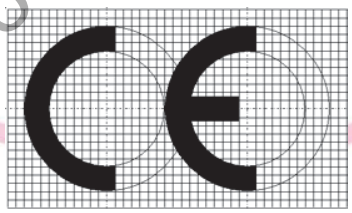
This certificate relates only to the assessment of conformity with the essential requirements of the cited regulation, not to acceptability of UKCA marking. It remains the responsibility of the manufacturer or their authorized representative to satisfy all requirements of this and other applicable requirements prior to placement of the UKCA mark[1].

Placement of the UKCA mark[2] is addressed under UK Department for Business, Energy & Industrial Strategy (BEIS) rules and available online.[3] The CKC CS UK Approved Body Number is not permitted to be placed with the UKCA mark. The UKCA mark must be constructed according to the following relative dimensions:



Notice: Products entering Northern Ireland continue to be governed under EU CE mark requirements.

Placement of the CE mark is addressed within Radio Equipment Directive Articles 19 and 20 in combination with a valid EU-RED assessment. The CKC CS Notified Body Number is not permitted to be placed with the CE mark. The CE mark must be constructed according to the following relative dimensions:



This certificate remains valid for and applicable to the equipment identified herein during the validity period of this certificate. Changes affecting conformity assessment including but not limited to modification of the equipment, antennas, accessories or software which have not been approved by CKC CS may invalidate this certificate.

All conditions of the CKC CS application form Exhibit A remain applicable to this certificate.

[1] Refer to https://www.gov.uk/guidance/placing-manufactured-goods-on-the-market-in-great-britain
[2] Placement of UKCA mark on products entering Great Briton becomes mandatory January 1 2022.
[3] Refer to https://www.gov.uk/guidance/using-the-ukca-marking#how-to-use-the-ukca-marking

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International Phone: +1 209-966-5240
International Fax: +1 858-300-5341

UK TYPE EXAMINATION CERTIFICATE
SI 2017/1206 Radio Equipment Regulations

Certificate Issued to:

Certificate Holder: **Festo Didactic Ltée/Ltd.**
675 Rue du Carbone
Québec QC G2N 2K7
Canada

Application ID: **105599-04-UKRE**

Product Identification:
This certificate applies to the following components of the 8096 Radar Training System:

Model Number(s):				*Device Name(s):*
Old	English	French	Spanish	
9608-1x	**581949**	**581950**	**581951**	**Jamming Pod**

Assessment Scope and Summary:

Essential Requirements:	*Applied Standard(s)*	*Type of Standard(s)*	*Deviations*	*Assessment Result*
Section 6.2, Radio Spectrum	**EN 303 213-6-1 v3.1.1**	**Designated, Product Out of Scope**	**See Annex A**	**Conforms**

Conditions / Restrictions:

Equipment is required to be installed indoors. Marketing is restricted to educational purposes only. Certain operational configurations are not permitted within UK. Equipment is restricted to operations within allocated spectrum 8-10.6 GHz, or user is required to obtain spectrum authorization prior to use of equipment. Manufacturer shall retain records of installation location when equipment is sold.

This certificate is issued in accordance with Schedule 3, Module B of BEIS SI 2017/1206 and the mutual recognition of their conformity, by CKC Certification Services, LLC., Approved Body 0976, who asserts the above determination regarding only the scope of assessment and the equipment as identified herein.

Acceptance Date: **October 29, 2021**
Expiration Date: **October 29, 2023**

Steve Behm, Authorized Signatory

This certificate is issued based on the evidence presented in the supporting technical documentation provided at time of review and is only valid in conjunction with attached Annex(es). This certificate cannot usurp the Directive; in legal disputes the Directive, or its implementation in National legislation takes precedence.

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ANNEX A

Equipment Specifications:

Frequency Range (MHz)	*Carrier Output (dBm EIRP)*	*Emission Type(s)*	*Protocol Specifications*
8000-10600	*23.2*	*CW / Pulse*	*Radar*

Assessment Comments:

Designated Standard applied represents the current state of the art with respect to fulfilling of essential requirement RER SI 2017/1206 Part 2, Chapter 1, Section 6.2.

Deviations:
Measured Bandwidth Clause 4.2.1.3. Due to similarities in operational design and purpose, the permitted bandwidth is extended to include frequencies also addressed under EN 303 135 v2.1.1. Spectrum allocations for radio determination and/or radio location exist between 7.9 GHz to 10.6 GHz. Standards permit power levels up to 80dBm; equipment operates at very low power levels minimizing interference potential. Spurious emissions limits relaxed at second harmonic, consistent with radiolocation allocation. The low operational power, high directivity of antenna, very limited quantities of product released, and limited duration of use minimize the equipment's interference potential of spurious emissions.

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ANNEX B – Certificate Conditions

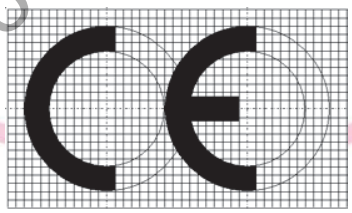
This certificate relates only to the assessment of conformity with the essential requirements of the cited regulation, not to acceptability of UKCA marking. It remains the responsibility of the manufacturer or their authorized representative to satisfy all requirements of this and other applicable requirements prior to placement of the UKCA mark[1].

Placement of the UKCA mark[2] is addressed under UK Department for Business, Energy & Industrial Strategy (BEIS) rules and available online.[3] The CKC CS UK Approved Body Number is not permitted to be placed with the UKCA mark. The UKCA mark must be constructed according to the following relative dimensions:



Notice: Products entering Northern Ireland continue to be governed under EU CE mark requirements.

Placement of the CE mark is addressed within Radio Equipment Directive Articles 19 and 20 in combination with a valid EU-RED assessment. The CKC CS Notified Body Number is not permitted to be placed with the CE mark. The CE mark must be constructed according to the following relative dimensions:



This certificate remains valid for and applicable to the equipment identified herein during the validity period of this certificate. Changes affecting conformity assessment including but not limited to modification of the equipment, antennas, accessories or software which have not been approved by CKC CS may invalidate this certificate.

All conditions of the CKC CS application form Exhibit A remain applicable to this certificate.

[1] Refer to https://www.gov.uk/guidance/placing-manufactured-goods-on-the-market-in-great-britain
[2] Placement of UKCA mark on products entering Great Briton becomes mandatory January 1 2022.
[3] Refer to https://www.gov.uk/guidance/using-the-ukca-marking#how-to-use-the-ukca-marking

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