CSR

CSR101x hardware design guidelines

CSR

Push every boundary.™

This Session

- Hardware design
  - Hardware design guidelines
  - Bringing up the new board

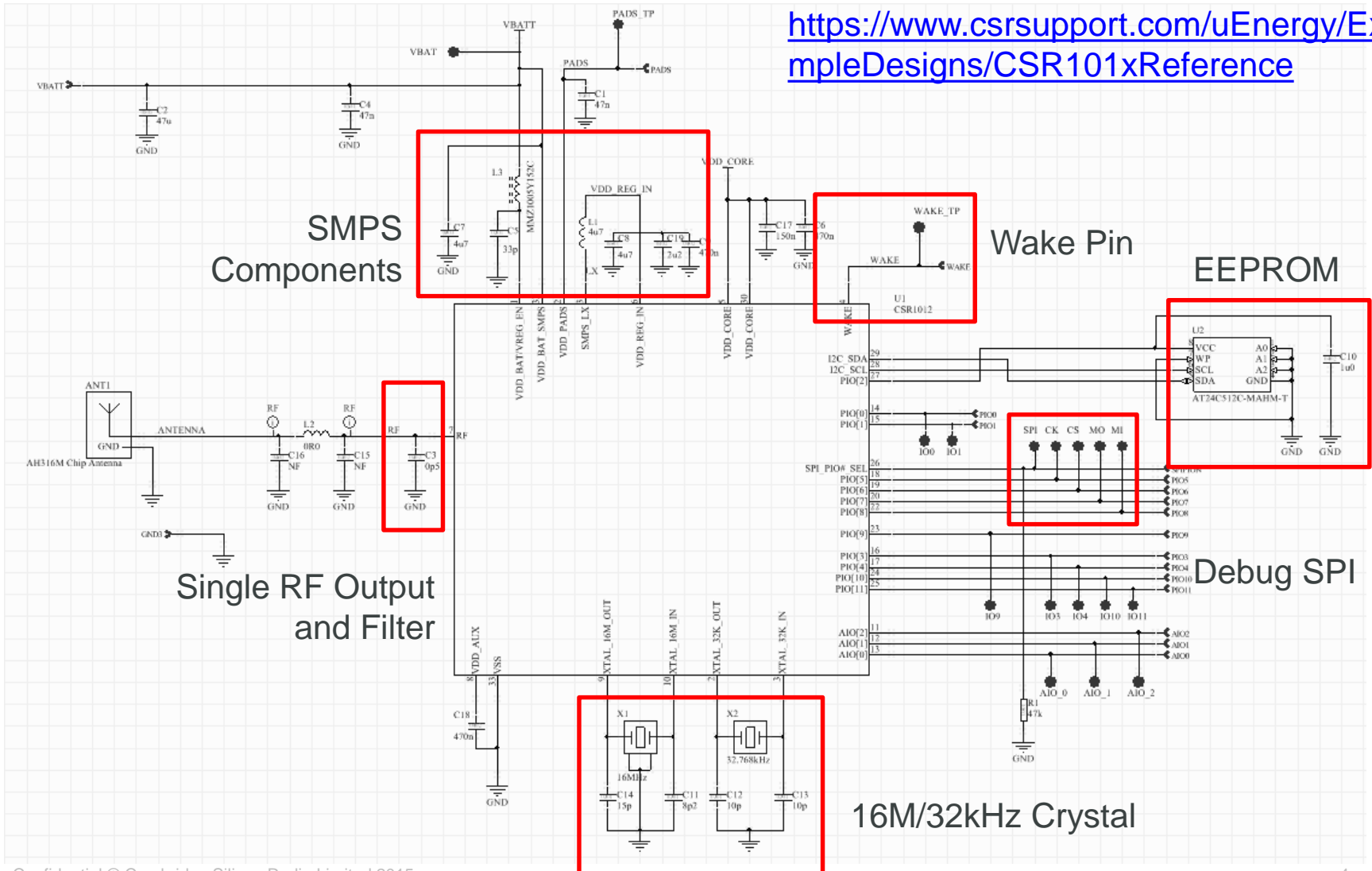- Production line test

- Bluetooth qualification process

Hardware design guidelines

CSR101x Reference schematic

CSR

CSR1010 Reference Schematic
https://www.csrsupport.com/uEnergy/ExampleDesigns/CSR101xReference

SMPS Components

Wake Pin

EEPROM

Single RF Output and Filter

Debug SPI

16M/32kHz Crystal
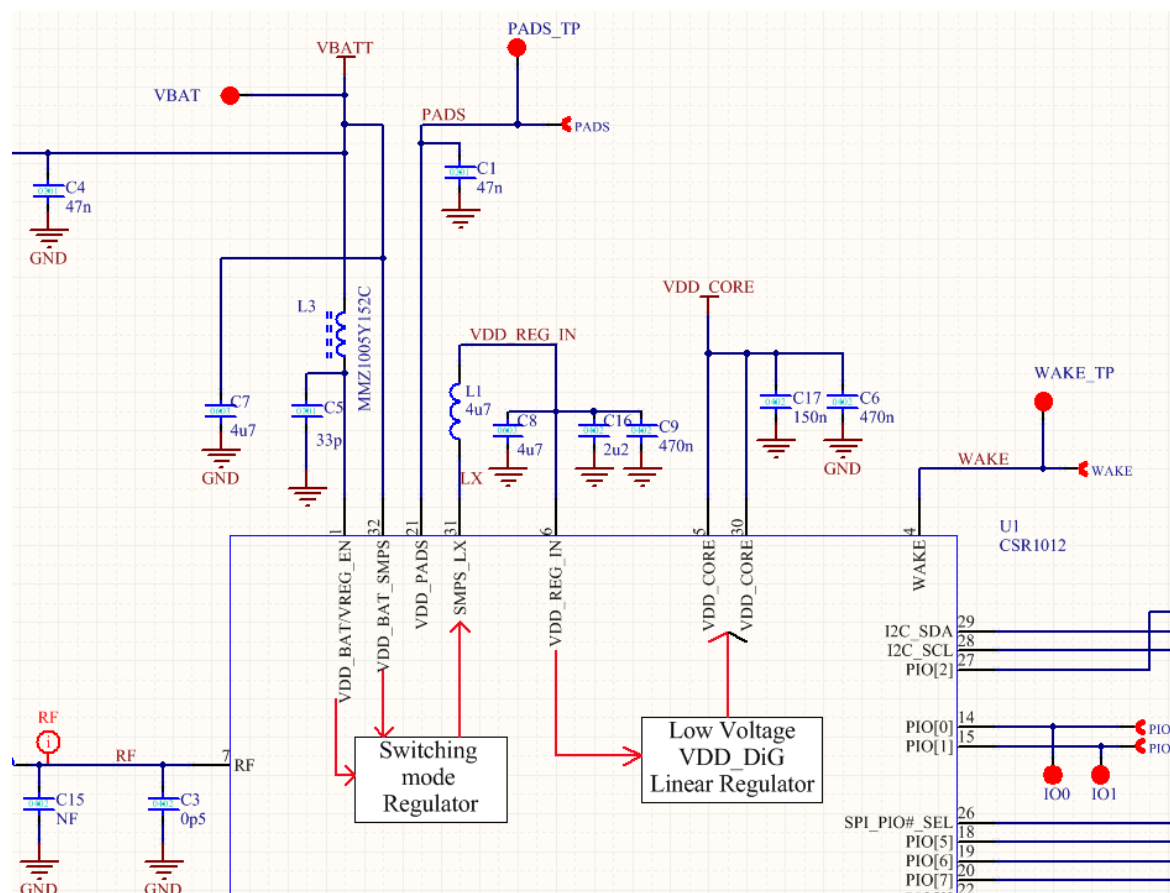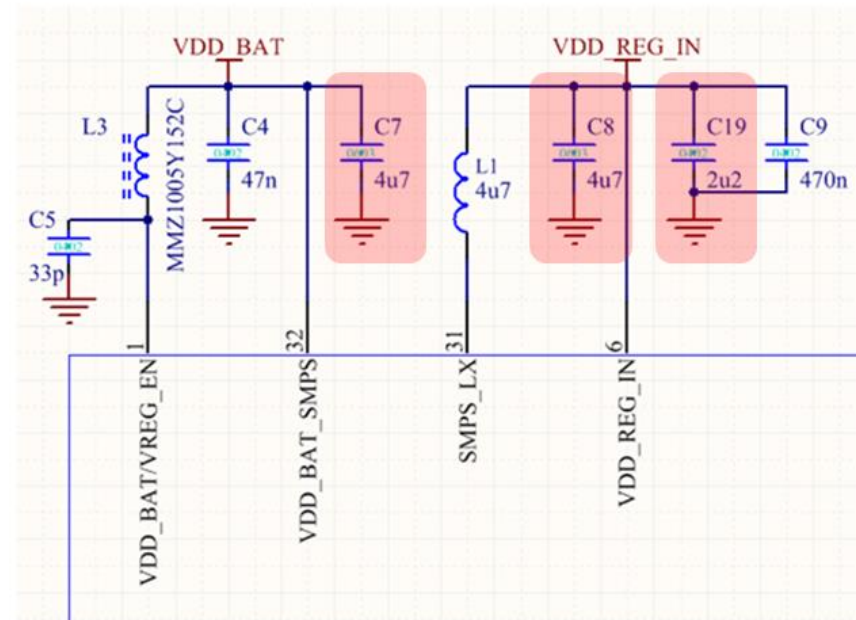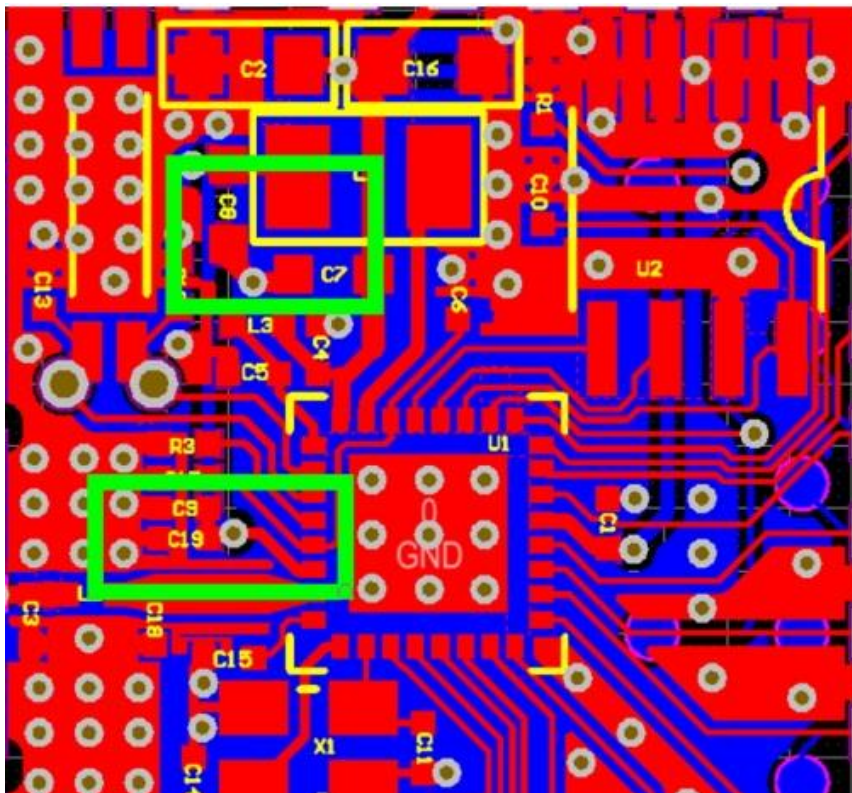
SMPS and DIG_LDO

The selection of the power supply components is critical to getting optimal efficiency out of the switch mode power supply and in maximising battery life.
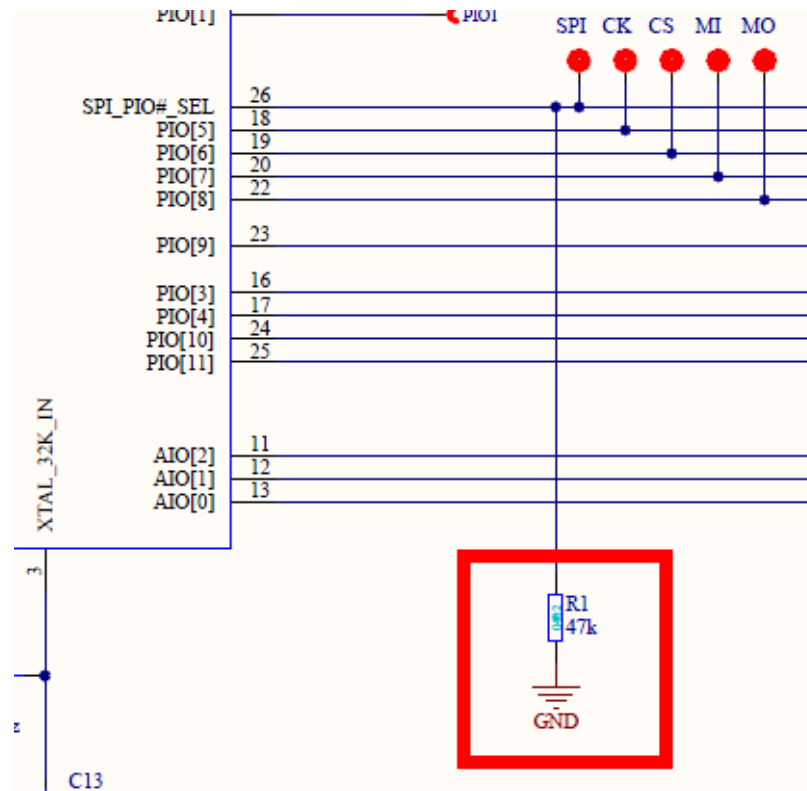
CSR

- C7 and C8 need an individual ground via separate from other grounds on top-layer (component side)
- C19 and C9 near VDD_REG_IN
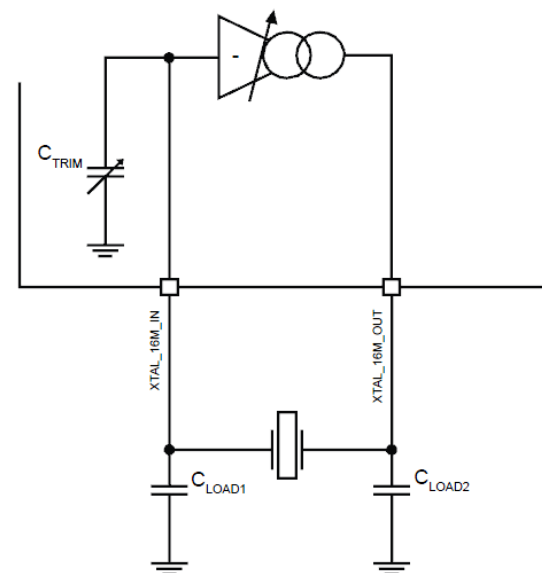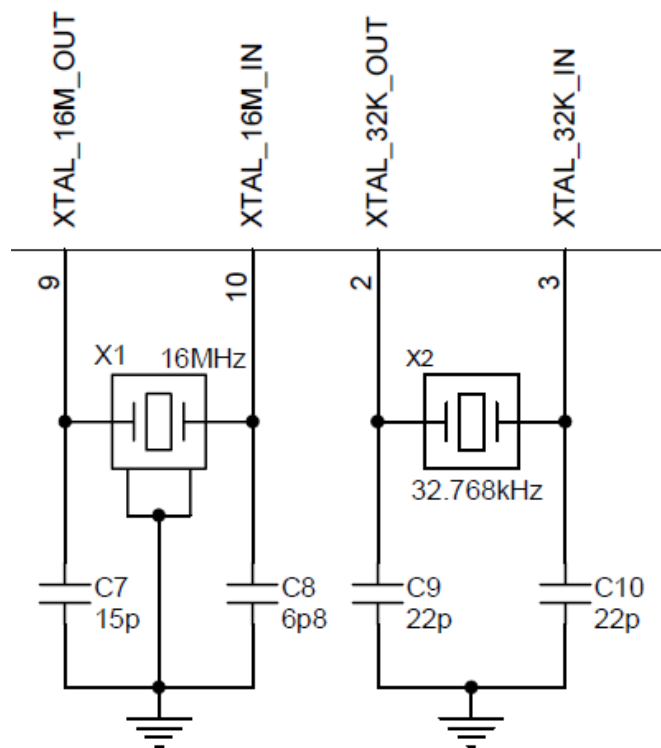
- Insert a 47kΩ pull-down resistor on SPI_PIO#_SEL if PIO is selected. Please don't leave the port open even in PIO mode
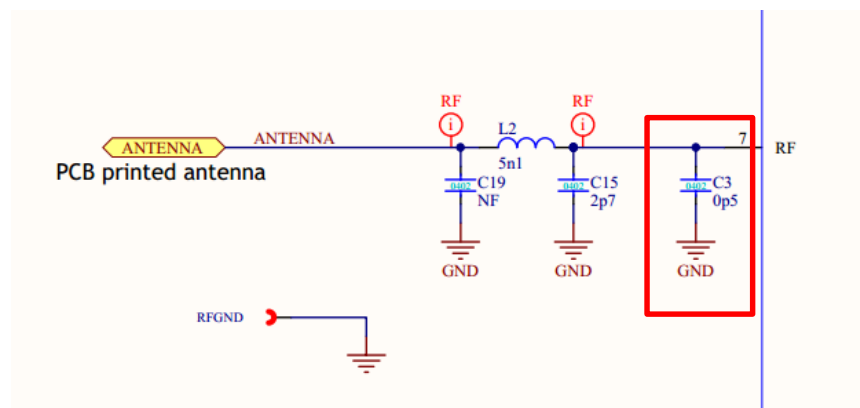- Add the VCC on SPI_PIO#_SEL to enable debug SPI mode on PIO[5..8]

The values of 16MHz XTAL tank capacitors are in the ratio **2:1** (recommended 15pF:6.8pF). Have the **smaller** capacitor **on XTAL_IN**

CSR101x simple RF filter

A simple RF filter (a 0.5pF) is good enough to pass FCC, ETSI and TELEC

		CSR1011 Demo-Board		DUT1		DUT2		DUT3	
		0R	0R+0.5pF	0R	0R+0.5pF	0R	0R+0.5pF	0R	0R+0.5pF
TX Spurious Emissions (dBm)	2nd Harmonic	-40.95	-47.03	-38.68	-43.46	-37.06	-50.19	-39.45	-48.26
	3nd Harmonic	-45.41	-49.33	-55.94	-51.34	-50.81	-54.64	-51.6	-55.49

CSR101x ground

- Need to add the ground pin in the schematic and assign to CSR101x central ground pad in the layout
- CSR1010 and CSR1012 require at least 9 vias on the central ground pad
- CSR1011 requires at least 25 vias on the central ground pad
- Failure to do so can cause significant RF performance degradation
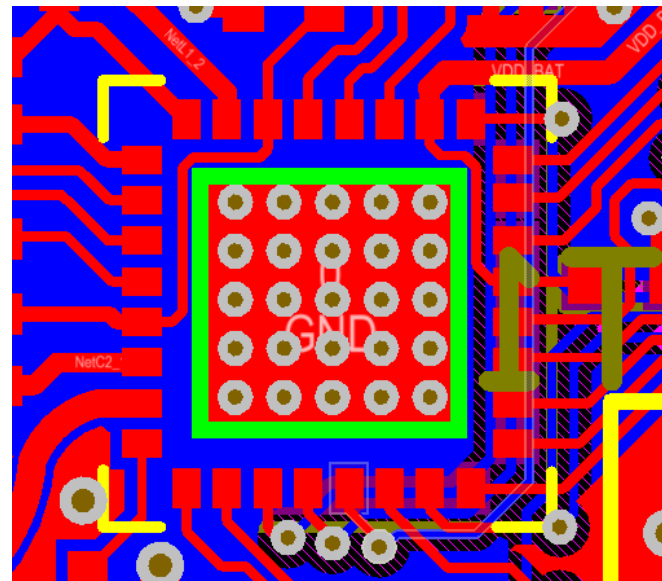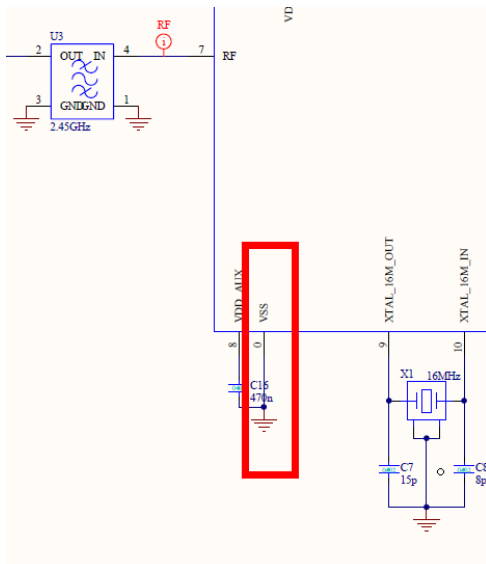
WAKE pin

- The CSR101x does not have an internal pull-up or pull-down resistor on the WAKE pin therefore an external resistor should be used
- Hardware detects WAKE level change only
- WAKE pin mode is configurable with the Power Management API

Rising Edge   Falling Edge

High Level

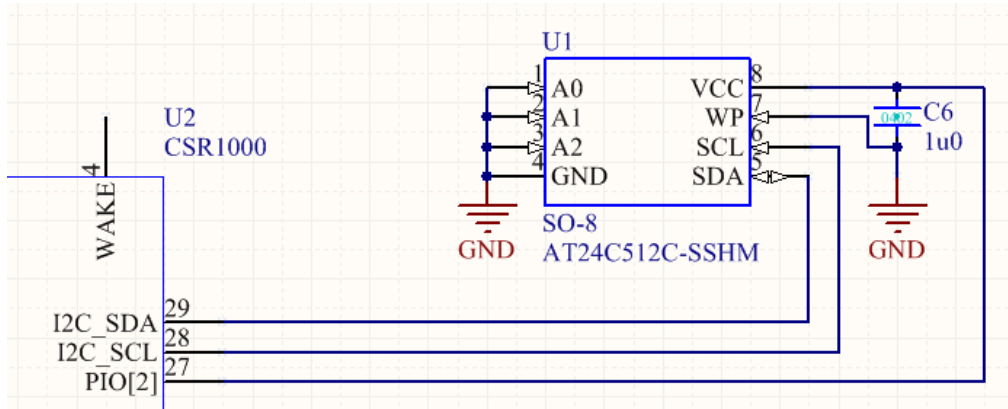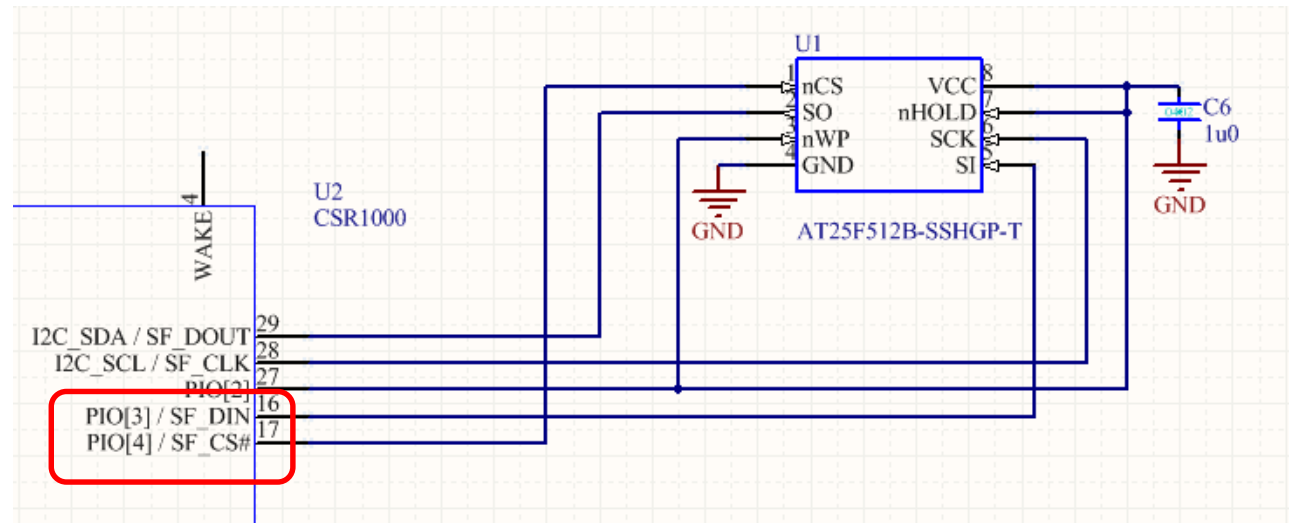Low Level

State changes here
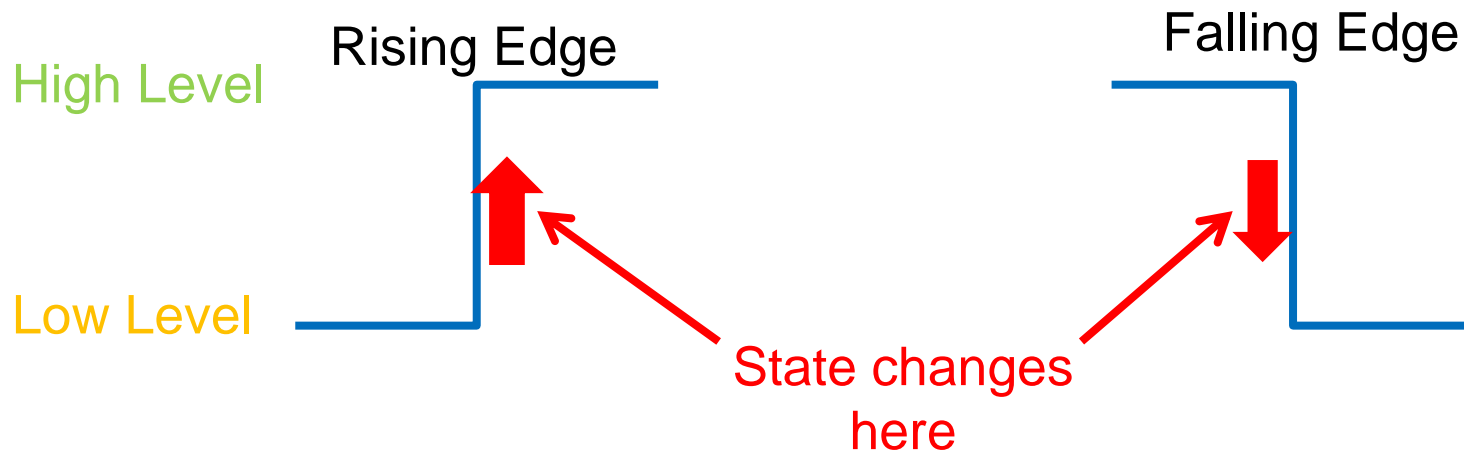
Figure a: Example of an I2C Interface EEPROM Connection

Default PIO[3] is SPI Flash_DIN
Default PIO[4] is SPI Flash _CS

Figure b: Example of an SPI Interface Flash Connection

Hardware Review

CSR Support:

Review Templates			Rename this section · Move this section
📄 CSR1012 HW review template	CSR1012 Hardware design review template Last updated: 26 Feb 2014, 02:50	Download... 727.9 KB	Move this document Remove
📄 CSR1000/CSR1010 HW review template	CSR1000/CSR1010 Hardware design review template Last updated: 26 Feb 2014, 03:00	Download... 682.9 KB	Move this document Remove
📄 CSR1001 HW review template	CSR1001 HW design review template Last updated: 24 Sep 2012, 17:00	Download... 791.1 KB	Move this document Remove

- There is a review template for each component
- Regularly updated to add additional test cases
- Comprehensive step-by-step schematic and layout guidelines
- Recommended reading before embarking on a new schematic/layout design
- When CSR provide design reviews, they are usually in the form of a completed review template

CSR101x Hardware Review Template

- All of the CSR reference and example designs can be found on *CSR Support in the uEnergy section under Hardware.

- *Access to CSR Support is based on development kit registration and account verification.

- The Hardware Review Template is used internally by CSR to verify that components and layouts have been implemented according to CSR's recommendations.

2.2. CSR1000/CSR1010 Hardware Design

2.2.1. Operational Temperature Range

Check	Limits	Verdict	Observations
Temperature range	-30 ~ +85°C	-	-

Table 2.2: Operational Temperature Range

2.2.2. Power Rails

| Check	Limits	Verdict	Observation
VDD_BAT	1.8 to 3.6 V		Note CSR1010 max. voltage 4.3V
VDD_BAT_SMPS	1.8 to 3.6 V		Note CSR1010 max. voltage 4.3V
SMPS_LX / VDD_REG_IN	0.65 to 1.35 V		SMPS_LX connects to VDD_REG_IN via a filter. **Note:** That SMPS_LX (pin 31) is SMPS output before smoothing and so is not a smooth 1.35 V but VDD_REG_IN (pin 6) is.
VDD_PADS	1.2 to 3.6 V		Note CSR1010 max. voltage 4.3V

CSR uEnergy CSR1000/CSR1010 Hardware Review Design Document
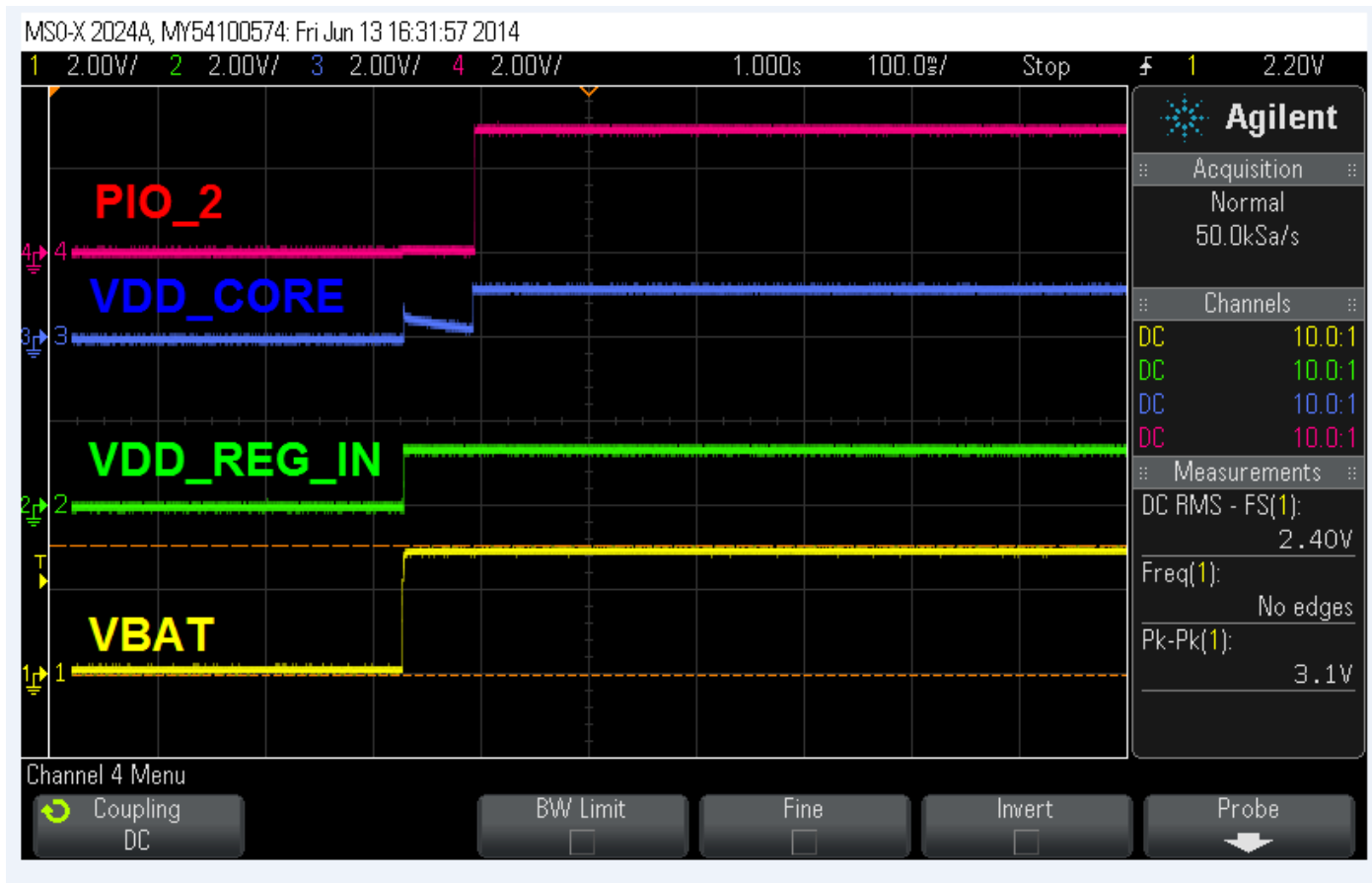
Bringing up a new board

Checking the power domain

1. VBAT :4.4V~1.8V
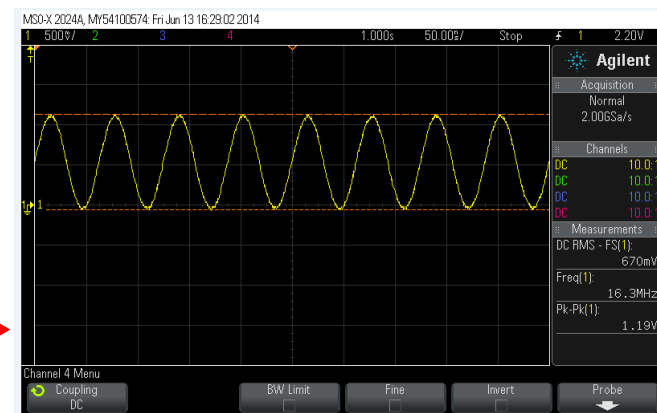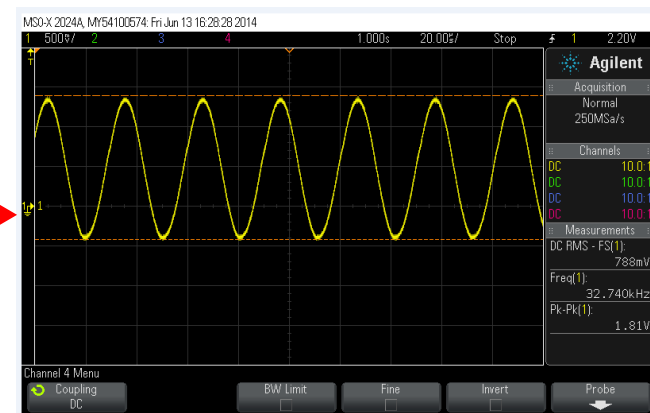2. VDD_REG_IN: 1.35V~0.8V
3. VDD_CORE:1.2V~0.65V
4. PIO2: Based on PADS
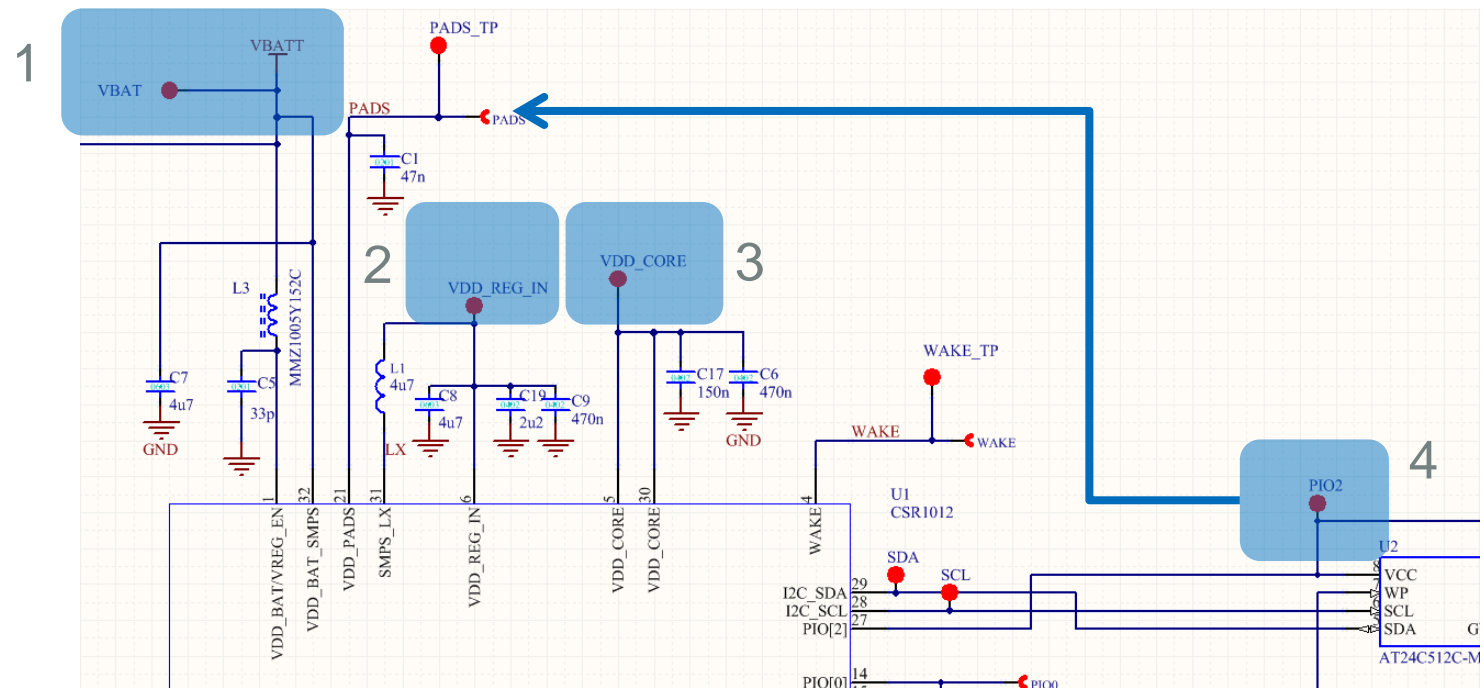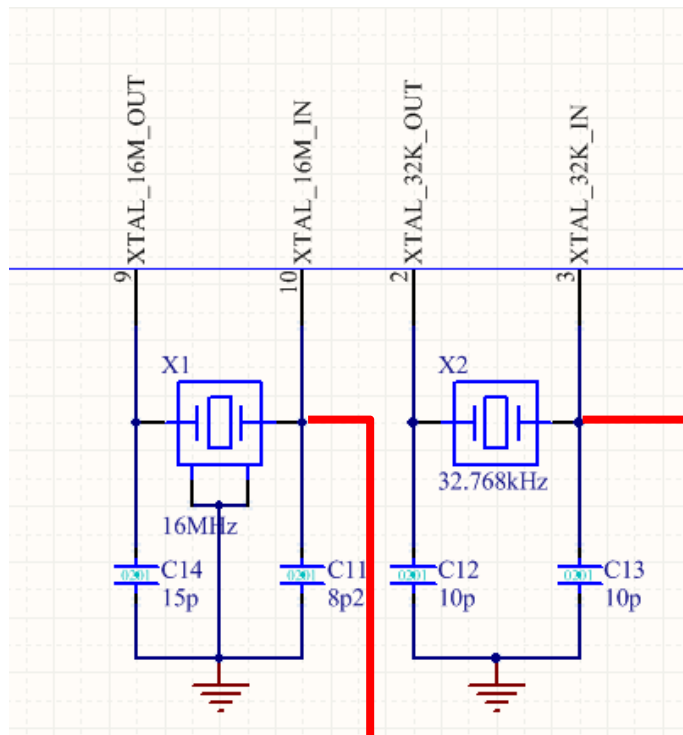
Power Domain

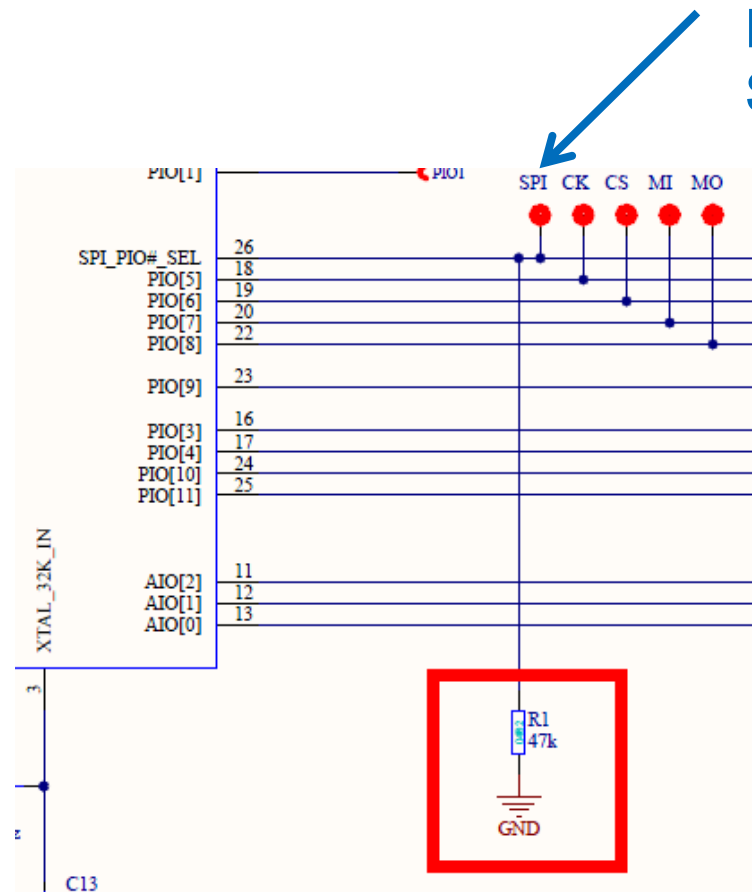If VDD_CORE and PIO2 don't show the correct voltage, check that the 32.768KHz clock is running

Check 16MHz and 32.768KHz clocks

Check SPI_PIO#_SEL state and pull high to enable debug SPI mode on PIO[5-8]

Pull high for debug SPI mode.

Production line test

- Development Boards

CSR1011

DB-CSR1011-10139-1A
DK-CSR1011-10138-1A (kit)

CSR1010

DB-CSR1010-10137-1A
DK-CSR1010-10136-1A (kit)

- USB-SPI Interface Board
  - Included with the development kits
  - Also available separately
    - Part number: DK-CSR1000-10086-1A
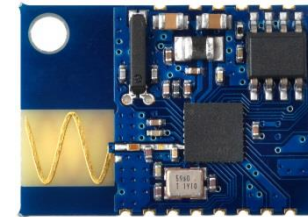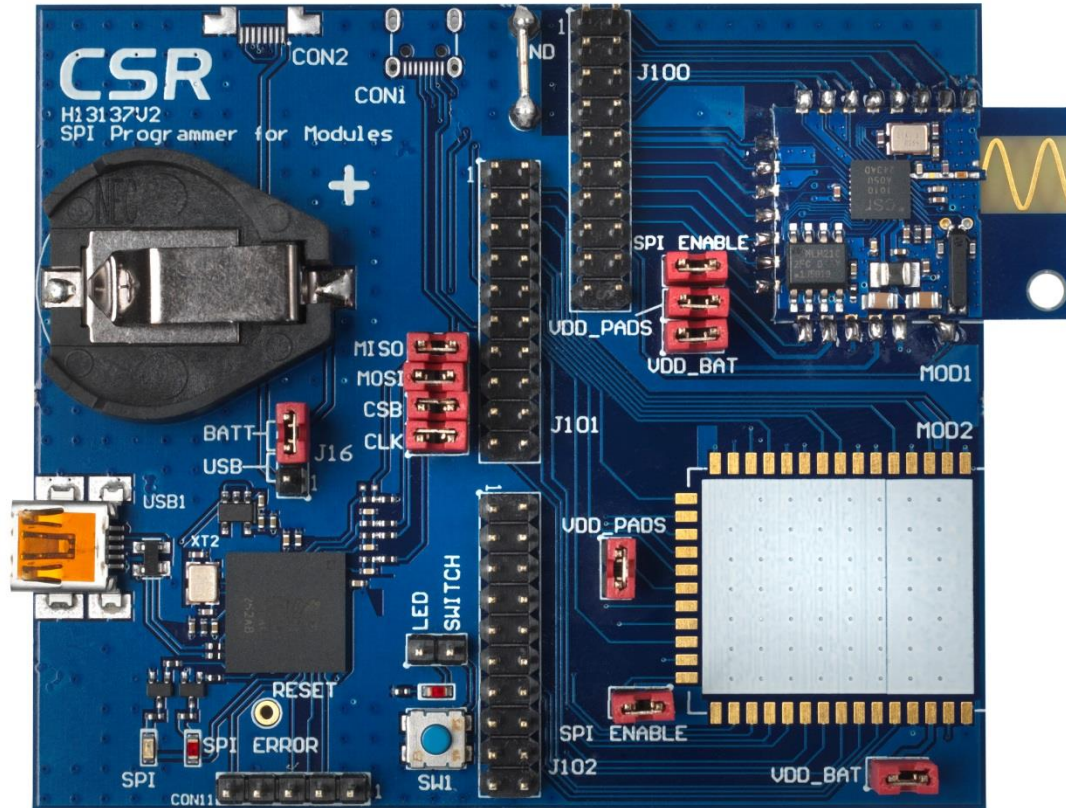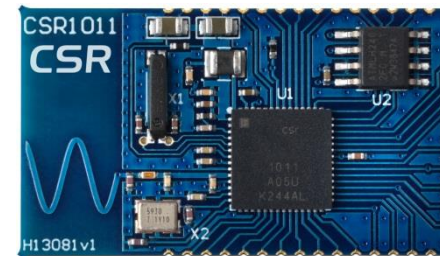
DK-CSR1010-10169-1A

CSR1010

CSR1012

CSR1011

Gang Programmer

CSR

- Supports up to 16 devices simultaneously

- Supports Flash devices using TestFlash DLL

- Supports EEPROM configuration using TestE2 DLL

- Increases throughput for production

SPI

Test PC
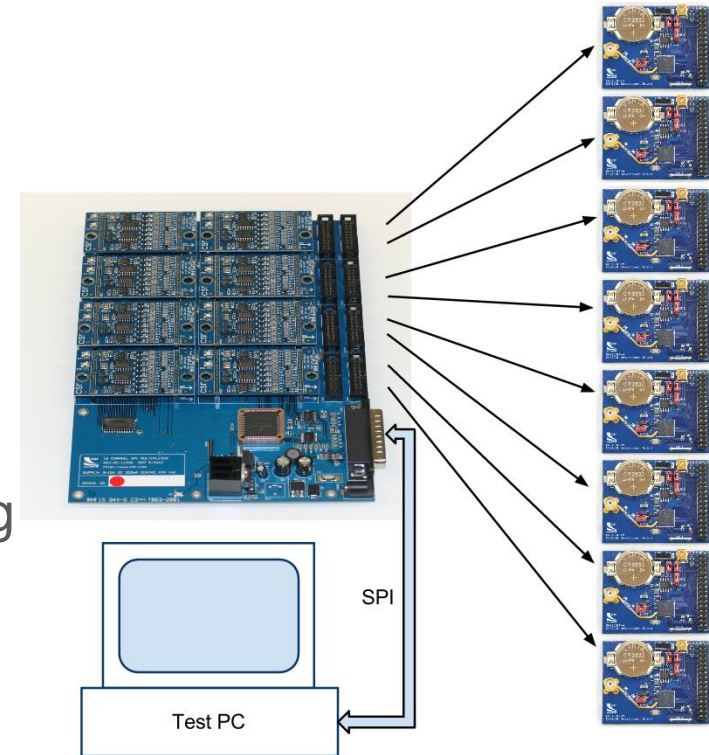
Tools support up to 16 instances of CNS10020V2A Interface Board
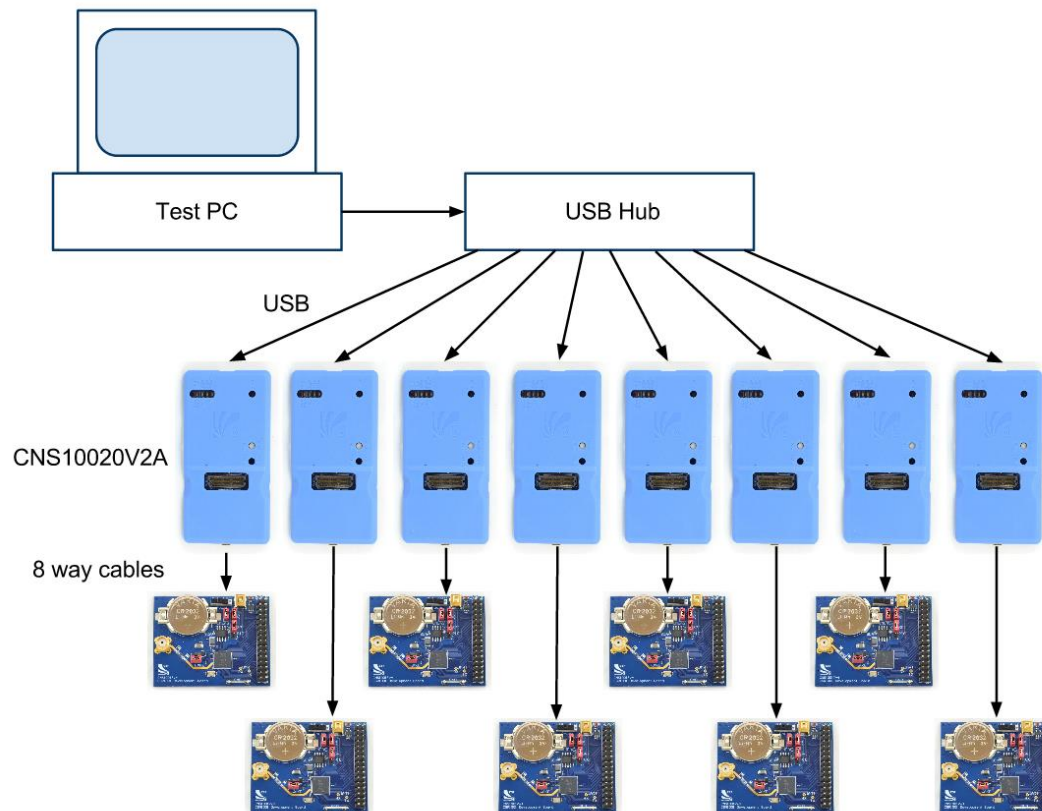
Low cost programmer board

- **Development Board**
  - Part Number: DK-USB-SPI-10225-1A
  - Price: USD $15
  - Description: USB to Debug SPI
  - Availability
    - Q1 2015
    - Via all CSR authorized distributors
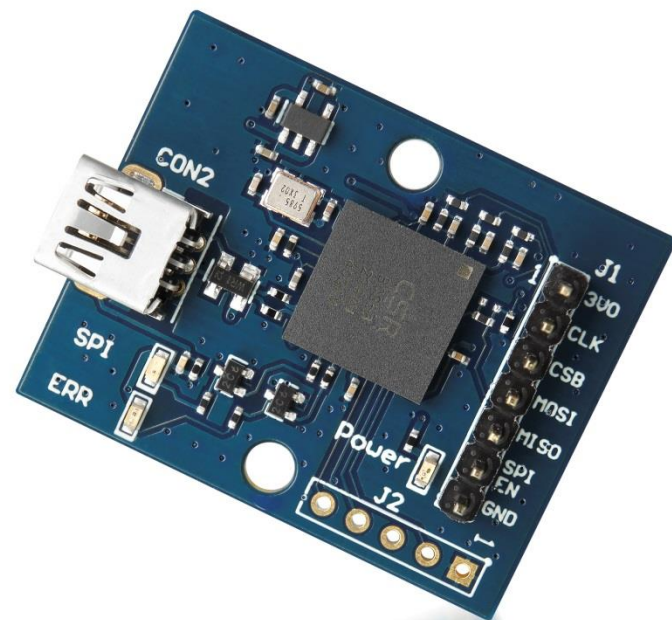
Low cost programmer board

- **Board Detail**
  - Board size: 35mm x 28mm
  - Debug SPI header
    (connector type: 7-way 0.1" pitch header)
  - Mounting holes 3.3mm hole with 22mm centre
  - LEDs for SPI activity, Power and Error status indication
  - USB Mini
  - Board H13516V1

Mounting hole 3.3mm

Debug SPI Header

22mm from centre

USB Mini

LEDs SPI and Error status indicator

Mounting hole 3.3mm

LED Power

26
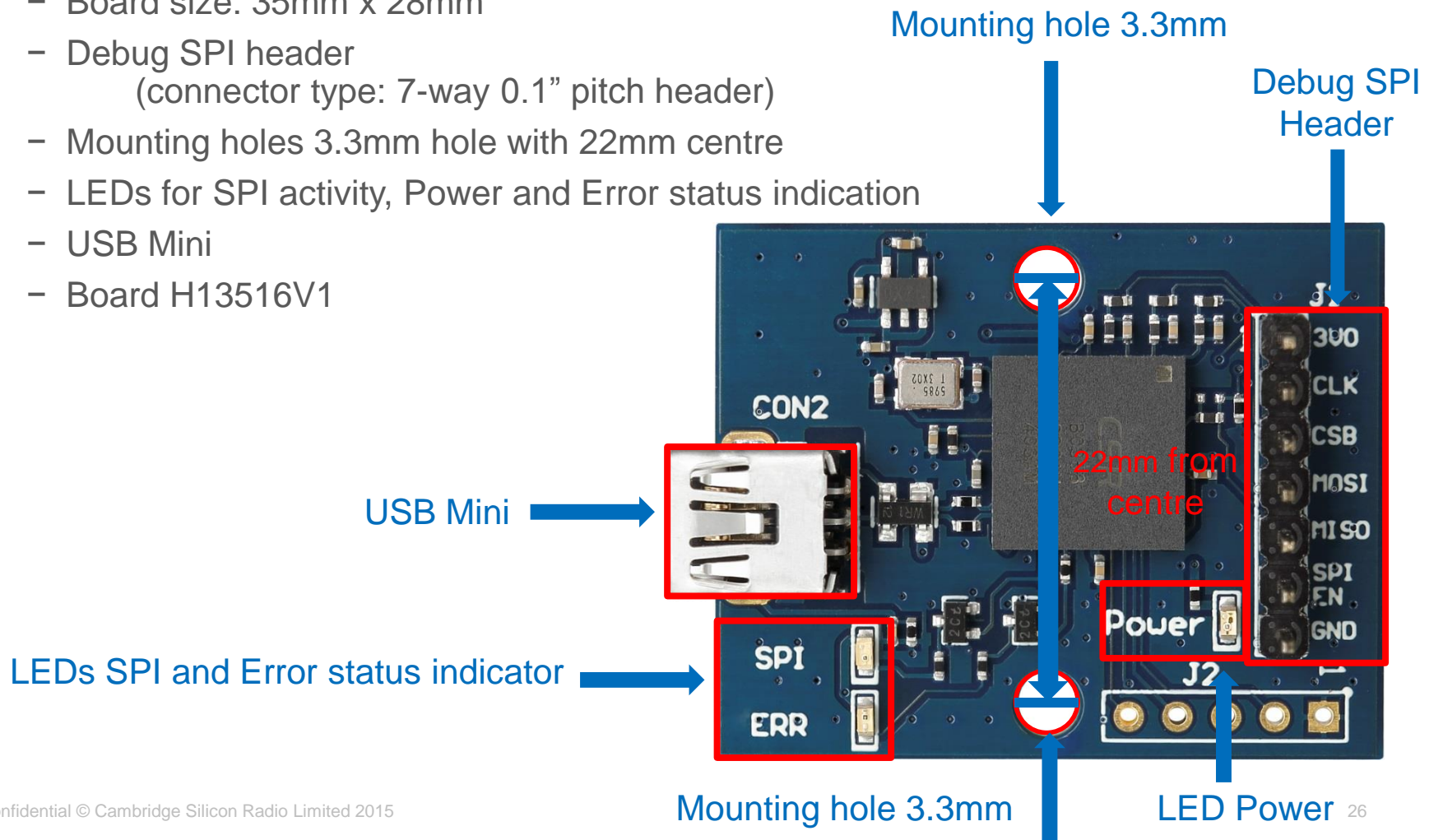
CSR µEnergy Test Tool

- Choose the correct "PTest firmware"
- CsKeys affect the RF testing result
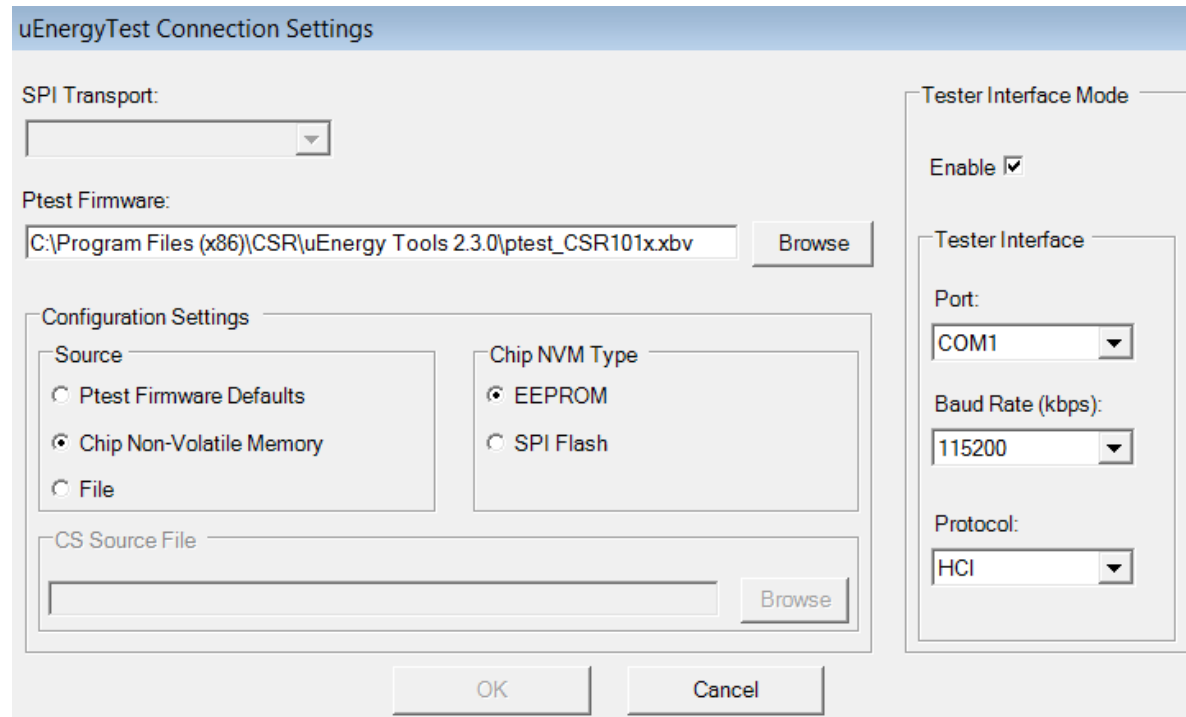
Note: CSR µEnergy PTest firmware is released as part of the CSR µEnergy Tools, and is downloaded to RAM on the CSR101x ICs to enable RF and other hardware test modes

CSR µEnergy Test Application Tool

- Application for testing of the board

- Various test functions available
    - RF functions
    - PIO Get/Set
    - AIO Get/Set
    - LED Set
    - UART Loopback

- "Reconnect" will show connection dialog then stop and reset chip after connection parameters selected
- "Cold Reset" will re-load same firmware and configuration as before without showing connection dialog
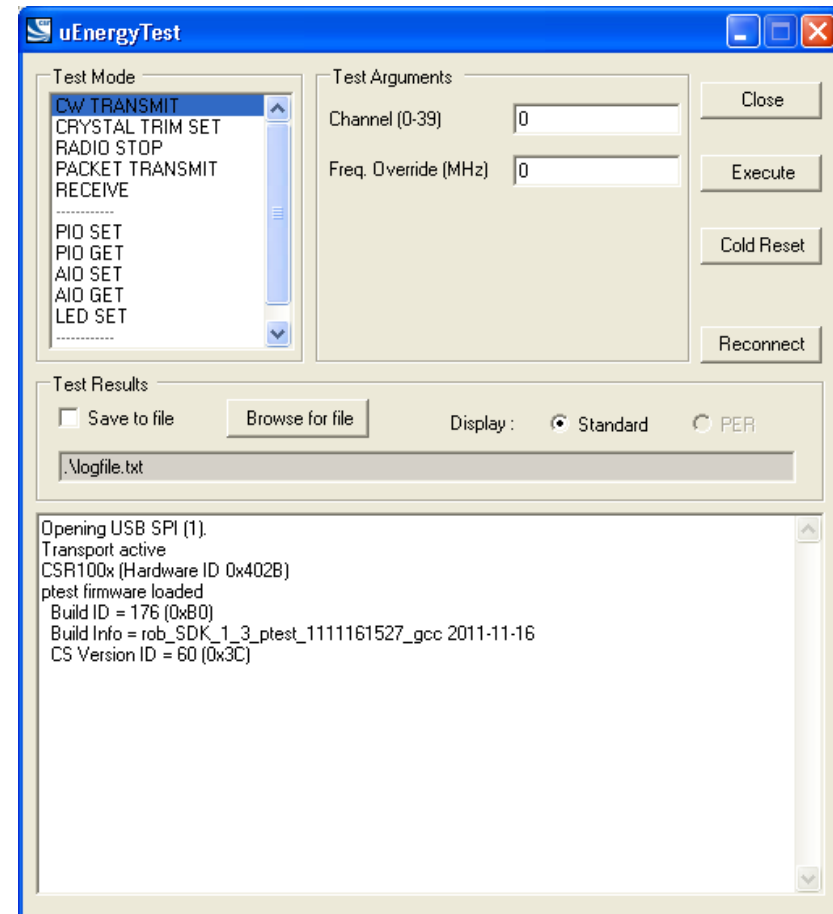
Crystal trim

- Trimming the crystal is an important part of the configuration of CSR101x design. A board with incorrect crystal trim value may suffer from poor RF performance (range, carrier frequency drift, sensitivity) that will affect the overall operation of the device
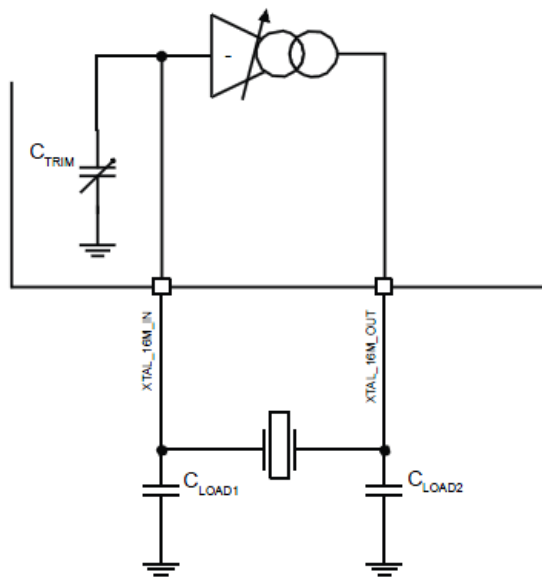
C_{LOAD1} and C_{LOAD2} in combination with C_{TRIM} and any parasitic capacitance provide the load capacitance required by the crystal

- Direct Test Mode is used to control the Device Under Test (DUT) and provides a report back to the Tester
- Direct Test Mode shall be set up using one of two alternate methods:
    1. over HCI or
    2. through a 2-wire UART interface
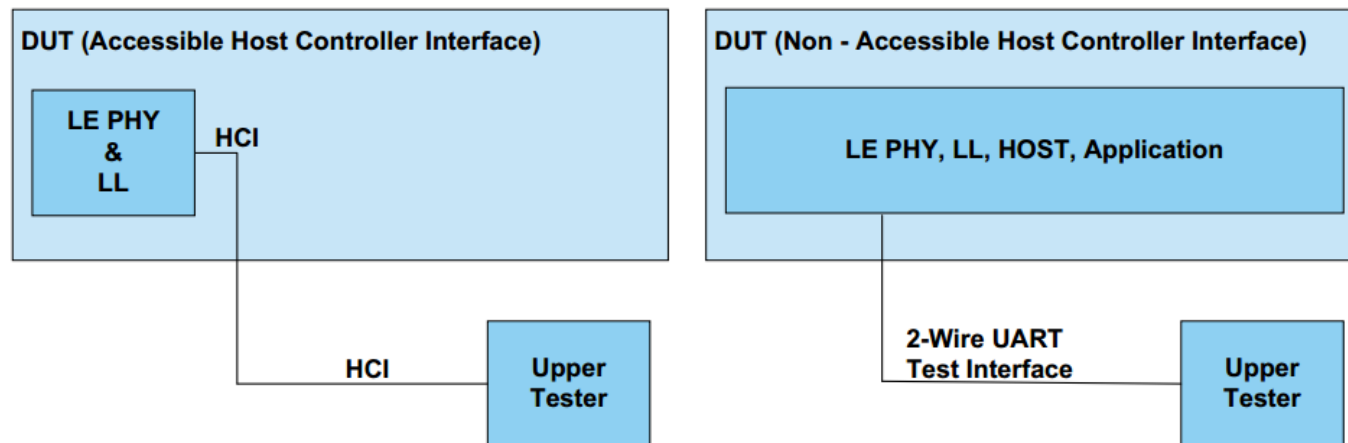
- The unit under test needs the CSR Direct test mode firmware to be loaded into it or for the same API calls to be built into the customer application
- To use a direct test, UART TX and RX test points are required on the PCB

Wired RF

CNS12016v1

Use DC power supply
instead of battery
during the tests

DUT

TESTER

(TTL) 2-wire LE
HCI Transport

Level Shifter
(RS232 – TTL)

(RS232) 2-wire
LE Transport
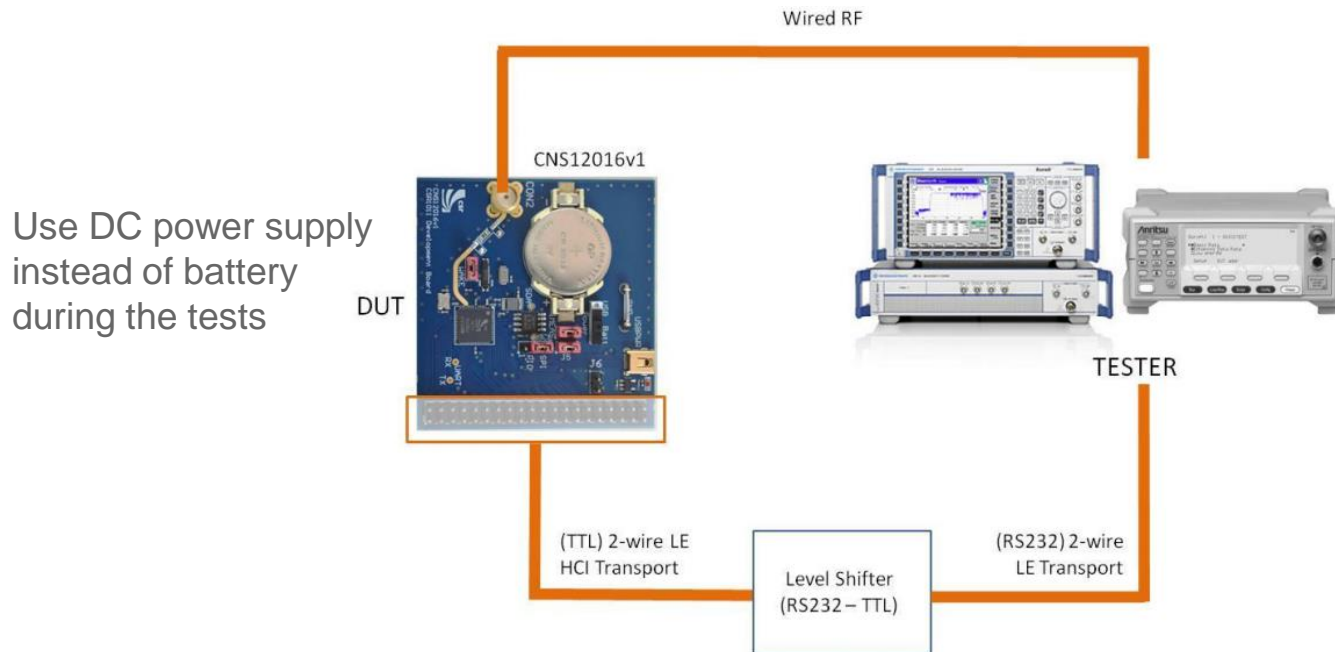
An example Direct Test Mode application project is available as an example app within the SDK

- Debug SPI could be also used for RF testing – for designs that lack spare PIOs or test points for UART interface

RF

Tester (Any)

Use power supply instead of battery during the tests

DUT

RS232 (UART)

SPI

SPI Level Shifter

SPI

Test PC

CSR
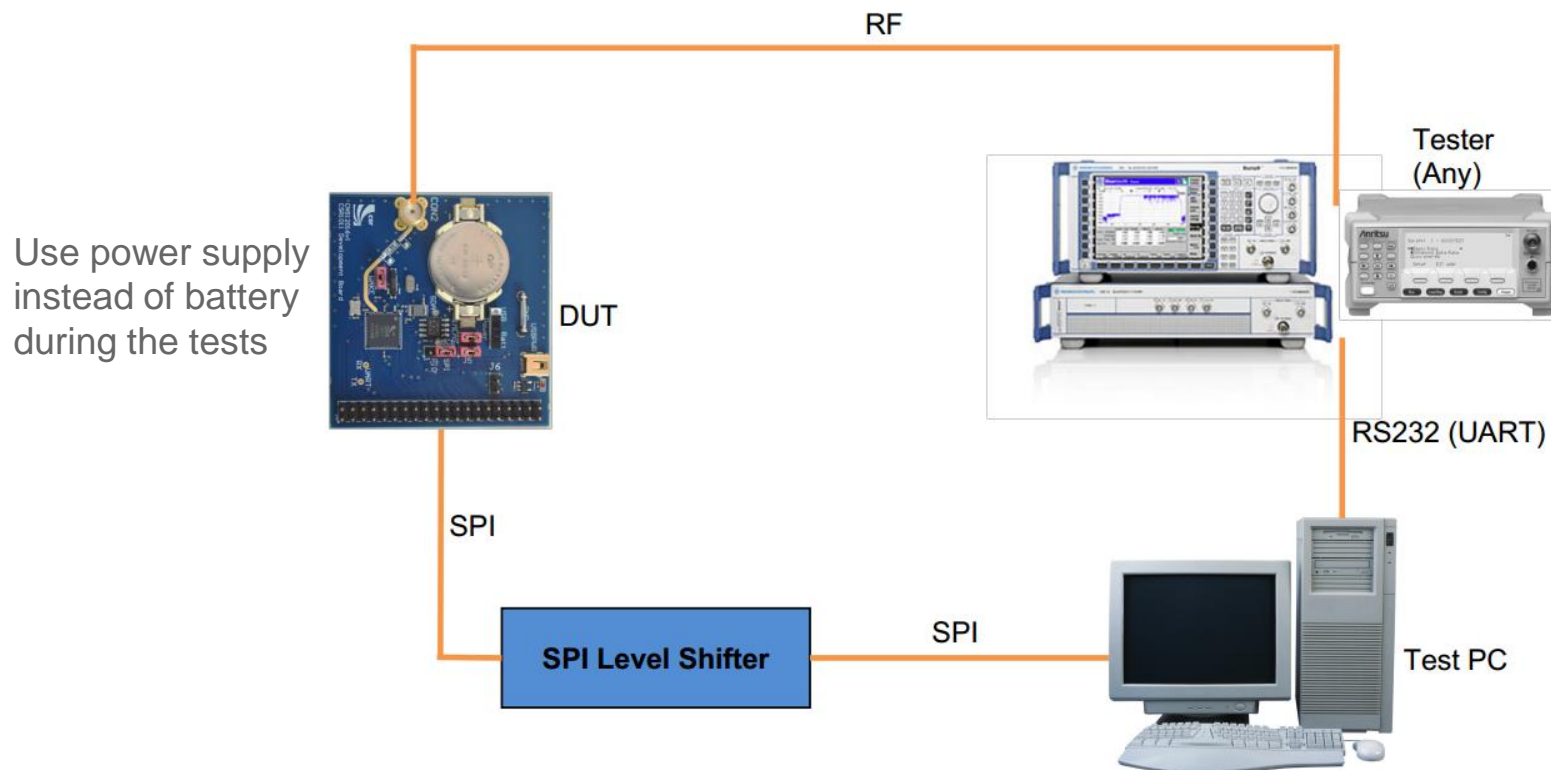
Push every boundary.™

Qualification for Bluetooth 4.1

Qualification for Bluetooth 4.1

- Bluetooth 4.1 improves usability for consumers, empowers innovation for product developers and extends the technology's foundation as an essential link for the Internet of Things

- The qualification process remains the same for all Bluetooth specifications

- Core Specification versions 2.0 +EDR, 2.1+EDR, 3.0+HS and 4.0 are still available for use and qualification

Qualification for Bluetooth 4.1

CSR

- SIG RF LE Test Cases

Test Case/Parameter	Temperature	Power Supply
TRM-LE/CA/01/C (Output power at NOC)	Nominal	Nominal
TRM-LE/CA/02/C (Output power at EOC)	Max/Min	Max/Min
TRM-LE/CA/03/C (In-band emissions at NOC)	Nominal	Nominal
TRM-LE/CA/04/C (In-band emissions at EOC)	Max/Min	Max/Min
TRM-LE/CA/05/C (Modulation characteristics)	Nominal	Nominal
TRM-LE/CA/06/C (Carrier frequency offset and drift at NOC)	Nominal	Nominal
TRM-LE/CA/07/C (Carrier frequency offset and drift at EOC)	Max/Min	Max/Min
RCV-LE/.CA/01/C (receiver sensitivity at NOC)	Nominal	Nominal
RCV-LE/.CA/02/C (receiver sensitivity at EOC)	Max/Min	Max/Min
RCV-LE/CA/0A/C (C/I- and selectivity performance)	Nominal	Nominal
RCV-LE/CA/04/C (Blocking performance)	Nominal	Nominal
RCV-LE/CA/05/C (Intermodulation performance)	Nominal	Nominal
RCV-LE/CA/06/C (Maximum input signal level)	Nominal	Nominal
RCV-LE/CA/07/C (PER Report Integrity)	Nominal	Nominal

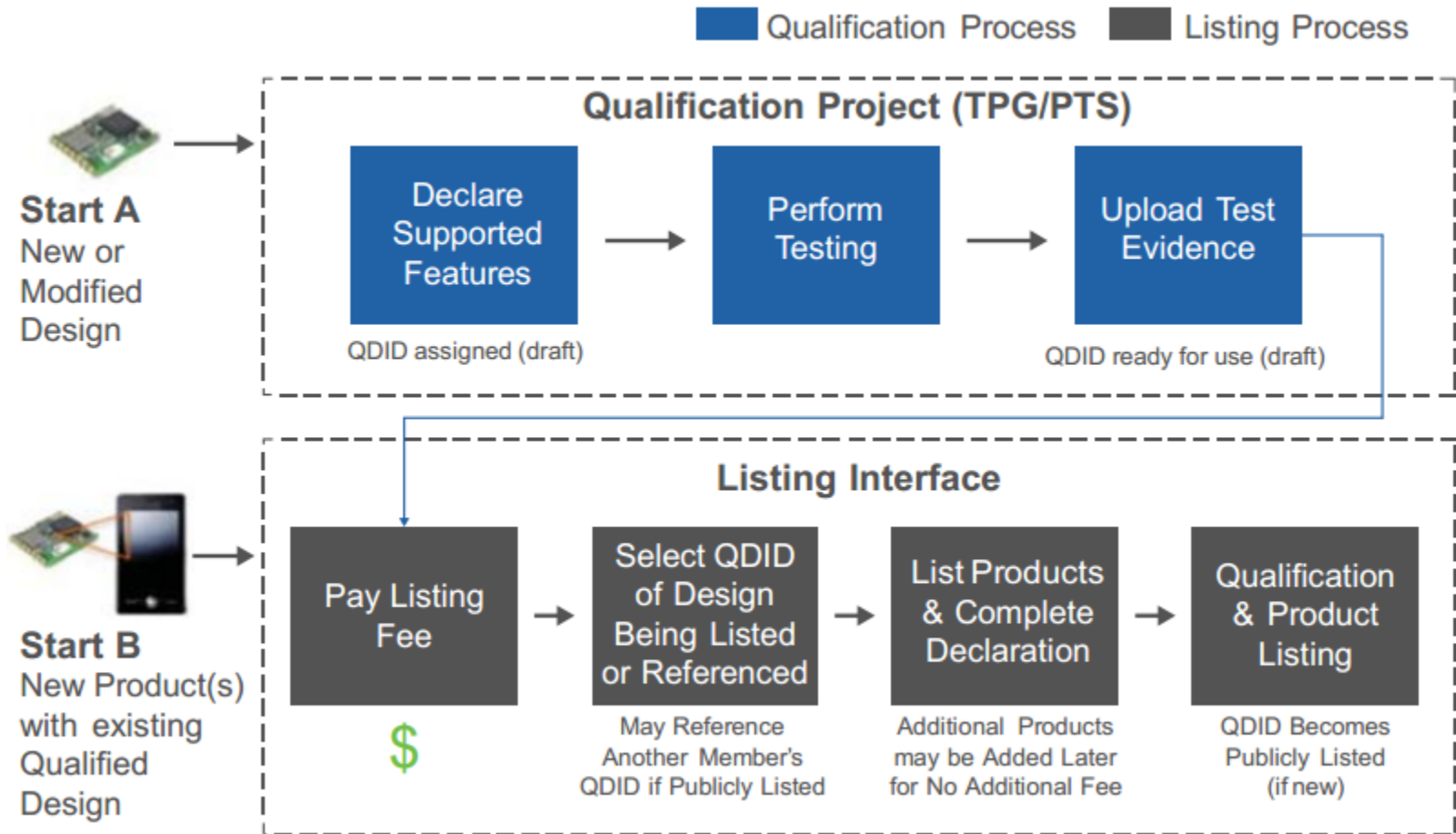**NOC = Normal Operating Condition**
EOC = Extreme Operating Condition

Note: Test cases in red require complex or expensive resources and are often omitted for pre-production line testing

New listing process from February 2014

- Discontinuing the QDID fee

- A new listing fee - either USD $8000 or USD $4000 depending on membership level

- Issuing a Declaration ID as your proof of purchase
  - The Declaration ID is a unique identification number assigned to a listing and used as a reference for the member's Declaration of Compliance (DoC)

- Simple Listing Process
  1. Create Qualification Project (new designs)
  2. Pay listing fee
  3. Reference a qualified design (QDID)
  4. List associated product(s)

CSR

Push every boundary.®