



CSR μ Energy[®]

Test Application

User Guide

Issue 5

Document History

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1. Introduction

The *uEnergyTest* application is a graphical Windows application that is part of CSR μ Energy[®] Tools.

The CSR μ Energy tools can be downloaded from www.csrsupport.com.

uEnergyTest enables RF and general hardware testing of CSR μ Energy ICs. Test modes are run on-chip, using test firmware (Ptest), which is downloaded to the IC by the application.

This guide documents the *uEnergyTest* application, which is designed for:

- Development and verification testing
- Hardware debug

The application uses the *uEnergyTest* DLL to perform all operations. The DLL is designed for mass production testing, as part of a customer's own production line test system. For more information about the *uEnergyTest* DLL, see the help installed with the tools.

1.1. Supported Devices

The tool supports the following μ Energy ICs:

- CSR100x™
- CSR101x™

2. Connecting

Before any tests can be performed, a connection must be established between uEnergyTest and the CSR μ Energy Device Under Test (DUT).

First ensure the DUT is powered, and connect the DUT's SPI port to the PC, using one of the following connection methods:

- CSR USB-SPI converter 1324
- CSR μ Energy USB-SPI converter board CNS10020V3A
- LPT (PC motherboard LPT1 only), via LPT to SPI cable

Note:

A USB-SPI connection is recommended as the Ptest firmware download is significantly faster than with LPT.

When the uEnergyTest application is executed, the window shown in Figure 2.1 appears. The **Ok** button initiates the connection attempt, and the **Cancel** button closes the application.

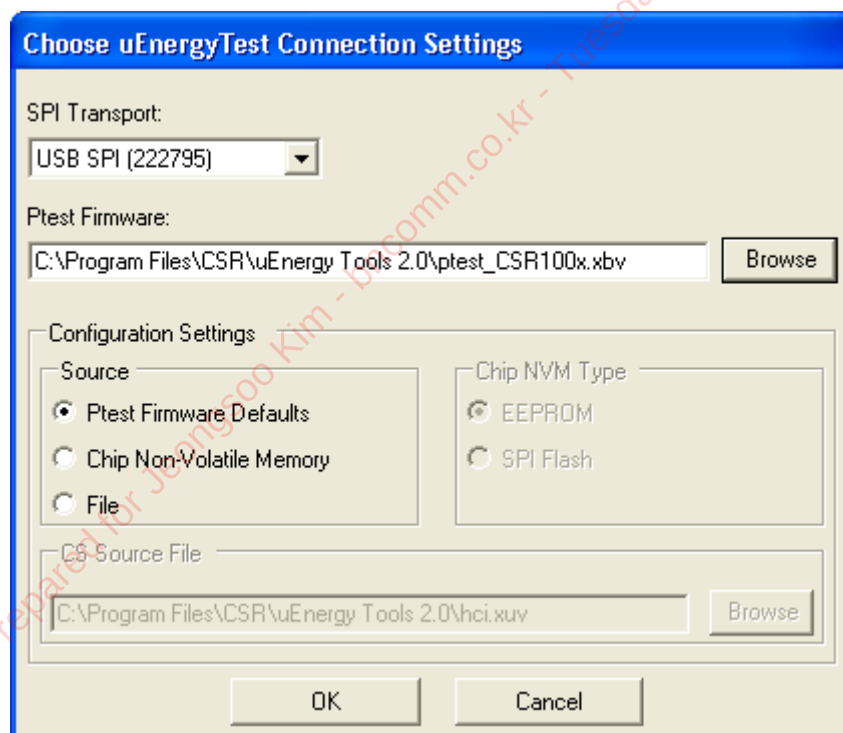


Figure 2.1: Connection Settings

2.1. SPI Transport

The **SPI Transport** drop-down list includes all available SPI ports. Select the port connected to the DUT which is to be tested.

2.2. Ptest Firmware

CSR µEnergy standard firmware does not include full hardware test functionality. Therefore device specific production test (Ptest) firmware is loaded to RAM to provide the test modes.

The **Ptest Firmware** edit box shows the full path to the Ptest firmware file which will be downloaded as part of the connection process. The default file is the Ptest firmware released with the tools for CSR100x. To change the file used, click the **Browse** button, and select the appropriate CSR µEnergy Ptest firmware file using the file selector dialog.

2.3. Configuration Settings

CSR µEnergy ICs have configuration settings, which define certain aspects of the DUTs behaviour and RF characteristics. The **Configuration Settings** options allow the source of these configuration settings to be defined, as shown in Table 1. The **Source** selection defines which other options are appropriate (enabled).

Source	Options	Configuration Settings Used
Ptest Firmware Defaults	None	Default values built into the selected Ptest firmware image
Chip Non-Volatile Memory	Chip NVM Type (EEPROM / SPI Flash)	Values read from the selected NVM source. The selected NVM source must contain a valid firmware image.
File	CS Source File, where the accepted formats are: .xuv: Firmware image file for SPI-Flash .img: Firmware image file for EEPROM .keyr: Configuration settings file	Values read from the selected file

Table 1: Configuration Settings

2.3.1. Compatibility

If a configuration settings **Source** other than **Ptest Firmware Defaults** is selected, the configuration settings used must have the same CS version as the Ptest firmware. This will be the case if the firmware image was built using the same version of SDK as the tools being used.

Each tools release includes an XML file (`cskey_db.xml`), which defines all supported CS versions up to and including the version built into the Ptest firmware included in the release. If the firmware image has a version higher than that supported by the tools release, matching Ptest firmware must be used, along with an updated CS XML file containing the definitions for that CS version.

2.3.2. Working with Configuration Settings

Configuration settings can be viewed or edited using the CsConfig tool (part of CSR µEnergy Tools). See the CsConfig help for further details.

3. Running a Test

Figure 3.1 shows the main application window following successful connection. The hardware ID of the uEnergy IC is displayed, as well as the Ptest firmware version information.

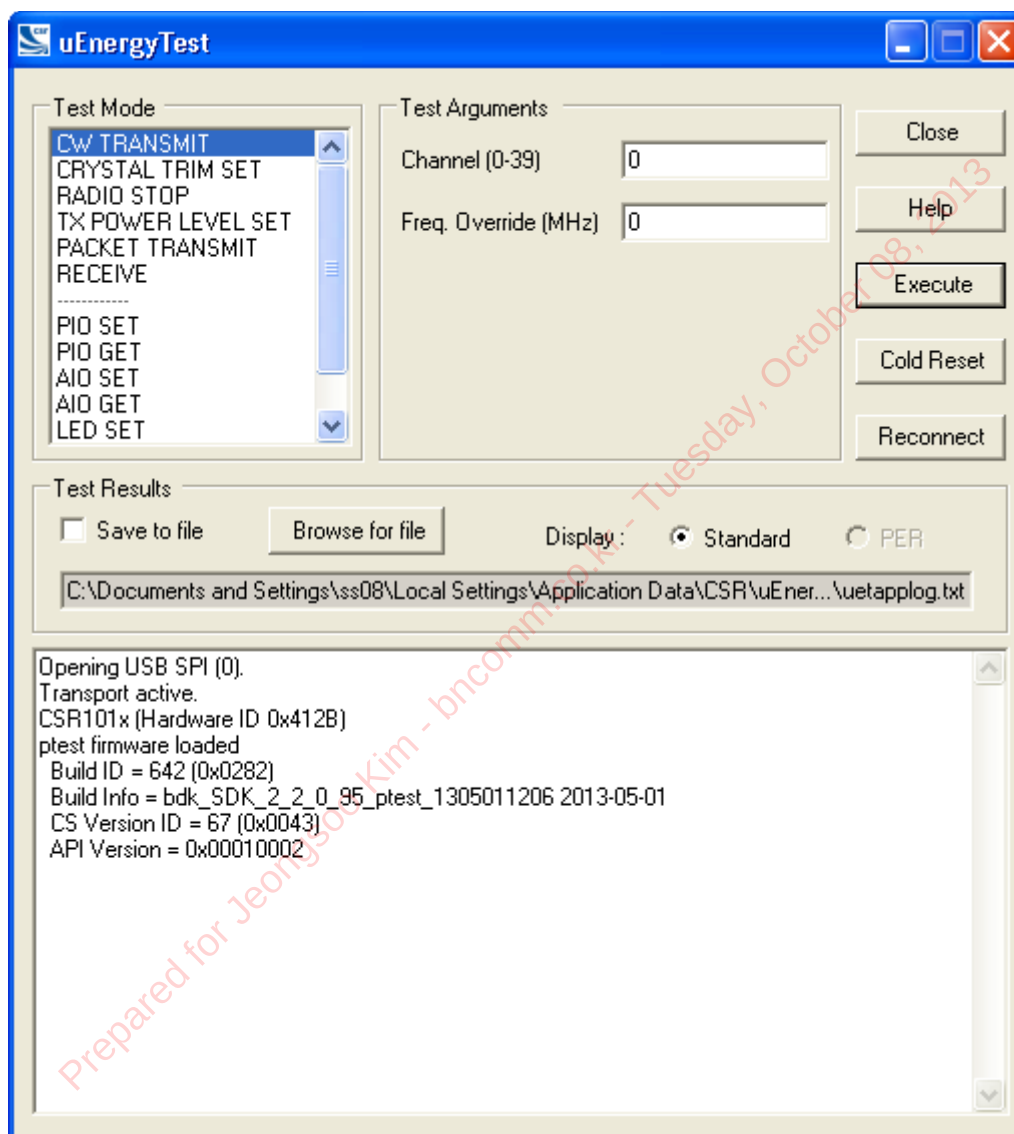


Figure 3.1: Running Tests

To run a test:

1. Select the required test from the **Test Mode** list.
2. Set the **Test Arguments**.
3. Click **Execute**.

The status for the command is shown in the log area (text box in the lower half of the window). If a test generates results, the results values are also displayed in the log area.

3.1. Logging Test Results

Test results are automatically displayed in the log area of the application's main window. In addition, results can be saved to a log file by checking the **Save to file** option. The log file can be specified by clicking the **Browse for file** button.

Only one **Display** mode (**Standard**) is currently supported.

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4. Tests

This section contains the details for each test mode supported by the uEnergyTest application. The following apply to all tests:

- Where "None" is specified for the *Results* of a test, it means that there are no results values other than success or failure.
- All tests end when **Cold Reset** or **Reconnect** is executed (cancelling a **Reconnect** does not result in tests being stopped). The *Test Ends* conditions for each test states whether a test ends automatically, or as the result of another test command being executed.
- Any *Additional Equipment* listed is not generally required to run a test mode (the application does not communicate with any external equipment), but it may be required to measure the DUT's output as a result of running a test, or to provide an input signal such that a test is meaningful.
- The uEnergyTest *DLL API Function(s)* used for each test are listed. Other uEnergyTest DLL functions are required to open a connection, load Ptest firmware and configuration settings, and to retrieve error information, but these are not listed. See the uEnergyTest DLL help file for further information.

4.1. Radio Tests

4.1.1. CW TRANSMIT

Description	Configures and starts Carrier Wave (Sine) transmission.
Arguments	Channel (0-39): The Bluetooth Low Energy RF channel to transmit on. Freq. Override (MHz): Frequency override value. If set to 0 (default), the frequency is calculated from the Channel value. Otherwise the valid range is 2402...2480 (MHz).
Results	None.
Test Ends	When RADIO STOP , PACKET TRANSMIT , or RECEIVE are executed.
Additional Equipment	Frequency counter, spectrum analyser, Bluetooth tester or other means of measuring the output frequency / power.
DLL API Function(s)	uetRadCwStart

4.1.2. CRYSTAL TRIM SET

Description	Sets the crystal trim value. Can be used while CW TRANSMIT is running to calibrate the crystal trim for a DUT.
Arguments	Trim Value (0-63): The trim value to set.
Results	None.
Test Ends	Automatically.
Additional Equipment	Frequency counter, spectrum analyser, Bluetooth tester or other means of measuring the output frequency / frequency offset when CW TRANSMIT or PACKET TRANSMIT are running.
DLL API Function(s)	uetRadSetXtalTrim

4.1.3. RADIO STOP

Description	Stops the current radio transmission / reception test mode. It can be used to stop transmission started with CW TRANSMIT or PACKET TRANSMIT , and reception started with RECEIVE .
Arguments	None.
Results	None.
Test Ends	Automatically.
Additional Equipment	None.
DLL API Function(s)	uetRadStop

4.1.4. TX POWER LEVEL SET

Description	Sets the power level to be used for transmissions. The power level can be set at any time and takes immediate effect if set whilst CW TRANSMIT or PACKET TRANSMIT is running.
Arguments	Power Level (0-7): The power level to set, where 0 gives the lowest power output.
Results	None.
Test Ends	Automatically.
Additional Equipment	Spectrum analyser, power meter, Bluetooth tester or other means of measuring the output power when CW TRANSMIT or PACKET TRANSMIT are running.
DLL API Function(s)	uetRadTxSetPowerLevel

4.1.5. PACKET TRANSMIT

Description	Starts packet transmission. This test mode can be used when testing against the <i>Bluetooth Low Energy RF PHY Test Specification</i> TRM-LE/CA/nn/C test cases.
Arguments	Channel (0-39): The Bluetooth Low Energy RF channel to transmit on. Pkt. Length (0-37): The length in bytes of the payload data in each packet. Payload Type (0-7): The transmit packet payload type, where: ▪ 0 = Pseudo-Random bit sequence 9 ▪ 1 = Pattern of alternating bits "11110000" ▪ 2 = Pattern of alternating bits "10101010" ▪ 3 = Pseudo-Random bit sequence 15 ▪ 4 = Pattern of all "1" bits ▪ 5 = Pattern of all "0" bits ▪ 6 = Pattern of alternating bits "00001111" ▪ 7 = Pattern of alternating bits "01010101" Num. Pkts. (0-65535): The number of packets to transmit. If set to 0 (default), packets are continuously transmitted. If > 0, the given number of packets will be transmitted, after which transmission will stop automatically.
Results	If Num. Packets = 0, none. If Num. Packets > 0, the number of packets left to send is reported at 1 second intervals.
Test Ends	When RADIO STOP, CW TRANSMIT, or RECEIVE are executed. In the case where Num. Packets > 0, the test ends automatically when the specified number of packets have been sent.
Additional Equipment	BLE tester or other means of performing RF measurements. An additional CSR µEnergy device can be used to report the received packet count using the RECEIVE test mode in another instance of the uEnergyTest application.
DLL API Function(s)	uetRadTxStart, uetRadTxGetPkts.

4.1.6. RECEIVE

Description	Configures the DUT to start receiving packets. This test mode can be used when testing against the <i>Bluetooth Low Energy RF PHY Test Specification</i> RCV-LE/CA/nn/C test cases.
Arguments	Channel (0-39): The Bluetooth Low Energy RF channel to receive on.
Results	Results are reported at 1 second intervals, and include: - The number of packets received. - The approximate RSSI (in dBm), averaged over the number of packets (this is not reported if the number of packets received is 0, or if the Ptest firmware API version is less than 0x00010001).
Test Ends	When RADIO STOP , CW TRANSMIT , or PACKET TRANSMIT are executed.
Additional Equipment	BLE tester or other means of generating BLE packets. An additional CSR µEnergy device can be used to generate packets using the PACKET TRANSMIT test mode in another instance of the uEnergyTest application.
DLL API Function(s)	uetRadRxStart, uetRadRxGetResults

4.2. Other Hardware Tests

4.2.1. PIO SET

Description	Sets the direction of the DUTs PIO lines, and the state of those lines assigned as outputs.
Arguments	Mask: Bit-field, where each bit represents one of 32 possible PIO lines (the number of PIOs available depends on the IC type). If a bit is set, the direction of the PIO will be set according to the Direction argument. If a bit is unset, the PIO will not be affected by this function. Direction: Bit-field, where each bit represents one of 32 possible PIO lines. Only bits set in the Mask will take effect. If a bit is set, the PIO is configured as an output, otherwise as an input. State: Bit-field, where each bit represents one of 32 possible PIO lines. If a bit is set, the line will be driven high, otherwise low. Only those PIOs included in the Mask, and set as outputs in Direction are set.
Results	None.
Test Ends	Automatically.
Additional Equipment	A multi-meter, oscilloscope, or digital I/O hardware can be used to check the state of the lines.
DLL API Function(s)	uetPioAssign, uetPioSet

4.2.2. PIO GET

Description	Gets the direction and state of the DUTs PIO lines.
Arguments	None.
Results	PIO direction and state (32bit hex values).
Test Ends	Automatically.
Additional Equipment	A multi-meter, oscilloscope, or digital I/O hardware can be used to check the state of the lines. A power supply or digital I/O hardware can be used to provide input levels.
DLL API Function(s)	uetPioGet

4.2.3. AIO SET

Description	Configures an AIO line as an output and sets the output voltage.
Arguments	AIO Line: The AIO line to set. The number of AIO lines available depends on the IC / package. Voltage (mV): The voltage, in millivolts, to set for the AIO line.
Results	None.
Test Ends	Automatically.
Additional Equipment	A multi-meter or oscilloscope can be used to check the output level.
DLL API Function(s)	uetAioSet

4.2.4. AIO GET

Description	Configures an AIO line as an input and measures the input voltage.
Arguments	AIO Line: The AIO line to get. The number of AIO lines available depends on the IC / package.
Results	AIO Voltage (mV).
Test Ends	Automatically.
Additional Equipment	A power supply can be used to provide an input level.
DLL API Function(s)	uetAioGet

4.2.5. LED SET

Description	Sets LED test modes.
Arguments	Mask: Bit-field used to indicate which of up to 32 PIOs, used to drive LEDs, are to be routed through the PWM hardware and set to the given mode. The number of PIOs supported and available for use to drive LEDs depends on the IC / package. Mode: The LED mode to set, where: ▪ 0 = Off ▪ 1 = On ▪ 2 = Flash ▪ 3 = Ramp Interval (ms): The interval, in milliseconds, used when the Mode is <i>Flash</i> or <i>Ramp</i>. In the case of <i>Flash</i> mode, the interval is the ON/OFF time. In the case of <i>Ramp</i> mode, the interval is the time taken to ramp up/down. Brightness (%): The brightness used when the Mode is anything other than <i>Off</i>. In the case of <i>Flash</i> mode, it is the brightness set for the ON state. In the case of <i>Ramp</i> mode, it is the maximum brightness.
Results	None.
Test Ends	Test modes 1, 2 and 3 run until a new mode is set. To switch off the LEDs completely, use mode 0.
Additional Equipment	None.
DLL API Function(s)	uetLedSet

4.2.6. UART LOOPBACK

Description	Tests the UART lines using a loopback test. The function first commands the DUT to enter the UART loopback mode, then opens a UART connection, writes test data, then reads from the DUT. A comparison is then performed between the sent and received data. If the data matches, the test passes, otherwise an error code indicating that the test failed is returned.
Arguments	Port Number: The number of the COM port to use, e.g. 1 means "COM1" will be used. Baud Rate: UART baud rate to use for the test. Supported rates are as follows (in bps, rates supported by PC UART hardware may be different): ▪ 2400 ▪ 9600 ▪ 19200 ▪ 38400 ▪ 57600 ▪ 115200 ▪ 230400 ▪ 460800 ▪ 921600 ▪ 1382400 ▪ 1843200 ▪ 2764800 ▪ 3686400 ▪ 5529600
Results	In the case of a failure, the failure reason is reported. Otherwise none.
Test Ends	Automatically.
Additional Equipment	UART cable between PC and DUT UART ports.
DLL API Function(s)	uetUartLbTest

5. Miscellaneous functions

5.1. Cold Reset

Clicking the **Cold Reset** button causes the DUT to be reset. Any test that is running is stopped, and all DUT state is lost. The Ptest firmware is reloaded as part of this process.

5.2. Reconnect

Clicking the **Reconnect** button causes the connection window to be shown, see Figure 2.1. In this case however, the **Cancel** button does not exit the application, but simply closes the connection window.

The connection settings can be changed to connect to a different device, or to use different CS settings. After connecting / reconnecting, the device state is the same as after a **Cold Reset**, i.e. the DUT state is not preserved.

5.3. Closing the Application

The application can be closed in the following ways:

1. Click the **Close** button on the application's main window.
2. Click the standard Windows application exit button on the title bar.
3. Left-click the application icon (left hand side of the title bar), and select Close from the context menu.
4. Right-click on the title bar, and select **Close** from the context menu.
5. Press the keys **Alt** and **F4** simultaneously.

Note:

Closing the application does not end any running tests.

5.4. Application Information

To bring up the application's **About** window, either left-click the application icon (left hand side of the title bar), or right-click anywhere on the window other than the log area. In both cases, select **About uEnergyTest...** from the context menu. The **About uEnergyTest** window is displayed, showing the application version and copyright information. Click the **OK** button to close the window.

Document References

Document	Reference
<i>Bluetooth Low Energy RF PHY Test Specification</i>	RF-PHY.TS/4.0.0

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Terms and Definitions

AIO	Analogue Input Output
BPS	Bits Per Second
BLE	Bluetooth® Low Energy
Bluetooth®	Set of technologies providing audio and data transfer over short-range radio connections
CS	Configuration Store. The area of memory used by the firmware to store configuration values
CSR	Cambridge Silicon Radio
CW	Carrier Wave
DUT	Device Under Test
EEPROM	Electrically Erasable Programmable Read-Only Memory
IC	Integrated Circuit
i.e.	<i>Id est</i> , that is
LED	Light Emitting Diode
LPT	Line Print Terminal
NVM	Non-Volatile Memory
PIO	Programmed Input Output
PWM	Pulse-Width Modulation
RF	Radio Frequency
RSSI	Received Signal Strength Indication
SDK	Software Development Kit
SPI	Serial Peripheral Interface
UART	Universal Asynchronous Receiver Transmitter
USB	Universal Serial Bus
XML	eXtensible Mark-up Language