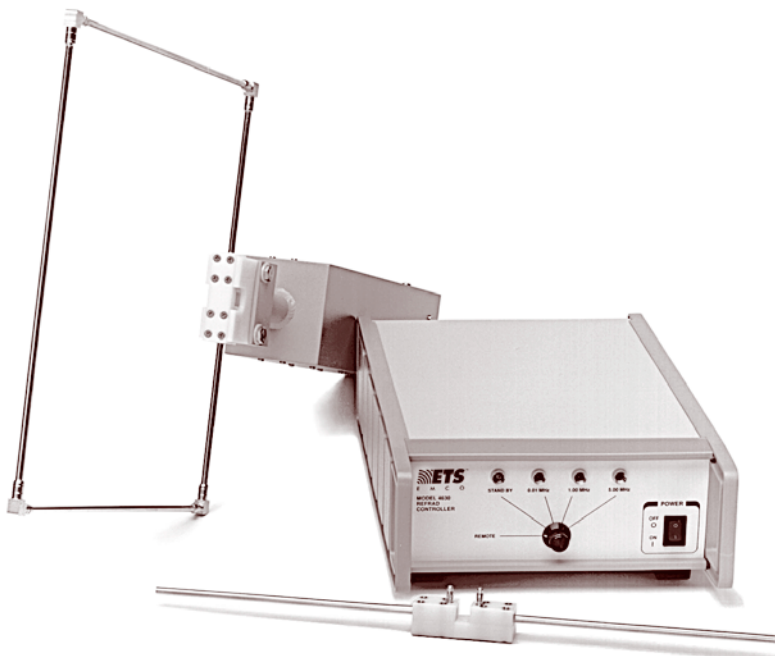


Model 4630

REFRAD

Reference Radiator

MANUAL



**ETS·LINDGREN**™
An ESCO Technologies Company

LICENCED FROM:

FORSCHUNGSZENTRUM SEIBERSDORF



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Table of Contents

INTRODUCTION.....	1
TYPICAL USE	1
COMB GENERATOR	1
<i>Operation of the Comb Generator.....</i>	<i>1</i>
<i>Battery Charger</i>	<i>2</i>
REMOTE CONTROL UNIT.....	3
TECHNICAL DATA	4
COMB GENERATOR	4
<i>Power Supply</i>	<i>4</i>
<i>Output Signal – Comb Spectrum.....</i>	<i>4</i>
<i>Remote Control</i>	<i>4</i>
<i>Temperature Range.....</i>	<i>4</i>
REMOTE CONTROL.....	6
<i>Power Supply</i>	<i>6</i>
<i>GPIB Bus</i>	<i>6</i>
<i>GPIB Command Set</i>	<i>6</i>
<i>GPIB Examples.....</i>	<i>7</i>
<i>Fiber Optic Out.....</i>	<i>7</i>
<i>Temperature Range.....</i>	<i>7</i>
OPERATION INVENTORY	7
ACCESSORIES.....	8
<i>Transmit Antennas</i>	<i>8</i>
<i>Tripod Mounting Accessories</i>	<i>8</i>
<i>Fiber Optic Link.....</i>	<i>8</i>
<i>Coaxial Adapter.....</i>	<i>8</i>
<i>Reference Cable and Attenuator.....</i>	<i>8</i>
<i>(Not Supplied with System).....</i>	<i>8</i>
APPLICATIONS	9
SITE INTERCOMPARISON	9
NORMALIZED SITE ATTENUATION	9
SYSTEM CHECKOUT	10
CABLE LOSS.....	11
CHAMBER FACTOR.....	11
FUNCTIONAL DESCRIPTION.....	12
COMB GENERATOR	12
REMOTE CONTROL UNIT.....	12
CERTIFICATE.....	14
WARRANTY STATEMENT	15

NOTICE: This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

SAFETY SYMBOL DEFINITIONS



REFER TO MANUAL

When product is marked with this symbol refer to instruction manual for additional information.



HIGH VOLTAGE

Indicates the presence of hazardous voltage. Unsafe practices could result in severe personal injury or death.



PROTECTIVE EARTH GROUND (SAFETY GROUND)

Indicates protective earth terminal. You should provide an uninterruptible safety earth ground from the main power source to the product input wiring terminals, power cord, or supplied power cord set.

CAUTION

CAUTION

Denotes a hazard. Failure to follow instructions could result in minor personal injury and/or property damage. Included text gives proper procedures.

GENERAL SAFETY CONSIDERATIONS



BEFORE POWER IS APPLIED TO THIS INSTRUMENT, GROUND IT PROPERLY through the protective conductor of the AC power cable to a power source provided with protective earth contact. Any interruption of the protective (grounding) conductor, inside or outside the instrument, or disconnection of the protective earth terminal could result in personal injury.

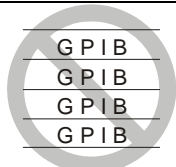


BEFORE SERVICING: CONTACT EMC TEST SYSTEMS – servicing (or modifying) the unit by yourself may void your warranty. If you attempt to service the unit by yourself, disconnect all electrical power before starting. There are voltages at many points in the instrument which could, if contacted cause personal injury. Only trained service personnel should perform adjustments and/or service procedures upon this instrument. **Capacitors inside this instrument may still be CHARGED even when the instrument is disconnected from its power source.**



FUSE
2 A: 250 V T

TO AVOID A SAFETY HAZARD, replace fuses with the same current rating and type (normal blow, time delay, etc.). Order any replacement parts direct from ETS.



TO AVOID UNDUE MECHANICAL STRESS on the GPIB I/O CONNECTOR, limit connector stacking to no more than three cables on one connector.



ONLY QUALIFIED PERSONEL should operate (or service) this equipment.

INTRODUCTION

The EMC Test Systems Model 4630 Refrad Reference Radiator is a precise highly stable field strength transfer standards with selectable frequency spacings over the range of 10 kHz to 1 GHz. The system consists of a small battery powered comb generator with a loop and two dipole transmit antennas, a coaxial output adapter, and a remote control unit with GPIB interface.

TYPICAL USE

1. Set up comb generator and remote control unit.
2. Connect both devices via the fiber optic cable. You may clean the connectors with a soft lint-free cloth if necessary.
3. The comb generator has to be operated in remote mode to be used with the remote control unit.
4. Operation by a remote computer is possible. (see the 'Remote Control Unit' section)
5. The comb generator should be recharged after each use. (battery charger with cable and power supply supplied)

COMB GENERATOR

OPERATION OF THE COMB GENERATOR

1. Plug the selected antenna elements into the balun on the comb generator.
2. For horizontal and vertical antenna polarization, use the supplied support base, support rod, and clamp bock for tripod mounting.
3. Select any comb spectrum by rotating the front panel knob to the desired setting (0.01 MHz, 1.0 MHz, or 5.0 MHz). To transfer to the remote control unit rotate the knob to the "REMOTE" setting.
4. To recharge the comb generator after use, put the ON/OFF switch in the CHARGE/OFF position and insert the battery charger output plug into the comb generator's input socket.

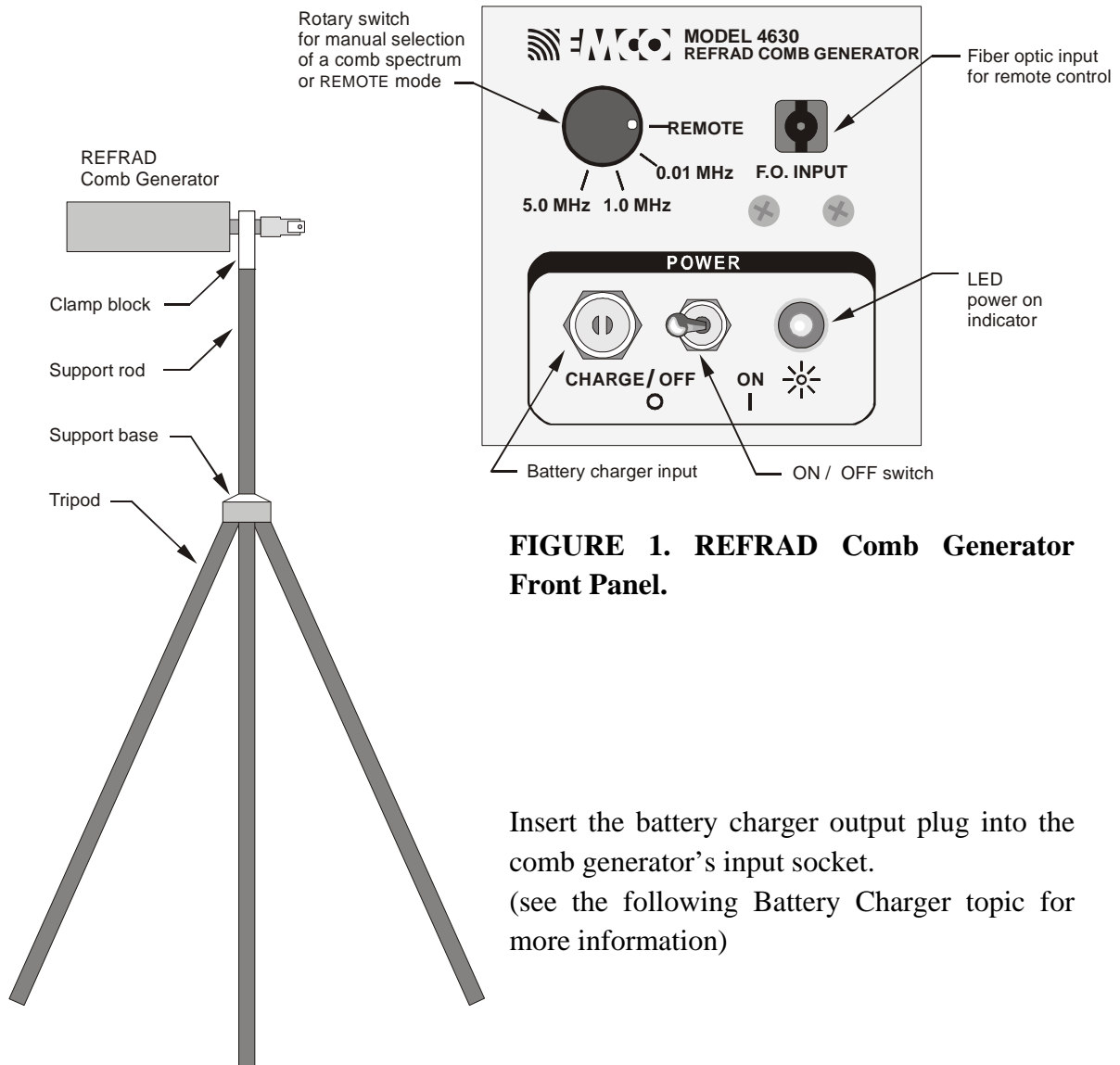


FIGURE 1. REFRAD Comb Generator Front Panel.

Insert the battery charger output plug into the comb generator’s input socket.
(see the following Battery Charger topic for more information)

FIGURE 2. Tripod Mounting of REFRAD Comb Generator

BATTERY CHARGER

There is one red LED and one green LED on the body of the separate battery charger. The “Power On” LED illuminates when the charger is plugged into the 20V DC power supply. Power is supplied to the supply via the IEC 302-type power inlet. The supplied safety-certified power cord should always be used to maintain safe operation.

A solid red LED indicates fast charge mode. When the red LED flashes, the charger is operating in a pre-charge mode. As the

battery nears full charge, the charge will begin to operate in a TOP-OFF/TRICKLE mode. This is indicated by the green LED.

The power supply uses a green LED to indicate that power is applied. In case of a fault condition, the green LED will be extinguished.

NOTE: The REFRAD comb generator is not designed to operate using the battery charger as a power source.

REMOTE CONTROL UNIT

1. Connect the remote control unit to the GPIB-bus.
 2. Connect the 9 V DC plug-in power supply.
- Note: Use only the power supply included with the unit.
3. With the comb generator set to “REMOTE” mode, the front panel knob on the remote control unit may be used to select any comb spectrum manually. The comb spectrum may also be selected by a remote computer connected to the GPIB (IEEE-488) bus with the control knobs on both the comb generator and remote control unit set to “REMOTE”. Note settings in to illustration below.

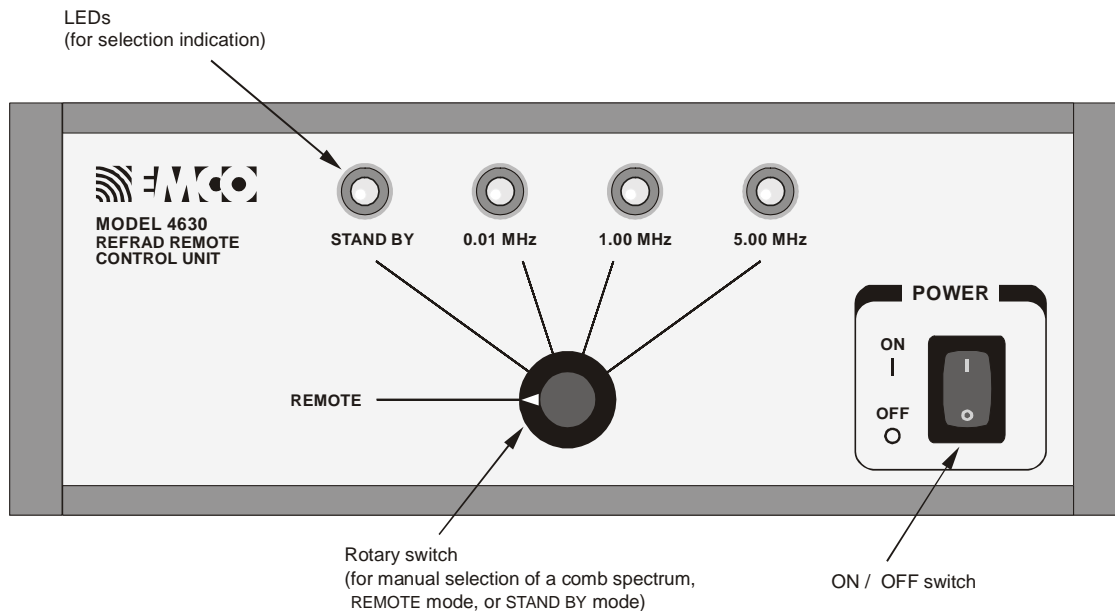


FIGURE 3. REFRAD Remote Control Unit Front Panel.

TECHNICAL DATA

COMB GENERATOR

POWER SUPPLY

One (1), internal 12 VNIMh 3.5 Ah.
Factory serviceable only.

OUTPUT SIGNAL – COMB SPECTRUM

BALUN	USED RANGE (MHz)	LINE SPACING (MHz)	OUTPUT POWER Per line, typical (dBm)
C	0.01-1	0.01	-17 to -20
B	1-100	1	-10 to -18
A	100-1000	5	-10 to -30

CAUTION For measuring the direct output signal, the comb generator has to be connected via an attenuator (attenuation 30 dB) to protect the test receiver or spectrum analyzer.

REMOTE CONTROL

Connection is made with Hewlett Packard low-loss plastic fiber optic cable with simplex-type connectors.

TEMPERATURE RANGE

+5 degrees to +30 degrees C.

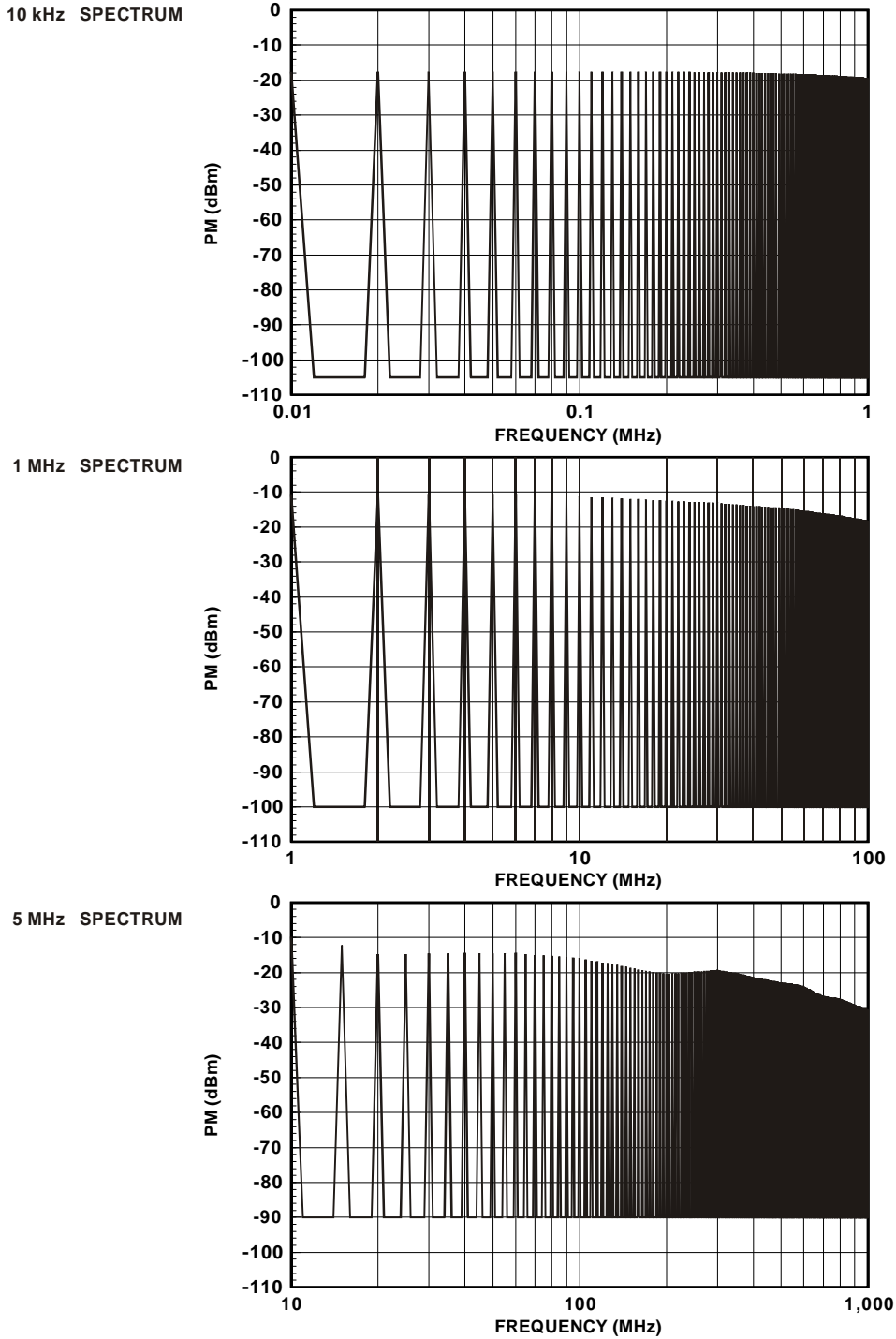


FIGURE 4. Typical comb generator output spectrum in the three frequency ranges.

REMOTE CONTROL

POWER SUPPLY

Plug in power supply, 9V DC, 50 mA.

GPIB BUS

Selection of address

The GPIB address (DEFAULT) is changed by removing the top of the remote control unit and selecting the desired switch settings on the GPIB interface boards (see diagram below). The table relates the switch setting to the actual address. (Note that moving the switch up turns it on and pushing it down turns it off.)

GPIB ADDR	A5	A4	A3	A2	A1
0	OFF	OFF	OFF	OFF	OFF
1	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	ON	OFF
3	OFF	OFF	OFF	ON	ON
4	OFF	OFF	ON	OFF	OFF
5	OFF	OFF	ON	OFF	ON
6	OFF	OFF	ON	ON	OFF
7	OFF	OFF	ON	ON	ON
8	OFF	ON	OFF	OFF	OFF
9	OFF	ON	OFF	OFF	ON
10	OFF	ON	OFF	ON	OFF
11	OFF	ON	OFF	ON	ON
12	OFF	ON	ON	OFF	OFF
13	OFF	ON	ON	OFF	ON
14	OFF	ON	ON	ON	OFF
15	OFF	ON	ON	ON	ON
16	ON	OFF	OFF	OFF	OFF
17	ON	OFF	OFF	OFF	ON
18	ON	OFF	OFF	ON	OFF
19	ON	OFF	OFF	ON	ON
20	ON	OFF	ON	OFF	OFF
21	ON	OFF	ON	OFF	ON
22	ON	OFF	ON	ON	OFF
23	ON	OFF	ON	ON	ON
24	ON	ON	OFF	OFF	OFF
25	ON	ON	OFF	OFF	ON
26	ON	ON	OFF	ON	OFF
27	ON	ON	OFF	ON	ON
28	ON	ON	ON	OFF	OFF
29	ON	ON	ON	OFF	ON
30	ON	ON	ON	ON	OFF
31	ON	ON	ON	ON	ON

Address - Switch setting table

GPIB COMMAND SET

The GPIB commands are listed in the following table:

LINE SPACING	GPIB COMMAND
Standby	"0"
0.01 MHz	"1"
1 MHz	"2"
5 MHz	"3"

NOTE: The commands have to sent without termination character(s) and without "CRIF".

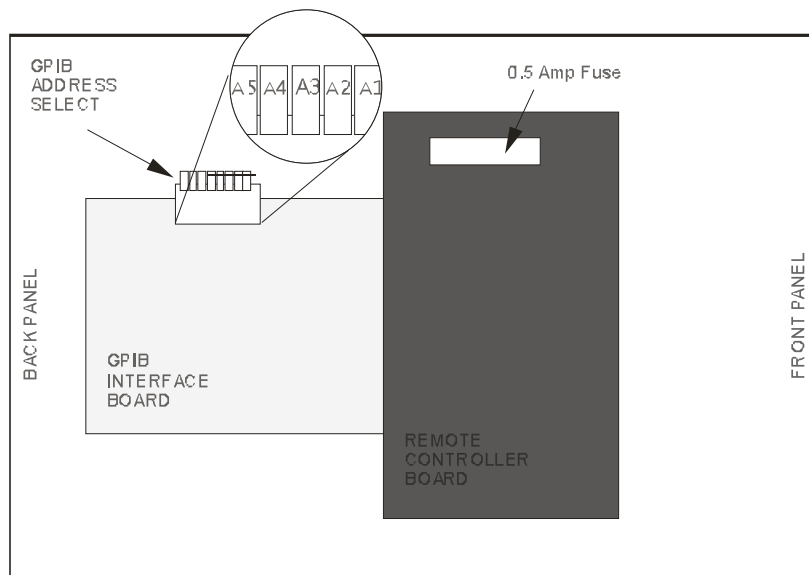


FIGURE 5. Remote Control Unit System Diagram.

GPIB EXAMPLES

ibwrt"0" sets STBY MODE
 ibwrt"1" sets 10 kHz MODE
 ibwrt"2" sets 1 MHz MODE
 ibwrt"3" sets 5 MHz MODE

FIBER OPTIC OUT

Hewlett Packard Simplex connector

TEMPERATURE RANGE

+5 degrees to +30 degrees C.

OPERATION INVENTORY

Comb Generator	Support Base
Remote Control Unit	Support Block
10 m Fiber Optic Cable	Clamp Block
Power Supply 9 VDC	Battery Charger with Cable
Square Loop Antenna Assembly	Coax Adapter
Long Dipole Antenna Elements	REFRAD Manual
Balun Assembly	
Short Dipole Antenna Elements	
Balun Assembly	

ACCESSORIES

TRANSMIT ANTENNAS

The system includes three antennas:

Long dipole antenna, element length 650mm

(for use with 10 kHz spacing)

Square loop, side length 300mm

(use for generating magnetic field)

Short dipole antenna, element length 200mm

(for use with 1 MHz and 5 MHz spacing)

TRIPOD MOUNTING ACCESSORIES

The following tripod accessories are included with the system:

Support rod

Support base

Clamp block

FIBER OPTIC LINK

Fiber optic link: Simplex connectors, standard length: 10m. Fiber optic link

COAXIAL ADAPTER

Provides a means to adapt the output of the comb generator to a type "N" coaxial connector.

REFERENCE CABLE AND ATTENUATOR (NOT SUPPLIED WITH SYSTEM)

Reference cable: Coaxial cable, length 25 cm.

Connectors: Type BNC male – Type N male

Attenuator: 30 dB, BNC

APPLICATIONS

The following applications assume the use of CalStan software. It allows automatic measurements, data processing and documentation of test results. See CalStan's manual for further information. CalStan is available from:

Austrian Research Center

Division of Electronics Electromagnetic Compatibility
Radio Frequency – Engineering Section
A-2444 Seibersdorf, Austria. Tel: +432254-780-2800.
emc@fzmarl.arcs.ac.at

Other applications are possible using the REFRAD as a field-strength transfer standard.

For outdoor operations, precautions have to be taken in order to avoid radio interference.

SITE INTERCOMPARISON

Intercomparisons are demanded by EN 45001 for all accredited test laboratories, but are useful for all other laboratories as well.

To carry out an intercomparison, the reference radiator REFRAD is set up in the center of the turntable. By analogy to NSA measurements, the REFRAD is operated with dipole and loop antennas at two heights above ground in horizontal and vertical polarization. The frequency range is 30-1000 MHz. This procedure requires no more than half a day. Computer control assures efficient, fault less operation and the data is automatically processed. Differences with respect to data from other sites can be plotted and analyzed.

NORMALIZED SITE ATTENUATION

Normalized site attenuation (NSA) measurements are carried out according to ANSI 63.4 and CISPR/A(Secr.)109, July, 1991. The frequency range is 30 - 1000 MHz. The "volume method" has to be applied: The transmit antenna with the reference radiator

REFRAD connected to it has to be set up at 10 different positions on the turntable. These positions are specified in the reference documents. The receive antenna is kept co-polarized at a constant horizontal distance and is always facing the transmit antenna. Transmission loss between the transmit and receive antennas is measured according to the standard test procedure (height scan of the receiving antenna) for each frequency and polarization.

During operation with CalStan, the REFRAD, test receiver or spectrum analyzer, and antenna positioning mast are remotely controlled. The operator is guided through the procedure by commands appearing on the screen.

Data processing can be done after the antenna factors of the transmit and receive antennas have been entered. Then, the measured NSA is computed and plotted against the values given in the standards. The +/- 4 dB- range is also shown for easy judgment of the measurement results.

SYSTEM CHECKOUT

The system checkout is an efficient method for regular routine checks of the whole system for radiated-emissions tests on the test site. The REFRAD is set up on the turntable as the equipment under test.

The signal from the comb generator is automatically measured and the data is compared to the values that were measured previously. Any observed differences are listed on the screen, otherwise the statement "OK" is given.

This procedure is an "overall" check, the receive antenna, preamplifier, antenna cable and test receiver or spectrum analyzer operates as they do during routine radiated-emission testing. If any component is defective, differing field-strengths will result.

The system checkout requires not more than 10 minutes. It is a useful tool for quality control and should be performed once a week. The computer automatically keeps a logbook of all performed system checkouts. This logbook is a valuable element of quality assurance of the EMC test laboratory.

CABLE LOSS

The cable loss D_K is the difference between two measurements of the receiver power level.

$$D_K \text{ (dB)} = P_O \text{ (dBm)} - P_K \text{ (dBm)}$$

P_O is measured with the comb generator connect to the test receiver via the 30 dB attenuator. For the measurement of P_K , both the cable and the 30 dB attenuator are connected between the comb generator and receiver.

CHAMBER FACTOR

The chamber factor is intended for the testing of absorber – lined chambers, where the +/- 4 dB – tolerance given by ANSI and CISPR is exceeded in the frequency range of 30 MHz approximately 200 MHz. Chamber factors are determined by comparison measurements with a standard open area test site.

The REFRAD acts as a field-strength transfer standard. It is operated separately with both the dipole and the loop transmit antennas. This is necessary in order to generate both fields having a high wave impedance in the near-field of the source and fields having a low wave impedance.

The reflection loss of common broadband pyramidal absorber material is a function of the wave impedance. This procedure, therefore, simulates extreme cases of possible characteristics of equipment under test.

The “volume method” given by ANSI and CISPR is applied similar to the NSA measurement. For each point, a comparison measurement is carried out using the dipole as the transmit antenna and another measurement using the loop. Each of these comparison measurements yields a correction factor. When all of the correction factors for one polarization are plotted onto one graph, a typical spread is found at each frequency. The upper envelope curve of the

correction factors is the worst – case chamber factor. The mean between the upper and lower envelope curve is the mean chamber factor.

Chamber factors (in dB) are to be added to the field-strengths (in dB $\mu\text{V}/\text{m}$) measured in the chamber in order to achieve open-site equivalents (in dB $\mu\text{V}/\text{m}$).

During operation with CalStan, the REFRAD, test receiver or spectrum analyzer, and antenna positioning mast are remotely controlled. The operator is guided through the procedure by commands appearing on the screen.

FUNCTIONAL DESCRIPTION

COMB GENERATOR

Functional groups: Remote control decoder
Crystal oscillator and divider
Switching power supply
Pulse generator
Matching network

The clock signal from the crystal oscillator is divided to the selected pulse repetition rate. With this signal the pulse generator produces nano-second pulses with a very high amplitude, requiring a voltage of 70 V generated by the switching power supply. A resistive 50 Ohm matching network is provide between the pulse generator and the output.

Due to the use of a regulated switching power supply, the output amplitude is stable for a 4.4 to 6 V power supply range.

REMOTE CONTROL UNIT

Functional groups: GPIB – bus decoder
Remote control signal encoder
Selection and display unit

The position of the selection switch determines whether the device is GPIB controlled (REMOTE) or manually controlled. In manual control mode the selected spectrum is generated independently of the actual GPIB state.

NOTE: For remote control operation of the comb generator, the selection switch on the comb generator must be in the remote position.

CERTIFICATE

THE FOLLOWING TESTS HAVE BEEN PERFORMED
BEFORE DELIVERY:

- Check of the pulse spectrum shapes
- Measurement of the output power
- Check of the optical interconnection

WARRANTY STATEMENT

EMC Test Systems, L.P., hereinafter referred to as the Seller, warrants that standard EMCO products are free from defect in materials and workmanship for a period of two (2) years from date of shipment. Standard EMCO Products include the following:

- ❖ Antennas, Loops, Horns
- ❖ GTEM cells, TEM cells, Helmholtz Coils
- ❖ LISNs, PLISNs, Rejection cavities & Networks
- ❖ Towers, Turntables, Tripods & Controllers
- ❖ Field Probes, Current Probes, Injection Probes

If the Buyer notifies the Seller of a defect within the warranty period, the Seller will, at the Seller's option, either repair and/or replace those products that prove to be defective.

There will be no charge for warranty services performed at the location the Seller designates. The Buyer must, however, prepay inbound shipping costs and any duties or taxes. The Seller will pay outbound shipping cost for a carrier of the Seller's choice, exclusive of any duties or taxes. If the Seller determines that warranty service can only be performed at the Buyer's location, the Buyer will not be charged for the Seller's travel related costs.

This warranty does not apply to:

- ❖ Normal wear and tear of materials
- ❖ Consumable items such as fuses, batteries, etc.
- ❖ Products that have been improperly installed, maintained or used
- ❖ Products which have been operated outside the specifications
- ❖ Products which have been modified without authorization
- ❖ Calibration of products, unless necessitated by defects

THIS WARRANTY IS EXCLUSIVE. NO OTHER WARRANTY, WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE REMEDIES PROVIDED BY THIS WARRANTY ARE THE BUYER'S SOLE AND EXCLUSIVE REMEDIES. IN NO EVENT IS THE SELLER LIABLE FOR ANY DAMAGES WHATSOEVER, INCLUDING BUT NOT LIMITED TO, DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

Note: Please contact the Seller's sales department for a Return Materials Authorization (RMA) number before shipping equipment to us.