

# DPM SERIES MM-WAVE POWER METER



## USER MANUAL Control unit and sensors

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# 1. COPYRIGHT AND STATEMENTS

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## 2. GENERAL DESCRIPTION

### 2.1 DPM SERIES POWER METER OVERVIEW

Power meter with power sensors (hereinafter referred to as PPM) shown in Fig.1 is designed to measure the power level of CW mm-waves in a certain frequency range (Table 1).



Fig.1. Power meter with the sensor and power supply

Table 1

Model Number	Frequency band letter	Frequency range, GHz
DPM-28	Ka	26.5-40
DPM-22	Q	33-50
DPM-19	U	40-60
DPM-15	V	50-75
DPM-12	E	60-90
DPM-10	W	75-110
DPM-08	F	90-140
DPM-06	D	110-170
DPM-05	G	140-220

The DPM provides the following operating options:

- Measurement of CW power levels in Watts or in dBm.
- Setting of the frequency step and control mode.
- Indication of measured CW power levels in Watts or in dBm.
- Operation with a PC using Ethernet, USB, GPIB, or RS-232 ports (depending on the model).

**\*\*Note:\*\*** Do not measure mm-wave power beyond the Max input power level (depends on the specific model, see technical description) to avoid sensor damage.

You can measure mm-wave power until the sign 'OVERLOAD' appears on the top line of the LCD. An alarm buzzer will sound simultaneously, and the measured power level will be displayed on the bottom line of the LCD.

If the sign 'OVERLOAD' appears, one must decrease the input mm-wave power until 'OVERLOAD' disappears.

The sensitivity of the sensor depends on frequency, and the input power can exceed the Max input power level specified in the datasheet at some frequencies. This does not result in damage to the power sensor.

The block diagram of the Power Meter is shown in Fig. 2.

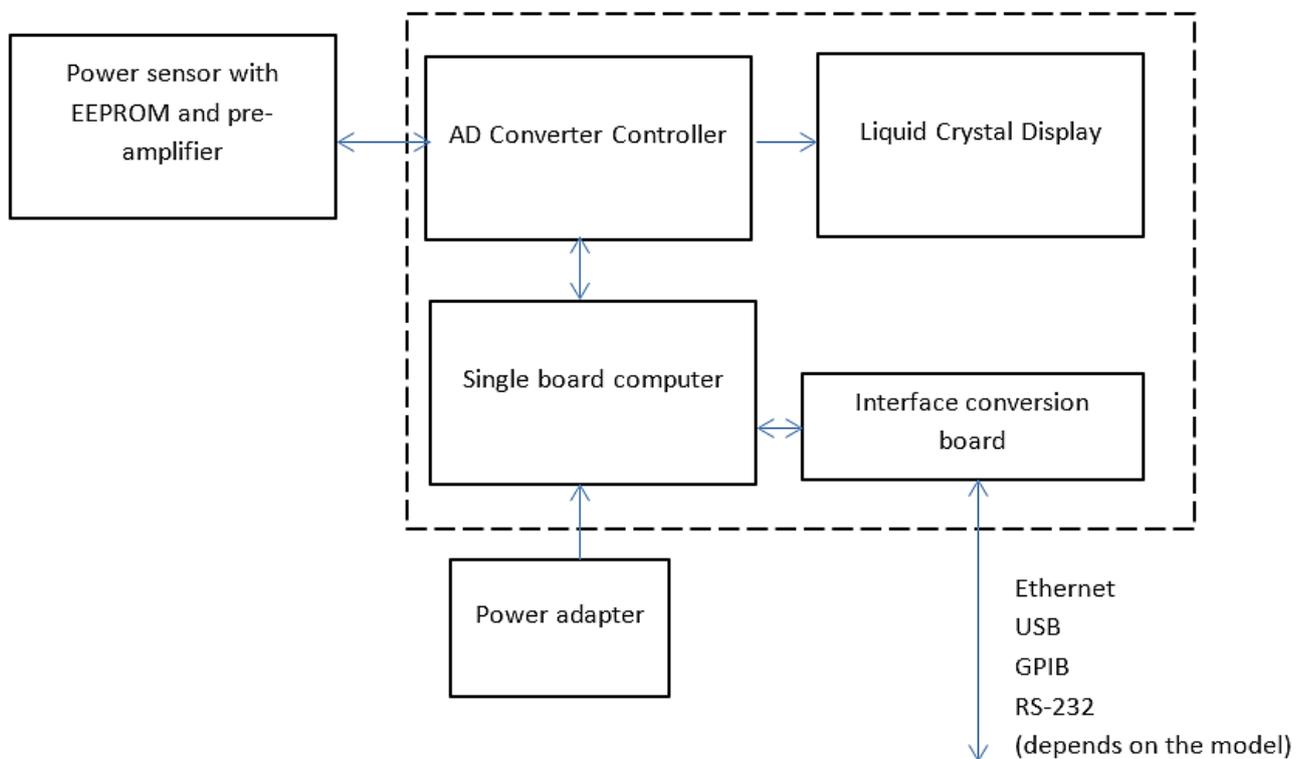


Fig.2 DPM block diagram

To obtain the correct absolute value of the measured power, it is necessary to set the frequency of the measured signal. The measured frequency value can be manually entered using the 12-button keyboard or automatically through the interface port.

The frequency format is XXX.XX. You can manually set the frequency in this format or use the web interface to input it. It is also possible to adjust the set frequency manually using the '\*' and '#' buttons. Pressing these buttons once will shift the frequency down or up by one step, respectively. The frequency step has several fixed values within the range of 0.01 GHz to 1 GHz.

The two-line LCD displays the set signal frequency in GHz and the absolute power value in microWatts (uW), milliWatts (mW), or dBm.

## 2.2 POWER SENSOR DESCRIPTION

The power sensor is based on a Zero-Biased Detector (ZBD) with a Low Barrier Schottky Diode manufactured by ELVA-1 Ltd. The power sensor provides high sensitivity, fast measurement speed, and quick response to changes in input power.

The sensitivity of the detector is frequency-dependent. To obtain the correct absolute value of the measured power, it is necessary to set the frequency of the measured signal using the 12-button keyboard on the front panel. The amplitude and frequency dependencies of the power sensor are stored in EEPROM installed inside.

There is an isolator or attenuator (depending on the model) at the input of the power sensor. The isolator provides good matching of the power sensor with the output of the mm-wave power source, while the attenuator allows moving the dynamic range to a higher power range.

The power sensor can be equipped with a 3-port directional coupler and a matched load for measuring power above 100 mW.

To improve sensitivity and decrease noise level, a pre-amplifier is built into the power sensor. This is very important when measuring small (< 10 microwatts) power.

The block diagram of the power sensor is shown in Fig. 3.

Possible outward appearances of the sensor are presented in Fig. 4 and Fig. 5.

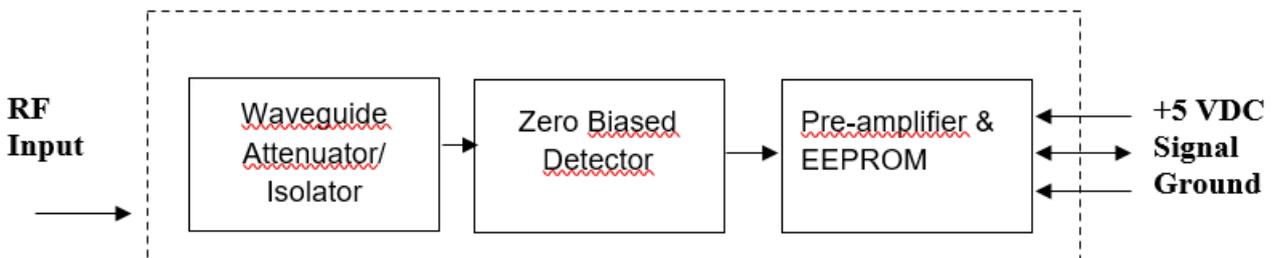


Fig. 3. Web interface after the 'Connect' button has been pressed

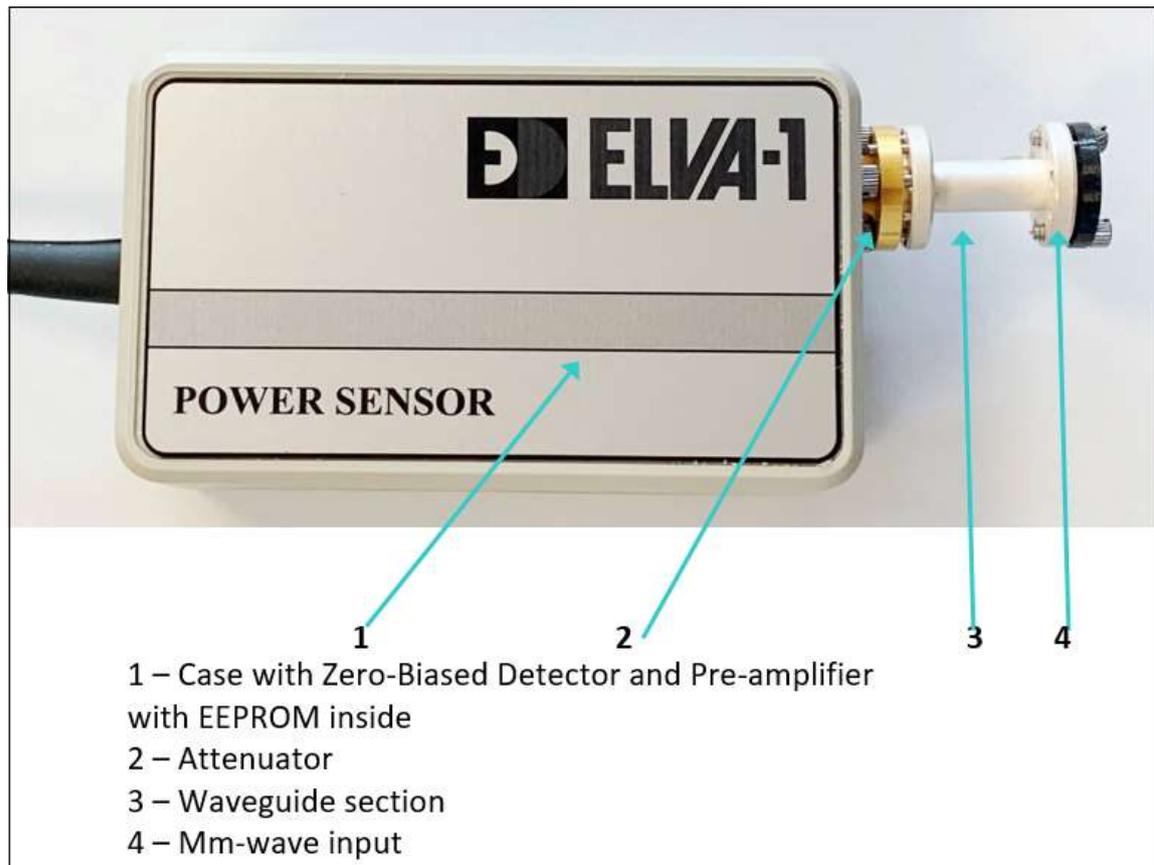


Fig.4. Power Sensor with attenuator

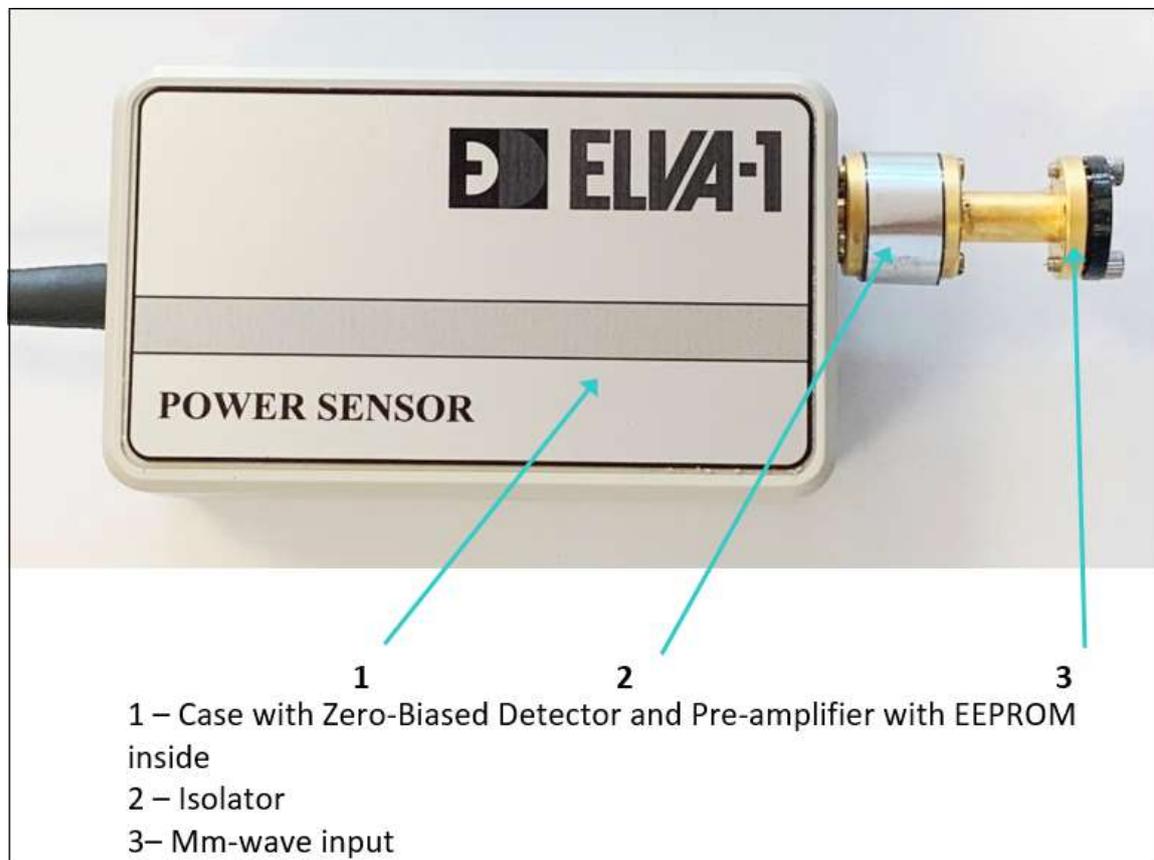


Fig.5. Power Sensor with isolator

### 2.3 POWER SENSOR' CONTROL AND DISPLAY UNIT

The Control and Display Unit has a 12-key keyboard, a 2-line LCD on the upper panel, and a power switch and connectors on the rear panel. The top line of the display shows the set frequency of the mm-wave signal entered by the keyboard or through web interface (depending on the model); the bottom line indicates the measured power.

The refresh rate of the measured power is about 2 times per second.

Ten digital keys ('0'...'9') are used for manually inputting the frequency, the '\*' key is used to decrease the frequency, and the '#' key is used to increase it.

One press on the key shifts the frequency by the set step value. Possible frequency values for each spectrum range are listed in Table 1.

The input frequency format is XXX.XX GHz, and **all 5 figures must be entered**. For example, to set the frequency to 74.00 GHz, one enters the symbols: 0-7-4-0-0. Wrong values will be rounded to one of the boundary values.

**\*\*Note\*\***: In case of an invalid actual signal frequency setting, there is an error in the displayed mm-wave power due to the non-flatness of the calibration frequency curve.

The outward appearance of the power meter control and display unit is shown in Fig. 6 and Fig.7.

Different versions of the connector panel are available depending on the order.

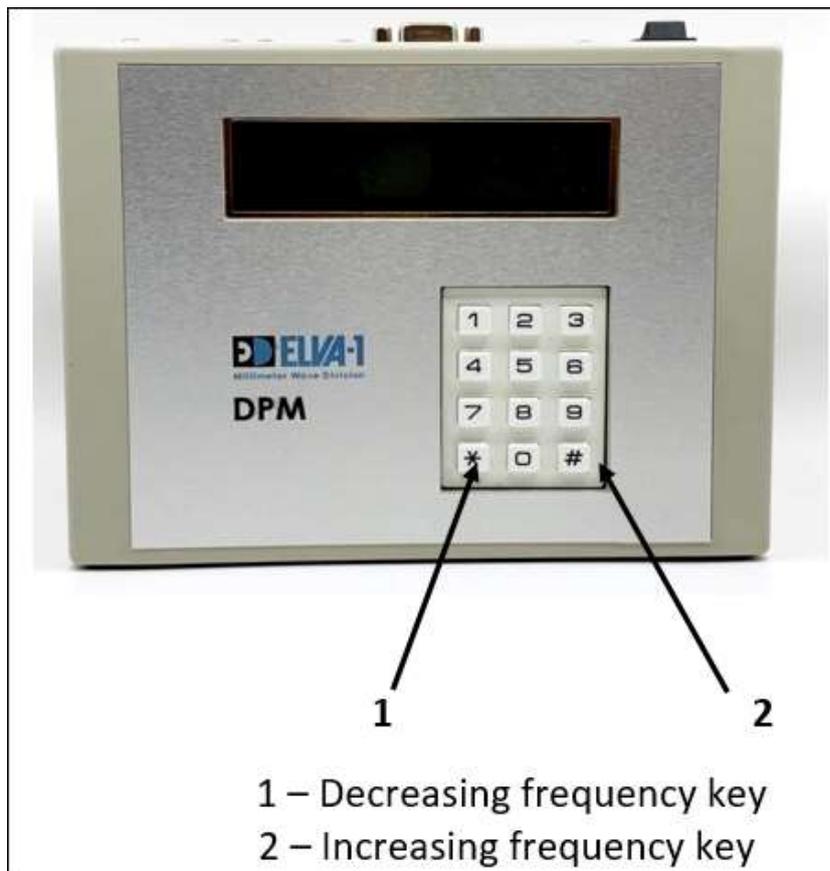


Fig.6. Upper panel of the DPM control and display unit

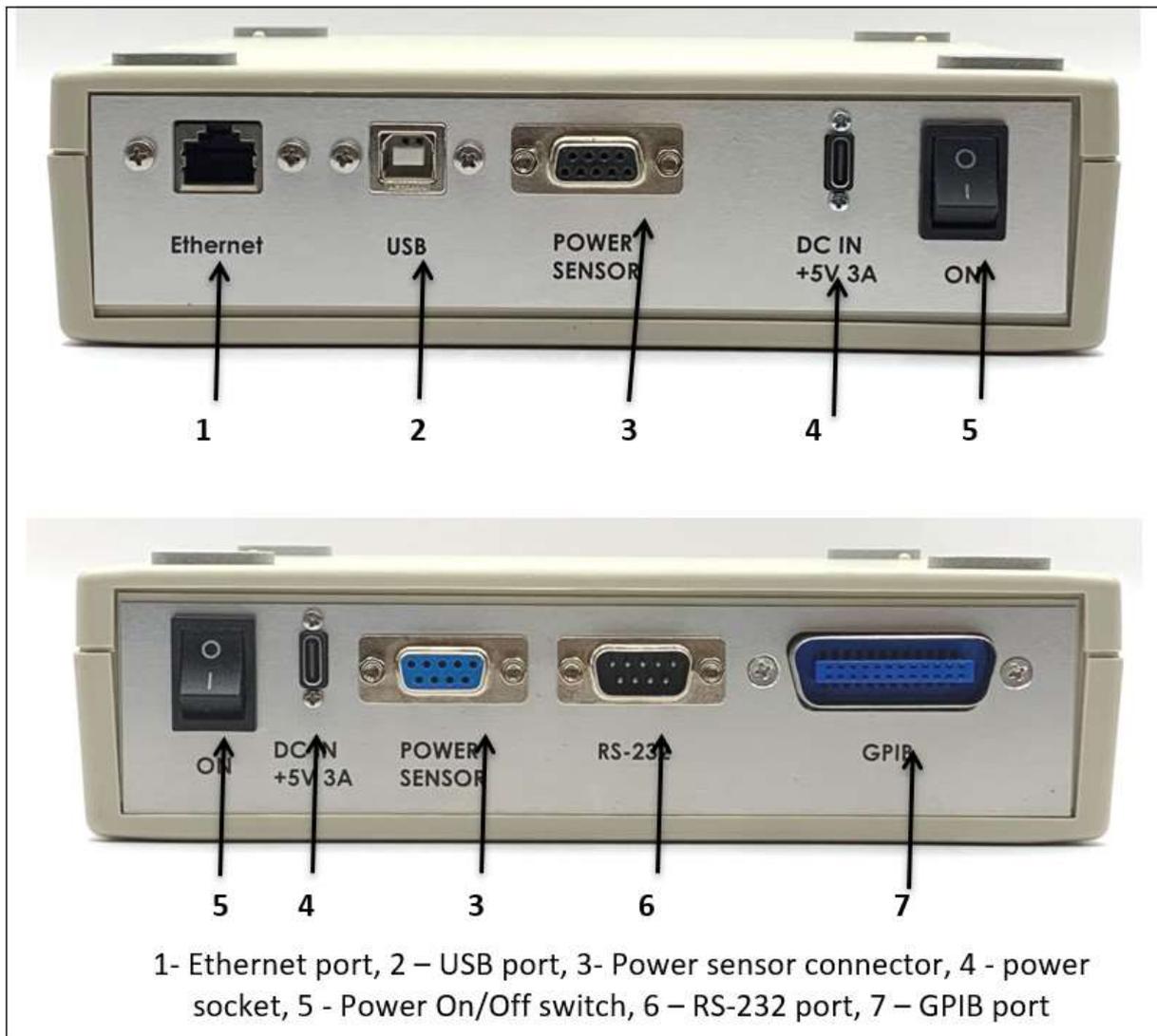


Fig.7. Examples of the different versions of the connector panel for the DPM Power Meter

Frequency setting and receiving of measured power value can be realized using interface ports.

## 3. DPM OPERATION

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### 3.1 DPM SELF-TEST AND FIRMWARE LOADING

Prepare the device for operation. For this purpose:

- Connect the control and display unit of the power meter and the sensor.
- Connect the control and display unit of the DPM to the power supply using the power adapter.
- Connect the control and display unit of the power meter to a computer or LAN if you plan to use remote operation of the device.

Start the device operation.

Turn the switch to position ON. Wait for loading the DPM:

- A line with the firmware version number will appear on the screen, see Fig.8.



Fig.8. DPM loading indication

The power sensor and firmware self-test is then performed.

If the tests are successful, the screen as shown in Fig. 9 and Fig.10 appears.



Fig.9. Indication of completed power sensor self-test



Fig.10. Indication of completed firmware self-test

### 3.2 INDICATION OF SENSOR SELF-TEST ERROR

If the symbol "Fa" appears on the screen, as shown in Fig. 11, and an alarm sound is heard, it means that the connection between the DPM and Power Sensor is unreliable.



Fig. 11: Failed sensor self-test screens

In this case, you must switch the DPM OFF and disconnect the Power Sensor. Then, properly connect the Power Sensor using the screws on the power sensor connector (DB-9) and switch on the DPM Control and Display unit again.

If necessary, repeat the operation until the "Program OK" line (Fig. 10) appears on the screen. You can skip the tests by pressing any key on the power meter built-in keyboard.

### 3.3 INDICATION OF DPM SETTINGS WHEN STARTED

The next screen shows two lines with the current settings of the DPM Control and Display unit. The settings are the same as those that were in place when the DPM was last switched OFF.

If it is necessary to set the factory default settings, one should press and hold the key "5" during the power-up process and release it after two alarm sounds.

Default settings are as follows (Fig. 12):

Upper line: Tab1, Step 1, W

Lower line: SCPI



Fig.12. Screen with default settings of DPM with SCPI control

The values mean:

"Tab 1"- mode 1

"Step 1" – step 0.01 GHz

"W"- indication in Watt units ( $\mu$ W, mW).

"Local SCPI"- PC control with SCPI protocol.

The screen in Fig. 13 shows that baud rate 1200 is set.

**\*\*Note\*\***: The recommended baud rate is 1200 bps.



Fig.13. Indication of the current baud rate

The DPM Power meter is ready for operation if lines with frequency and power values are displayed like in Fig.14.

Transcript of readings is as following:

- Frequency of measured signal #Mode (#Tab)
- Measured power level



Fig.14. Average count setup

Appearance of the indication "READY TO START" (Fig. 15) or the symbol \* or #\* in the upper right corner of the display (Fig. 15) means that the control panel is currently in automatic mode. To exit the automatic mode press any key.





Fig.15. Power meter in automatic mode indication

### 3.4 MEASURING PROCEDURE IN MANUAL MODE

Check that the connection of the input of the sensor to a source of mm-wave CW power is ok.

For manual mode measurement, proceed as following.

Set the frequency of the measured signal in GHz:

- Press any key on DPM keyboard to start entering the input frequency mode. Keep the key pressed until an underline sign appears. The presence of an underline sign on the LCD indicates the frequency setting mode.

- Insert the frequency. The underline shows which symbol is being set. The frequency format is XXX.XX GHz, and all five figures must be entered.

**\*\*Note\*\*:** If the correct frequency value is not determined, the absolute value of the measured power will be incorrect because the output signal of the power sensor is frequency-dependent.

- Use the key '\*' to decrease the frequency and the key '#' to increase it by one step. The frequency steps are as follows: 1 GHz, 0.5 GHz, 0.25 GHz, 0.2 GHz, 0.1 GHz, 0.05 GHz, 0.02 GHz, 0.01 GHz.

**\*\*Note\*\*:** For information on how to set the frequency step from a computer using web-interface, please refer to the relevant document.

- A frequency value displayed without an underline sign on the LCD indicates the measuring mode.

- Read the value of the measured power on the LCD.

### 3.5 MEASURING PROCEDURE IN REMOTE MODE USING ETHERNET INTERFACE

Check that the connection of the input of the sensor to a source of mm-wave CW power is ok.

The DPM must be connected to the local network using a network cable with an RJ-45 connector. Set the subnet on the computer's network card to match the default web interface IP address (192.168.127.191). The IP address on the PC must be within the same subnet as the DPM device.

**\*\*Note\*\*:** For information on how to use web-interface, please refer to the relevant document.

The factory default IP address is set on the DPM (192.168.127.191), and this IP address can be changed using the web interface.

- The computer's static IP address has to be: ABC.DEF.GIH.xxx
- The DPM's static IP address has to be: ABC.DEF.GIH.yyy

Both xxx and yyy values can be within the range of 0 to 253 and must be different for the computer and the DPM.

**\*\*Note\*\***: Do not use 254 for xxx or yyy values.

To exit automatic mode and switch to manual mode, press any key on the DPM keyboard.

Use the ON/OFF switch on the DPM control unit if you need to reset the power meter.

**\*\*Note\*\***: Do not turn the power meter on/off if mm-wave input power is present at the power sensor input. Disconnect the source of the external mm-wave CW signal first.

### 3.6 MEASURING PROCEDURE IN REMOTE MODE USING USB INTERFACE

Check that the connection of the input of the sensor to a source of mm-wave CW power is ok.

The power meter with a USB interface requires a USB A-Male to B-Male cable.

The Silicon Laboratories CP2110 HID USB-to-UART Bridge Controller is used in the DPM. It is a USB 2.0-compliant, full-speed device.

The CP2110 is a USB Human Interface Device (HID), and most operating systems include native HID drivers; custom drivers do not need to be installed.

The interface specification for the CP2110 is also available to enable the development of an API for any operating system that supports HID.

**\*\*Note\*\***: The CP2110 does not fit into one of the standard HID device types, such as a keyboard or mouse."

Any software application needs to use the CP2110's HID specification to communicate with the device. The low-level HID specification for the CP2110 is provided in 'AN434: CP2110/4 Interface Specification (see link below).

<https://www.silabs.com/documents/public/application-notes/AN434-CP2110-4-Interface-Specification.pdf>

This document describes all the basic functions for opening, reading from, writing to, and closing the device.

A Windows DLL that encapsulates the CP2110 HID interface and also adds higher-level features is provided by Silicon Labs. This DLL is the recommended interface. 'AN433: CP2110/4 HID to UART API Specification' is the application note that describes how to interface with the CP2110 using the Windows Interface DLL and the Mac OS X dylib." See the link below.

<https://www.silabs.com/documents/public/application-notes/AN433-CP2110-4-HID-to-UART-API-Spec.pdf>

All documents, DLLs, and product support information for CP2110 are available online at [www.silabs.com](http://www.silabs.com).

The 'HidUartExample.exe' program can be used to test the work with the DPM. It is available in the CP2110 evaluation kit installation in the following path: the folder where the program is installed\SiliconLabs\MCU\CP2110\_4\_SDK\Software\HidUartExample. See the link to the evaluation kit below. The HidUart Example interface example is shown in Fig.16.

<https://www.silabs.com/products/development-tools/interface/cp2110ek-evaluation-kit>

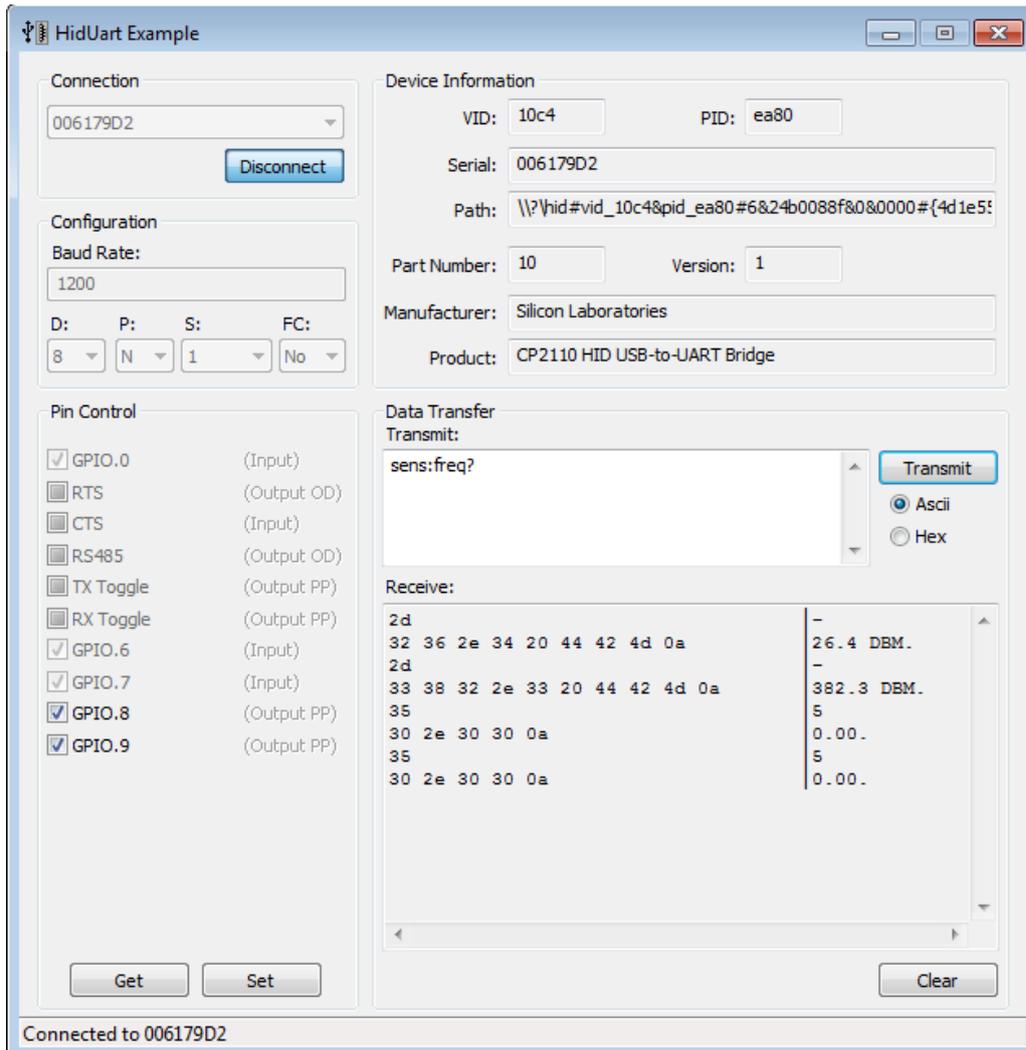


Fig.14. HidUart Example interface

Since CP2110 is USB-to-UART Bridge Controller, UART must be configured.

UART configuration:

Data format –8 data bits, no parity, 1 stop bit ( 8N1 ); Baud rate – 1200 bps. (recommended)

### 3.7 MEASURING PROCEDURE IN REMOTE MODE USING GRIB INTERFACE

Check that the connection of the input of the sensor to a source of mm-wave CW power is ok.

The DPM is pre-configured for proper operation, so the only thing to be changed in its settings is the GPIB address (factory default GPIB address – 4).

#### **DPM GPIB operation commands are as in Table 2.**

Command strings and responses are given in apostrophes to separate them from spaces and comments. In reality, there mustn't be apostrophes. All commands have to end with the symbol LF (line feed, 0xA, \n)."

Table 2

Action	Command string	Response
Identification Query	'IDN?\n'	'DPM'
Save current configuration in the Flash as the new power on setting.	'*SAV 0\n'	'Save Ok' Provide 2sec delay after command before restart the DPM.
Reset settings to settings in Flash memory (when DPM turned on)	'*RCL 0\n'	'Ok' Provide 30ms delay after command before next command.
Default settings	'*RST\n'	'Ok' Set DPM GPIB address - 4 Provide 30ms delay after command before next command.
Set new GPIB address 11	'SYST:COMM:GPIB:ADDR 11\n'	Do not forget it! Address will be changed after 30 mSec delay.
GPIB operation All commands from Appendix (List of commands of SCPI format)	Example: 'read?\n'	Example: '10.05 mW'

### 3.8 MEASURING PROCEDURE IN REMOTE MODE USING RS-232 INTERFACE

Check that the connection of the input of the sensor to a source of mm-wave CW power is ok.

The communication requires a modem cable; the minimum RS-232 connection uses just three lines to connect the DPM to a PC: transmit data, receive data, and ground.

Data format – 8 data bits, no parity, 1 stop bit (8N1).

Baud rate – 1200 bps (recommended).

The list of commands is in the Table 3 as commands of SCPI format (firmware version 160126).

Table 3

Command	Description	Respond
SYST2:***		
syst2:beep:stat off	Turn Buzzer off Buzzer does not sound (is off) when a command receives at remote mode	
syst2:beep:stat on	Turn Buzzer on Buzzer sounds (is on) when a command receives at remote mode	
syst2:beep:stat?	Query of Buzzer status	on , Buzzer is on off , Buzzer is off
syst2:pres	Default DPM settings: Tab1 Frq_step=20 (0.2 GHz) Indication in uW/mW Manual control syst:beep stat off, aver:count 50, disp:enab off	
syst2:err?	Query to type of last error After the command error bite gets 0	0, No error -100, Command error -128, Numeric data not allowed -365, Time out error
SENS:***		
sens:corr:tabl 1	Set mode Tab1 (for sensors with directional coupler only)	
sens:corr:tabl 2	Set mode Tab2 (for sensors with directional coupler only)	
sens:corr:tabl?	Query of status Tab	1 , Tab1 is set 2 , Tab2 is set
sens:freq [xxx.xx] examples: sens:freq 91	Setting of frequency of measured signal	

sens:freq 091 sens:freq 91.0 sens:freq 091.00		
sens:freq?	Query of set frequency	91.00
CALC:***		
calc:aver:coun [1...250]	Setting of number of measurement points averaging	
calc:aver:coun?	Query of set number of averaging	50
UNIT:***		
unit:pow dbm	Setting of indication of power level in dBm	
unit:pow w	Setting of indication of power level in uW/mW	
unit:pow?	Query of type of power measurement unit	W, power level in uW/mW DBM, power level in dBm
READ:***		
read?	Start of measurements and receiving data	0.185 UW, measured power level or -37.3 DBM, measured power level
fetc?	Reading of result of last done measurement (without new process of measurement)	0.185 UW, measured power level or -37.3 DBM, measured power level
DISP:***		
disp:enab off	Display does not refresh measurement information at REMOTE(RS_control) mode	
disp:enab on	Display indicates actual measurement information at REMOTE(RS_control) mode	
disp:enab?	Display operation status	on , Display indicates actual data (is on) off , Display does not refresh data (is off)
gtl	Setting of manual control (Go To Local control)	

**\*\*Notes\*\*** to Table 3:

- The command type for SYST2 is **\*\*\*** and is used for DPM control.
- Only a brief format of commands is allowed, for example: `sens:aver:coun 50`.
- The entire format is not allowed, for example: `sensor:average:counts 50`.
- The format of a command allows the use of capital or lowercase letters.
- A command with a leading colon " : " is incorrect, for example: `:disp:enab?`. The correct format is `disp:enab?`.
- All commands must end with the symbol LF (line feed, 0xA).

Switching from Manual mode to Remote (RS\_control) mode is done automatically if a command through the GPIB/RS-232 interface appears. There is a symbol "\*" in the LCD (14th symbol in the 1st line) if REMOTE mode is ON, regardless of whether `disp:enab?` is off.

The frequency format in command and response is numerical with 2 digits after the decimal point. Examples: 93.00, 105.20.

The power level format includes uW/mW or dBm units. Examples: 0.185 uW, 0.185 mW, -37.3 dBm.

If the set frequency value is outside the permissible range, the value is not accepted and changed, and an error appears as -128, "Numeric data not allowed," which can be read upon query.

The code of the last error is stored in DPM and can be read with the command `syst2:err?` After the command, the error byte returns 0. The error byte also returns 0 if commands like `syst2:pres` or `gtl` are sent or if DPM is switched OFF.

If Remote (RS\_control) is on, switching off the DPM and then turning it on again turns off `disp:enab?` (i.e., the display does not refresh indicated data).

## 3.9 CHANGING POWER METER SETTINGS

### 1. Measurement mode (Watt or dBm):

- Press any key.
- Insert the code "997" using the DPM keyboard.
- Press "0" to select Watt mode.
- Press any key, except "\*" to choose dBm mode.
- Press "\*" to exit the mode.

### 2. TAB Number (TAB1 or TAB2) (mode number):

- Press any key.
- Insert the code "999" using the DPM keyboard.
- Press "1" to select TAB1.

- Press "2" to select TAB2.
- Press "\*" to leave the mode.

**\*\*ATTENTION:\*\*** Usually, one mode (Tab1=Tab2) is provided in the DPM. The other mode is available upon special request for power meters supplied with additional attenuators and couplers and with calibration with/without these devices.

### 3. **Control and squeak mode (squeak ON or squeak OFF):**

- Press any key.
- Insert the code "996" using the DPM keyboard.
- Press any key, except "3" and "\*", to choose the manual mode. "Remote Off" indicates the manual mode, and squeak is always ON in this mode.
- Press any key, except "3" and "\*", to choose the control mode through a PC interface without squeak. "Remote On" means remote mode without the squeak mode ON.
- Press "3" to choose the control mode through a PC interface with squeak. "Remote On #" means remote mode with the squeak mode ON.
- Press "\*" to leave the mode. The sign "Remote READY TO START" or two lines displaying FREQUENCY/POWER will appear on the LCD. The sign "\*" or "\*#" in the upper right corner of the LCD indicates automatic mode (Fig 15.).

### 4. **Frequency step:**

- Press any key.
- Insert the code "998" using the DPM keyboard.
- Press any key, except "\*", to choose the frequency step. For example, "50" means a frequency step of 0.50 GHz.
- Press "\*" to leave the mode.

### 5. **Baud rate** (baud rates 1200, 9600, 56000 are available):

- Press any key.
- Insert the code "991" using the keypad. You will see the current baud rate (Fig.13).
- Press "1" to select a baud rate of 1200, "2" to select 9600, or "3" to select 56000. A baud rate of 1200 bps is recommended.
- Press "#" to apply changes and exit the mode, or press "\*" to exit the mode without applying changes.

\*\*\*

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