EMPower™

ETSI Burst Measurement System

User Guide

ETS•LINDGREN®
An ESCO Technologies Company

Revision Record

MANUAL,ETSI BURST MEASUREMENT SYSTEM | Part 1697575, Rev. A

Revision	Description	Date
A	Initial Release	DECEMBER, 2018

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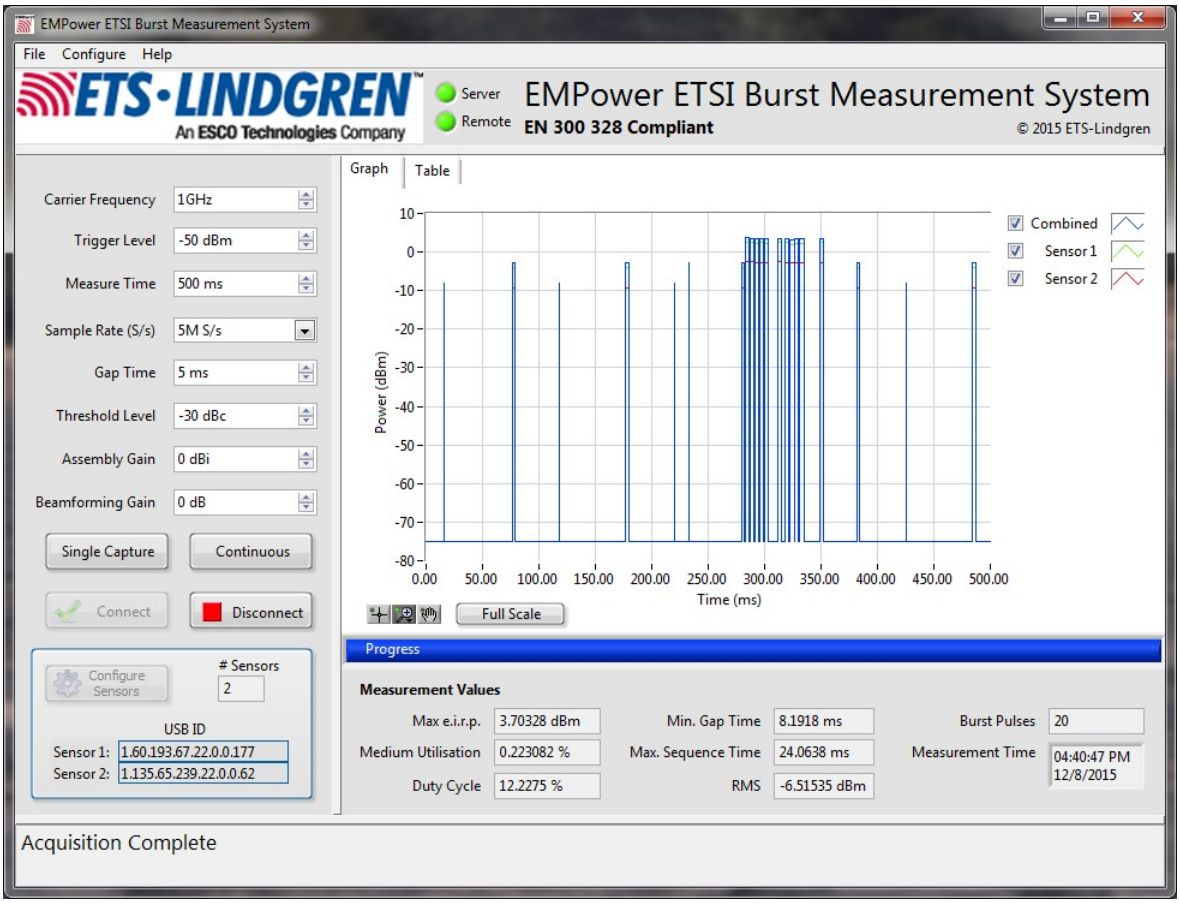
1.0 Introduction

The EMPower ETSI Burst Measurement System is software supplied by ETS-Lindgren to work with the EMPower 7002-006 USB RF Power Sensors. The software supports up to eight (8) sensors and is compliant with ETSI EN 300 328, v2.1.1.



2.0 Installation

Install the EMPower ETSI Software

Run the **setup.exe** file and follow the dialog prompts.

Install the USB Drivers

1. Plug the EMPower 7002-006 sensor(s) into any available USB port(s) on the computer.
2. If this is the first time the sensors have been plugged into the computer, Windows will attempt to locate device drivers for the sensors. This step will likely fail.
3. Run Control Panel->Device Manager and find the EMPower sensor(s) listed in the “Other Devices” section. Double-click the EMPower entry and select **Update Driver**.
4. Select **Browse my computer for driver software** and browse to C:\Program Files (x86)\ETS-Lindgren\EMPower ETSI\USB Drivers. The USB drivers were installed to this directory by the EMPower ETSI installer.
5. If a security warning appears, select **Install this driver software anyway**.
6. Repeat steps 1-5 for each EMPower sensor. When completed, the sensor should appear in the Device Manger under the Universal Serial Bus controllers section and is listed as “EMPower 7002-006.”

3.0 Using the EMPower ETSI Software

1. Run the EMPower ETSI software from the desktop shortcut or from Start Menu\All Programs\ETS-Lindgren\EMPower ETSI.
2. Select the **Configure Sensors** button to configure the system (see the following section, *Configuring the System*, for details).
3. Select **Connect** to establish communication with the connected sensors. If any errors occur, double-check the information you entered in Step 2, and ensure that all sensors are plugged into the computer. Also make sure that the sensors are listed correctly in Device Manager (see the Install the USB Drivers section above).
4. Select either the **Single Capture** or **Continuous** button to begin a trace capture. The Graph and Measurement Values are automatically updated when new data is acquired.
5. Once data is acquired, the results can be printed or saved to a report from the **File** menu.

Report Generation is configured from the File->Options menu, Report Settings tab. You can select the report folder and name, specify the output type (HTML, PDF, Word, or Excel), and specify the Report Data Format (Graph, Raw Data, or both Graph and Raw Data). The default settings are Excel for Report File Type, and Graph and Raw Data for Report Data Format. **Note:** In order to later import the report data back into the EMPower ETSI software using the Import Raw Data feature, Excel must be selected as the Report File Type, and the Report Data Format must include Raw Data, when initially creating the report.

Configuring the System

1. Select **Configure Sensors** from the main panel or go to the Configure->Sensors menu option. **Note:** if sensors are currently configured and Connected or an acquisition is in progress, the Configure Sensors button and menu option will be disabled.
2. Set **Number of Sensors** to the desired value.
3. For each sensor in the system, enter the USB Identifier located on the sensor label (in the format x.x.x.x.x.x.x.x) in the USB IDs column. The correct ID format will be validated for each entry when you select **OK**. Each unique ID that is entered in the system will be saved in a list for later use. This list can be modified by selecting the **Edit USB ID List button**. Quick selection of previously used IDs is accessed by using the dropdown arrow to the right of each USB ID entry.

4. For each sensor in the system, select whether to enable corrections and select the **Correction File** path if enabled. Template correction files are supplied for each sensor and are simple .csv files in the following format:

   frequency1,
   value1
   frequency2,
   value2

   where units for frequencies are Hz and units for values are db. These files may be edited directly to modify the correction values for each sensor in the system. There is no limit to the number of frequency/value pairs that can be added to the correction files. The only requirement is that each frequency entry must increase in ascending order.
5. In the **Configure Sensors** dialog, select whether to use Logarithmic or Linear interpolation method for the frequency axis (if any **Enable Correction**s buttons have been turned on). Corrections are applied to sensor readings by using the system carrier frequency to look up the correction value using the specified interpolation method.
6. The **Time Units** can be toggled between milliseconds (ms) and seconds (s) from the File->Options, Units tab (also Ctrl-m for milliseconds, Ctrl-n for seconds).

Import Report Data

The EMPower ETSI Burst Measurement System software can be used as a data viewer and validation tool for previously acquired data. Any Excel format report that includes Raw Data can be loaded back into the system at a later time using the **Import Report Data** tool. Run this tool by selecting File->Import Report Data or pressing Ctrl-I. You will be prompted to open an Excel report file. All settings and raw data are extracted from the report and reloaded into the user interface. It is important to note that only INPUT parameters are loaded into the system, and all OUTPUT values (combined waveform data and all measurement values) are recalculated based on these inputs, allowing the user to perform validation on the report. For example, specific burst data parameters (start time, stop time, or power) can be modified in the Excel file before importing and the resulting change in the combined power waveform and the measurement values can be observed. Also, post-processing input settings can be changed on the EMPower ETSI burst panel to recalculate measurement values on the previously acquired data. The post-processing input settings are:

- Gap Time
- Threshold Level
- Assembly Gain
- Beamforming Gain.

Useful Features

1. All input settings are cached to the hard drive automatically when the test panel is closed, and reloaded automatically when starting the software. This means that configuration values (Number of Sensors, USB ID strings, correction files) should only have to be input once (assuming the config info does not change). Upon re-running the software, you can immediately connect to the sensors without using the Configure Sensors dialog.
2. The Graph resizes automatically when resizing main panel. You can use Full Screen mode to maximize the graph area.
3. Data plots can be individually disabled on the Graph by deselecting the checkboxes next to each plot entry in the legend. There are numerous other built-in graph features accessed from pop-up menus, such as changing plot color, Fill Base Line-> -Infinity which makes them bar-chart-like. You can also right-click the graph to Export to the clipboard or directly to Excel (you can also do this on individual plots from the legend icons). The zoom is very straightforward (just select the graph and draw a box) and can be configured in the lower left graph palette to zoom horizontally, vertically, or in both axis. There is a Full Scale button on the graph to return the axis to full scale after zooming.
4. The Table View allows for live viewing of the Raw Data in a table format, similar to what is available in the Raw Data format for Report Generation files. For each sensor configured in the acquisition, the Start Time, Stop Time, and Power are displayed in separate columns of the Table. For example, a MIMO system with 3 sensors would create a total of 9 data columns in the table. In addition, there will always be 3 columns allocated to the Combined Start Time, Combined Stop Time, and Combined Power of each burst. Finally, there are two calculated columns TxOn Time and TxOff Time displayed.
5. Context Sensitive Help is available by selecting Help->Show Context Help, or pressing Ctrl-H. If you move the mouse over controls/indicators, you will see Help descriptions for specific input/output values. Press Ctrl-H again to hide the Help Window.

KEYBOARD SHORTCUTS

1. Once you are connected to the sensors, pressing <Enter> will start a Single Capture.
2. You can tab between each control in a meaningful order. If you have already configured sensors and are restarting the software, you can press tab and then Enter to Connect, and then Enter again to Single Capture.
3. <Esc> key will exit the application (or click upper right Windows X, or File->Quit).
4. You can get to most menu options using either Alt and a shortcut key (Alt F, P to print, Alt F, O to show the options dialog, Alt F, S to save report, Alt F, I to import report data, Alt F, X to exit, Alt C, F to configure sensors, Alt H, H to show context help) or Ctrl-key shortcuts directly (Ctrl-P to print, Ctrl-O to show options, Ctrl-S to save report, Ctrl-I to import report data, Ctrl-Q to exit/quit system).

OTHER USEFUL CTRL SHORTCUTS:

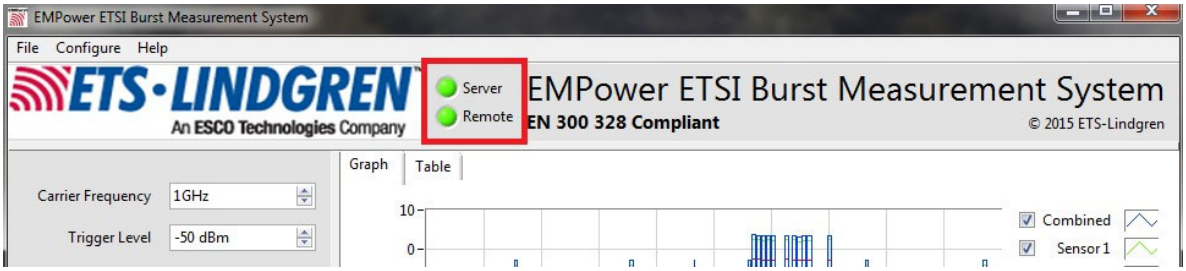
Ctrl-M = set Time Units to milliseconds Ctrl-N = set Time Units to seconds
Ctrl-G = view Graph Ctrl-T = view Table

5. F1 will show this User Guide (also accessible from Help->Show User Guide menu option).

Remote Server

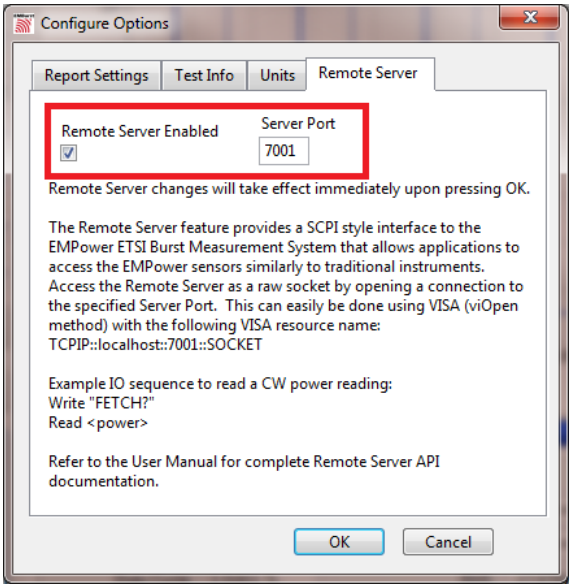
Version 1.0.3 of the software adds the Remote Server feature. The Remote Server feature provides a SCPI style interface to the EMPower ETSI Burst Measurement System that allows applications to access the EMPower sensors similarly to traditional instruments.

The Remote Server is enabled when the Server indicator is lit on the EMPower ETSI Burst Measurement System panel. Additionally, a Remote indicator displays when a client has connected to the server.



Configuration

The Remote Server options are accessed from the File->Options menu (or type Ctrl-O), Remote Server tab. The Remote Server Enabled checkbox enables the server, and the Server Port specifies the port address of the server on the host computer. The IP address of the host computer, and this Server Port will be needed by the client software to access the Remote Server.



Connecting to the Remote Server

Access the Remote Server as a raw socket from the client software by opening a connection to the specified Server Port and IP address of the host computer. This can easily be done using VISA (viOpen method) from many software applications (e.g. TILE!, LabVIEW, Visual Studio) using the following VISA resource name format:

TCPIP::<ipaddress>::<port>::SO

CKET where:
<ipaddress> is the IP address of the host computer. If the client software is running on the same computer as the host computer, then use the string “localhost” as the <ipaddress>.
<port> is the Server Port you specified in the Remote Server configuration.

The VISA resource name to access the Remote Server running at the default port address, from client software on the same computer, would be:

TCPIP::localhost::7001::SOCKET

COMMUNICATION ISSUES

Pay special attention to Read terminations when reading from raw socket servers. In particular, you will need to set the termination character in your client software to LF (0x0A), and enable termination using the termination character. This can be done using the viSetAttribute function after opening the VISA resource (attributes VI_ATTR_TERMCHAR and VI_ATTR_TERMCHAR_EN, respectively).

Append a LF to all Write commands in the client software (incoming command strings to Remote Server). This will allow proper parsing of input commands by the Remote Server software.

Make sure to set the VISA timeout value to a high enough value to allow for expected *OPC? completion times. For example, systems with multiple sensors will take longer to complete the Connect command. If the sensor connection takes 20 seconds, a “Connect” command followed by “*OPC?” query would need a VISA timeout greater than 20 seconds to allow the Operation Complete query to complete.

REMOTE SERVER COMMANDS

The following commands and functionality are supported by the Remote Server.

Command	Return Value	Description
***IDN?**	ETS-Lindgren, ETSI Burst Measurement System, ,<version>	Identification. Returns identification string for the system, including the vendor
	1.0.3.10	
***RST**	none	Reset. Initiates a reset sequence that attempts to make the EMPower sensors ready for data collection. This includes connecting to the sensors if they are currently disconnected, and enabling Continuous mode. This function is designed for compatibility with off- the-shelf power meter drivers and can be followed by “Fetch?” to read the combined power reading (Max e.i.r.p). Reset can be followed by *OPC? to determine when the sequence has completed.
***OPC?**	Returns “1” when previous command has completed	Operation Complete. Use this query command to determine when a previous command has completed executing. In particular, *OPC? can be used following “Connect”, “Reset”, or “Start Burst” commands, or during Continuous mode acquisition to determine when the next frame of data is available.
Connect	none	Connect. Initiates the connection sequence to the currently configured sensors. Identical to pressing the Connect button on the UI. Follow this command with a *OPC? query to determine when the connection is complete.

Disconnect	none	Disconnect. Initiates a disconnect sequence from the sensors if they are currently connected.
Start Burst	none	Start Burst. Initiates a single frame acquisition for the sensors. Same as pressing the Single Capture button on the UI. Follow this command with a *OPC? query to determine when the acquisition is complete.
Set Continuous <on|off>	none	Set Continuous. Sets Continuous mode On or Off. Same as toggling the Continuous button on the UI.
Fetch?	Returns the Max e.i.r.p value displayed on the UI, which is the combined power reading of all configured sensors.	Read Combined Power. This command returns the Max e.i.r.p reading, in units of dBm. If an acquisition is currently in progress when the command is received (either Single Capture or Continuous mode), the next available power reading will be returned. If there is no acquisition in progress, the last available power reading is returned. This function is designed to emulate traditional Power Meter functionality and can be used to read CW power for single sensor configurations, or combined power for multiple sensor configurations
Fetch<0 to 8>? **<0 to 8> = Sensor**	Returns the max power of the specified Sensor (when Sensor = 1 to 8), or the max power of the combined burst power array (when Sensor = 0)	Read Channel Power. This command returns the maximum power of individual Sensor burst waveforms. For CW input signals, this value will represent the CW power of the input signal. If an acquisition is currently in progress when the command is received (either Single Capture or Continuous mode), the next available power reading will be returned. If there is no acquisition in progress, the last available power reading is returned. This function is designed to emulate traditional Power Meter functionality and can be used to read CW power for multiple sensor configurations.

Fetch:<measurement>?	Returns the specified measurement value	Read Measurement. This command returns the last measured value of a Measurement Value displayed on the UI. The following measurement values can be returned:
<measurement>:		
rms		RMS: The Medium Utilisation % represented in units of dBm.
dutycycle		Duty Cycle: The sum of all TxOn times divided by the observation period. TxOn time is defined as the time between the start and stop times of each individual burst.
mingaptime		Min. Gap Time Any TxOff time that is greater than the Gap Time input setting is considered a Tx-gap. Min. Gap Time is the smallest such Tx-gap time in the observation period. Min. Gap Time is expressed in seconds. TxOff time is defined as the time between the stop and start times of two subsequent bursts.
maxsequencetime		Max. Sequence Time The Tx-sequence time is the time between two subsequent Tx-gaps. Max. Sequence Time is the longest such Tx-sequence time. Max. Sequence Time is expressed in seconds. Any TxOff time that is greater than the Gap Time input is considered a Tx-gap.
mediumutilsation		Medium Utilisation

		The Medium Utilisation (MU) factor is a measure to quantify the amount of resources (Power and Time) used by non-adaptive equipment. The Medium Utilisation factor is defined by the formula: MU = (P/100 mW) × DC where: MU is Medium Utilisation factor in % P is the RF output power as defined in clause 4.3.1.1.1 expressed in mW DC is the Duty Cycle as defined in clause 4.3.1.2.1 expressed in %
burstpulses		Burst Pulses The total number of burst pulses in the Observation Period. Note that this number will be at least one smaller than the total bursts listed in the Burst Data Table view. This is because the last burst is not included in the calculations. Additionally, the first burst is not included if it starts at time 0. (clause 5.4.2.2.1.3, Step 3, v2.1.1)
Fetch<0 to 8>:<array>? **<0 to 8> = Sensor**	Returns the specified data array from the specified Sensor. Sensors 1 to 8 are the individual sensor's burst data, and Sensor 0 is the combined burst data.	Read Array. This command returns data in an array format. The returned string is represented in a CSV format, where each value is a series of characters representing a numeric value, separated from the next numeric value by a comma.
<array>:		The following arrays can be retrieved:
ontimes		On Times An array representing the TxOn Times of the burst dataset.
offtimes		Off Times An array representing the TxOff Times of the burst dataset.
burst:x		Burst X An array representing the X values of the burst data plot.
burst:y		Burst Y An array representing the Y values of the burst data plot.
burst		Burst This format includes both X and Y values interleaved in the array, so the entire X Y plot can be retrieved with a single command.

		Data[0] = X[0] Data[1] = Y[0] Data[2] = X[1] Data[3] = Y[1] Etc.
Set Carrier Frequency <numeric_value>	none	Set Frequency. Sets the Carrier Frequency setting, in units of Hz. When this command is received, the UI input will update. Most standard formats are accepted for <frequency>, e.g.: 100000000 100e6 HZ 100 MHZ 0.1 GHZ
Set Trigger Level <numeric_value>	none	Set Trigger Level. Sets the trigger level for each sensor configured in the acquisition, expressed in dBm.
Set Measure Time <numeric_value>	none	Set Measure Time. Sets the measurement time period for the acquisition, expressed in seconds.
Set Sample Rate <numeric_value >	none	Set Sample Rate. Sets the sample rate for the acquisition, expressed in Samples/Sec (S/s).
Set Gap Time <numeric_value >	none	Set Gap Time. Sets the Gap Time (expressed in Seconds) for the post-processing analysis of the last data set. Any TxOff time that is greater than the Gap Time is considered a Tx-gap. The minimum of all Tx-gaps in the observation period is measured and output as the Min. Gap Time measurement value. TxOff time is defined as the time between the stop and start times of two subsequent bursts.
Set Threshold Level <numeric_value >	none	Set Threshold Level. Sets the Threshold Level (expressed in dBc, or dB to Carrier) for the post-processing analysis of the last data set. Threshold Level is used to determine the Start and Stop values of the Combined burst data. The Start and Stop times for each burst are defined as the points where the power is at least Threshold Level dB below the highest value of the stored (summed) samples.

Set Assembly Gain <numeric_value >	none	Set Assembly Gain. Sets the Assembly Gain “G” (expressed in dBi) for the post- processing analysis of the last data set. Assembly Gain is the (stated) antenna assembly gain "G" in dBi of the individual antenna.
Set Beamforming Gain <numeric_value>	none	Set Beamforming Gain. Sets the Beamforming Gain “Y” (expressed in dB) for the post-processing analysis of the last data set.

REMOTE SERVER COMPATIBILITY COMMANDS

The Remote Server supports a small subset of “traditional” Power Meter command sets, in order to provide compatibility with some simple Power Meter software drivers.

Note: These commands are loaded dynamically from a configuration file. Additional commands may be added in the future. Contact ETS-Lindgren support for requests for additional instruments. Note also that the “Fetch?” command is native to both ETSI Burst Measurement System and to many traditional power meters, so no compatibility command is necessary for instruments that use this function (e.g. R&S NRP, Keysight EPM Series).

The following table lists some of the included compatibility commands.

Instrument	Compatibility Command	Native ETSI command
R&S NRP	INIT:CONT <ON|OFF>	Set Continuous
R&S NRP/Keysight EPM	SENSE:FREQ <value>	Set Carrier Frequency
R&S NRVD	SENSE:CORR:FREF <value>	Set Carrier Frequency
R&S NRVD	MEAS?	Read Power
Yokogawa WT1600	:NUMERIC:NORMAL:ITEM4?	Read Power
Wavetek 8502	UPDN	Read Power
ETS-Lindgren EMPower	[slot][ch]:FREQUENCY <value>	Set Carrier Frequency
ETS-Lindgren EMPower	[slot][ch]:POWER?	Read Power