Model 7002-006

EMPower™
Power Meter

User Manual

ETS·LINDGREN

An **ESCO Technologies** Company

Revision Record

MANUAL,EMPOWER POWER METERS,7002-006 | Part 1679937, Rev. A

Revision	Description	Date
A	Initial Release	MAY, 2018

Table of Contents

Notes, Cautions, and Warnings

Note: Denotes helpful information intended to provide tips for better use of the product.

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

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

Note: See the ETS-Lindgren *Product Information Bulletin* for safety, regulatory, and other product marking information.

Safety Information

Refer to Manual: When product is marked with this symbol, see the instruction manual for additional information. If the instruction manual has been misplaced, download it from **ets-lindgren.com,** or contact ETS-Lindgren Customer Service.

Waste Electrical and Electronic Equipment (WEEE) Directive: (European Union) At end of useful life, this product should be deposited at an appropriate waste disposal facility for recycling and disposal. Do not dispose of with household waste.

ONLY QUALIFIED PERSONNEL should operate or service this equipment.

Note: See the ETS-Lindgren *Product Information Bulletin* for safety, regulatory, and other product marking information.

ETS-Lindgren Product Information Bulletin

See the ETS-Lindgren *Product Information Bulletin* included with your shipment for the following:

- Warranty information

- Safety, regulatory, and other product marking information

- Steps to receive your shipment

- Steps to return a component for service

- ETS Lindgren calibration service

- ETS Lindgren contact information

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1.0   Introduction

The EMPower^{TM} is a RF power meter especially designed for power measurements during EMC tests.

The EMPower RF power sensor is mounted in a rugged metal housing to ensure a long life and excellent RF shielding. The power sensor is equipped with an N-type precision RF input connector and a mini USB- B connector for communication with a computer.

In addition to the USB interface, the EMPower^{TM} can be controlled by both the EMPower^{TM} Viewer integral EMC measurement software and any other EMC measurement packages, because all the software codes needed to control the unit are available. For 'stand-alone use' of the EMPower^{TM}, EMBurst Data Acquisition software is delivered with the system. By using the USB1004A plug-in card, up to four EMPower^{TM} heads can be connected to a single plug-in card in an EMCenter^{TM}.

In combination with EMPower Viewer^{TM}, the 7002-006 can be used to perform simultaneous power measurements on multiple ports of MIMO devices in accordance with EN 300 328. All necessary parameters are calculated by EMPower^{TM} Viewer.

COMPONENTS

The EMPower is delivered with the following items:

EMPower RF Power Sensor
Model: 7002-006

Shielded USB Cable
Model: USB A male to mini USB B male
For connecting the RF power sensor with the plug-in card.

Trigger cable
For measurements on multiple ports.

Functional Description

The EMPower™ uses a high speed RMS power detector to measure the RF signal, independent of the crest factor of the input signal waveform. The detected signal is sampled, at high speed, by a high speed ADC and the samples are processed by a powerful DSP. The sophisticated software enables unique functions, such as burst logging. The following table shows the different measurement modes.

Mode	7002-006
CW power	√
Peak power	√
Burst logging	√

- **CW Mode**

The EMPower^{TM} performs RMS power measurements of CW-signals. In RMS mode the EMPower^{TM} samples the signal at high speed. The RMS value of the power is calculated over the number of samples defined by the filter setting and can be read by a simple command. Due to the high sampling speed the number of readings is high, even at large filter settings.

- **Peak Mode**

The EMPower^{TM} performs peak measurements (max hold) on RF-signals. In peak mode the EMPower^{TM} keeps track of the highest level that has been measured. This can be done for an infinite time. Once the power level has been read, the maximum value is automatically reset.

- **Envelope Tracing**

The EMPower^{TM} captures the envelope of an RF-signal. This is a unique feature which enables the possibility to visualize, for example, the inrush phenomena of transmitters or signal generators, without the need for an expensive RF analyzer. Due to the extensive trigger possibilities, almost any RF-signal can be captured in the large buffers of the EMPower.

- **Burst Mode**

The EMPower logs RF-bursts of a wide variety of RF standards, including LTE, WiMAX, W- CDMA, CDMA2000, TD-SCDMA, and EDGE. For these complex transmitters, such as WLAN devices, a special burst mode has been implemented. During the observation time, the time and RMS power of each RF-burst is logged into memory. These measurements can be used to perform conducted measurements of RF output power, according to the latest version of the ETSI EN 300 328 standard. Parameters such as medium utilization, Tx-gap and Tx- sequence are automatically calculated and displayed on the PC screen by EMBurst Data Acquisition software. The EMPower is equipped with a trigger in- and output to enable simultaneous measurements on multiple ports of MIMO devices. By daisy chaining the trigger signal of the 7002-006, multiple power meters can be synchronized using EMBurst Data Acquisition software.

The 7002-006 is especially designed for (MIMO) measurements according to EN 300 328. For this purpose the power meter is equipped with a RMS responding power detector.

The power of the RF signal in an equivalent decibel-scaled value is precisely converted into DC voltage on a linear scale, independent of the crest factor of the input signal waveforms. This DC voltage is translated to a power value in dBm or Watts, based on the frequency of the RF signal. Therefore each sample measured by the 7002-006 represents the RMS power. The sample speed in burst mode can be set to 1 MSps or 5 MSps. All samples within a RF burst are calculated by the power meter according to:

$$P_{burst} = \frac{1}{m} \sum_{n=1}^{m} P_{sample}(n) \ [W]$$

Where m is the number of RMS power samples within the start and stop time of the RF burst. These times are defined as the points where the power is at least 30 dB below the highest value of the measured samples. This value (threshold level) can be set in EMBurst Data Acquisition software. For each RF burst, the RMS power, start time and stop time is stored in the power meter.

For MIMO measurements using multiple 7002-006 power meters, the total RF power of a burst is calculated using for example EMBurst Data Acquisition software. The burst data of each power meter is gathered by EMBurst Data Acquisition software and calculated to a total power of the RF burst according to:

$$P_{burst, total} = \sum_{i=1}^{j} P_{burst}(i) \ [W]$$

Where j is the number of 7002-006 power meters of the MIMO test setup. Corrections like coupler values as well as beamforming gain (Y) and the assembly gain (G) of the DUT can be added in EMBurst Data Acquisition software and will be accounted for in the results of the total power of the bursts.

CONTACTING ETS-LINDGREN

Note: Please see ets-lindgren.com for a list of ETS-Lindgren offices, including phone and email contact information.

SENDING A COMPONENT FOR SERVICE

For the steps to return a system or system component to ETS-Lindgren for service, see the *Product Information Bulletin* included with your shipment.

CALIBRATION SERVICES AND ANNUAL CALIBRATION

See the *Product Information Bulletin* included with your shipment for information on ETS-Lindgren calibration services.

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2.0 Specifications

Electrical	
Detector type	RMS detector
Measuring function	RMS CW power, Peak power Burst mode
Frequency range	10 MHz to 6 GHz
Power measuring range	-50 to + 10 dBm
Input damage level	> +20 dBm
Resolution	0.01 dB
RF input connector	Precision N-type
RF input impedance	50 Ohm
Max SWR: < 100 MHz	1.10
100 MHz to 1 GHz	1.10
1 GHz to 6 GHz	1.15
Frequency response accuracy (at 23º C ± 2º C)	+/- 0.2 dB
Deviation from CW for signals with high Crest factor	< 0.2 dB

*This table continues on the next page.

Electrical (continued)	
Linearity error	0.05 dB + 0.005 dB/dB
Temperature effect	0.15 dB max over full temperature range
Measuring units	dBm or Watts
Zero adjustment	Not required
Frequency response correction	Stored frequency response data is taken into account by numerical entry of the measurement frequency
Measurement speed	10, 50, 100 kS/s, 1, 5, 10, 20, 40 MS/s
Storage capacity	100,000 samples
Power Consumption	
Supply voltage	+5VDC from USB port (4.75 V to 5.25 V)
Current consumption (USB)	Max. 200 mA
Filter setting for RMS (Mode 0)	**Number of samples used for RMS calculation**
Filter 1	10
Filter 2	30
Filter 3	100
Filter 4	300
Filter 5	1000
Filter 6	3000
Filter 7	5000
Auto filter mode	**Number of samples used for RMS calculation**
+10 to 0 dBm	100 (filter 3)
0 to -10 dBm	100 (filter 3)
-10 to -20 dBm	100 (filter 3)
-20 to -30 dBm	300 (filter 4)
-30 to -40 dBm	1000 (filter 5)
-40 to -50 dBm	3000 (filter 6)
Below -50 dBm	5000 (filter 7)

Interfaces	
Communication	USB 1.0 (drivers supplied for Windows XP and Windows 7)
Mechanical	
Dimensions of measuring device	124 * 32 * 32 mm
RF input connector	N type precision
Data connector (power head side)	USB mini type B
Trigger input and output	MMCX
EMCenter	USB1004A plug-in card
Environmental Conditions	
Temperature range (operating)	0° to 40° Celsius
Temperature range (storage)	-20 to 85º C
Relative humidity	10 – 90% (non-condensing)

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3.0   EMPower 7002-006 Installation

CAUTION: Before connecting any components, follow the safety information in the ETS-Lindgren *Product Information Bulletin* included with your shipment.

Hardware Configuration

Connect the EMPower™ sensor to a Windows computer with a USB 1.1 compatible port. Use the supplied USB cable to connect the EMPower™ sensor.

The hardware installation for the EMPower™ sensor is now complete. The user can control the EMPower™ using the EMBurst Data Acquisition software.

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4.0 Operation

CAUTION: Before placing into operation, follow the safety information in the ETS-Lindgren *Product Information Bulletin* included with your shipment.

CAUTION: Prior to operation, verify that the mains voltage is within the operating range of the equipment..

Standalone Use

Connect the EMPower™ sensor to a Windows computer with a USB port for 'stand-alone' use. Use the supplied USB cable to connect the sensor to your computer.

Windows will prompt that new hardware has been found. The USB-driver for the EMPower™ is Windows certified and will be loaded automatically from the Windows update.

If the drivers are not loaded automatically, these can be installed manually from the supplied USB-key. Follow the normal instructions from Windows to install the drivers manually.

Once the drivers are loaded successfully, the EMPower™ will be shown in the device list.

GENERAL

The EMPower™ uses a high speed communication protocol that is supported by EMPower Viewer™. This results in short transfer times of the data, even at long observation times or large numbers of samples.

As a result, a simple terminal program cannot be used to communicate with the EMPower™ directly. The EMPower™ uses a USB2.0 FTDI transceiver with a D2XX driver for Windows. Programmers can use the functions which are supported by the D2XX driver to read from, and write data to, the EMPower™ to design their own driver for other automation software.

DEFAULT VALUES

The following table shows the default values for the EMPower™. Use the "RESET" command to return to these factory defaults values:

Command	Default value	Description
MODE	0	RMS power measurement.
AUTO_STORE	0	Parameter changes will not be stored automatically.
FREQUENCY	1300000 kHz	1300 MHz
FILTER	AUTO	Automatic filter setting (related to power level).
POWER_OFFSET	0.00	Sets power offset to 0.00 dB.
POWER_UNIT	0	Sets measurement unit to dBm.
VBW (mode 0) VBW (mode 1, 2 and 3)	1k AUTO	1kHz VBW in RMS mode for CW signals. Automatic VBW setting for all other modes.
ACQ_SPEED	1000	1 MSps
ACQ_LOG_THRESHOLD	-40.0	-40 dBm
ACQ_LOG_TRIG_TYPE	0,1	Internal triggering, rising edge.
ACQ_LOG_TRIG_SET	1,2	2 samples with 2 samples distance for evaluation.
ACQ_AUTO_TRIGGER	0	Single trigger
ACQ_LOG_DELAY	0	No delay time before trigger.
ACQ_LOG_TRIG_HOLDOFF	0	No hold off before trigger.
BM_MEASURE_PERIOD	60000	60000 ms
BM_NOISE_TIMER	10	10 samples
BM_TRIG_LEVEL	-40	-40 dBm

GENERAL COMMANDS (ALL MODES)

The following table shows the general commands for the EMPower™ RF power sensor. Please note that every command has to be terminated with a carriage return.

Command	Reply	Description
"*IDN?"	"ETS-Lindgren, ETSI Burst Measurement System, , <version>"	Returns identification string for the system, including vendor.
"ID_NUMBER?"	"x.x.x.x.x.x.x.x"	Returns the unique id number. For example: 114.80.79.87.20.0.0.225
"VERSION_SW?"	"2.27"	Returns SW version.
"REBOOT SYSTEM"	"OK"	Reboots the system / Restarts embedded software.
"RESET"	"OK"	Resets the EMPower to default values.
"TEMPERATURE?"	"272"	Returns board temperature in 0.1 degrees. In this example: 27.2°C
"MODE <m>"	"OK"	Sets mode, with: <m> = 0 for RMS mode <m> = 1 for max hold (peak) <m> = 2 for envelope tracing mode <m> = 3 for burst mode
"MODE?"	"0", "1", "2" or "3"	Returns current mode.
"STORE"	"OK"	Stores the current settings in flash memory.
"AUTO_STORE <s>"	"OK"	Sets the auto store mode, with: <s> = 0 (settings will not be automatically stored) <s> = 1 (settings will be stored in flash after each change of the settings)

*This table continues on the next page.

Command	Reply	Description
"AUTO_STORE?"	"0" or "1"	Returns the current store setting.
"FREQUENCY <f>"	"OK"	Set the frequency <f> in kHz.
"FREQUENCY?"	"1300000 kHz"	Returns the frequency in kHz. In this example: 1.300.000 kHz
"FREQUENCY? MIN"	"9 kHz"	Lowest measurable frequency. In this example: 9 kHz
"FREQUENCY? MAX"	"6000000 kHz"	Highest measurable frequency. In this example: 6 GHz
"FILTER AUTO"	"OK"	Sets the filter to automatic. See specification for setting.
"FILTER <n>"	"OK"	Sets the number of samples used to calculate the RMS power value, with: <n> = 1 (10 samples) <n> = 2 (30 samples) <n> = 3 (100 samples) <n> = 4 (300 samples) <n> = 5 (1000 samples) <n> = 6 (3000 samples) <n> = 7 (5000 samples)
"FILTER?"	"1" to "7" or "AUTO"	Returns the filter setting.
"POWER?"	"-38.81 dBm"	Returns the measured power in dBm. In this example: -38.81 dBm
"POWER_OFFSET <p>"	"OK"	Sets the power offset, with: <p> = -100.00 dBm to +100.00 dBm
"POWER_OFFSET?"	"30.00 dB"	Returns the power offset in dB. In this example: 30 dB
"POWER_UNIT <u>" 2	"OK"	Sets the power unit, with: <u> = 0 for dBm and 1 for Watts

*This table continues on the next page.
[2] Applies only to the "POWER?" command in mode 0 and mode 1.

Command	Reply	Description
"POWER_UNIT?"	"0" or "1"	Returns the power unit.
"VBW AUTO" 3	"OK"	Set the VBW to automatic. The VBW is coupled to the sample speed of the power meter: VBW = 10 MHz at 20 MSps and 40 MSps VBW = 1 MHz at 5 MSps VBW = 100 kHz at 1 MSps and 500 kSps VBW = 10 kHz at 100 kSps VBW = 1 kHz at 10 kSps and 50 kSps
"VBW?" 3	"1k", "10k", "100k", "1M", "10M" or "AUTO"	Returns the VBW setting
"ACQ_SPEED <s>"	"OK"	Sets ADC sample speed in kSps. <s> can be 10, 50, 100, 500, 1000, 5000, 10000, 20000 or 40000
"ACQ_SPEED?"	"5000"	Returns ADC speed in kSps
"FILTER_BW?	"BW"	Returns the filter bandwidth <BW> in Hz. Sample speed divided by number of averages defined by the filter setting.

In RMS mode, a new power measurement is started after the "power?"-command has been given. Depending on the filter setting, the EMPower™ performs the required number of measurements and returns the average value of all linear power samples.

Acquisition speed, filter and VBW settings are important to obtain accurate measurements for power measurements of AM modulated signals. In general, the VBW should be 10 times smaller than the RF carrier frequency, but higher than the modulation frequency. For example if an AM modulated signal is measured with a modulation frequency of 1 kHz, the VBW should be set to 10k or higher.

The acquisition speed and filter should be set in such a way that at least one full period of the modulation signal is measured. At 1 Msps, the filter should be set to 5 or higher, which results in 1000 or more samples being averaged. At lower sampling speeds, for example 100 ksps, the filter should be set to 3 or higher to cover at least one full period of the envelope signal.

In formula:

$$Filter\ bandwidth = \frac{Acquisition\ speed}{number\ of\ averages} < modulation\ frequency$$

While:

$$Modulation\ frequency \ll VBW \ll Carrier\ frequency$$

In PEAK mode, the "power?"-command will return the highest value measured, since the previous "power?"-command. After reading the power, the stored value will be cleared.

The filter setting does not apply in peak mode, envelope tracing or burst mode.

The VBW setting can be different for RMS mode and the other modes. If a VBW has been set for RMS mode, this will not affect the VBW setting for the other modes and vice versa. VBW command does not apply for the burst mode (7002-006), since this model has no video filter.

Power measurements will be interrupted if a temperature reading is requested.

The STORE command stores all settings in flash memory. All parameters mentioned in the table in chapter 5.2 (default values) are stored.

During Envelope Tracing, temperature readings are not updated as long as the trigger is armed. While armed, temperature readings are still possible, but the actual values are taken before the measurement is armed. As soon as a trigger occurs, the temperatures are updated in the sensor.

COMMANDS (BURST MODE)

Command	Reply	Description
BM_MEASURE_PERIOD <T>	"OK"	Sets the measurement period T (ms), with <T> can be from 1 to 60.000 ms.
BM_MEASURE_PERIOD?	"500"	Returns the measurement period. In this example 500 ms
BM_NOISE_TIMER <n>	"OK"	Sets the number n of samples, which are allowed below the threshold, before a new burst is counted. <n> can be set between 0 and 5000 samples.
BM_NOISE_TIMER?	"10"	Returns the number of samples which are set. In this example 10.
BM_TRIG_LEVEL <l>	"OK"	Sets the trigger level for burst detection. The level <l> can be set between -50 and +10 dBm.
BM_TRIG_LEVEL?	"-40"	Returns the trigger level in dBm. In this example the level is set to -40 dBm.
BM_GO	"OK"	Starts a single burst measurement.
BM_STAT?	"0" or "1"	Returns the status of the burst measurement: 0 if the measurement is not started or in progress. 1 if the measurement is completed and the data is ready to be read.
BM_BURST_COUNT?	"252"	Returns the number of bursts found within the set measurement period. The maximum number is 100.000
BM_BURST_DATA?<i>	"x;y;z" or "NO DATA"	Returns for burst with number <i> the start time (x); end time (y); RMS power (z). Final character is a newline.
BM_BURST_DATA_DUMP	"x;y;z" or "NO DATA"	Returns for each burst within the measurement period the start time (x); end time (y); RMS power (z). Final character is a newline.

In burst mode, the EMPower™ can store the information of 100.000 bursts independent of the observation time. For each burst the RMS power and start/stop-times are stored in the buffers. The sample speed can be set to 1 MS/s or 5 MS/s to ensure correct measurements according to the ETSI standard for wideband devices.

In MIMO measurements, using multiple synchronized EMPower™ meters, EMPower Viewer™ captures samples simultaneously and calculates the total power according to the EN 300 328 standard.

ERROR CODES

The following table shows the error codes for the EMPower™.

Error Code	Description
"ERROR 1"	Wrong command
"ERROR 50"	Wrong argument
"ERROR 51"	Argument too low
"ERROR 52"	Argument too high
"ERROR_601"	Frequency not set
"ERROR_602"	Over range
"ERROR_603"	Under range
"ERROR_604"	No Cal data

Appendix A: Warranty

Note: See the *Product Information Bulletin* included with your shipment for the complete ETS-Lindgren warranty for your 7002-006.

Duration of Warranties

All product warranties, except the warranty of title, and all remedies for warranty failures are limited to three years.

Product Warranted	Duration of Warranty Period
EMPower Power Meter 7002-006	3 Years

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Appendix B: EC Declaration of Conformity

ETS-Lindgren Inc. declares these products to be in conformity with the following standards, following the provisions of EMC-Directive 2004/108/EC:

EMControl Positioner Controller Plug-In Card

Emission: EN 61326-1:2006, Class B

Electrical equipment for measurement, control, and laboratory use.

Immunity: EN 61326-1:2006, Industrial level, performance criteria A

Electrical equipment for measurement, control, and laboratory use.

Technical Construction Files are available upon request.