bqTESLA Wireless Power TX Trouble shooting Guide

Rev 1.0 – Dec 3, 2014

TX Trouble Shooting

- This Guide is based around the bq500212A but is applicable to other TX designs. Key difference will be in the Sleep & Snooze circuit.
- The User's guide for the EVM is a good reference for a working circuit and expected performance.
- Do not try to de-bug too much at once.
  - Use a know good RX or TX for testing.
  - If new RX or TX coil are also part of the design try to start with proven coils.

Test Set-Up Configuration

- When testing a new TX for the first time we recommend:
  - Test with a know good RX, TI has several EVMs that would work well.
  - Disable Sleep / Snooze mode by shorting the LED Mode resistor to ground. The Sleep & Snooze function will be internally controlled. Note-LED will be off.
  - Disable FOD and PMOD by removing resistors on Mod_Threshold pin. Open on the pins is disable.

First Power up and standby

- **Check out steps—NO RX:**
  - Good to check for short on the power bus before applying power.
  - Voltage regulators.
    - 3.3V, V33D
    - 5V, V-gate regulator (does not apply to bq500212A)
    - Voltage at top of power section, after current sense resistor.
  - Digital PWM
    - With no RX on the unit check digital PWM output from the IC this should be a burst of pulses at about a 500mS interval. (scope shot)
  - Power Section:
    - H-Bridge drive at power switch will switch from ground to V-in

Normal Start Up with RX

- **Check out steps—RX-NO load:**
  - Monitor the TX Coil Voltage, RX V-rect and RX out.
  - Place RX on the TX and compare wave form with figure XX
    - The V-rect should rise above UVLO, 2.7VDC.
    - The SS, ID and Config packet should be visible
    - Next the voltage on V-rect will change as CEP are sent, voltage will typical increase.
    - When V-rect has reached target voltage output voltage will turn on.
    - TX coil voltage is flat for SS, ID and Config Packets but will change with CEP packets.
- Increase Load:
  - Device can support up to 5W output power. Load can be increased across the expected load range.
  - A good measure of performance is efficiency, see EVM User's Guide for typical performance of your device.
  - Note efficiency will be low at light loads but increase as higher load.
  - Max efficiency is about 75%

bq500212A & bq51013B Start Up

Signal strength
ID
Configuration
Packets

Vrec is greater than
UVLO
bq51013 starts

Power Transfer
Tuning to 7.5V using control
error packets

Note that the first phase (extended digital ping) is at 175kHz.
During Power transfer the freq is
changed

Possible Problems at Start Up

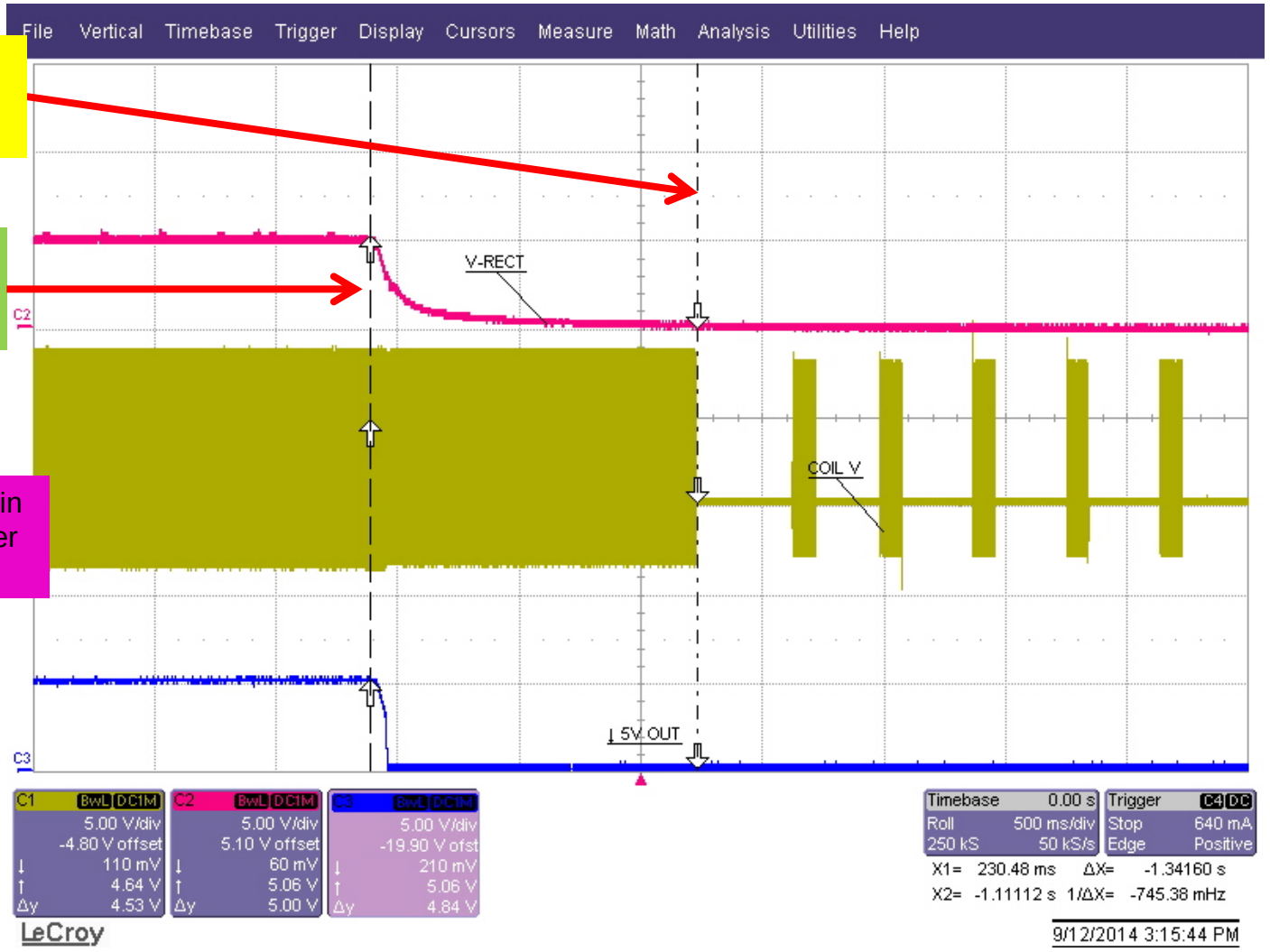
- For the TX to start or continue power transfer it must decode the packets set by the RX.
  - Problems in communication can be seen during the digital ping phase, RX will reply but the TX will still stop sending power.
  - During power transfer phase the TX must decode a valid packet every 1.5 seconds or power transfer will stop.
- A large number of problems can cause communication problems.
  - Noise corrupting COMM+ signal
    - Noise on the voltage into the sample / bias ckt, local decoupling required
    - Noise due to layout of Comm +/- trace, etch should be parallel and avoid high noise areas.
    - Grounding and VCC filtering of bq500XXX, the decoding will use high speed digital circuits that are effected by poor decoupling.
    - Ground plane noise---a solid unbroken ground plane layer is required to reduce noise.

Removed RX and TX shutdown after 1.5 sec

TX Stops power transfer after 1.5Sec

RX Removed
Note – TX continues Power Tranfer

If no valid CEP are received in 1.5 sec the TX will stop power transfer

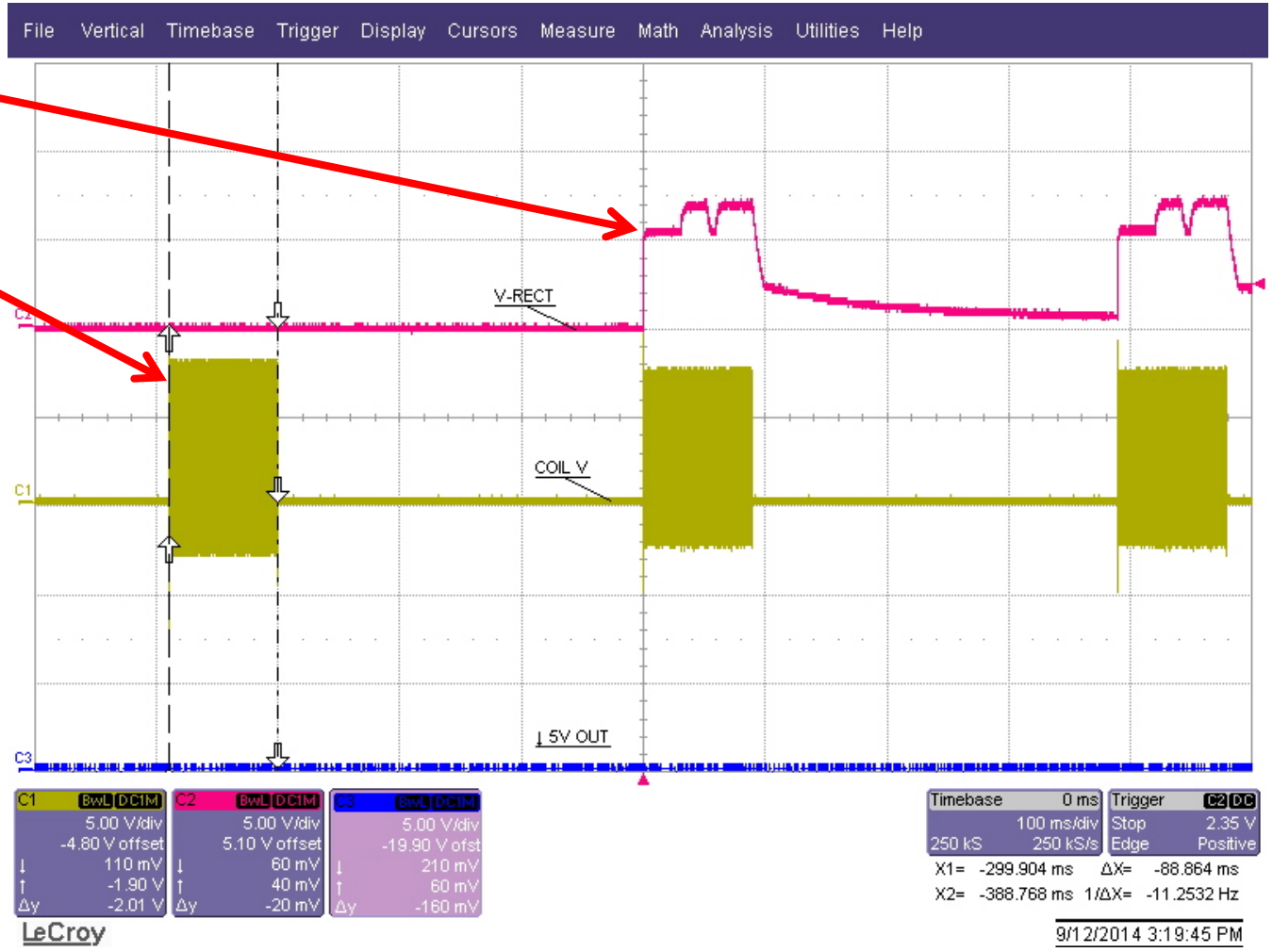


Failure to start

RX Sends Packets but TX does not receive them Power transfer does not start

Typical digital ping is 70mS

Note TX will stop power Transfer Immediately during SS/ID/CONFIG stage
After power Transfer Starts the 1.5 sec rule applies



Testing of Sleep and Snooze

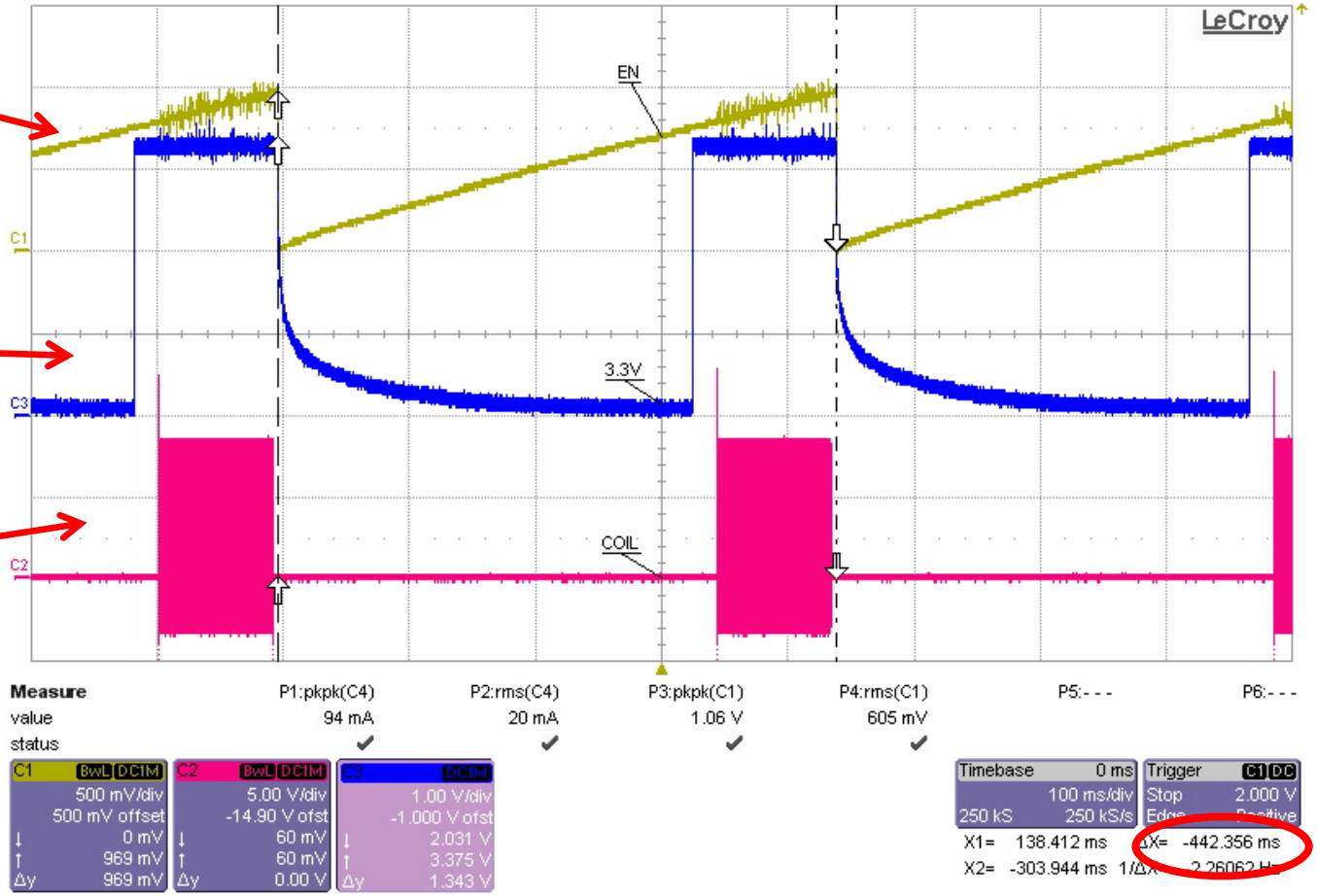
- **Snooze** ckt is used to reduce power during standby, device will power down of about 500mS
- **Sleep** ckt is used to reduce power during charge complete or fault condition by turning the device off for about 4 seconds.
- Enable external Sleep & Snooze by removing the short across LED_Mode. Make sure you cycle power to enable change.
- Verify that with NO RX on the TX Snooze Circuit will control 3.3V enable line turning off the device at a 500mS interval. Time is set by the RC time constant of the circuit. Start of the off cycle is controlled by a pulse from the bq500XX to discharge the timing capacitor.
- Snooze circuit will use the same approach with a longer time constant.
- A bq51013B EVM can be configured to send charge complete by setting EN1 and EN2 high. See UG for more info.

Snooze Time Out -- Standby

3.3V LDO EN pin / C22

TX 3.3V LDO Output

TX Coil Voltage

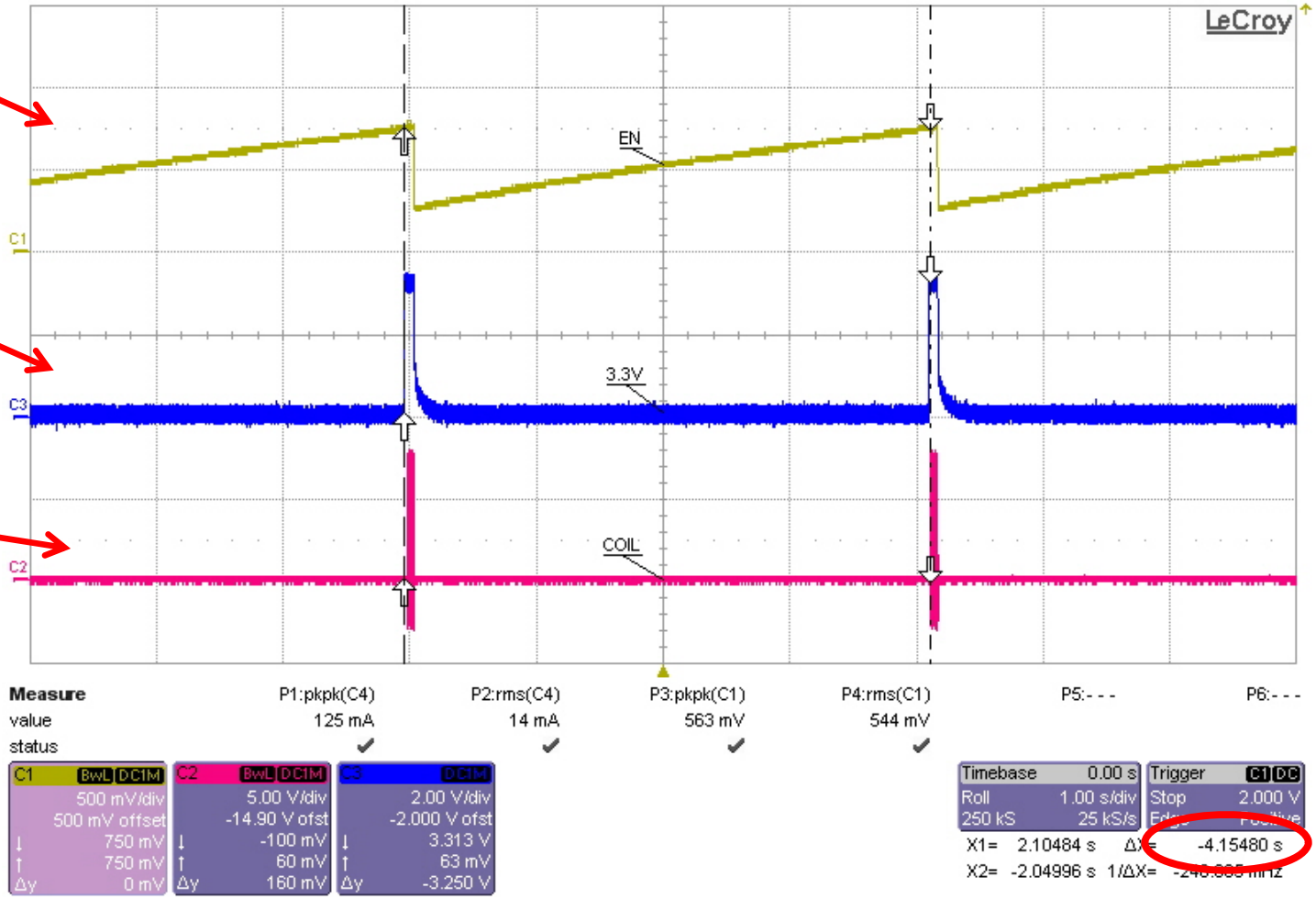


Sleep Time Out --- EPT01

3.3V LDO EN pin / C22

TX 3.3V LDO Output

TX Coil Voltage



Power Section Problems

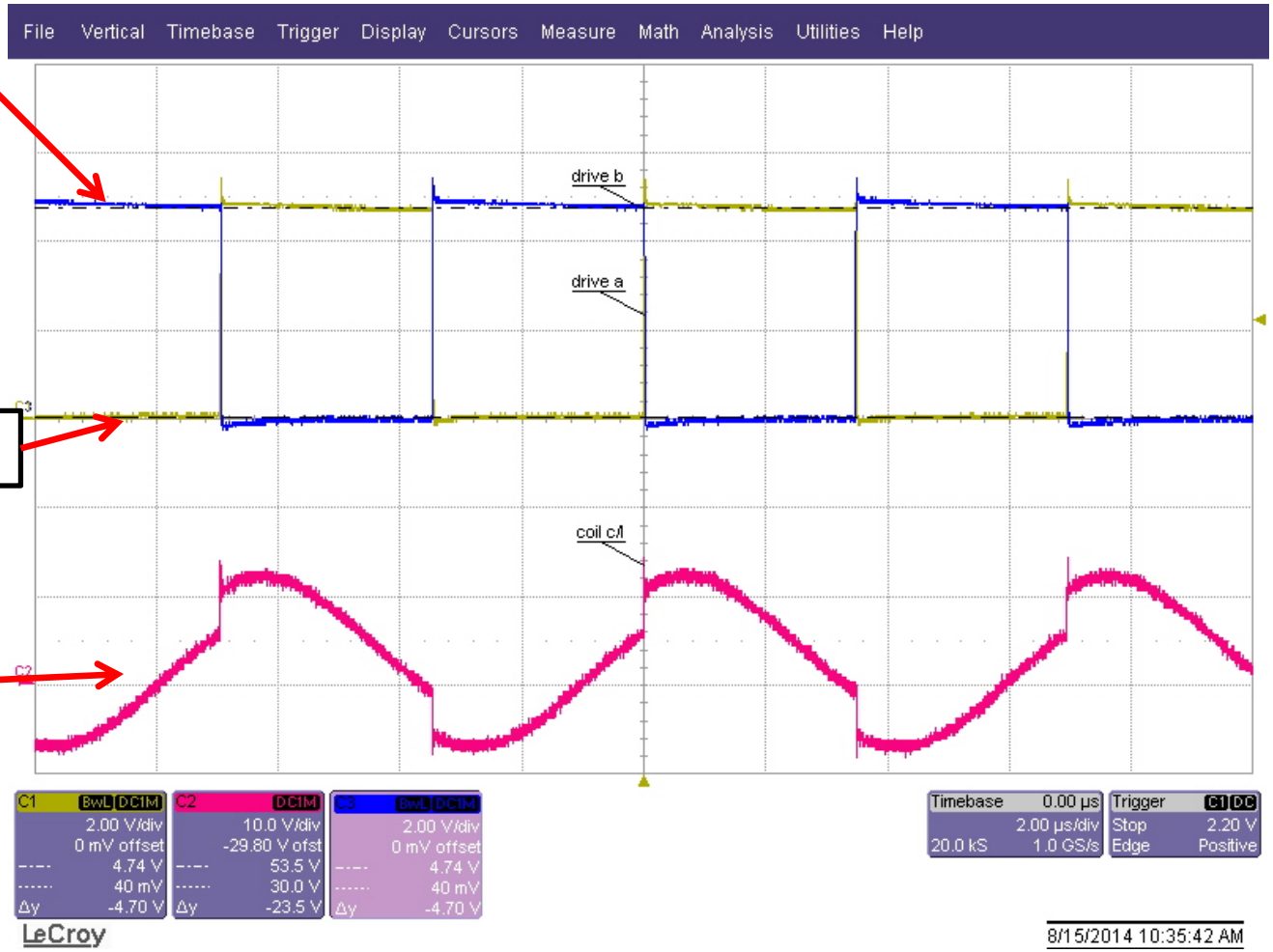
- Power Transfer between the TX and RX will have an efficiency of about 74% but this depends on several factor.
  - Load—Efficiency will be low at light load, less 500mA.
  - TX Coils—It is recommended to use a standard WPC coil. TX coil design is difficult and time consuming.
  - RX Coils---The RX Coil is typical designed specicly for the application. Size, Shape, Wire DCR and shield will change efficiency.
  - Power Section—Selection of lower loss parts such as low RDSon mosfets and low loss COG/NPO capacitors will improve efficiency.

Coil Drive bq500212A EVM at 1A Load

Drive A signal

Drive B signal

Coil C / L node Tank Voltage



Typical Start Up Problems you May see

- What does a start up problem tell me?
  - Consistent digital ping width and RX replies
    - The TX is not decoding any of the packets from RX, Communication failure
  - During digital width will vary, see part of SS, ID and Config
    - During decoding if an error is detected power transfer will stop. This only applies to the first three packets.
  - Power transfer will start but only see priority packets then power transfer stops and restarts.
    - After SS, ID & Config power transfer will start with priority packets used to tune operating point to target.

For Further Reference – resources available on-line

- TI Wireless Power Landing Page: www.ti.com/bqtesla

- Application Notes and Articles on TI Website (type in literature number – "SLxxx" into the search window at www.ti.com to access each document):
  - SLUA649: "bqTESLA Transmitter Coil Vendors" Application Note
  - SLUA635A: "Building a Wireless Power Transmitter"
  - SLYT477: "Qi-compliant Wireless Power Receiver Coil Design Guidelines" article in TI Analog Applications Journal (Q3 2012)
  - SLYT399: "An introduction to the Wireless Power Consortium standard and TI's compliant solutions" TI Analog Applications Journal (Q1 2011)

- "Universally Compatible Wireless Power Using Qi Protocol"
  - http://www.low-powerdesign.com/article_TI-Qi.html

- http://www.wirelesspowerconsortium.com/