TRN-2013 Integration Specification

On-Ramp Wireless Incorporated
10920 Via Frontera, Suite 200
San Diego, CA 92127
U.S.A.

TRN-2013 Integration Specification

014-0057-00 Rev. B

June 4, 2013

Contents

Figures

Tables

Revision History

Revision	Release Date	Change Description
A	September 13, 2012	Initial release
B	June 4, 2013	Updated product names, block diagram, and regulatory/certification information.

1 Overview

The purpose of this document is to provide guidelines allowing an integrator to design a host product that uses the TRN-2013 MCM (Meter Communications Module) and ensures that the system meets all of its technical objectives and requirements.

1.1 On-Ramp Wireless Total Reach Network

The On-Ramp Wireless Total Reach Network is comprised of host modules, such as TRN-2013 modules equipped with microNodes, and Access Points (APs). The network operates in the unlicensed 2.4 GHz ISM band. The TRN-2013 circuit board is designed to easily integrate into electric meters, through standard interfaces, enabling robust wireless communication with one or more APs interfaced with a service provider's local or wide area network.

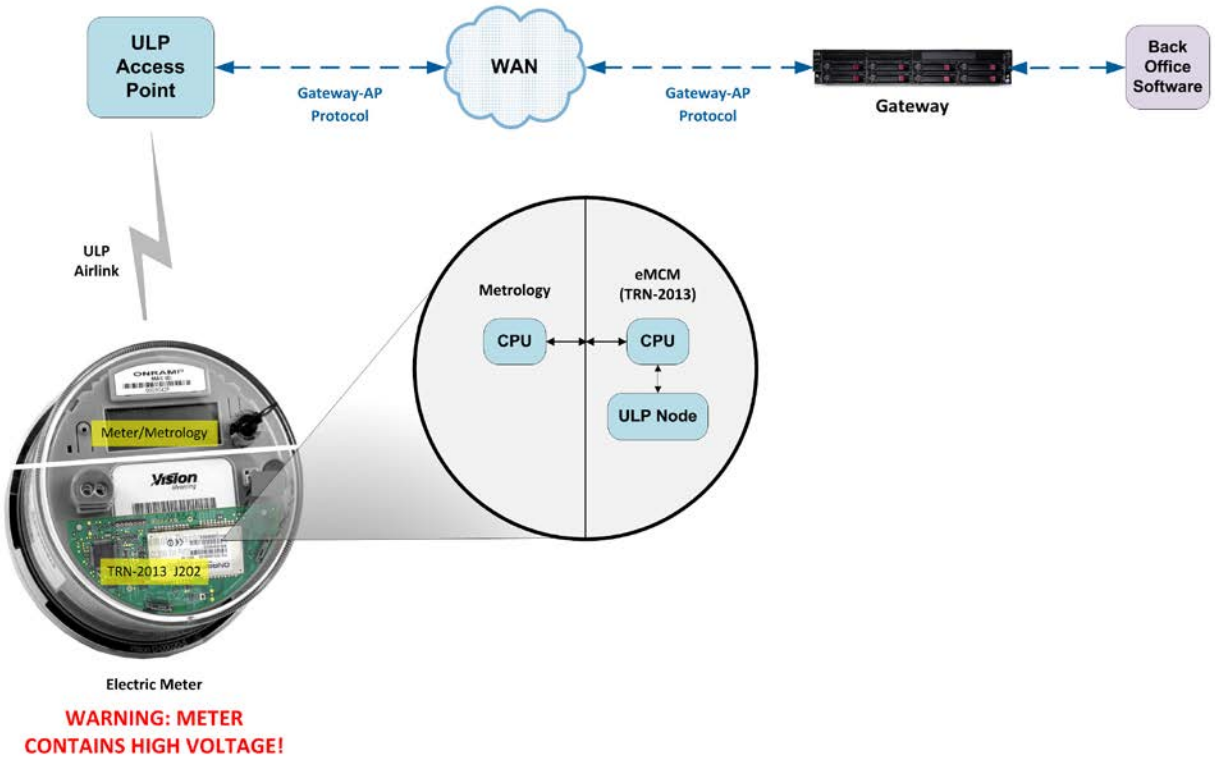


Figure 1. On-Ramp Wireless Total Reach Network

1.2 Referenced Documents

The following documents are referenced and provide more detail:

- **TRN-2013 FCC and IC EMC Compliance Grants**
  These are the Regulatory Grants issued by their respective governments.
- **Provisioning Guide (010-0074-00)**
  Describes setup, configuration, and use of a collection of utilities called Node Provisioning Tools (NPT) used for Node provisioning.
- **Node Host Message Specification (014-0020-00)**
  Provides details relating to Node Host commands and messages.
- **Node Interface Library (UNIL) (010-0066-00)**
  Provides information about the library of portable C code provided by On-Ramp Wireless which can be integrated into a customer's existing software architecture.
- **UNIL API (010-0072-00)**
  Provides details relating to the UNIL Application Programming Interface.

2 DC and RF Characteristics

2.1 Absolute Maximum Ratings

Operation outside of the Absolute Maximum Ratings may damage the module.

Table 1. Absolute Maximum Ratings

Parameter	Min	Max	Unit
Storage Temperature (Ts)	-40	85	ºC
Ambient Temperature (Ta)	-40	85	ºC
Input Voltage (VBATT)	0.0	5.0	V

2.2 Recommended Operating Conditions

Operation outside of the Recommended Operating Conditions may not yield proper operation.

Table 2. Operating Conditions

Parameter	Min	Max	Unit
Ambient Temperature (Ta)	-40	85	ºC
Input voltage (VBATT)	3.0	4.4	V

2.3 Operating Characteristics

The following characteristics apply across the -40°C to +85°C temperature range unless otherwise noted.

Table 3. Operating Characteristics

Parameter	TRN-2013 Module
Wireless Frequency	2.4 GHz ISM
Bandwidth	1 MHz nominal
Protocol Standard	IEEE 802.15.4k
Modulation	Dynamic-Direct Sequence Spread Spectrum (D-DSSS)
Multiple Access Scheme	Random Phase Multiple Access (RPMA)
Transmit Power (peak EiRP)	+23 dBm (FCC/IC)
Receive Sensitivity	-136 dBm (includes peak antenna gain)
Antenna	Integrated antenna diversity
Data Throughput	60 kbps (at access point in 1 MHz channel bandwidth)
Outdoor Range (FCC/IC markets)	Pole Top: 4 – 6 square miles Building Top: 70 – 400 square miles Communication Tower: 140 – 420 square miles

Parameter	TRN-2013 Module
Maximum Allowable Path Loss	172 dB (FCC/IC)
Current Consumption	0.22A max. @ 4VDC (during TX[1]) 0.20A max. @ 4VDC (during RX[2])
Operating Temperature	-40°C to 85°C
Relative Humidity	5% to 95% non-condensing
Security	AES 128-bit payload encryption, mutual authentication of network elements
Certifications	FCC and IC EMC certifications for TRN-2013 are pending. Meter ANSI and Unintentional Radiator certifications required once integrated into the meter product.
Note: Specifications subject to change	

NOTE 1: During TX mode the supercap charger is disabled to reduce peak currents.

NOTE 2: During RX mode the supercap charger is enabled. The supercap charge current is limited to about 110mA.

2.4 Power Supplies

The TRN-2013 utilizes two main power supplies when it is functioning:

1. **Main switching power supply (3.3VDC output).**
   This main buck-boost power supply is operating at all times. It supplies power to all digital and radio circuits.
2. **Supercap Charger (~4.4VDC output).**
   This boost type switching power supply is used to charge the super capacitors. It can only operate with an input supply up to about 4.4VDC. It is in use at all times when primary power is applied. Once primary power is interrupted this power supply is disabled and the super caps supply power to the main switching power supply.

Additionally the microNode module on the TRN-2013 printed circuit board has its own switching power supply (buck-boost) that uses, as its source, the main switching power supply of the TRN-2013.

3 Electrical Interface

This chapter describes the electrical interface of the TRN-2013.

3.1 Signal Connectors

Both sides of the TRN-2013 printed circuit board are shown below.

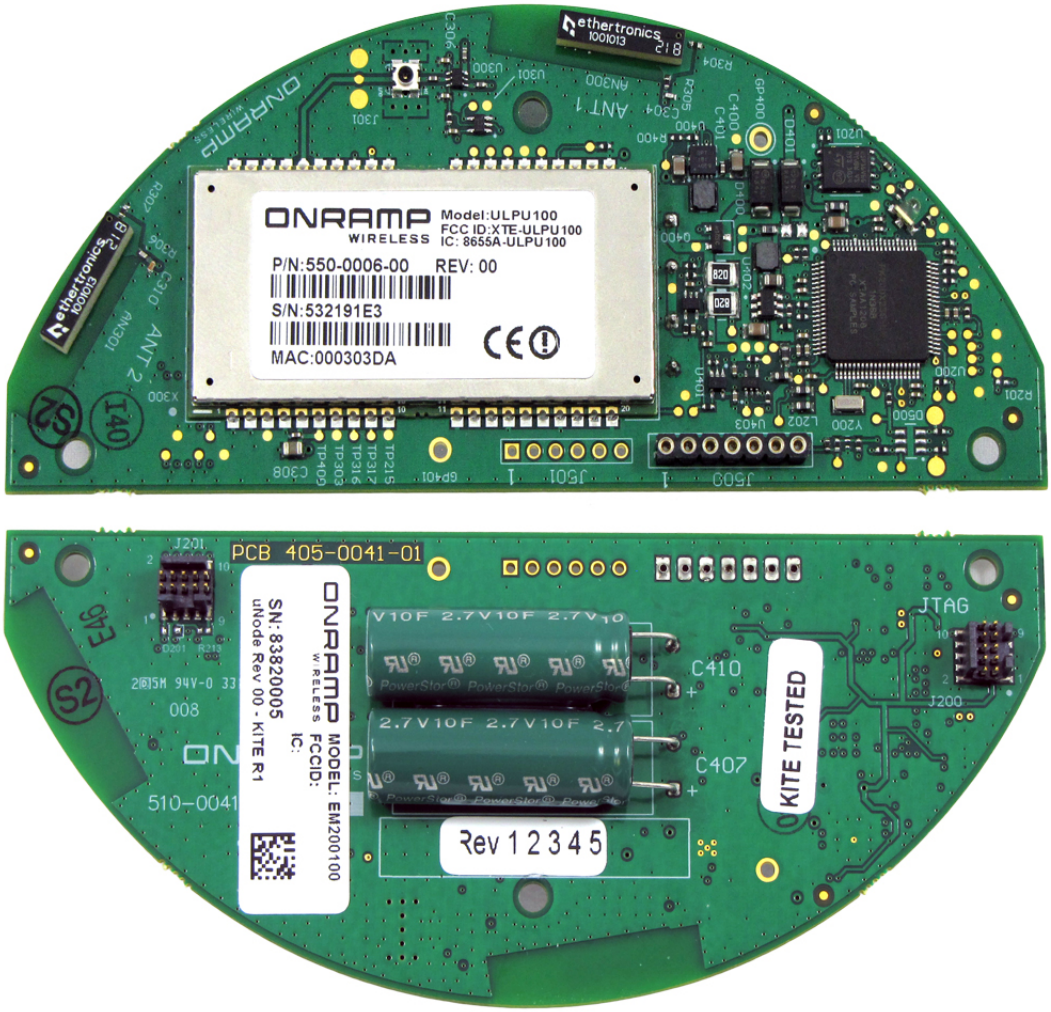


Figure 2. TRN-2013 Printed Circuit Board

3.2 Pin and Signal Descriptions

The following table lists the pins and signals for the J500 connector.

Table 3. Pins and Signals for J500 Signal and Power Connector

MCM Pin #	Pin Name	Signal Description
1	TX	Transmit signal from Meter
2	RX	Receive signal from Meter
3	GND	Signal ground (not Earth ground)
4	VCC	AMI power input; 3.3VDC nominal.
5	METER_ERROR	Meter Error – AMI must go read status
6	METER_READY	Meter Ready – Ready from communications
7	YPULSE	Power Fail from Meter

3.3 Environmental

3.3.1 ESD

The TRN-2013 has bidirectional ESD protection diodes on its 8 digital I/O pins providing protection to IEC 61000-4-2; level 4.

Table 4. ESD Rating

ESD Model	Class and Minimum Voltage
HBM	Class 1C (>1000V)
MM	Class A (>100V)

The antennas have protection in the form of an inductor to ground, thus allowing some robustness to direct ESD strikes. Additionally, the antennas are encapsulated in the polycarbonate housing of the meter – so there is little chance of high voltages on the antennas, or others of the board.

3.3.2 Harsh Environments

The TRN-2013 is designed to be an embedded circuit board in an enclosed protective shell. It is not designed to be exposed to outdoor environments without a case or similar protection. An IP 67 or better protective casing is strongly recommended. The polycarbonate dome of the meter nominally provides robustness to harsh environments.

4 Safety Considerations

Danger: High Voltages

When the TRN-2013 is integrated into the meter, high voltages are present:

CAUTION: When the TRN-2013 is mounted in a a Meter, the term “GND” or “Ground” does NOT refer to Earth ground. All signals will have a 120/240/480VAC power superimposed onto those lines. All signals to/from the TRN-2013 need to be isolated. No grounded instruments or computers should touch the TRN-2013 signals.

It is recommended to use the following isolation/drivers.

Isolator:

http://www.bb-elec.com/product_family.asp?FamilyId=651&webSyncID=85656815-ad8a-a188-b050-1143ad0dee45&sessionGUID=bc450985-a6c1-9981-a0d7-6391dcb1c046

UART:

http://www.digikey.com/product-detail/en/TTL-232R-3V3-WE/768-1016-ND/1836394

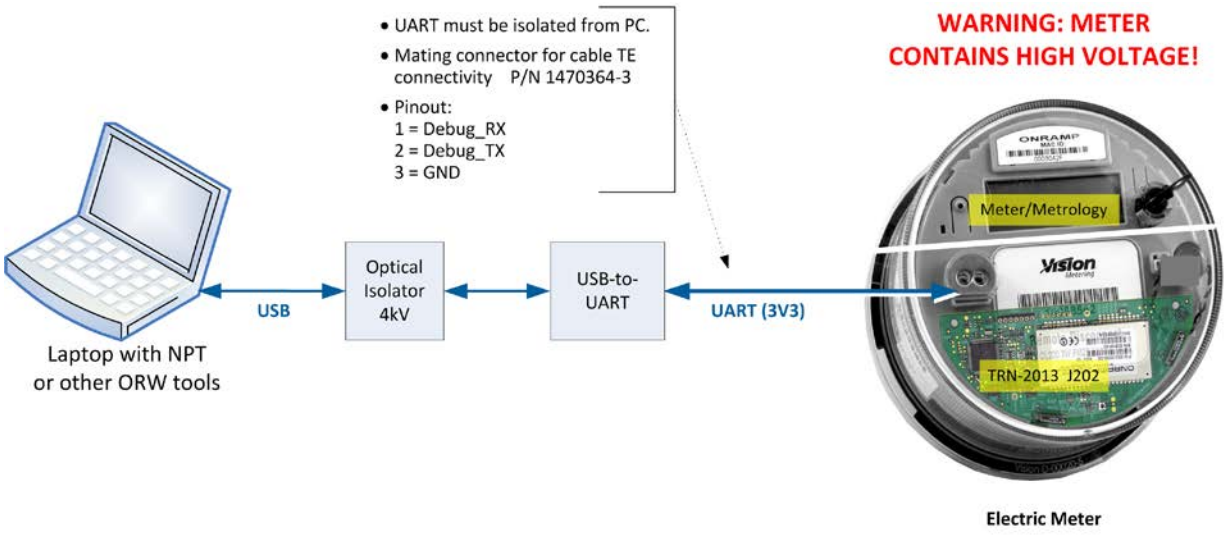


Figure 4. Meter Test Connection Diagram

5 Regulatory Considerations

5.1 Block Diagram

Some regulatory domains require a block diagram of the module for their documentation similar to that shown in the following figure.

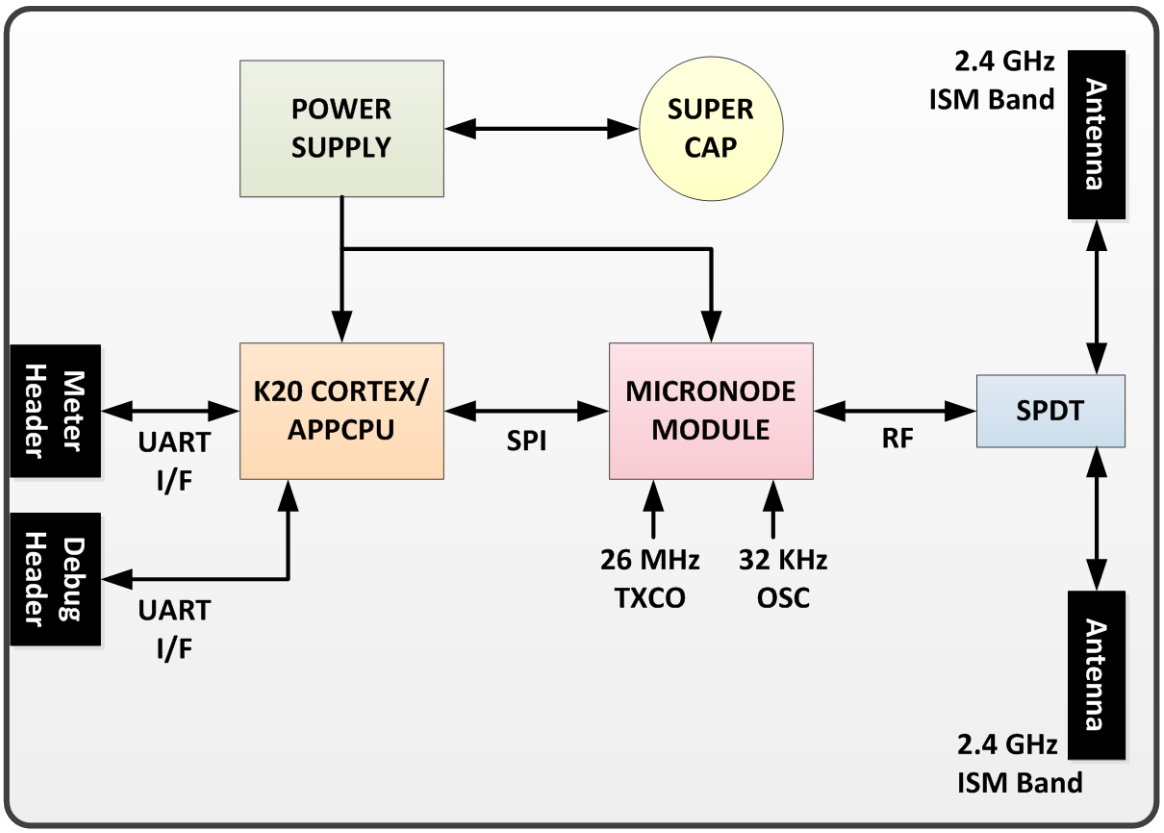


Figure 5. TRN-2013 Block Diagram

5.2 Antenna

This device has been certified to operate with the built-in (PCB chip) antenna listed below. Adherence to these EMC certifications requires that only this antenna be used. All other antennas with greater peak gain are strictly prohibited for use with the TRN-2013 unless new EMC certifications are obtained.

Table 5. On-Ramp Wireless EMC Certified Antenna

Manufacturer	Part Number	Gain	Type	Comments
Ethertronics	1001013	2.1 dBi	Monopole	Internal PCB chip antenna

5.3 EMC Certifications

The TRN-2013 is designed to meet regulations for world-wide use. It has EMC modular approval certifications in the United States and Canada. These certifications allow the TRN-2013 to be installed in any final product and only Unintentional Radiator testing is required for the final product. This saves cost and time for System Integrators. The certifications currently achieved are listed in the following table. Other countries will vary.

Table 6. TRN-2013 EMC Compliance Certifications

Country	Certifying Agency	Requirement Documents or Paragraph
United States	Federal Communications Commission (FCC)	■ 15.207 for power-line conducted emissions. ■ 15.215 for TX 20dB bandwidth ■ 15.247 for RF TX 6dB bandwidth, power, conducted and radiated emissions.
Canada	Industry Canada (IC)	■ RSS210e includes FCC tests and IC-specific tests (RX radiated emissions, 99% BW).

The Grants issued by their respective governments for TRN-2013 are available to System Integrators to ensure that the product has been certified. For more information about these documents, see the list of documents referenced in section 1.2.

The integrator of the final product is often required to do additional compliance tests. The integration application and market will determine the specifics. The integrator is advised to consult with local experts in compliance certifications for complete information.

- **FCC**
  The TRN-2013 is Single-Modular Certified, therefore the final product may only need Class B unintentional radiator and power-line conducted emissions tests. This should be done with the actual production antenna.

- Other countries will vary.

5.4 FCC Warnings

This device complies with part 15 of the Federal Communications Commission (FCC) Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

WARNING: This equipment generates, uses, and can radiate radio frequency energy. If not installed and used in accordance with the instructions, this equipment may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- **Re-orient or relocate the receiving antenna.**
- **Increase the separation between the equipment and receiver.**
- **Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.**
- **Consult the dealer or an experienced radio/TV technician for help.**

5.5 IC Warnings

The installer of this radio equipment must ensure that the antenna is located or pointed so that it does not emit RF field in excess of Health Canada limits for the general population. Consult Safety Code 6 which is obtainable from Health Canada's website http://www.hc-sc.gc.ca/index-eng.php.

Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

To reduce potential radio interference to other users, select the antenna type and its gain so that the equivalent isotropically radiated power (EIRP) is not more than that permitted for successful communication.

Canadian Two Part Warning Statement:

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

5.6 Usage

FCC ID: XTE-TRN-2013. IC: 8655A-TRN-2013. This device is only authorized for use in fixed and mobile applications. To meet FCC and other national radio frequency (RF) exposure

requirements, the antenna for this device must be installed to ensure a separation distance of at least 20cm (8 inches) from the antenna to a person.

5.6.1 Product Labels

A label showing the FCC ID and IC designators, listed above, must be affixed to the exterior of any device containing the TRN-2013 (if the TRN-2013 is not visible). The exterior label must include: *Contains FCC ID: XTE-TRN-2013 IC: 8655A-TRN-2013*.

The product label is shown in Figure 8.

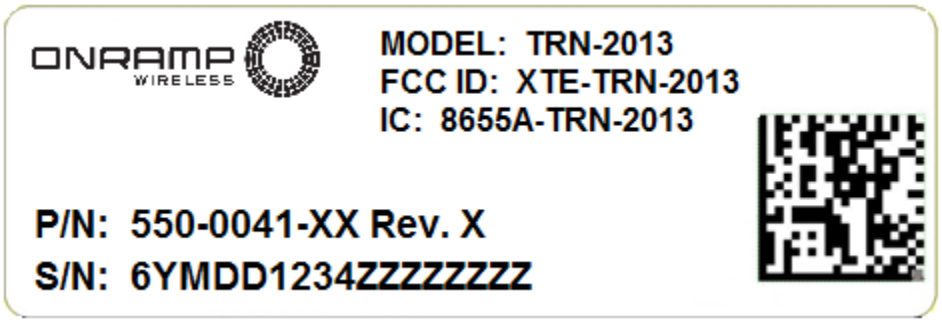


Figure 6. TRN-2013 Product Label

5.6.2 RF Exposure Statement

The air interface supports operation on channels in the 2402 MHz – 2476 MHz range for FCC/IC regulatory domains. Before this product becomes operational it must undergo a commissioning procedure, during which critical information required for operation is entered into the device and stored in non-volatile storage. It is during the initial commissioning procedure that the regulatory domain, under which the device will operate, is set. Subsequent configuration of the device during operation is checked against the commissioned regulatory domain and non-permitted channels or transmit power levels are rejected and the device will not transmit until a permissible configuration per the commissioned regulatory domain is set.

5.7 WEEE Directive

Neither the TRN-2013 nor the Node is considered “end products” that put them under the WEEE initiatives in the EU. The WEEE directives do not apply to the TRN-2013 product.

5.8 REACH Directive

As of August 2012 the TRN-2013 by itself is REACH compliant under 1907/2006/EC. On-Ramp Wireless expects to receive a declaration of conformance from the Taiwan-based manufacturer of the node starting in September 2012. REACH compliance statements are found in Appendix C.

5.9 RoHS Directive

The TRN-2013 and node comply with RoHS directive 2002/95/EC. On-Ramp Wireless has received Certificates of Conformance (CoC) for all components, printed circuit board and contract manufacturers for the TRN-2013 and the Node. Copies of the CoCs are stored at On Ramp Wireless and available upon request.

6 Installation of TRN-2013 Board

The following figure shows how the TRN-2013 MCM is mounted inside the meter. Three screws (P/N 9925887027, #4-24X.31 self-tapping, type BF Phillips pan-head steel zinc screw) are required to mount TRN-2013 in place. The recommended torque values for the screws are 6 to 7 in.-lbf.

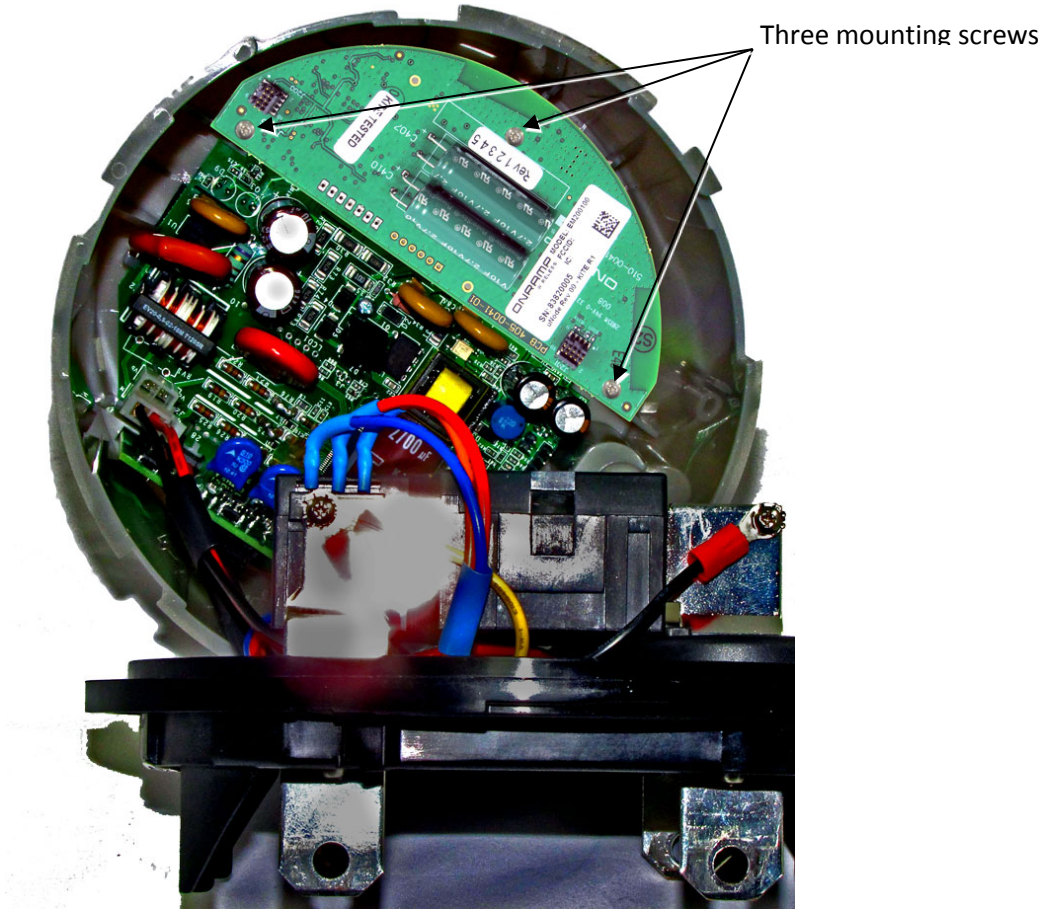


Figure 7. Meter Assembly with a TRN-2013 MCM

7 Provisioning

The tools and software required for provisioning the TRN-2013 modules are described in this section.

The Provisioning process can be handled in two main ways:

- Manual for small runs
- Automatic for full production.

7.1 Manual

The Node Provisioning Tool (see referenced tools/documents) can be used to provision TRN-2013 boards in small quantity. The PC will attach to the DUT TRN-2013 via its Provisioning header (UART is 3.3V). The TRN-2013 connector is J202 and requires a “TE Connectivity” connector PN 1470364-3 to mate with it. The pin out is:

- Pin 1 Debug_RX (3V3 logic)
- Pin 2 Debug_TX (3V3 logic)
- Pin 3 GND

CAUTION: When the TRN-2013 is mounted in an I210 Meter, the term “GND” or “Ground” does NOT refer to Earth ground. All signals will have a 120/240VAC power imposed onto those lines. ***All signals to/from the TRN-2013 board need to be isolated*.** No grounded instruments, or computers, should touch the TRN-2013 board signals. Use the setup as described in Figure 2.

7.2 Automatic

The automatic process is defined and built by the Customer. On-Ramp Wireless has assisted in the development of these tools but these tools are not the property of On-Ramp Wireless. It is the customer who owns, defines, develops, document, and maintains the Manufacturing Tools.

The Provisioning process nominally deals with:

- Loading in current versions of Software to microNode and K20 processors
- Configuring (channels, TX power, etc.)
- Setting and configuring Security Keys (via LKS server)
- Performing an OTA test to ensure the complete meter-TRN-2013-antenna chain is verified
- Lock down all access ports such as UART header and JTAG.

A graphical representation of the provisioning process is shown in Appendix A.

Appendix A RF Test Mode Interface

The RF Test Modes, described below, are set by setting the "testMode" parameter in the configuration file for the eMCM.

A.1 Normal Operating Mode 0

This mode is entered based on a flash configuration setting. This mode is persistent across boots. This is the normal operating mode of the eMCM. UNIL is initialized to communicate with the Node. The meter software layer is initialized to communicate with the meter. Although the eMCM is in its normal operating mode, as determined by the flash configuration setting, other factors may subsequently cause the eMCM to change to a non-normal operating mode (e.g., meter is not in metering mode).

A.2 Non-Persistent Idle / Factory Test Mode 1

This mode is entered based on the testMode flash configuration setting. This mode is not persistent across boots (self-clearing). UNIL is initialized to pass-through mode. Meter software layer is not initialized. The UART on the AMR (automatic meter reading) serial interface is placed in loopback mode (using the same baud rate as the meter, e.g., 9600). Same as mode 2 except the flash testMode setting is automatically cleared to mode 0 when entering this mode. A subsequent "set test mode" command can set the cleared value to some other test mode value.

A.3 Persistent Idle / Factory Test Mode 2

This mode is entered based on the testMode flash configuration setting. This mode is persistent across boots. UNIL is initialized to pass-through mode. Meter software layer is not initialized. The UART on the AMR serial interface is placed into loopback mode (using the same baud rate as the meter, e.g., 9600). Same as mode 1 except the flash testMode setting is persistent across boots. To exit this mode, the test mode configuration setting must be set to another value which will take effect on eMCM reset.

A.4 Non-Persistent Node RF Test Mode 3

This mode is entered based on the testMode flash configuration setting. This mode is not persistent across boots (self-clearing). UNIL is initialized to pass-through mode. The meter software layer is not initialized. Same as mode 4 except the flash testMode setting is automatically cleared to mode 0 when entering this mode. A subsequent "set test mode" command can set the cleared value to some other test mode value.

- The TX test mode is controlled by the "txTestMode" parameter in the configuration file.
  - 1 = CW_CENTER
  - 2 = CW_OFFSET
  - 3 = MODULATED

- The antenna is controlled by the "txTestAntenna" parameter in the configuration file.
  - 0 or 1
- The frequency is controlled by the "txTestCenterFreqKhzOffset" parameter in the configuration file.
  - KHz offset from 2.4 GHz
  - 2000 - 100000
  - Example: 50000 = 2.45 GHz
- The VGA is controlled by the "txTestVga" parameter in the configuration file.
  - 0 - 63, 255
- The on/off duration is controlled by the "txTestModeSec" and "txTestModeUsec" parameters in the configuration file.

A.5 Persistent Node RF Test Mode 4

This mode is entered based on the testMode flash configuration setting. This mode is persistent across boots. UNIL is initialized to pass-through mode. The meter software layer is not initialized. Same as mode 3 except the flash testMode setting is persistent across boots. To exit this mode, the test mode configuration setting must be set to another value which will take effect on eMCM reset.

A.6 Non-Persistent Manufacturing Cal Mode 5

This mode is entered based on the testMode flash configuration setting. This mode is not persistent across boots (self-clearing). UNIL is initialized normally so that it communicates with the Node. The meter software layer is not initialized. The UART on the AMR serial interface is not initialized or used. Same as mode 6 except the flash testMode setting is automatically cleared to mode 0 when entering this mode. A subsequent "set test mode" command can set the cleared value to some other test mode value.

A.7 Persistent Manufacturing Cal Mode 6

This mode is entered based on the testMode flash configuration setting. This mode is persistent across boots. UNIL is initialized normally so that it communicates with the Node. The meter software layer is not initialized. The UART on the AMR serial interface is not initialized or used. Same as mode 5 except the flash testMode setting is persistent across boots. To exit this mode, the test mode configuration setting must be set to another value which will take effect on eMCM reset.

A.8 Non-Persistent Meter Diagnostic Mode (Not Yet Implemented)

This mode is entered based on a flash configuration setting. This mode is not persistent across boots (self-clearing). UNIL is initialized normally so that it communicates with the Node. The meter software layer is initialized and communication to the meter is tested and validated. If communication with either the Node or the meter fails (or any other error condition detected), then the red LED is blinked with an error code indefinitely (or until the deployment mode LED timer expires). If no errors are detected, the green LED is blinked normally to indicate network connection state (scanning, joined, etc.). A reset is required to recover. Note: this mode may not be needed if a basic diagnostic or POST check is done by the eMCM as part of its initialization process.

A.9 Setting eMCM to Test Mode 1 - Non-Persistent Idle Factory Test Mode

How to Enter

- Set the 'testMode' flag in the configuration file to one.

  Example: ./emcm_set_cfg.py -d /dev/ttyS0 --testMode=1

- Reset the eMCM to take effect.

  Example: ./emcm_dev_reset.py -d /dev/ttyS0 --emcm

How to Exit

- Because this mode is non-persistent, it can be exited via an eMCM reset.
- Reset the eMCM to exit the test mode. By default, the eMCM will return to normal operational mode 0 after reset unless another mode was explicitly specified with the emcm_set_cfg.py command prior to resetting.

  Example: ./emcm_dev_reset.py -d /dev/ttyS0 --emcm

- If a different mode is desired upon reset, explicitly

Description

- UNIL is in pass-through mode.
- Meter UART is in loopback mode.
- AHP debug port is functional.
- Mode is not persistent after resets.

A.10 Setting eMCM to Test Mode 2 - Persistent Idle Factory Test Mode

How to Enter

- Set the 'testMode' flag in the configuration file to two.
  Example: ./emcm_set_cfg.py -d /dev/ttyS0 --testMode=2
- Reset the eMCM to take effect.
  Example: ./emcm_dev_reset.py -d /dev/ttyS0 --emcm

How to Exit

- Because this mode is persistent, it will remain in effect across eMCM resets.
- Set the 'testMode' flag to the new desired mode, e.g., normal operational mode 0.
  Example: ./emcm_set_cfg.py -d /dev/ttyS0 --testMode=0
- Reset the eMCM for the new mode to take effect.
  Example: ./emcm_dev_reset.py -d /dev/ttyS0 --emcm

Description

- UNIL is in pass-through mode.
- Meter UART is in loopback mode.
- AHP debug port is functional.
- Mode is persistent across resets.

A.11 Setting eMCM to Test Mode 3 - Non-Persistent RF Test Mode

How to Enter

- Set the 'testMode' flag in the configuration file to three.
  Example: ./emcm_set_cfg.py -d /dev/ttyS0 --testMode=3
- Reset the eMCM to take effect.
  Example: ./emcm_dev_reset.py -d /dev/ttyS0 --emcm

How to Exit

- Because this mode is non-persistent, it can be exited via an eMCM reset.
- Reset the eMCM to exit the test mode. By default, the eMCM will return to normal operational mode 0 after reset unless another mode was explicitly specified with the emcm_set_cfg.py command prior to resetting.
  Example: ./emcm_dev_reset.py -d /dev/ttyS0 --emcm
- If a different mode is desired upon reset, explicitly

Description

- UNIL is partially operational.
- Meter UART is disabled.
- AHP debug port is functional.
- Mode is not persistent after resets.

A.12 Setting eMCM to Test Mode 4 - Persistent RF Test Mode

How to Enter

- Set the 'testMode' flag in the configuration file to four.
  Example: ./emcm_set_cfg.py -d /dev/ttyS0 --testMode=4
- Reset the eMCM to take effect.
  Example: ./emcm_dev_reset.py -d /dev/ttyS0 --emcm

How to Exit

- Because this mode is persistent, it will remain in effect across eMCM resets.
- Set the 'testMode' flag to the new desired mode, e.g., normal operational mode 0.
  Example: ./emcm_set_cfg.py -d /dev/ttyS0 --testMode=0
- Reset the eMCM for the new mode to take effect.
  Example: ./emcm_dev_reset.py -d /dev/ttyS0 --emcm

Description

- UNIL is partially operational.
- Meter UART is disabled.
- AHP debug port is functional.
- Mode is persistent across resets.

Appendix B REACH Compliance Statements

DDi

Building Tomorrow's Technology . . . Today

February 25, 2012

To Whom It May Concern:

Subject: REACH Regulations, http://echa.europa.eu/reach_en.asp

The European Union Regulation on Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) Directive has become of significant interest to our customers. DDi considers manufactured Printed Circuit Boards (PCBs) to be an "article" per REACH, Article 3(3); thus, exempt from the REACH Regulations, unless;

1. DDi ships an article to the EU that exceeds a SVHC (Substance of Very High Concern) concentration of 0.1%w/w. , or
2. Greater than one metric ton per year is intended to be released under normal or reasonably foreseeable conditions of use.

The European Chemicals Agency (ECHA) issued its first list of Substances of Very High Concern (SVHC) in 2008. Various other chemicals have been published and included in the SVHC candidate list every year thereafter. The tables below contain all known chemicals that have been submitted by ECHA thus far; additional chemicals will be added to this statement as soon as they become available. It is DDi's commitment to insure current and accurate information is provided to our customers. We will continue to monitor updates to the SVHC list as they are submitted for consultation.

Candidate List Tables

2008 List

Anthracene (CAS# 120-12-7)	4,4'-diaminodiphenylmethane (CAS# 101-77-9)	Dibutyl phthalate (CAS# 84-74-2)	Benzyl butyl phthalate (CAS# 85-68-7)
Hexabromocyclododecane (HBCDD) and all major diastereoisomers (CAS# 3194-55-6; 25637-99-4)	Cobalt dichloride (CAS# 7646-79-9)	Diarsenic pentoxide (CAS# 1303-28-2)	Diarsenic trioxide (CAS# 1327-53-3)
Sodium dichromate, dehydrate (CAS# 7789-12-0/ 10588-01-9)	Musk xylene (CAS# 81-15-2)	Bis (2-ethyl(hexyl)phthalate (CAS# 117-81-7)	Bis (tributyltin) oxide (CAS# 56-35-9)
Lead hydrogen arsenate (CAS# 7784-40-9)	Triethyl arsenate (CAS# 15606-95-8)	C10-C13 chlorinated paraffins (CAS# 85535-84-8)	

2009 List

Anthracene oil (CAS# 90640-80-5)	Coal tar pitch, high temperature (CAS# 65996-93-2)	Diisobutyl Phthalate (CAS# 84-69-5)	Anthracene oil, Anthracene paste, (CAS# 90640-81-6)
Anthracene oil, Anthracene paste, distin. Lights (CAS# 91995-17-4)	Acrylamide (CAS# 79-06-1)	**Lead chromate** * (CAS# 7758-97-6)	2,4-Dinitrotoluene (CAS# 121-14-2)
Anthracene oil, Anthracene paste, Anthracene fraction (CAS# 91995-15-2)	Lead Sulfochromate yellow (C.I. Pigment Yellow 34) (CAS# 1344-37-2)	Lead Chromate Molybdate Sulphate red (C.I. Pigment Red 104) (CAS# 12656-85-8)	Tris (2-chloroethyl) Phosphate (CAS# 115-96-8)
Anthracene oil, Anthracene-low distin. (CAS# 90640-82-7)	Zirconia Aluminosilicate Refractory *Ceramic Fibres covered by index number 650-017-00-8 in Annex VI, part 3, table 3.2 of Regulation (EC) No 1272/2008*	Aluminosilicate Refractory *Ceramic Fibres are fibres covered by index number 650-017-00-8 in Annex VI, part 3, table 3.2 of Regulation (EC) No 1272/2008*	

1220 N. Simon Circle, Anaheim, CA 92806 • Tel 714.688.7200 • Fax 714.688.7400 • www.ddiglobal.com

Gemtek
Wireless Broadband Anywhere

Gemtek Technology Co., Ltd
No.1 Jen Ai Road,Hsinchu Industrial Park,
Hukou,Hsinchu, Taiwan, R.O.C. 303
TEL: 886-3-598-5535
FAX: 886-3-597-2103

DECLARATION OF CONFORMITY WITH RoHS DIRECTIVE AND REACH REGULATION

Gemtek declares that the product or part set forth below,

Customer Product Name: uNode/ 550-0006-00
Product Name: WMDO-142 jNode
Product Number: 990-900-0124R

has been manufactured in compliance with the EU Directive 2011/65/EU Restriction of Hazardous Substance (RoHS) and the regulation concerning Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) by meeting the following demand,

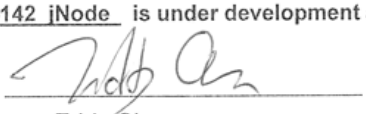
1. Said Gemtek Product is through utilization of exemption as below:

1) Copper alloy containing up to 4% lead by weight
2) Lead in high melting temperature type solders (i.e., lead-based alloys containing 85% by weight or more lead)
3) Electrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors ,e.g. piezoelectronic devices, or in a glass or cramic matrix compound。

2. In regard to the information on substances in the said product, in case a concentration therein is above 0.1 % weight by weight (w/w), Gemtek will provide customers with the information outlined in addendum A to allow safe use of the product.

Compliance with RoHS and REACH has been verified via internal design controls and/or analytical test data. The person undersigned below is entitled and authorized to furnish this letter to customers.

WMDO-142 jNode is under development and will follow RoHS & REACH rule.

Signature: 
Printed Name: Eddy Chen
Title: A.V.P Quality
Date: 2012/08/20
Contact Information: Eddy chen@gemtek.com.tw +886 3 5985535 Ext.1060

Appendix C Abbreviations and Terms

Abbreviation/Term	Definition
AGC	Automatic Gain Control
ALC	Automatic Level Control
AMI	Advanced Metering Infrastructure
AMR	Automatic Meter Reading
AP	Access Point (this product)
API	Application Programming Interface
ASIC	Application-Specific Integrated Circuit
BOM	Bill of Materials
BW	Bandwidth
CMOS	Complementary Metal-Oxide-Semiconductor
CPOL	Clock Polarity (for SPI)
CPU	Central Processing Unit
DFS	Dynamic Frequency Selection
DPLL	Digital Phase-Locked Loop
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
EVM	Error Vector Magnitude
FCC	Federal Communications Commission
FER	Frame Error Rate
GND	Ground
GPIO	General Purpose Input/Output
HBM	Human Body Model
IC	Industry Canada
IIP3	Input Third-Order Intercept Point
LDO	Low Drop Out
LNA	Low Noise Amplifier
LO	Local Oscillator
microNode	The second generation of the On-Ramp Wireless module that communicates sensor data to an Access Point. The microNode forms the basis for On-Ramp Wireless Total Reach Network communications with the TRN-2013 product.
MISO	Master Input, Slave Output
MM	Machine Model
MOSI	Master Output, Slave Input
MRQ	Master Request
MSL	Moisture Sensitivity Level
Node	The generic term used interchangeably with eNode, microNode, or dNode.
NPT	Node Provisioning Tools

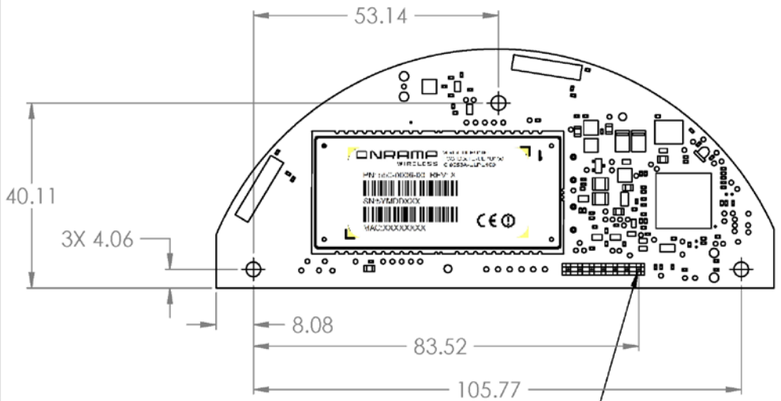
Abbreviation/Term	Definition
On-Ramp Wireless Total Reach	On-Ramp Wireless proprietary wireless communication technology.
OTA	Over-the-Air
PA	Power Amplifier
PAPR	Peak-to-Average Power Ratio
PCB	Printed Circuit Board
POR	Power On Reset
QoS	Quality of Service
RF	Radio Frequency
RFIC	Radio Frequency Integrated Circuit
RoHS	Restriction of Hazardous Substances
RSSI	Receive Signal Strength Indicator
RT	Remote Terminal
RTC	Real Time Clock
RX	Receive/Receiver
SCLK	Serial Clock
SMT	Surface Mount Technology
SNR	Signal-to-Noise Ratio
SPI	Synchronous Peripheral Interface
SRDY	Slave Ready
SRQ	Slave Request
TRN-2013	On-Ramp Wireless AMI circuit board (PCB). An MCM for ANSI meters with an internal antenna but does not contain Zigbee.
TX	Transmit/Transmitter
UART	Universal Asynchronous Receiver/Transmitter
VCO	Voltage Controlled Oscillator
VCTCXO	Voltage Controlled Temperature Compensated Crystal Oscillator
VSWR	Voltage Standing Wave Ratio
XO	Crystal Oscillator

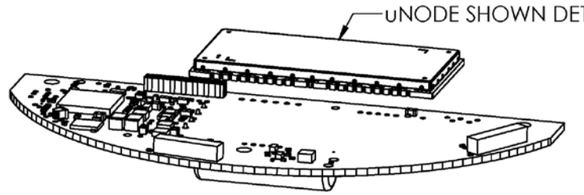
Appendix D TRN-2013 Mechanical Drawing and Schematics

NOTES- UNLESS OTHERWISE SPECIFIED

1. PER IPC-2221 GENERIC STANDARD ON PRINTED BOARD DESIGN SECTION 5.2.4 - THE MAXIMUM BOW AND TWIST SHALL BE 0.75% FOR BOARDS THAT USE SURFACE MOUNT TECHNOLOGY.

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	INITIAL RELEASE	04/29/2013	05/30/2013





PIN TABLE	
Pin #	Pin Name
1	YPULSE
2	Meter Ready
3	Meter Error
4	Vcc
5	GND
6	RX
7	TX

ON-RAMP WIRELESS, INC. PROPRIETARY

METRIC ONLY

UNLESS OTHERWISE SPECIFIED		NAME	DATE
INTERPRET DRAWING PER ASME Y14.100-2004	DRAWN	A. CASCIA	04/28/2013
ALL DIMENSIONS ARE IN MM (MILLIMETERS) AND APPLY AFTER SURFACE TREATMENT	CHECKED	D.C.	04/29/2013
INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-2009	ENG. APPR.	D.ESPEY	05/16/2013
	MFG APPR.	D.C.	05/13/2013
	Q.A.		
	C.M.		

TOLERANCES

LINEAR

MORE THAN	LESS THAN	TOLERANCE
0.00	63.50	±0.20
63.50	304.80	±0.002 MM/MM

X.X ±0.25

ANGULAR: X° ±1°00'

(EXCLUDING SHEET METAL FLANGES)

HOLE DIAMETERS

Ø0.34-6.35	+0.13-0.03
Ø6.37-12.70	+0.15-0.03
Ø12.72-25.40	+0.25-0.03

MATERIAL

FINISH

DO NOT SCALE DRAWING

ONRAMP WIRELESS

10920 VIA FRONTERIA, SUITE 200, SAN DIEGO, CA 92127

TITLE: MECHANICAL DRAWING, KITE

SIZE	DWG. NO.	REV
B	510-0041-XX	A

SCALE: 1:1 SHEET 1 OF 1

Figure 8. Mechanical Dimensions for TRN-2013

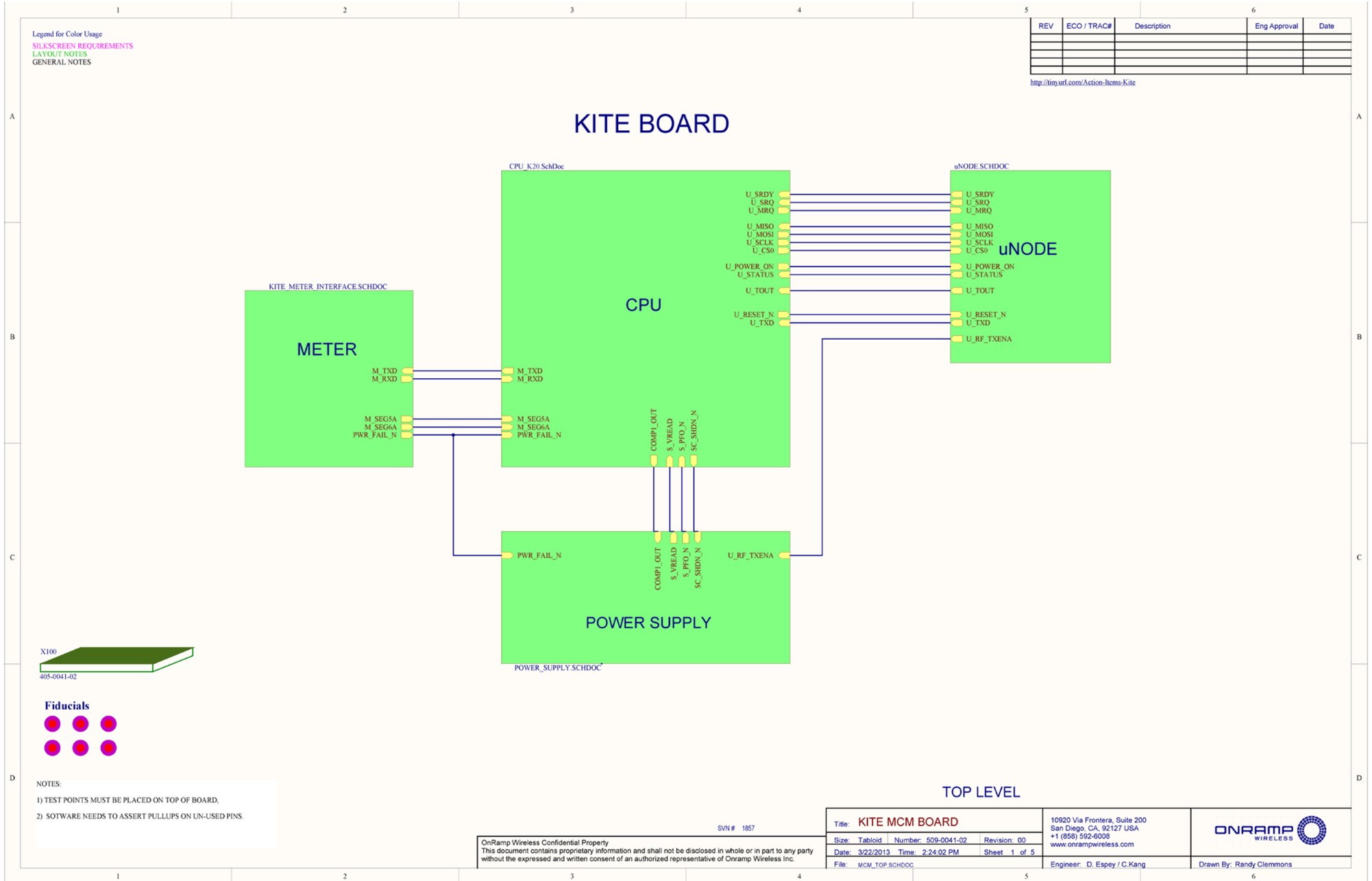


Figure 9. TRN-2013 board schematic, page 1

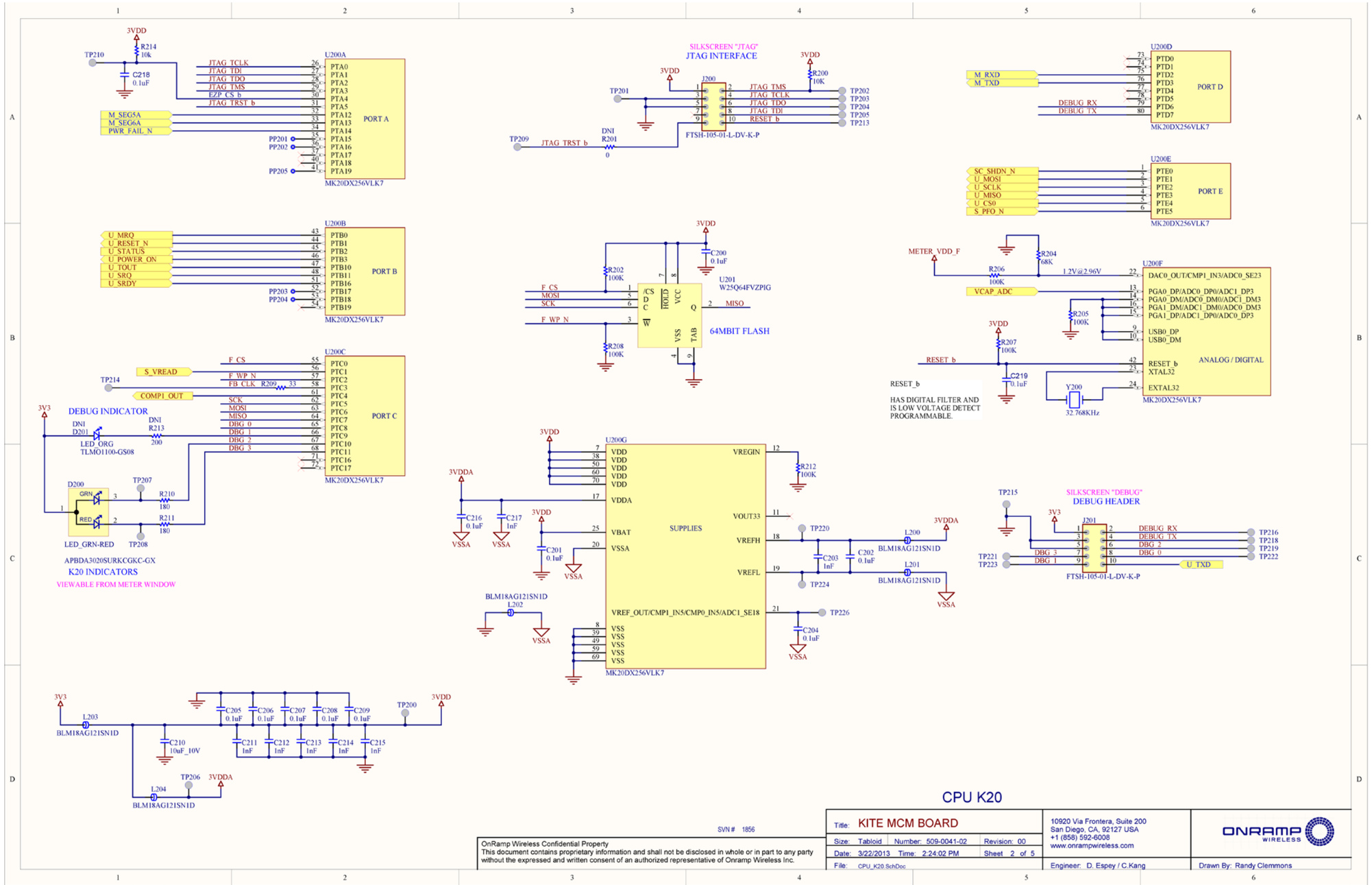


Figure 10. TRN-2013 schematic, page 2

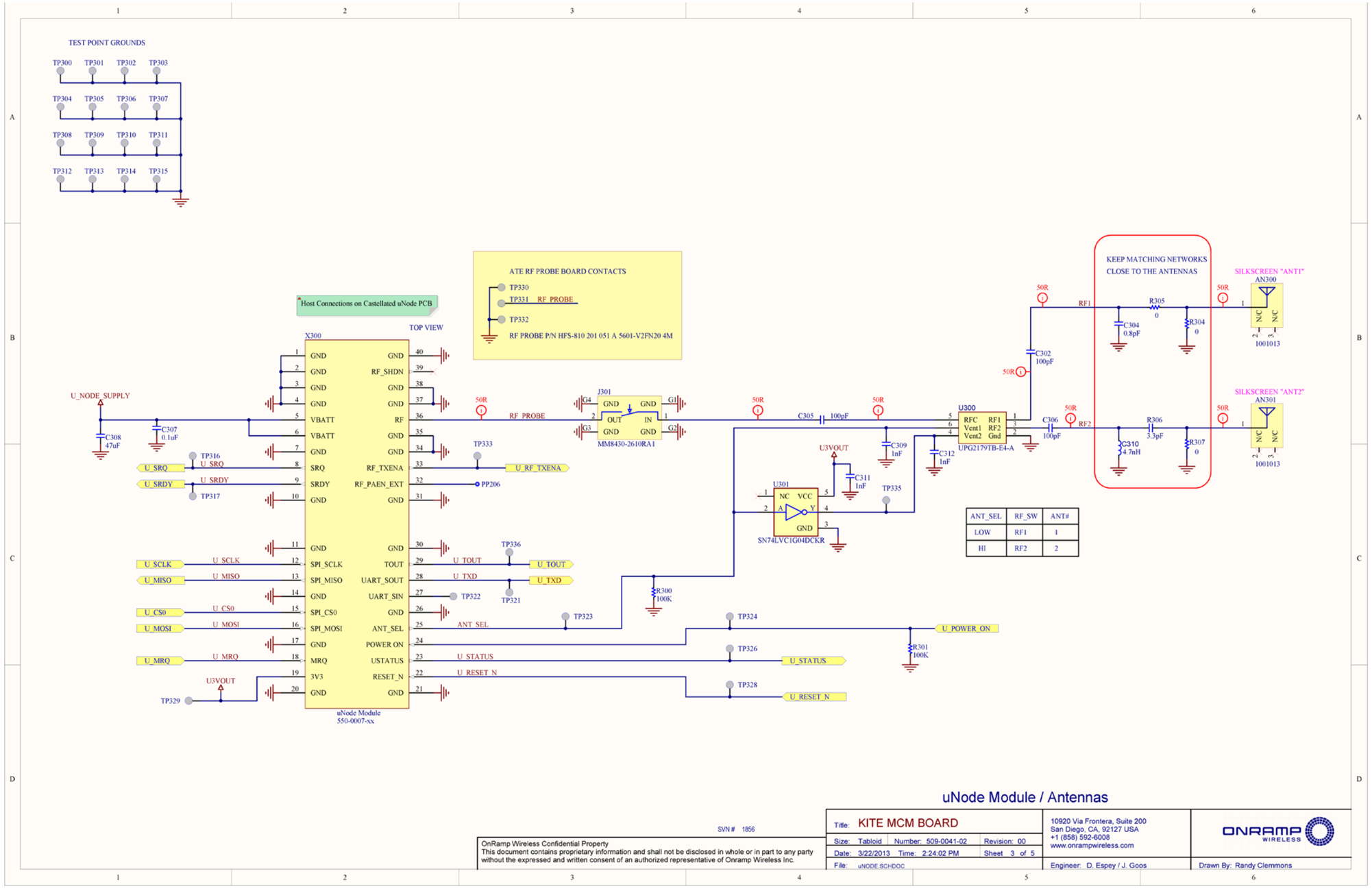


Figure 11. TRN-2013 schematic, page 3

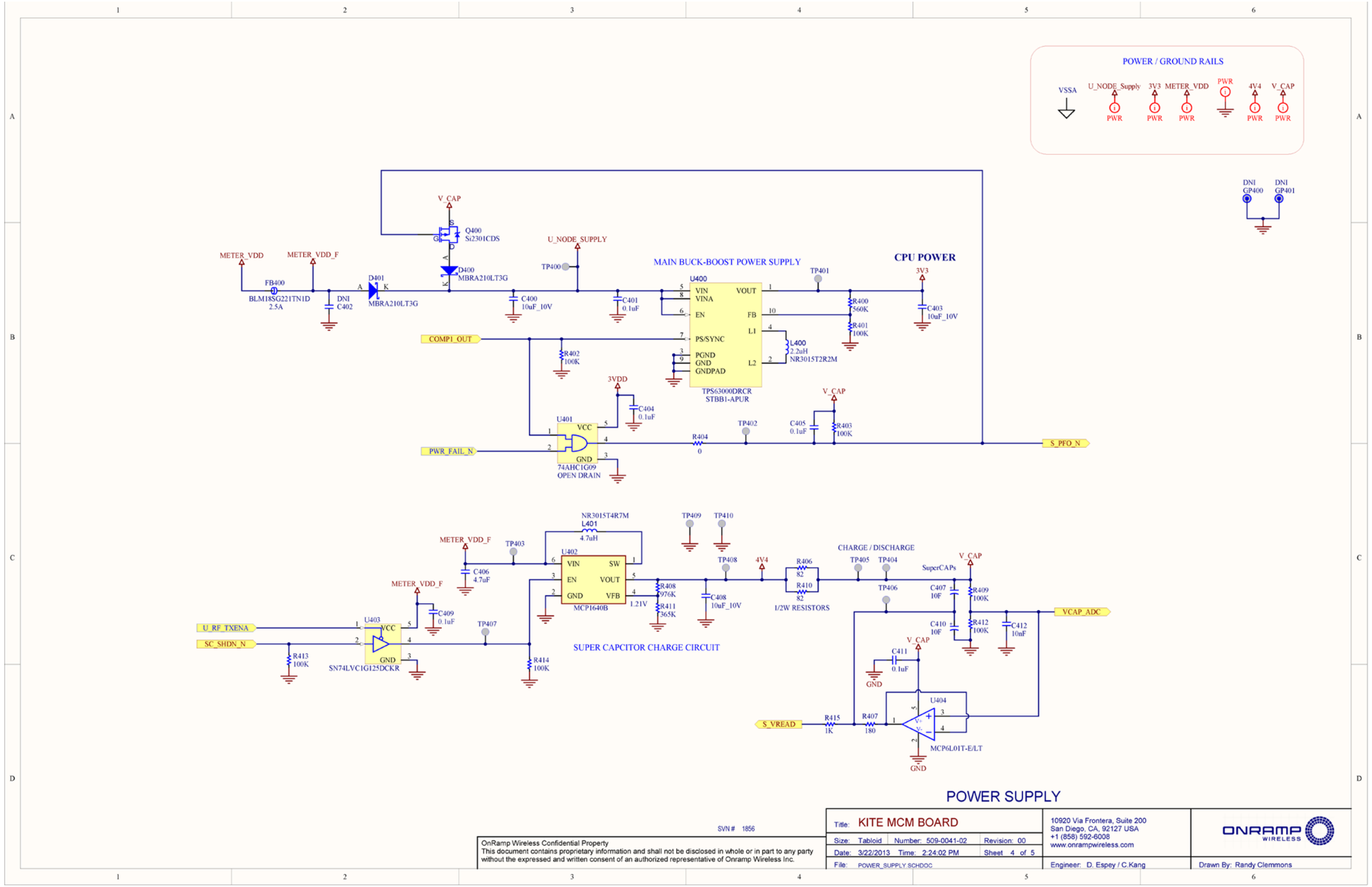


Figure 12. TRN-2013 schematic, page 4

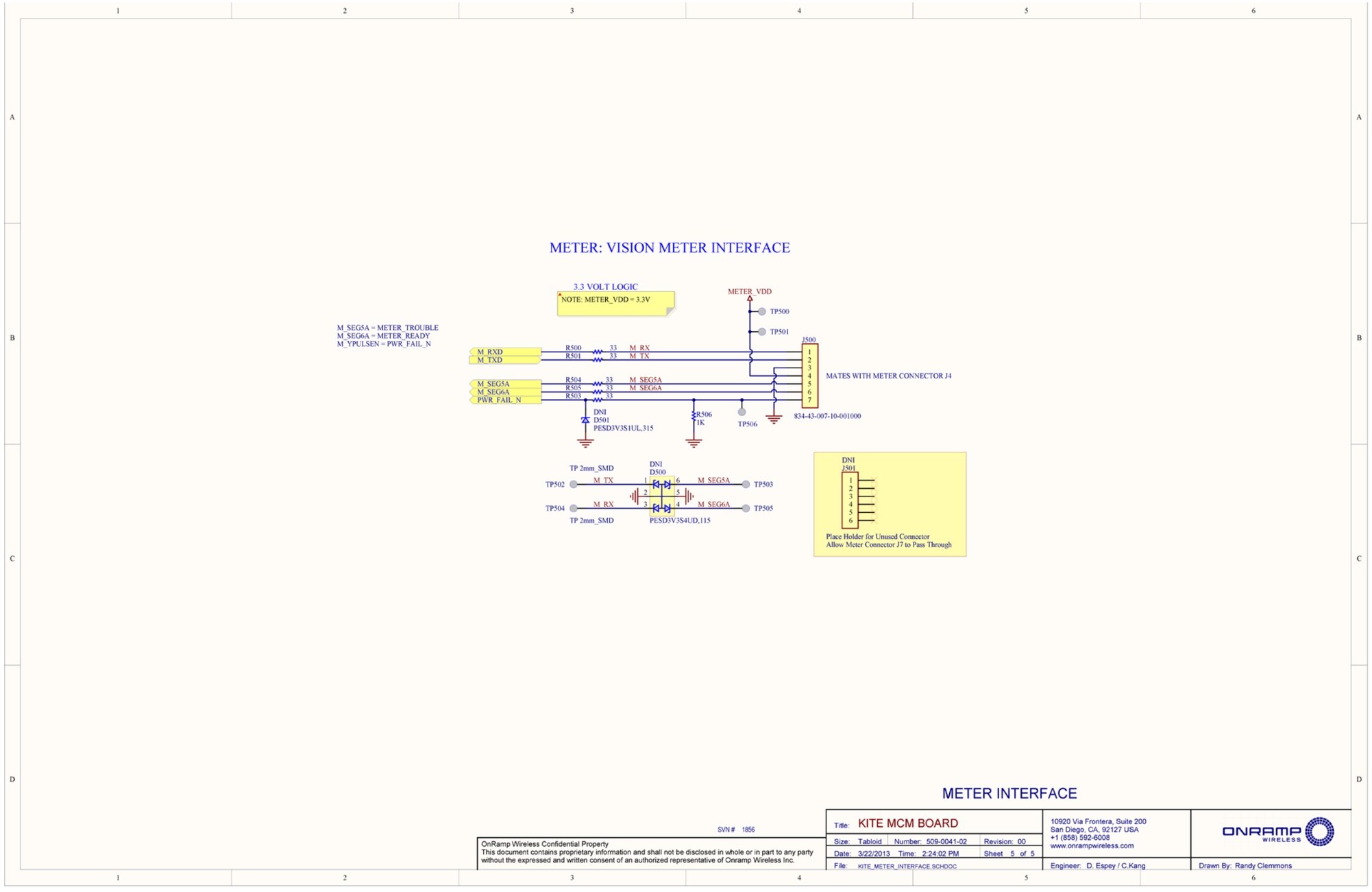


Figure 13. TRN-2013 schematic, page 5