Integrated 1W UHF pRFID Reader for Psion Workabout

User's Manual

Document ID: VER-551-11UM

Version 2.0

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FCC Notice

FCC ID: SD8FFP466M12P1

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. 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.These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, 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:

- Reorient 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.

Warning: Modifications not approved by the responsible party could void the user's authority to operate this equipment.

IC Notice

IC ID: 10968A-FFP466M12P1

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.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Exposure to RF Energy

THIS MODEL DEVICE MEETS U.S. AND INTERNATIONAL REQUIREMENTS FOR EXPOSURE TO RADIO FREQUENCY RADIATION.

The VER-551-11 is a radio transmitter and receiver module. It is designed and manufactured not to exceed the emission limits for exposure to radio frequency (RF) energy set by the Federal Communications Commission of the U.S. Government and by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The device also meets the European Radio and Telecommunications Terminal Equipment (R&TTE) directive, for protecting the health and safety of the user and other persons.

These limits are part of comprehensive guidelines that establish permitted levels of RF energy for the general population. The guidelines are based on standards that were developed by independent scientific organizations through periodic and thorough evaluation of scientific studies. The standards include a substantial safety margin designed to assure the safety of all persons, regardless of age and health.

Before a device model is available for sale to the public, it must be tested and certified to operate within the limits for safe exposure established by the FCC and international organizations. The tests are performed in positions and locations (e.g., next to the body) as required by the FCC for each model. The FCC has granted an Equipment Authorization for this model device with all reported SAR levels (see below) evaluated as in compliance with the FCC RF emission guidelines.

This device meets RF exposure guidelines when the antennas are positioned at a minimum distance from the body. In order to transmit data or messages, this device requires a quality connection to the RFID tag devices. In some cases, transmission of data or messages may be delayed until such a connection becomes available. Be sure that the recommended distance is observed until the transmission is complete.

The exposure standard for wireless devices employs a unit of measurement known as the Specific Absorption Rate, or SAR. Tests for SAR are conducted using standard operating positions specified by the FCC with the device transmitting at its highest certified power level in all tested frequency bands. The SAR limit set by the FCC is 1.6 W/kg. The international guidelines state that the SAR limit for mobile devices used by the public is 2.0 W/kg averaged over 10 grams of body tissue. SAR values may vary depending on national reporting requirements and the network band. Although the SAR is determined at the highest certified power level, the actual SAR level of the device while operating can be well below the maximum value because the device operates at multiple power levels and at a low duty cycle based on the number of RFID tag devices it is currently communicating with.

SAR information on this model device is on file with the FCC and can be found under the Display Grant section and http://www.fcc.gov/oet/fccid after searching on FCC ID: SD8FFP466M12P1 and IC: 10968A-FFP466M12P1.

Contents

1 Overview

This module is intended for operation in a handheld or low power/battery device. Once installed it will normally remain with that host unless the functionality is no longer needed or the unit must be removed for repair. It is not intended as a module that is added or removed by an end user in the normal procedure for operating the host device or its application.

1.1 Installation

Installation of the VER-551-11 module should be carried out by technicians trained and authorized by Firefly RFID Solutions. The firmware does have self check firmware, such as antenna port tests and host interconnection checks and the module hardware has regulators and power monitors to help to insure proper operation of the module or limit operation if not properly installed.

The module interface is through an FX6 100 pin connector that is common on many handheld devices and specifically on the Psion Workabout Pro. This connector provides power, a logical module enable signal and communications over a two pin Tx/Rx at 3.3V asynchronous serial interface. The device connects to the host's antennae through four MMCX coax connectors.

The battery and or power source should be removed from the host device before attempting to install the VER-551-11 module in order to avoid possible damage to the host device or the module. The inspection covers on the host device must be removed to allow access to the expansion bay in the host device. The module is aligned in the expansion bay to match up with the FX6 connector and pushed down to mate up this connector. The module is then screwed into place using the four mounting holes. The antennae from the host are plugged into the module and the covers replaced. The battery or power source can then be connected back into the host device.

The description above is only provided to identify the steps involved and make the user aware of what has been added to the host device. The actual installation should be carried out by a properly trained and authorized technician. The following figure shows a Psion Workabout Pro with the covers removed so the user can see if the module has been physically installed in the handheld.

Psion Workabout Pro showing all inspection covers removed, battery removed and empty expansion bay.

Psion Workabout Pro showing all inspection covers removed, but with the module and the battery installed. The lower photo has the antennae folded back to better show the module and antennae connections.

1.2 Module Verification

The module performs a self check whenever power is applied and whenever the module enable pin changes from off to on. The results of this self-check are immediately presented on the serial interface to the host device. The results can also be querried by the host device at anytime by issuing a status request command over that serial interface.

The micro-controller serial interface is always available when power is provided over the interface connector, even if the module enable pin is off. The radio functions however will not operate unless this enable pin is on. Since this module can fit in different host devices, the enable pin can be configured at time of installation to be active high, low or don't care with serial interface on/off commands required. The status can be verified without having to enable the module.

It is a function of the host device's human interface to alert the user of a problem with the status. It is important to note however that the firmware within the module will not allow any operation that the self check has shown to be unavailable, such as requesting operation over an antenna port that is showing faulty/missing antenna status or requesting operation when there are insufficient power levels to execute the operation.

On the very first power up, the module will output the two non XML format lines over the serial interface which identifies the master firmware on the module and the module's hardware version including the board manufacturer's identification.

```
VER-551-11Sx1.7 2/26/2013
VER-551-11Hx1.1 2812-475 1007624-5
```

From this point on, all serial line communications in either direction will be in an XML format. The module does a self check then puts out a status report on the current state. The following would be a typical example;

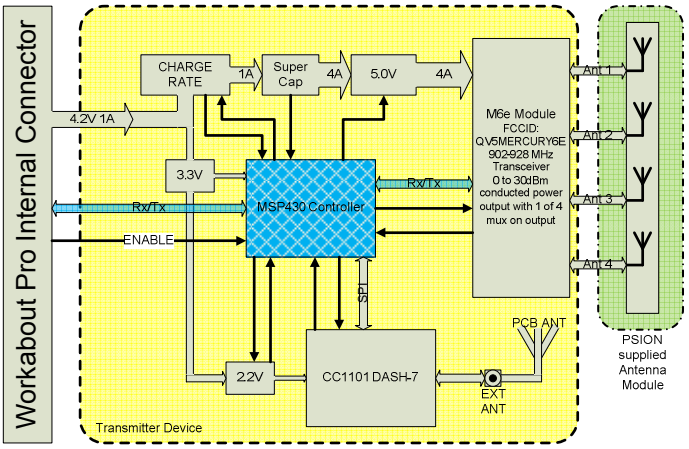
```
<Status state="RST" fmwr="VER-551-11Sx1.7 2/26/2013" hdwr="VER-551-11Hx1.1 2812-475
1007624-5" a433="000004" PWR="300" ANT="43-1" Vcap="3.72" Vsup="3.72" seq="000001"/>
```

state="RST"	Indicates the module is starting operation from hard RESET, which could be power up, power glitch or watchdog timer.
fmwr="VER-551-11S…"	Gives the master firmware for the module. The version and date shown in the above example above is that which went through compliance testing.
hdwr="VER-551-11H…"	Gives the module's hardware version and manufacture information. The version shown in the above example above is that which went through compliance testing.
a433="000004"	Gives the version number of the 433 MHz transceiver used for the 'active' telemetry channel.
ANT="43-1"	Indicates that antenna ports 4, 3 and 1 on the passive RFID reader radio are properly connected to an antenna. There is a problem with port 2, either the antenna is not connected or there is a problem with the cable or connectors. In anycase it means any passive RFID operations will be restricted to ports 4, 3 and 1.
Vcap="2.97"	Indicates power level available for operation of the radios. This read the same value as Vsup when fully ready for operation. At power up as in this case or after high power operations, it will read lower than Vsup and then build up to Vsup. Operation is suspended unit this value builds up to a level that can support the requested operation.
Vsup="3.72"	Indicates voltage level of power supply to the module provided over the interface connector. Typically this is the battery level in a handheld or portable device.
seq="00001"	Indicates the very first operation after a hard reset.

The above table shows the important fields on the startup status which indicate the device has been properly installed. The fact that the message comes up at all indicates there is power and the module is functioning. The version levels will give compatibility information for the application. The antenna information is important to gain data about the configuration whether intentional or error/damage during installation. The voltage levels give battery condition and indication of whether there is enough power to operate. very first power up, the module will output the two non XML format lines over the serial interface which identifies the master firmware on the module and the module's hardware version including the board manufacturer's identification.

2 Module Operation

The block diagram at right gives the general architecture of this module. There are three major components; the passive 915 MHz RFID reader, the active RFID 433 MHz reader (DASH-7 in diagram) and the power management system. The power management system handles all communications to the host device (Workabout Pro in diagram at right) and controls all operations of the other two components. It converts commands from the host into the appropriate actions keeping the module working within specification and withoperating conditions.



2.1 Module Command Channel

All module command and control is through the serial port on the host interface connector with the exception of the enable hardware line which can be configured at time of installation to enable or disable the radio functions in the module. The commands are in an XML format, typically with multiple attributres and no elements. The 'XML TAG' identifies the destination as the passive 915 MHz RFID radio, the 433 MHz radio or the power management system. The 'XML ATTRIBUTE(S)' defines the actions required. The four possible 'XML TAG's or destinations are;

- pRFID - Passive RFID reader only actions / parameters,
- a433 - Active 433MHz telemetry only actions / parameters,
- ALL - Actions / Parametrs affect both radio subsystems,
- MAINT - Maintenance actions and parameters.

For example the pRFID:pwr attribute is a separate attribute from the a433:pwr attribute, and ALL:pwr sets both the pRFID:pwr and a433:pwr to that same value or to the maximum/minimum for the function that best matches the requested power.

`<pRFID pwr="300"/>` Sets passive RFID 915 MHz power to 300 deci-dBm (30.0 dBm)
`<a433 pwr="75"/>` Sets active RFID 433 MHz power to 75 deci-dBm (7.5 dBm)
`<ALL pwr="300"/>` Sets passive radio to 30.0 dBm and active radio to 10.0 dBm

These commands can have multiple attributes so that;
`<pRFID pwr="300" ant="31"/>` is equivalent to issueing the following two commands;
`<pRFID pwr="300"/>`
`<pRFID ant="31"/>`
The above commands will configure the passive 915 MHz RFID reader to use only antenna port 1 and antenna port 3 at a power level of 30.0 dBm. The reader will remain in this configuration until those attributes are changed.

The module will respond as appropriate to the command as described in the sections bellow or with a `<NAK />` if it cannot decode the command.

2.2 pRFID passive RFID subsystem

The passive RFID reader subsystem commands are of the following general format;

```
<pRFID cmd="MR" ant="1234" pwr="300" rpt="1" dur="250" dc="50" fields="oid+cnt+ant"/>
```

The above command, which is a read request on antenna ports 1,2,3 and 4 at full 30.0 dBm power reporting back oid, count and antennae, might give the following response of a tag read if that tag was in view of the module's port 2 and port 3 antennae.

```
<tag STS="RAW" OID="20120225D655020001020019" CNT="12" ANT="23" />
```

Note here that the 'xml tag' `pRFID` identifies this as an action to be taken by the passive RFID reader. The on-board power management system decodes this command into the required actions based on power availability and forwards the appropriate commands to a 1 watt UHF M6e radio.

The `<pRFID />`attributes are optional. Those attributes required for the requested action are based on;

1. Attributes in the command string, such as `pwr="300"` in the above example
2. If not in command, then use last setting of the missing attributes.
   `<pRFID cmd="MR"/>` (Issued after the above example repeats the same command)
3. If not in command and not previously set, missing attributres use the default values as described below.

The one exception is the `cmd` attribute which if not specified will cause the unit to return version numbers and configuration for the module. The attributes have the following effect;

- `cmd` default - if not specified, unit returns version and configuration
  - `cmd="MR"` specifies unit to do a multiple scans for tags on the each of the specified antennae for the specified duration of continuous power at the specified power level with the whole operation being run the specified repeat number of times. The repeat rate being governed by the specified duty cycle and the amount of power available according to the power management system.
  - `cmd="CR"` specifies unit to do a continuous scans for tags on the each of the specified antennae for the specified duration of continuous power at the specified power level with the whole operation being repeated continuously. The routine will continue to run until the abort command or until power levels are too low to reliably continue operations. As above, the repeat rate being governed by the specified duty cycle and the amount of power available according to the power management system.
  - `cmd="AB"` specifies unit to abort all reader operations. This includes continuous reads or multiple read operations.
  - `cmd="ON"` same effect as the Psion's hardware line. It overrides that control line and will turn on the reader.
  - `cmd="OFF"` intended to turn off the reader if ther Psion control line is not being used, however if that control line is set to enable the reader that will override this command.

  - cmd="LT" Lists all tags in the buffer since the last LT command was issued. It packages the tag reads into a

- ant default ant="12" This attribute is a string of up to 10 characters which specifies the antennae to be used in the scan and their sequence. For example an attribute of ant="121314" would specify starting the scan on antenna 1 then scanning antenna 2 then antenna 1 again then antenna 3 and so on. In this manner one can bias the scan to specific antenna elements as required by the application. The above example having a heavy bias in favor of antenna 1.
- pwr default pwr="300". This attribute is a number from 1 to 300 and represents the rf conducted power used for the reading in tenths of dBm. The maximum is 300 and represents 30.0 dBm or 1 watt conducted power.
- rpt default rpt="1". This attribute is a number from 1 to 250 and represents the number of time the scan sequence through all the specified antennaes is repeated.
- dur default dur="250". This attribute is a number from 1 to 1000 and represents minimum time in milliSeconds that the reader will stay scanning on each of the specied antennae.
- dc default dc="30". This attribute is a number from 1 to 100 and represents the duty cycle in percentage points for operating the reader. The reader shuts down between successive read scans to save power. This factor basically determines how long that shutdown is based on usage in a scan sequence. A dc = 30 with dur = 300 would give a read of 300 mS every second. This number is a goal and may be overridden based on power and battery conditions.
- baud default baud="115200". This attribute can be one of the following rates; { 460800, 230400, 115200, 57600, 38400, 9600, 4800, 2400, 1200 }. This routine only looks at the first three significant digits to set one of the above fixed baud rates, so using baud=115900 would end up setting the baud rate to 115,200 however setting a baud rate to baud=9643 would be unrecognizable and would end up not changing baud rate since the current rate is communicating.
- fields default fields="oid+ant". This attribute is a collection of field names separated by '+', or any white space and specifies the attributes that are returned with each tag read. The valid field names are;
  - oid This value is the tag's OID, typically 96 bit EPC number,
  - ant This value is antenna that the read was made on,
  - pwr This value is the conducted power used for the read..
  - cnt This value is number of times the tag was read during the scan.
  - rssi This value is the receive signal strength for the read.
  - bat This value is the battery voltage after read.
  - seq This value is an incrementing sequence number .

2.3 a433 active RFID subsystem

The active RFID reader subsystem is more of a peer to peer type communications and could actually be viewed as a telemetry channel. Indeed the system would not know that it is talking to an active tag or another tag reader other than by the data content over the protocol. This channel can then be used as a bridge between different types of readers, or to a remote access link. The commands are of exactly the same format as for the passive RFID subsystem other than the defaults and limits.

```
<a433 cmd="MR" ant="1234" pwr="300" rpt="1" dur="250" dc="50" fields="oid+cnt+ant"/>
```

The above command, which is identical to the pRFID example above would also execute a read request but ignore the `ant` attribute as that subsystem can only use the PCB antenna integral to the module. The power level would be 10.0 dBm as that is the maximum power level available on that subsystem. It would report back oid, count and antenna and might give the following response of a tag read if that tag was in range of the module. Note if requested the ant field will always respond back as 0 for this subsystem to indicate the integral PCB antenna.

```
<tag STS="RAW" OID="20120225D655020001020019" CNT="12" ANT="0" />
```

As with the 915 MHz reader, `<a433 />`attributes are optional. Those attributes required for the requested action are based on;

4. Attributes in the command string, such as `pwr="300"` in the above example
5. If not in command, then use last setting of the missing attributes.
   `<p433 cmd="MR"/>` (Issued after the above example repeats the same command)
6. If not in command and not previously set, missing attributres use the default values as described below.

The one exception is the `cmd` attribute which if not specified will cause the unit to return version numbers and configuration for the module. The attributes have the following effect;

- `cmd` default - if not specified, unit returns version and configuration
  - `cmd="MR"` specifies unit to do a multiple scans for tags on the each of the specified antennae for the specified duration of continuous power at the specified power level with the whole operation being run the specified repeat number of times. The repeat rate being governed by the specified duty cycle and the amount of power available according to the power management system.
  - `cmd="CR"` specifies unit to do a continuous scans for tags on the each of the specified antennae for the specified duration of continuous power at the specified power level with the whole operation being repeated continuously. The routine will continue to run until the abort command or until power levels are too low to reliably continue operations. As above, the repeat rate being governed by the specified duty cycle and the amount of power available according to the power management system.
  - `cmd="AB"` specifies unit to abort all reader operations. This includes continuous reads or multiple read operations.
  - `cmd="ON"` same effect as the Psion's hardware line. It overrides that control line and will turn on the reader.

- cmd="OFF" intended to turn off the reader if ther Psion control line is not being used, however if that control line is set to enable the reader that will override this command.
- cmd="LT" Lists all tags in the buffer since the last LT command was issued. It packages the tag reads into a

- pwr default pwr="100". This attribute is a number from 1 to 100 and represents the rf conducted power used for the reading in tenths of dBm. The maximum is 100 and represents 10.0 dBm or 10 milliWatts conducted power.
- rpt default rpt="1". This attribute is a number from 1 to 250 and represents the number of time the scan sequence through all the specified antennaes is repeated.
- dur default dur="250". This attribute is a number from 1 to 1000 and represents minimum time in milliSeconds that the reader will stay scanning on each of the specied antennae.
- dc default dc="30". This attribute is a number from 1 to 100 and represents the duty cycle in percentage points for operating the reader. The reader shuts down between successive read scans to save power. This factor basically determines how long that shutdown is based on usage in a scan sequence. A dc = 30 with dur = 300 would give a read of 300 mS every second. This number is a goal and may be overridden based on power and battery conditions.
- baud default baud="115200". This attribute can be one of the following rates; { 460800, 230400, 115200, 57600, 38400, 9600, 4800, 2400, 1200 }. This routine only looks at the first three significant digits to set one of the above fixed baud rates, so using baud=115900 would end up setting the baud rate to 115,200 however setting a baud rate to baud=9643 would be unrecognizable and would end up not changing baud rate since the current rate is communicating.
- fields default fields="oid+ant". This attribute is a collection of field names separated by '+', or any white space and specifies the attributes that are returned with each tag read. The valid field names are;
  - oid This value is the tag's OID, typically 96 bit EPC number,
  - ant This value always returns a 0 indicating the read was made on a433,
  - pwr This value is the conducted power used for the read..
  - cnt This value is number of times the tag was read during the scan.
  - rssi This value is the receive signal strength for the read.
  - bat This value is the battery voltage after read.
  - seq This value is an incrementing sequence number .

3 Applications on the Module

3.1 Developing on a Handheld

This host handheld terminal itself is all that is required to operate this module. The handheld terminal provides power and the pRFID antennae and by definition provides a human interface capability. The module would normally be controlled by an application program running on this handheld terminal, so the user functions would therefore be defined by that application. Note that since the radios on the module are controlled by the module's firmware, power monitoring and self check functions, the application developer does not have to worry about low level control and perhaps operating the radios outside of certification limits or protocol specifications.

In developing an application program one can still try command sequences to verify operation using a terminal emulation program. Since all commands and responses are in a human readable XML format, it makes this fairly easy to manually enter the commands and read the responses. The Psion Workabout Pro comes with a serial test program called 'Serial Demo' which can be used as a crude terminal emulation program. The total equipment required to develop an application or run the module would therefore be;

1. Handheld Terminal – Psion Workabout-Pro.
2. Terminal emulator software such as Psion's **"Serial Demo"** program.

The handheld terminal must be turned on then use the 'File Explorer' to navigate to the location of the Serial Demo software folder. Double click Serial Demo executeable to start the program which will give direct access to the command inputs for the Transmitter Device module.

The program should start up with the screen as shown at left. Reset the com port to COM1: and the baud to 115200 using the list selector – note the scroll bar on the list for each one. Once these have been selected, click the 'Open Port' button. The outgoing text box which initially will show 'Hello World!' is the command string to the Transmitter Device module.

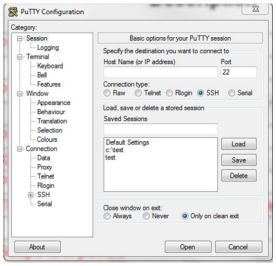
The outgoing text has the full XML command set interpreter that is used to control and use the Transmitter Device module in a software application. However, a number of shortcut commands have been implemented to make this process easier for testing using this simple serial demo program. Note that to send the command to the Transmitter Device module one must click the 'send' button, using the ENTER key does not send the command.

3.2 Developing on a PC

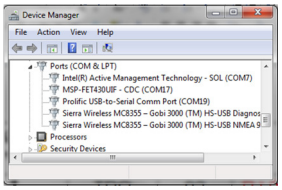
Alternately, the transmitter device can be tested in a stand-alone mode through the JTAG connector that is used to program the device. In that case power needs to be supplied and there is a serial console port connection through the JTAG connector to allow the same control of the device as if it were in the handheld terminal. In the following configuration the application could directly be developed on a more feature rich PC platform before being ported over to a handheld device.

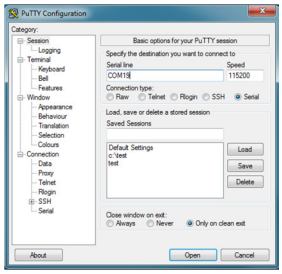
1. Power supply, 3-5V minimum 1amp capability.
2. External cable with MMCX connector for antenna or test device.
3. Laptop Computer with serial port capability
4. RS232-to-TTL (3.3V) converter
5. Terminal emulator software such as freeware program **"PUTTY"**.

3.2.1 Putty Serial Connection



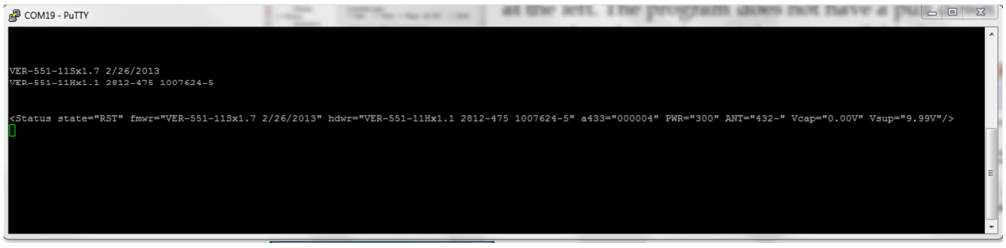
Putty is freeware that can be downloaded from www.putty.org. It will startup with defaults as shown at the left. The program does not have a pull down menu that shows the serial ports available for connection. One way to determine which ports are which especially with USB based serial ports if to run the 'Device Manager'. In this case we can see that our serial port is COM 19.





One can then use this information to fill out putty configuration screen first selecting the 'Serial' button under the Connection Type then entering 'COM19' for the serial line and 115200 for the speed as shown at left. One can also save the session for faster starts at a later time and recording the sessions.

Pressing the open button will then open a dialogue screen which should look as follows as the module powers up.



3.2.2 JTAG Connector

The hardware connections to run the device in a standalone configuration are through the JTAG programming connections shown below. The required connections are shown in red. There are also three test point connections available on this connector to aid in developing and debugging applications.

Header 0.1" 2x7	JTAG Signal	MSP pin	Description
1	TDO	92	PJ.0/TDO Test Data Output port
2	Vcc		
3	TDI	93	PJ.1/TDI/CLK Test Data Input port
4	Vcc Ext		Power Supply 4V, 1A
5	TMS	94	PJ.2/TMS Test Mode Select
6	KEY	KEY	KEY
7	TCK	95	PJ.3/TCK Test Clock
8	Test	91	TEST/SBWTCK Test Mode pin – select JTAG pins
9	GND		Power Supply Ground
10	N/C	17	Scope test point 0
11	RST	96	RST/NMI/SBWTDIO Reset input active low
12	N/C	18	Scope test point 1
13	N/C	72	TxD for External debug/console link
14	N/C	73	RxD for External debug/console link

4 Revision History

Author	Date	Modification	Telephone Number
Bill Davidson	March-1, 2013 April-5, 2013 May-15, 2013	Initial entry and formatting Assigned version V1.0 (SVN) V2.0 add SAR warning label	919-460-1177