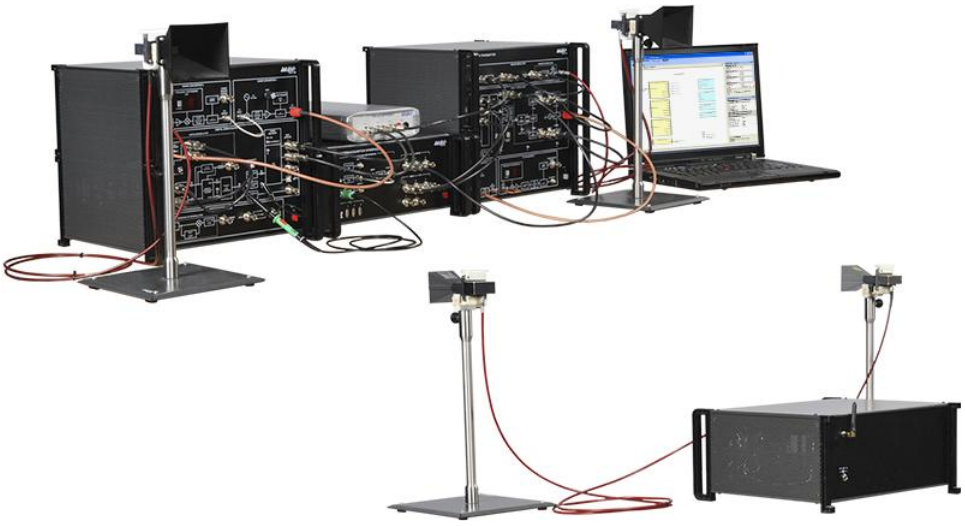
Satellite Communications Training System
8093-00

LabVolt Series

Datasheet



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General Description

The Satellite Communications Training System is a versatile telecommunications training platform designed to teach modern telecommunications technologies in the classroom using a fully operational satellite link. The transmitter, receiver, and satellite repeater operate at realistic uplink and downlink frequencies and at safe power levels.

The system allows students to observe and study a wide range of telecommunications concepts such as digital and analog modulation, scrambling, differential encoding, and frequency conversion as well as concepts specifically related to satellite communications. In addition, since noise and losses affect the performance of all telecommunications systems, performance-related concepts such as noise figure, figure of merit, link budget, and the performance ratio C/N0 are also covered.

The Earth Station Transmitter performs analog (wideband FM) or digital (DQPSK) modulation of the baseband signal, then transmits the upconverted uplink signal to the Satellite Repeater. The Satellite Repeater is a transparent repeater that shifts the uplink signal to a lower frequency, amplifies it, and then retransmits it as the downlink signal. The Earth Station Receiver downconverts and demodulates the downlink signal to recover the baseband signal. The Earth Station Transmitter and the Earth Station Receiver can be placed on the same table for easy connection to instruments, as shown in the photo above, or can be physically separated.

In order to meet a variety of needs and budgets, a number of options are available. With the Satellite Communications Training System and customer-supplied conventional instruments, students have all the components required to study concepts and technology of telecommunications and satellite communications. The optional Telemetry and Instrumentation Add-On is an economical alternative to expensive, high-frequency conventional instruments. This add-on, used in conjunction with the Telemetry and Instrumentation software, provides telemetry with the Satellite Receiver as well as a full suite of virtual instruments.

The Orbit Simulator (included with the Satellite Communications Training System and available separately) provides interactive visualization of satellite orbital mechanics and satellite coverage. It can be used to study satellite orbits for any type of application including communications, remote sensing, military reconnaissance, navigation, scientific research, mapping, or disaster detection. It also illustrates the theory behind antenna alignment with geostationary satellites. The optional Dish Antenna and Accessories provides hands-on experience in aligning a typical antenna with real geostationary satellites.

Note: Telemetry and instrumentation equipment is required to perform the exercises using the satellite repeater in the Satellite Communications Training System. This required equipment is available in the Telemetry and Instrumentation Add-On, Model 8093-1. Alternately, users can use their own telemetry and instrumentation equipment (0-11.26 GHz spectrum analyzer, oscilloscope, BER indicator, function generator, and one or more data generators).

A Windows-based computer is required to run the applications in the Orbit Simulator and Software Suite. Customers can supply their own computer or purchase the optional Satellite Communications Host Computer, Model 9695-B0.

System Configurations and Capabilities

The student manuals contain optional procedure steps to take into consideration the different options available. The following table shows the possible system configurations and the capabilities of each configuration:

This product:	Plus these items:	Provides these Satellite Communications Capabilities			Provide these Orbit, Coverage, and Antenna Alignment Capabilities	
		Analog/digital satellite link, signal display and measurement, troubleshooting the transmitter and receiver	Data transfer	Telemetry, troubleshooting the repeater, virtual instrumentation	Satellite Orbit and coverage simulation	Antenna alignment with real geostationary satellites
Satellite Communications Training System (including the Orbit Simulator)	• Telemetry and Instrumentation Add-On • Computer	•	•	•	•	
	• User-supplied conventional instruments • Computer	•	•		•	
	• User-supplied conventional instruments (no computer)	•				
	• Dish antenna and accessories • Computer	N/A			•	•
Orbit Simulator (purchased separately)	• Computer				•	
	• Dish antenna and accessories • Computer				•	•

Note: When performing data transfer using one computer, the data sent from the computer is transmitted over the satellite link and received by the same computer. The Data Transfer software allows using two computers, a sending computer connected to the Earth Station Transmitter and a receiving computer connected to the Earth Station Receiver.

Topic Coverage

- Satellite Communication Fundamentals
- Analog and Digital Transmission
- Link Characteristics and Performance
- Orbital Mechanics
- Satellite Orbits and Coverage
- Antenna Alignment for Geostationary Satellites
- Troubleshooting

Features & Benefits

- Provides hands-on, system-level training in telecommunications and satellite communications technologies.
- Realistic system reflecting the standards and modulation types used in modern satellite communications systems.
- Uses license-free transmission and low power levels for complete safety.
- Can be interfaced with external analog or digital equipment.
- Fault-insertion capability in the Earth Station Transmitter, Earth Station Receiver, and Satellite Repeater (via telemetry) allows the teaching of troubleshooting.
- Comprehensive courseware provides theory and step-by-step laboratory procedures.
- Includes both analog and digital modulators/demodulators to provide an analog or digital link from transmitter to repeater to receiver.
- The analog link uses Wideband FM Modulation allowing transmission and reception of analog (e.g. audio or video) signals. The 10 MHz bandwidth is sufficient for transmission of composite video or multiplexed (FDM) signals from external equipment.
- The digital link allows data rates up to 20 Mbit/s and includes a built-in 4-channel TDM multiplexer and demultiplexer. On the transmitter and the receiver, three TDM channels have BNC connectors; one channel has a USB port for data transfer with a computer running the Data Transfer applications.
- The Data Transfer applications allow transmission of files, text messages and real-time data over the satellite link.
- The Orbit Simulator software provides interactive visualization of satellite orbital mechanics and satellite coverage and illustrates the theory behind antenna alignment with geostationary satellites.
- The Telemetry and Instrumentation Add-On provides waveform and data generation, data acquisition, virtual instruments, and telemetry with the Satellite Repeater.
- Telemetry capabilities include remote power measurement, gain control, and redundancy switching, as well as remote fault insertion and diagnostics for troubleshooting the Satellite Repeater.
- Optional Telemetry and Instrumentation Add-On is an economical alternative to expensive, high-frequency conventional instruments
- Can expand and complete existing telecommunication programs (radar, antenna, microwave, etc.)
- With the horn antennas included, the maximum transmission distance (between the transmitter or receiver and the repeater) is at least 4 m (13 ft).

List of Available Training Systems

Qty	Description	Model number
1	Satellite Communications Training System	582081 (8093-00)
1	Telemetry and Instrumentation - Add-On	582084 (8093-10)

Additional Equipment Required to Perform the Exercises

Qty	Description	Model number
1	Satellite Communications Host Computer	587470 (9695-B0) [1]

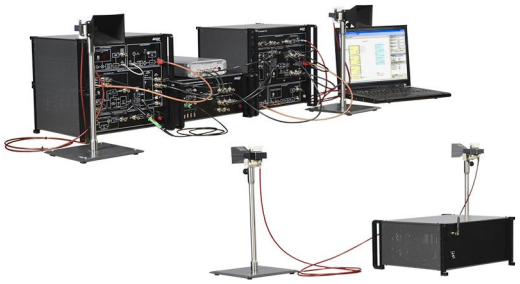
Optional Equipment

Qty	Description	Model number
1	Satellite Communications Training System (Manuals on CD-ROM)	580539 (86311-A0)

[1] Refer to the Computer Requirements in the System Specifications section of this datasheet if the computer is to be provided by the end-user.

Available Training Systems

Satellite Communications Training System 582081 (8093-00)



The Satellite Communications Training System is a state-of-the-art training system that covers the field of satellite communications. Specifically designed for hands-on training, the system covers modern satellite communication technologies including analog and digital modulation. This system is designed to use realistic satellite uplink and downlink frequencies at safe power levels and to reflect the standards commonly used in modern satellite communications systems.

This training system must be used in conjunction with either the Telemetry and Instrumentation - Add-On, Model 8093-1, or telemetry devices provided by the user.

List of Equipment

Qty	Description	Model number
1	Earth Station Transmitter	581864 (9570-00)
1	Earth Station Receiver	581867 (9571-00)
1	Satellite Repeater	581870 (9572-00)
1	Cables and Accessories	581876 (9579-00)
1	Orbit Simulator Software	581877 (9581-00)
3	Power Cord - Type B	789405 (95451-00)

List of Manuals

Description	Manual number
Principles of Satellite Communications (Student Manual)	580537 (86311-00)
Principles of Satellite Communications (Instructor Guide)	580538 (86311-10)
Satellite Communications Training System (User Guide)	580540 (86311-E0)
Link Characteristics and Performance (Student Manual)	580541 (86312-00)
Link Characteristics and Performance (Instructor Guide)	580542 (86312-10)
Satellite Orbits, Coverage, and Antenna Alignment (Student Manual)	580610 (87768-00)
Satellite Orbits, Coverage, and Antenna Alignment (Instructor Guide)	580611 (87768-10)

Table of Contents of the Manual(s)

Principles of Satellite Communications (Student Manual) (580537 (86311-00))

- 3-3 Differential Encoding
- 4-1 Troubleshooting the Earth Station Transmitter
- 4-2 Troubleshooting the Earth Station Receiver
- 4-3 Troubleshooting the Satellite Repeater using Telemetry (Optional, Requires the Telemetry and Instrumentation Add-On)
- 4-4 Troubleshooting a Satellite Communication Link

Link Characteristics and Performance (Student Manual) (580541 (86312-00))

- 1 Power Gain and Antenna Parameters
- 2 Losses, Radiated Power and Receiver Input Power
- 3 Noise and the Link Budget

Satellite Orbits, Coverage, and Antenna Alignment (Student Manual) (580610 (87768-00))

- 1 Orbital Mechanics
- 2 Satellite Orbits and Coverage
- 3 Antenna Alignment for Geostationary Satellites

System Specifications

Parameter	Value
Computer Requirements	A currently available personal computer running under one of the following operating systems: Windows® 7 or Windows® 8.
Physical Characteristics	
Intended Location	On a table
Dimensions (H x W x D)	450 x 5540 x 1850 mm (17.7 x 218.1 x 72.8 in)
Net Weight	TBE

Telemetry and Instrumentation - Add-On 582084 (8093-10)

The Telemetry and Instrumentation Add-On is used with the Telemetry and Instrumentation software to provide virtual instruments and telemetry with the repeater. This add-on consists of two modules: the Data Generation/ Acquisition Interface, Model 9573, and the Virtual Instrument Package, Model 1250-A. These modules, used in conjunction with the Telemetry and Instrumentation software, provide virtual instruments designed for the display and measurement of the baseband, IF and RF signals present in the system as well as virtual generators used to generate analog and digital baseband signals for transmission.

List of Equipment

Qty	Description	Model number
1	Data Generation/Acquisition Interface	581873 (9573-00)
1	Power Cord - C7 Type A	782859 (85978-00)
1	Power Cord - Type B	789405 (95451-00)

System Specifications

Parameter	Value
Computer Requirements	A currently available personal computer running under one of the following operating systems: Windows® 7 or Windows® 8.

Equipment Description

Earth Station Transmitter 581864 (9570-00)

The Earth Station Transmitter is designed to teach ground-segment signal processing, modulation, and frequency conversion techniques. It includes an Analog Modulator and a Digital Modulator as well as two up converters.

The Analog Modulator section provides pre-emphasis baseband processing as well as wideband FM modulation, both commonly used in satellite communications systems. The 10 MHz bandwidth is sufficient for transmitting one composite television signal. The Wideband FM Modulator generates a modulated signal at 340 MHz, the first intermediate frequency (IF 1) of the transmitter.

The Digital Modulator section provides time-division multiplexing (TDM), scrambling, encoding and digital modulation. The TDM multiplexer allows multiplexing up to four data streams at a maximum data rate of 4 Mbit/s per stream. Three of the multiplexer inputs have BNC connectors whereas the fourth input has a USB connector for transmitting data from a computer. A fifth BNC input connector with its own Sampler is provided for a high bit-rate, unmultiplexed data stream of up to 20 Mbit/s. A switch allows selecting either the multiplexed or the high-bit rate data.

A Scrambler is used to ensure frequent transitions in the data and to spread the power smoothly over the available bandwidth. A Clock & Frame Encoder is used to add transitions to the multiplexed data in order to ensure reliable clock recovery in the receiver as well as control bits for frame synchronization. Both the Scrambler and the Clock & Frame Encoder can be switched on or off independently.

The Digital Modulator section uses DQPSK (differential quadrature phase-shift keying) modulation, a type of digital modulation commonly used in satellite communications systems. BNC connectors provide access to the I and Q channel signals of the DQPSK modulator. Front-panel test points provide access to signals at each intermediate stage of the modulation process. The DQPSK modulator generates a modulated signal at 340 MHz, the first intermediate frequency (IF 1) of the transmitter.

An SMA cable is used to connect the IF 1 signal from either the Analog Modulator or the Digital Modulator section to Up Converter 1, which shifts the signal frequency up to the IF 2 range (1.56 GHz). Up Converter 2 further shifts the signal frequency to produce the RF Output signal. Up Converter 2 includes a Channel selector to select one of six uplink frequencies in the 11 GHz range. It also has a Power Sensor to facilitate measurement of the transmitted power. A large-aperture horn antenna connected to the RF output transmits the uplink signal to the Satellite Repeater.

Additional Equipment Required to Perform the Exercises

Qty	Description	Model number
1	Power Cord - Type F	789182 (93992-05) [2]
1	Power Cord - Type B	789405 (95451-00) [3]
1	Power Cord - Type I	789406 (95451-0A) [4]

Specifications

Parameter	Value
Analog Modulation Type	Wideband FM (10 MHz bandwidth)
Analog Baseband Signal Processing	Pre-emphasis
Analog Inputs	
Connector Type	BNC
Voltage Range	Calibrated for 1.0 Vpp, 5.0 Vpp max.
Digital Modulation Type	DQPSK (differential quadrature phase-shift keying)
Digital Baseband Signal Processing	4-channel TDM (time-division multiplexing), scrambling, clock & frame encoding
Data Inputs	
Connector Type	3 BNC and 1 USB for TDM channels, 1 BNC for unmultiplexed data
Voltage Level	TTL (for BNC inputs)
Maximum Bit Rates	4 Mbit/s per BNC TDM channel, 2 MBit/s for USB TDM channel, 20 Mbit/s for unmultiplexed data
Intermediate Frequencies	340 MHz (IF 1) and 1.56 GHz (IF 2)
RF Output	
Connector Type	SMA
Power Level	5 dBm (typical, varies slightly with selected channel)
Plane-Wave Equivalent Power Density	0.04 mW/cm² with Large-Aperture Horn Antenna (Health Canada and FCC maximum exposure recommendation for the general public at this frequency is 1 mW/cm²)
Carrier Frequency Range	10.7 – 11.2 GHz
Uplink Channels	6
Power Sensor Output Characteristic	
Slope	12.5 dBm/V approx. (at 11 GHz)
Intercept	0 V corresponds to approx. -16.6 dBm (at 11 GHz)
Faults	7 (switch-insertable)
Power Requirements	
From dc source	15 V (60 VA max.)
External power adapter	100 - 240 V AC, 50-60 Hz, 2A
Service Installation	Standard single-phase outlet
Physical Characteristics	
Dimensions (H x W x D)	305 x 330 x 305 mm (12 x 13 x 12 in.)
Net Weight	4.5 kg (12.0 lb.)

[2] The power cord line is not included with stand-alone Earth Station Transmitters. Please add the right power cord line for the region. Note that when ordering a system, all power cord lines are included.

[3] The power cord line is not included with stand-alone Earth Station Transmitters. Please add the right power cord line for the region. Note that when ordering a system, all power cord lines are included.

[4] The power cord line is not included with stand-alone Earth Station Transmitters. Please add the right power cord line for the region. Note that when ordering a system, all power cord lines are included.

Earth Station Receiver
581867 (9571-00)

The Earth Station Receiver is designed to teach ground-segment frequency conversion, demodulation, and signal processing techniques. It includes two down converters as well as an Analog Demodulator and a Digital Demodulator.

A large-aperture horn antenna with an integrated LNA (low-noise amplifier) receives the downlink signal from the Satellite Repeater. This antenna is connected to the RF Input of Down Converter 2, which includes a Channel selector to select one of six downlink frequencies in the 9 GHz range. Down Converter 2, which also includes a Power Sensor to facilitate measurement of the received power level, shifts the signal down to the 1.56 GHz range (IF 2). Down Converter 1 further shifts the signal down to the 280 MHz range (IF 1). An SMA cable is used to connect the IF 1 signal to either the Analog Demodulator or the Digital Demodulator section.

The Analog Demodulator section provides wideband FM demodulation as well as de-emphasis baseband processing.

The Digital Demodulator section provides DQPSK demodulation, decoding, descrambling and demultiplexing. Front-panel test points provide access to signals at each intermediate stage of the demodulation process. The DQPSK demodulator uses a Costas loop to recover the carrier from the IF 1 signal. BNC connectors provide access to the I and Q channel signals of the QPSK Costas loop. The demodulator also has a Clock Recovery block to recover a clock signal which is made available at a BNC connector. The serial data from the DQPSK demodulator is sent through a Clock & Frame Decoder and a Descrambler and then to the TDM demultiplexer which demultiplexes the data into four data streams. Three of the demultiplexer outputs have BNC connectors whereas the fourth output has a USB connector for sending the received data to a computer. A fifth BNC output connector with its own Descrambler is provided for a high bit-rate, unmultiplexed data stream.

Additional Equipment Required to Perform the Exercises

Qty	Description	Model number
1	Power Cord - Type F	789182 (93992-05) [5]
1	Power Cord - Type B	789405 (95451-00) [6]
1	Power Cord - Type I	789406 (95451-0A) [7]

Specifications

Parameter	Value
Analog Demodulation Type	Wideband FM (10 MHz bandwidth)

[5] The power cord line is not included with stand-alone Earth Station Receivers. Please add the right power cord line for the region. Note that when ordering a system, all power cord lines are included.

[6] The power cord line is not included with stand-alone Earth Station Receivers. Please add the right power cord line for the region. Note that when ordering a system, all power cord lines are included.

[7] The power cord line is not included with stand-alone Earth Station Receivers. Please add the right power cord line for the region. Note that when ordering a system, all power cord lines are included.

Parameter	Value
Analog Baseband Signal Processing	De-emphasis
Analog Output	
Connector Type	BNC
Digital Demodulation Type	DQPSK (differential quadrature phase-shift keying)
Digital Baseband Signal Processing	Descrambling, clock & frame decoding, 4-channel TDM (time-division demultiplexing)
Data Outputs	
Connector Type	3 BNC and 1 USB for TDM channels, 1 BNC for unmultiplexed data
Voltage Level	TTL (for BNC outputs)
Maximum Bit Rates	4 Mbit/s per BNC TDM channel, 2 MBit/s for USB TDM channel, 20 Mbit/s for unmultiplexed data
Intermediate Frequencies	1.56 GHz (IF 2) and 280 MHz (IF 1)
RF Input	
Connector Type	SMA
Power Level	-50 dBm
Carrier Frequency Range	8.7 – 9.2 GHz
Downlink Channels	6
IF 1 Input	
Power Level	+5 to +7 dBm to Analog Demodulator; -5 to -3 dBm to Digital Modulator
Gain	35 to 65 dB (variable)
Power Sensor Output Characteristic	
Slope	24.0 dBm/V approx.
Intercept	0 V corresponds to approx. -65.9 dBm
Faults	7 (switch-insertable)
Power Requirements	
From dc source	15 V (60 VA max.)
External power adapter	100 - 240 V AC, 50-60 Hz, 2A
Service Installation	Standard single-phase outlet
Physical Characteristics	
Dimensions (H x W x D)	305 x 330 x 305 mm (12 x 13 x 12 in.)
Net Weight	6 kg (12.4 lb.)

Satellite Repeater 581870 (9572-00)

The Satellite Repeater is designed to teach the operation of a transparent satellite payload, including telemetry and remote troubleshooting and maintenance using redundancy switching.

A small-aperture horn antenna receives the uplink signal from the Earth Station Transmitter. A low-noise block (LNB) shifts all frequencies in the uplink signal range (11 GHz) to the downlink frequency range (9 GHz). The bandwidth of the LNB is sufficient to include all six channels. A single Satellite Repeater can therefore be used with up to six different earth stations simultaneously.

The functional blocks after the LNB implement a single transponder. These blocks include a variable-gain amplifier (VGA), an isolator, a pass-band filter and a power amplifier (PA). The LNB, VGA, filter and PA each have a MAIN and a BACKUP LED. Internal circuits controlled by telemetry simulate faults and redundancy switching for troubleshooting exercises. A Power Sensor facilitates direct measurement of the power level of the transmitted downlink signal. This power level, as well as the status of the redundant functional blocks, can be monitored at the earth station via the telemetry link. Another small-aperture horn antenna transmits the downlink signal to the Earth Station Receiver.

Additional Equipment Required to Perform the Exercises

Qty	Description	Model number
1	Power Cord - Type F	789182 (93992-05) [8]
1	Power Cord - Type B	789405 (95451-00) [9]
1	Power Cord - Type I	789406 (95451-0A) [10]

Specifications

Parameter	Value
Transponders	1
Transponder Bandwidth	2 GHz
Gain	25 dB (typical)
RF Output	
Power Level	-10 dBm (typical, depends on distance)
Plane-Wave Equivalent Power Density	0.004 mW/cm² (typical) with Small-Aperture Horn Antenna (Health Canada and FCC maximum exposure recommendation for the general public at this frequency is 1 mW/cm²)
Telemetry Antenna	
Connector Type	SMA (on rear panel)
Power Sensor Output Characteristic	
Slope	11.2 dBm/V approx.
Intercept	0 V corresponds to approx. -43.7 dBm
Faults	5 (controlled by telemetry)
Power Requirements	
From dc source	15 V (60 VA max.)
External power adapter	100 - 240 V AC, 50-60 Hz, 2A
Service Installation	Standard single-phase outlet
Physical Characteristics	
Dimensions (H x W x D)	152 x 330 x 305 mm (6 x 13 x 12 in.)
Net Weight	3.7 kg (8.2 lb.)

Data Generation/Acquisition Interface 581873 (9573-00)

The Data Generation/Acquisition Interface is part of the Telemetry and Instrumentation Add-On. It provides a physical interface (BNC input and output connectors) for the digital generators and digital instruments of the Telemetry and Instrumentation software.

The module also provides a Spectrum Analyzer Interface for use with the Virtual Instrument Package, Model 1250-A. This interface includes two attenuators and a probe buffer. Any one of these can be connected to a software-controlled frequency converter which shifts the frequency of the signal to a range compatible with the Virtual Instrument. Together, the Spectrum Analyzer Interface, the Virtual Instrument Package, and the software provide a virtual spectrum analyzer covering four frequency ranges from DC to over 11 GHz, allowing the frequency-domain display and measurement of all signals in the training system.

[8] The power cord line is not included with stand-alone Satellite Repeaters. Please add the right power cord line for the region. Note that when ordering a system, all power cord lines are included.

[9] The power cord line is not included with stand-alone Satellite Repeaters. Please add the right power cord line for the region. Note that when ordering a system, all power cord lines are included.

[10] The power cord line is not included with stand-alone Satellite Repeaters. Please add the right power cord line for the region. Note that when ordering a system, all power cord lines are included.

The Data Generation/Acquisition Interface also contains the circuitry and the antenna required for telemetry, over a dedicated RF link, with the Satellite Repeater. The Data Generation and Acquisition Interface communicates with the host computer via a USB port and includes a 3-port USB bridge with front-panel connectors to facilitate interfacing the other modules with the host computer.

The Virtual Instrument Package

Virtual Instrument Package (USB Version) - Add-On to 8093.

The Virtual Instrument Package is included with this equipment.

The Virtual Instrument Package is an interface module that provides high-speed sampling (up to 1 GS/s) and generation of analog signals. It interfaces to a computer's USB port and is used in conjunction with the Telemetry and Instrumentation software in order to implement all the analog virtual instruments required to perform the laboratory exercises.

Two BNC input connectors on the front panel of the Virtual Instrument Package allow connecting either BNC cables or the supplied probes. A third BNC connector on the front panel provides the Waveform Generator output signal. A BNC connector on the back panel of the Virtual Instrument Package unit is used for the external trigger input of the virtual Oscilloscope.

Additional Equipment Required to Perform the Exercises

Qty	Description	Model number
1	Power Cord - C7 Type A	782859 (85978-00) [11]
1	Power Cord - C7 Type C	782860 (85978-05) [12]
1	Power Cord - C7 Type I	782861 (85978-0A) [13]
1	Power Cord - Type F	789182 (93992-05) [14]
1	Power Cord - Type B	789405 (95451-00) [15]
1	Power Cord - Type I	789406 (95451-0A) [16]

Specifications

Parameter	Value
Spectrum Analyzer Interface	
Attenuators	2 (10 dB and 20 dB)
Probe Buffer Bandwidth	5 MHz

[11] The power cord line is not included with stand-alone Virtual Instrument Package. Please add the right power cord line for the region. Note that when ordering a system, all power cord lines are included.

[12] The power cord line is not included with stand-alone Virtual Instrument Package. Please add the right power cord line for the region. Note that when ordering a system, all power cord lines are included.

[13] The power cord line is not included with stand-alone Virtual Instrument Package. Please add the right power cord line for the region. Note that when ordering a system, all power cord lines are included.

[14] The power cord line is not included with stand-alone Data Generation/Acquisition Interface. Please add the right power cord line for the region. Note that when ordering a system, all power cord lines are included.

[15] The power cord line is not included with stand-alone Data Generation/Acquisition Interface. Please add the right power cord line for the region. Note that when ordering a system, all power cord lines are included.

[16] The power cord line is not included with stand-alone Data Generation/Acquisition Interface. Please add the right power cord line for the region. Note that when ordering a system, all power cord lines are included.

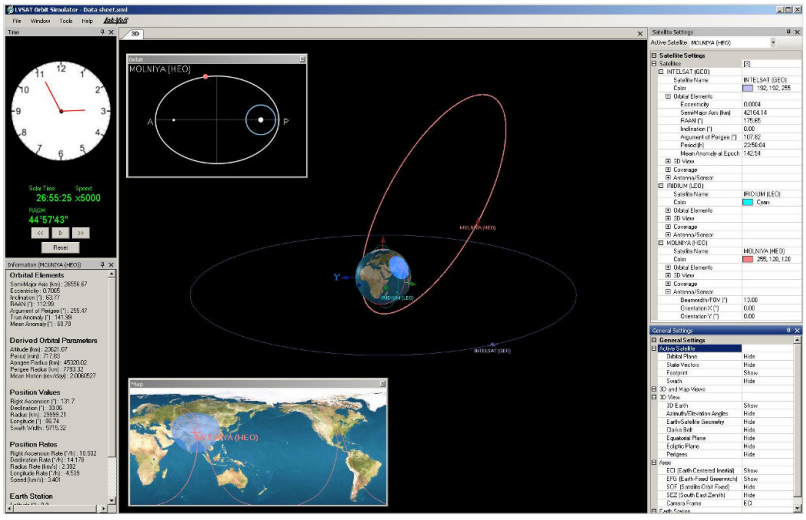
Parameter	Value
Frequency Converter Max. Input Level	-10 dBm
Digital Inputs	
Connector Type	BNC (1 data input, 2 clock inputs)
Voltage Level	TTL
Digital Outputs	
Connector Type	BNC (5 configurable outputs)
Voltage Level	TTL
USB Connectors	4 (1 type B, 3 type A)
Telemetry Antenna	
Connector Type	SMA (on rear panel)
Power Requirements	
From dc source	15 V (60 VA max.)
External power adapter	100 - 240 V AC, 50-60 Hz, 2 A
Service Installation	Standard single-phase outlet
Physical Characteristics	
Dimensions without the telemetry antenna (H x W x D)	152 x 330 x 305 mm (6 x 13 x 12 in)
Dimensions with the telemetry antenna (H x W x D)	178 x 330 x 305 mm (7 x 13 x 12 in)
Net Weight	6.5 kg (12.4 lb)

Cables and Accessories
581876 (9579-00)

The Cables and Accessories set includes the following items:

- SMA cables
- BNC cables
- USB cables
- 2 small-aperture horn antennas
- 2 large-aperture horn antennas
- 4 horn antenna supports
- Adapters

Orbit Simulator Software
581877 (9581-00)



The Orbit Simulator software is a highly motivating and interactive tool designed to help students visualize and grasp these important concepts.

This software provides 2D and 3D animated views of the Earth and orbiting satellites as well as a plane view of one orbit. Students can display typical orbits of existing satellites, such as geosynchronous, geostationary, quasi-geostationary, quasi-zenith, polar, LEO, MEO and highly elliptical (e.g. Molniya) orbits and create their own satellites by entering the appropriate orbital

elements. They can also modify the orbital elements of any satellite and observe the result. The animation can be viewed in real time, accelerated or stopped.

The software demonstrates various aspects of satellite coverage such as visibility, footprints, elevation contours, time of visibility, revisit time, swath, satellite constellations, global and spot satellite antenna beams, and instantaneous and long-term coverage. It also helps students understand factors critical to the alignment of Earth station antennas to geostationary satellites such as satellite longitude, antenna look angles and polarization angle (skew).

A Student Manual and an Instructor Guide with exercises on satellite orbits and coverage are included.

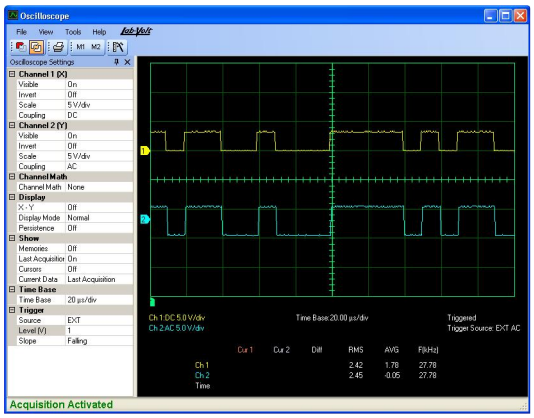
The Orbit Simulator Software includes three software applications: Telemetry and Instrumentation, Data Transfer and Orbit Simulator. For convenience, all three applications are included in the Orbit Simulator Software. The installation program allows installing some or all of the applications, depending on the Equipment purchased by the user.

Telemetry and Instrumentation

The Telemetry and Instrumentation software, used in conjunction with the Telemetry and Instrumentation Add-On, provides a user interface for telemetry with the Satellite Receiver. It also provides the following virtual instruments:

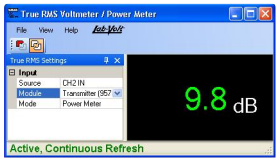
- Oscilloscope
- Spectrum Analyzer
- True RMS Voltmeter / Power Meter
- BER Tester
- Waveform Generator
- Three user-configurable Binary Sequence Generators

The following figures show some of the virtual instruments.

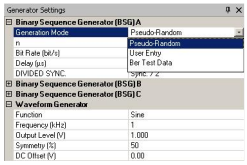


Oscilloscope

Spectrum analyzer



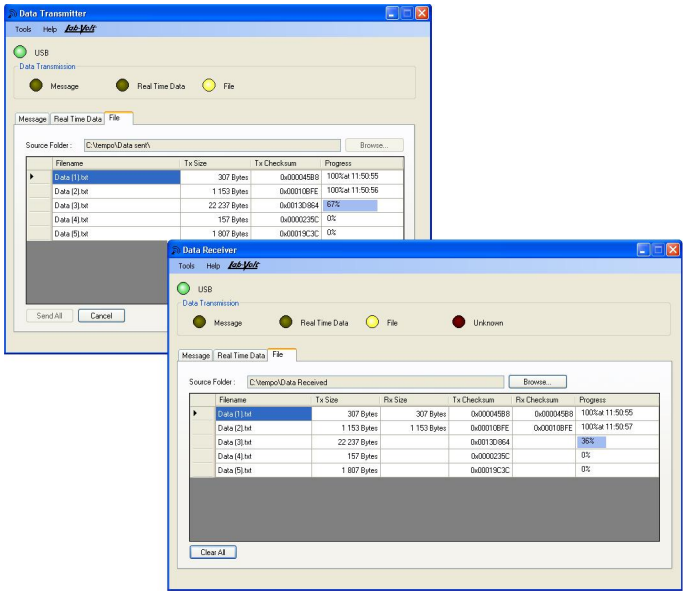
True RMS Voltmeter / Power Meter



Binary Sequence Generator and Waveform Generator settings

Data Transfer

The Data Transfer software consists of two separate applications designed to demonstrate the transfer of computer data over a satellite link. Data is sent using the Data Transmitter application via the Earth Station Transmitter. The data is received using the Data Receiver application via the Earth Station Receiver. The Data Transfer applications can be run on the same computer or on two different computers.



File transfer using the Data Transmitter and Data Receiver applications

Orbit Simulator

Because the space segment is an essential part of every satellite system, whether it is intended for communications, remote sensing, military reconnaissance, navigation, scientific research, mapping, or disaster detection and relief or for any other application, it is vitally important to understand the behavior of the satellites when designing, using or maintaining a satellite system. For this reason, educational programs for these fields usually cover orbital mechanics and satellite coverage.

Earth-station dish antennas used to link with geostationary satellites must be correctly pointed at the desired satellite. To carry out the alignment procedure accurately and efficiently, it is important to understand the different types of antennas used, the earth station-satellite geometry involved, and the different adjustments required. It is also important to acquire an effective procedure that can be used in the field.

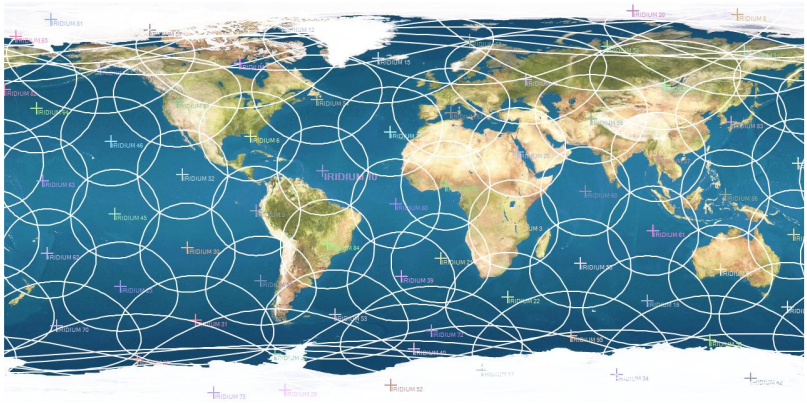
Unfortunately, these subjects are usually taught using static images in text books, requiring students to imagine unfamiliar concepts such as inertial and rotating frames of reference and coordinate systems, satellite state vectors and Keplerian orbital elements, the apparent movement of satellites relative to observers on the rotating earth, and the characteristics of different types of orbits, as well as satellite visibility, ground tracks, footprints, elevation contours, and global and spot beams.

The Orbit Simulator software is a highly motivating and interactive tool designed to help students visualize and grasp these important concepts. This software provides 2D and 3D animated views of the Earth and orbiting satellites as well as a plane view of one orbit. Students can display typical orbits of existing satellites, such as geosynchronous, geostationary, quasi-geostationary, quasi-zenith, polar, LEO, MEO and highly elliptical (e.g. Molniya) orbits and create their own satellites by entering the appropriate orbital elements. They can also modify the orbital elements of any satellite and observe the result. The animation can be viewed in real time, accelerated or stopped.

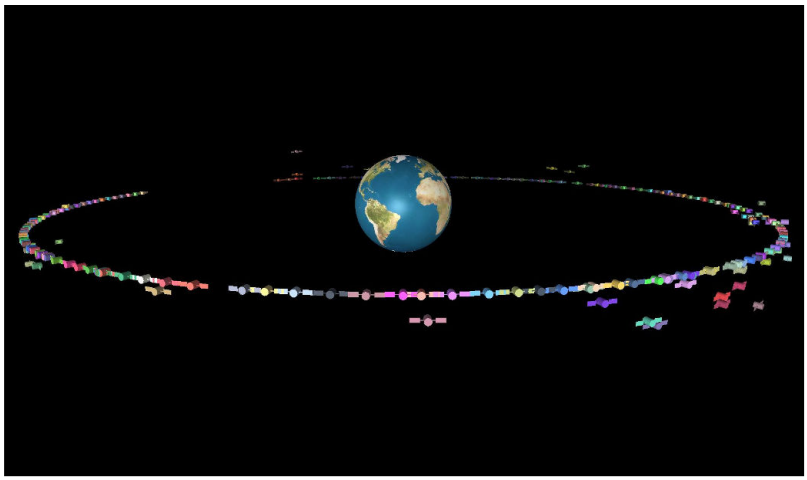
The software demonstrates various aspects of satellite coverage such as visibility, footprints, elevation contours, time of visibility, revisit time, swath, satellite constellations, global and spot satellite antenna beams, and instantaneous and long-term coverage. It also helps students understand factors critical to the alignment of Earth station antennas to geostationary satellites such as satellite longitude, antenna look angles and polarization angle (skew).

The Orbit Simulator (included with the Satellite Communications Training System and available separately) comes with a Student Manual and an Instructor Guide with exercises on satellite orbits, coverage, and antenna alignment. To practice antenna alignment with real geostationary satellites, the optional Dish Antenna and Accessories is used.

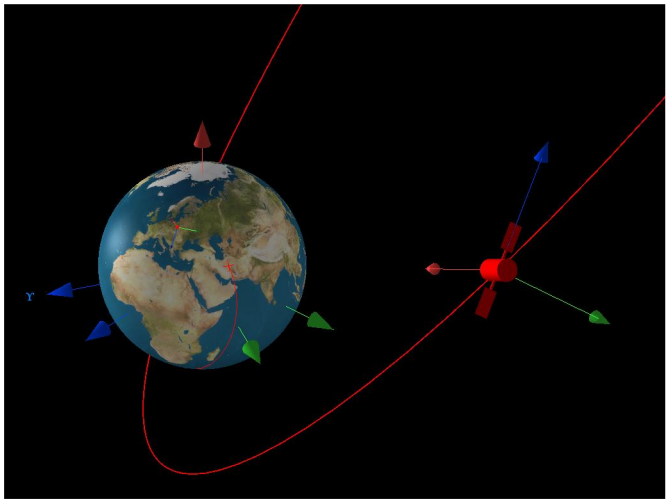
The following figures illustrate some of the possibilities of this software.



World-wide coverage provided by the IRIDIUM satellite system



Active geostationary satellites



Four different coordinate system axes, subsatellite point and ground track

List of Manuals

Description	Manual number
Satellite Communications Training System (Manuals on CD-ROM)	580539 (86311-A0)
Satellite Orbits, Coverage, and Antenna Alignment (Student Manual)	580610 (87768-00)
Satellite Orbits, Coverage, and Antenna Alignment (Instructor Guide)	580611 (87768-10)
Principles of Satellite Communications (Student Manual)	591802 (86311-00)
Principles of Satellite Communications (Instructor Guide)	591803 (86311-10)
Satellite Communications Training System (User Guide)	591804 (86311-E0)
Satellite Orbits, Coverage, and Antenna Alignment (Student Manual)	592071 (87768-00)
Satellite Orbits, Coverage, and Antenna Alignment (Instructor Guide)	592072 (87768-10)

Table of Contents of the Manual(s)

Satellite Orbits, Coverage, and Antenna Alignment (Student Manual) (580610 (87768-00))

- 1 Orbital Mechanics
- 2 Satellite Orbits and Coverage
- 3 Antenna Alignment for Geostationary Satellites

Topic Coverage

- Satellite Orbits
- Coverage
- Antenna alignment

Features & Benefits

- Use IT to help students understand the behavior of the satellites when designing, using or maintaining a satellite system
- Demonstrate various aspects of satellite coverage
- Practice antenna alignment with real geostationary satellites (with optional accessories)
- Students can see unfamiliar concepts in action, such as inertial and rotating frames of reference and coordinate systems, etc.

Specifications

Parameter	Value
Personal Computer Requirements	The software requires a current model computer running Windows® 7, Windows® Vista or Windows® XP, including a 3D graphics card. The Satellite Communications Host Computer meets these requirements.

Power Cord - Type B
789405 (95451-00)

Optional Equipment Description

Satellite Communications Host Computer (Optional) 587470 (9695-B0)

The Satellite Communications Training System Host Computer is a Pentium-type personal computer running under a Windows®operating system with the LVSAT software preinstalled.

Satellite Communications Training System (Manuals on CD-ROM) (Optional) 580539 (86311-A0)

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

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