COMARK
A Fluke Company

RF500A Gateway

Service Manual

Issue 1.0

17 November 2011

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Introduction

This manual is intended for all aspects of fault diagnosis and repair for the RF500A/AP. It is structured into 3 tiers of testing each requiring more technical competence than the last. Each tier indicates the technical requirements at the beginning of the section under the "**Operator Technical Competency"** heading.

Familiarity with use of the RF500A Gateway is assumed and procedures such as those which appear in the user manual or RF500A System Manual will not be detailed here.

Related Documentation

Installation and Basic Operation	RF500A System Manual
Web Interface Operation	RF500A-WebView Help

RF500A System Manual is supplied in printed form with each Gateway
The above can be downloaded from http://www.comarkltd.com/comark-operator-manuals.tpl

Safety Information

Under no circumstances may a user make any changes to the RF500A Gateway that would alter its performance. Any modification would void the CE compliance of the Gateway and may invalidate the warranty.

If the equipment is used in a manner not specified by Comark Instruments, then the protection provided by the equipment may be impaired.

Warnings

- Before connecting or disconnecting the antenna, ensure anti-static precautions are observed.
- Use only the FRIWO 12V AC adaptor; Type FW74010/12 as supplied; with the RF500A Gateway.
- Do not modify the RF500A Gateway AC adaptor in any way.
- Use only the PHIHONG, PSM11R-050 5V AC adaptor or FRIWO type FW7662/05 with RF500 Transmitters. It is supplied by Comark Instruments as three variants:

RF520	Transmitter AC adaptor with UK plug
RF520/EU	Transmitter AC adaptor with European style plug
RF520/US	Transmitter AC adaptor with North American style plug

- Do not modify the AC adaptor in any way.
- RF500 Transmitters contain a C-size lithium cell. This cell must not be incinerated or subjected to temperatures in excess of 100°C. Do not deform, mutilate, crush, pierce, disassemble, recharge or short circuit. Such abuse can result in loss of seal, and/or cell explosion. Also exposure to humid conditions for long periods should be avoided.
- Do not insert metal objects into connectors.
- Ensure the antenna is securely connected before powering the equipment. Internal damage may result otherwise.
- The Gateway and Transmitters have been designed to operate with the antenna supplied by Comark, and having a maximum gain of 7dBi. Antennas not supplied by Comark Instruments or having a gain of greater than 7dBi are strictly prohibited for use with this device. The required antenna impedance is 50 Ohms. If in doubt please contact Comark Instruments or your Distributor for advice.

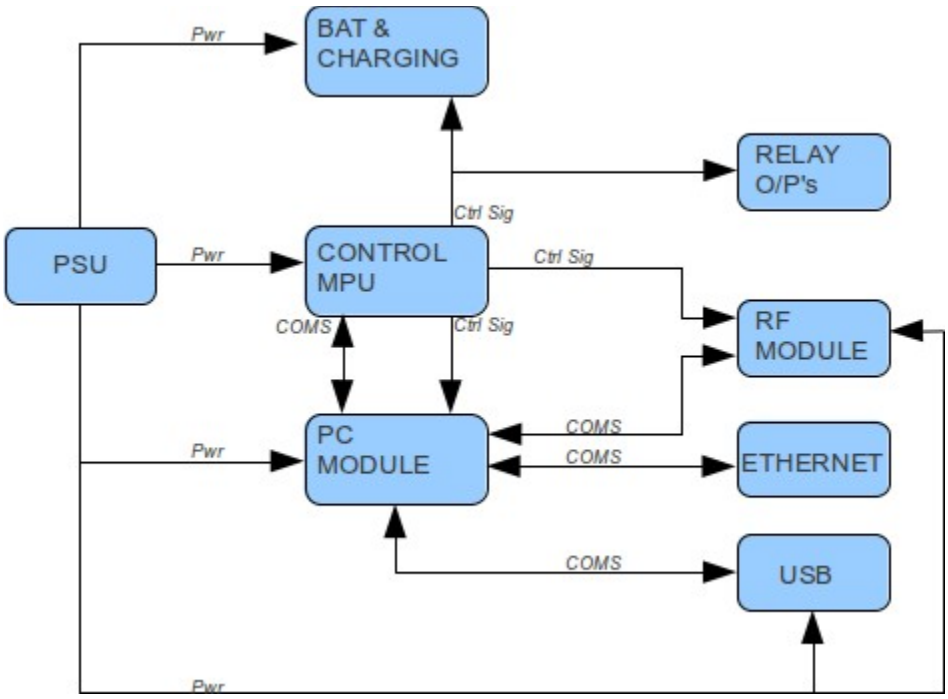
WEEE

RF512, RF513, RF515 and RF516 Transmitters contain a non-rechargeable lithium battery. This battery must be disposed of in accordance with local regulations.

Specification

No of Channels	Up to 256
No of Transmitters	Up to 64
Storage Capacity	Up to 10 years storage
RF Frequency	2.4GHz using IEEE 802.15.4
Operating Conditions	0°C to 40°C, 10-90% RH non-condensing
Power Sources	AC power adaptor, rechargeable Ni-Mh battery RF500AP only: Power over Ethernet (PoE) capability. Compliant to IEEE 802.3af
Power Adaptor	100-240VAC 1.5A 50/60Hz FRIWO DT12 12V 1A O/P
Battery Backup	4.3Ah Ni-Mh Rechargeable Battery. Running time approximately 1 hour
Clock Accuracy	4ppm (2 minutes per year)
Relay Outputs (SW1 & SW2)	Two individual 2.5mm jack sockets. Contacts: 24Vdc 500mA maximum
Power Consumption	12W Max
Dimensions	L 225mm x W 150mm x D 40mm
Weight	1.3kg

System Block Diagram

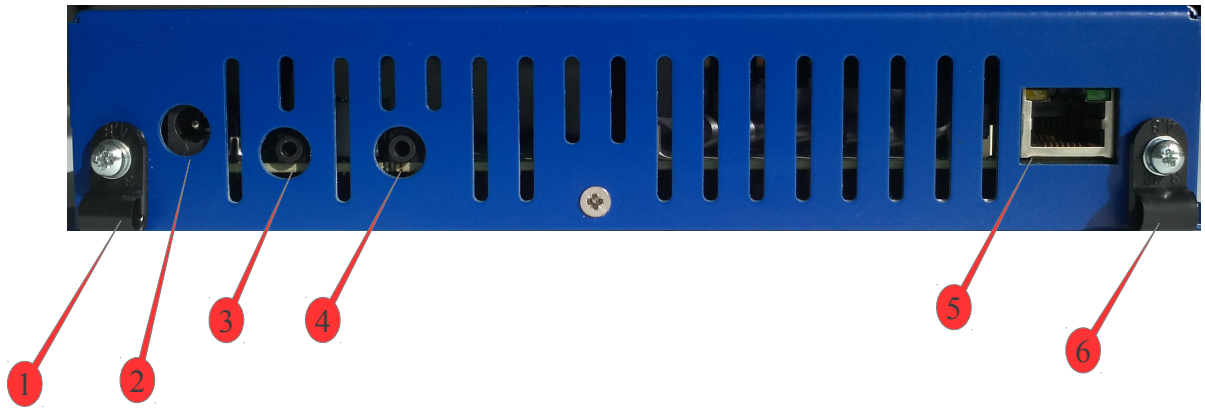


Visual Tour

Front View

No.	Item	Description
1	*ON*	Steady Blue: Gateway is running ¼s on ¼s off Blue : Gateway is starting up 2s off 2s on Blue: Gateway is shutting down
2	*POWER/BATTERY*	Steady Green: External Power is available Flashing Green: Gateway is on and running off the battery pack Off: Gateway is off and external power is not available
3	*FAULT*	Flashing: There is a fault with the system, could indicate hardware or software fault
4	*ALARM*	Flashing Red: An enabled alarm event has occurred

Bottom View

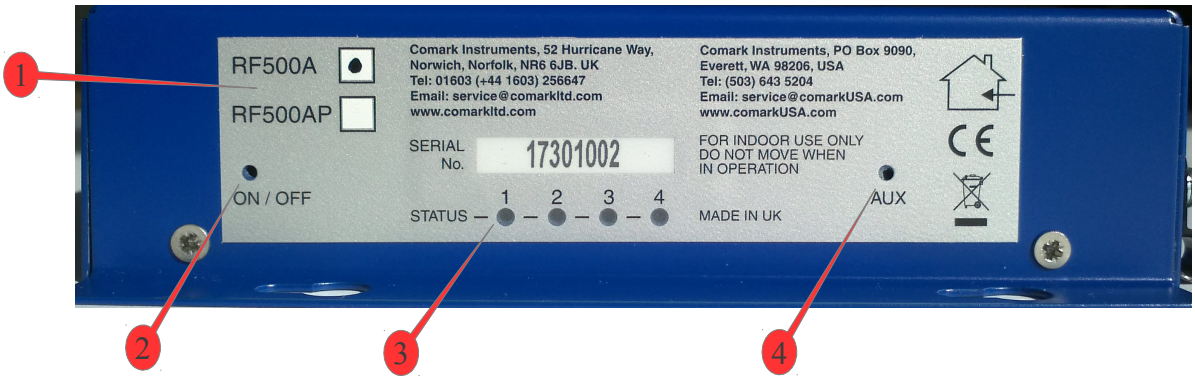


No.	Item	Description
1	*Cable Clamp*	To secure cables during installation
2	*12V DC Input*	Input for Friwo DT12 external power adapter
3	*SW1*	Jack Socket for Relay Output 1
4	*SW2*	Jack Socket for Relay Output 2
5	*RJ45 Socket*	RJ45 Ethernet LAN Socket
6	*Cable Clamp*	To secure cables during installation

Side View (USB Connector)

No.	Item	Description
1	*USB*	Used for initial configuration and as a debug port using the RF500A Config software or Hyper-terminal (or similar comms program)
2	*Memory Card Door*	For access to both µSDHC cards
3	*Module Reset*	Direct access to the PC module reset line

Side View (Serial Number Label)



No.	Item	Description
1	*Model*	Indicates which build variant the unit is (RF500AP is the PoE version)
2	*ON/OFF Switch*	Gateway Startup/Powerdown switch
3	*Status LED's*	Diagnostic LEDs (See Fault Code table)
4	*AUX Button*	Not Used

Top View

No.	Item	Description
1	*Antenna Port*	RP-SMA Connector for standard or hi-gain antenna

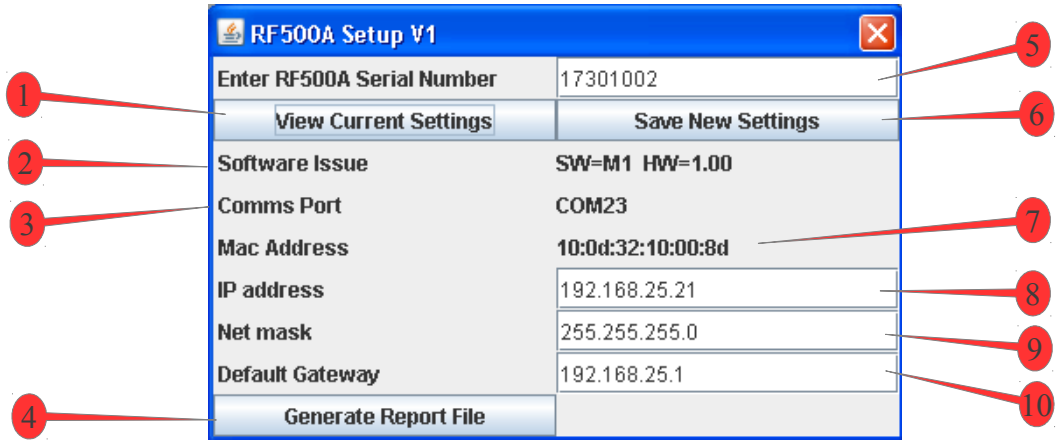
Software Utilities

RF500A Config Utility

This accompanying software is released to the customer to allow basic configuration of the unit via the USB interface. Additionally it can provide a status report to aide fault finding.

To use the software Java 1.6.0 or higher must be installed, the installer can then be run and the utility will be installed on the target machine.

Run the application with an RF500A/AP turned on and connected to the PC via the USB port, enter the serial number and click “View Current Settings”:

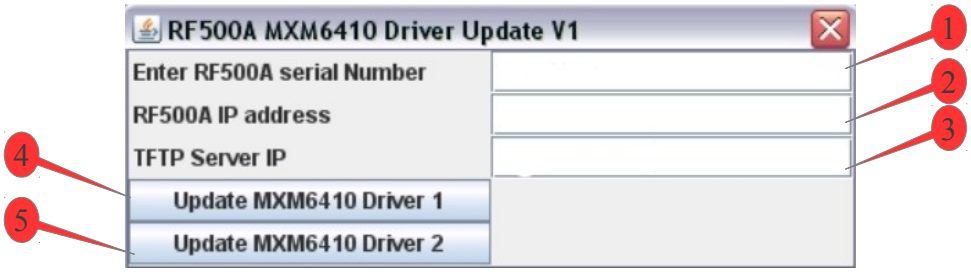


No.	Item	Description
1	*View Current Settings*	View settings of unit
2	*Software Issue*	SW refers to the software issue currently running on the unit HW refers to the firmware version currently running on the control MPU
3	*Comms Port*	This is the USB virtual com port currently being used
4	*Generate Report File*	Will output a text file with status information
5	*Serial Number*	Serial number of the unit to be interrogated
6	*Save New Settings*	Once new settings are entered in the relevant boxes this will initiate the upload of those settings to the unit
7	*MAC Address*	This is the MAC address of the unit
8	*IP Address*	This is the current IP address of the unit (this can be changed and saved back to the RF500A/AP)
9	*Net Mask*	This is the current Net Mask of the unit (this can be changed and saved back to the RF500A/AP)
10	*Default Gateway*	This is the current Default Gateway IP address of the unit (this can be changed and saved back to the RF500A/AP)

Driver Update Software

The stock PC module requires custom drivers to be installed before it can be used in an RF500A/AP. A simple software utility is available to apply the update. The system uses the USB port for control and the Ethernet port for the actual data transfer.

On the same PC running this update utility Tftpd32 must be installed and running, and the latest drivers installed into C:\tftp.



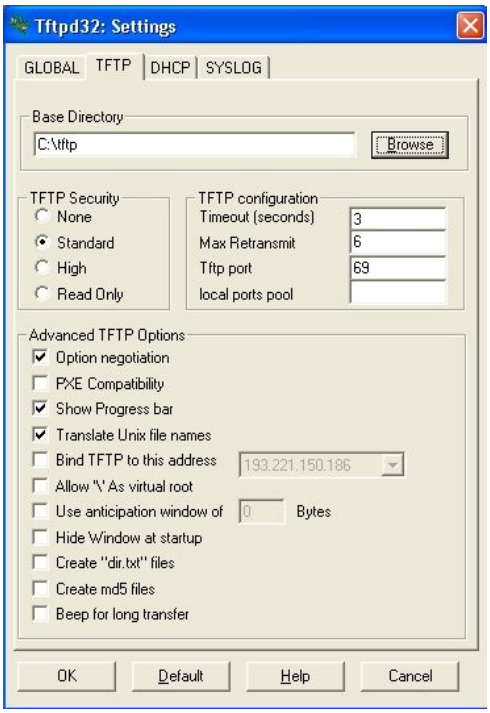
No.	Item	Description
1	*Enter RF500A serial Number*	Serial number of the target RF500A/AP
2	*RF500 IP address*	IP address of the target RF500A/AP
3	*TFTP Server IP*	IP address of the PC running the update software
4	*Update MXM6410 Driver 1*	Start Driver 1 update process
5	*Update MXM6410 Driver 2*	Start Driver 2 update process

Tftpd32 Software

To perform the driver update a tftp (Trivial File Transfer Protocol) server need to be running on the same PC as the driver update software.

Tftpd32 can be obtained from http://tftp32.jounin.net

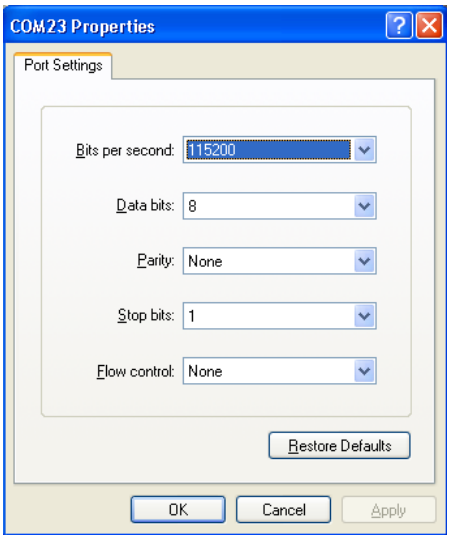
This software must be configured as shown below:

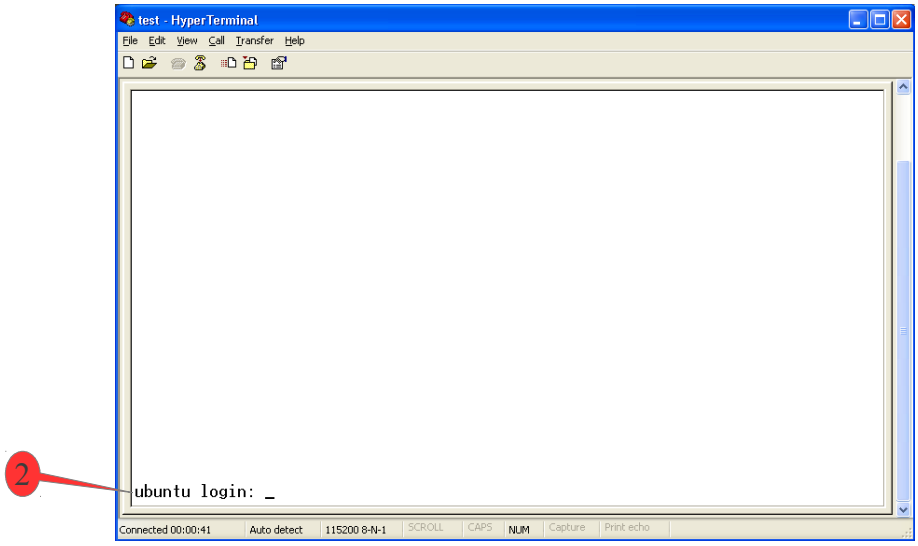


Hyper-terminal

Further access to the RF500A/AP can be gained using a terminal program such as Hyper-terminal. Root access can be achieved via the USB port for further fault diagnosis.

Hyper-terminal Settings





No.	Item	Description
1	*Comms Port*	This is the Virtual Com Port created by the USB drives (if the number is not known it can be found in Device Manager → Ports)
2	*Login Prompt*	Indicates connection has been established and is now waiting for login credentials

Disassembly

Tools

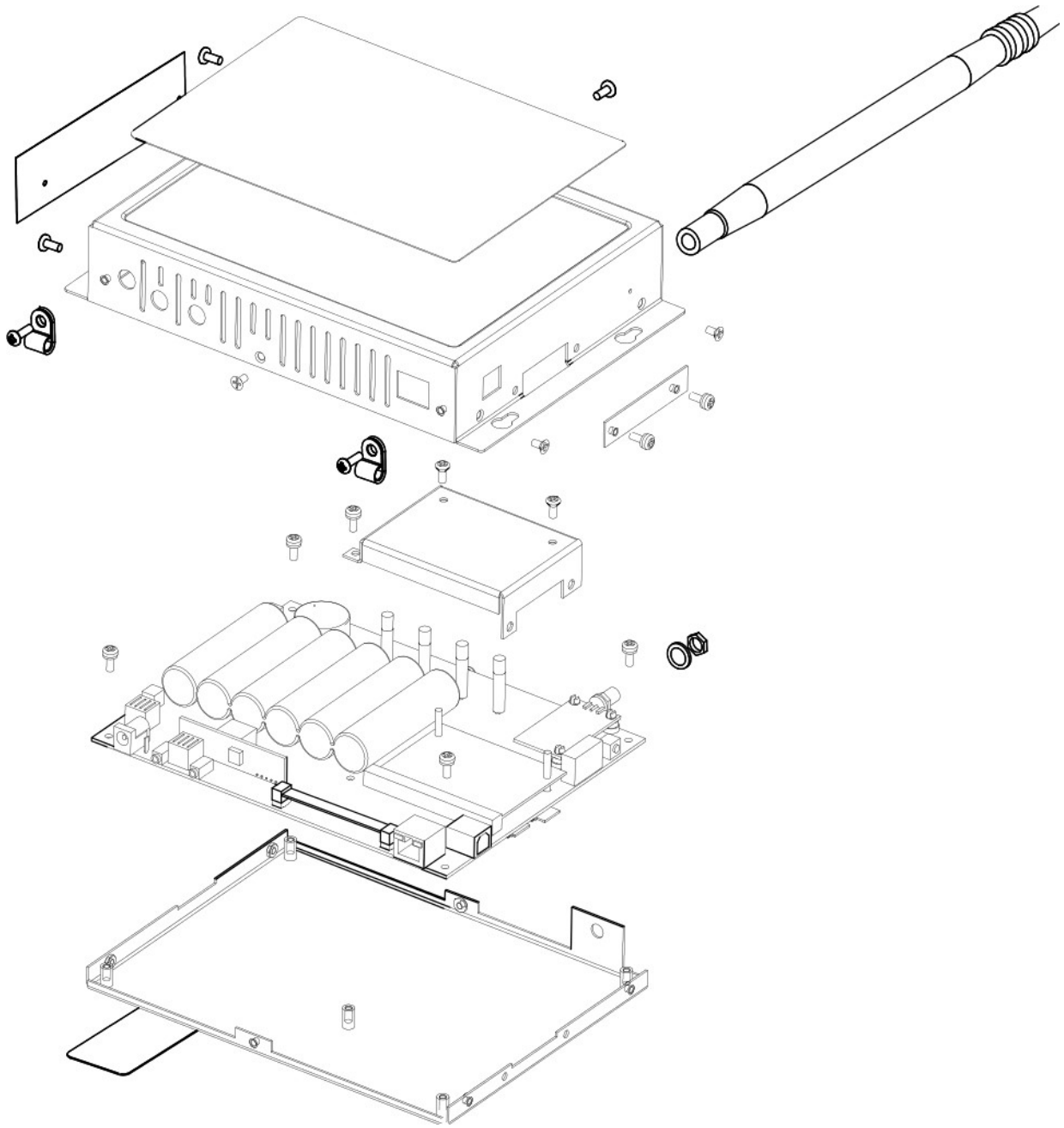
To disassemble an RF500A/AP you will need the following tools:

- Wrist grounding strap and conductive mat for preventing electrostatic discharge
- Phillips screwdriver
- 8mm box driver
- 5mm box driver
- Thin nose pliers

Prerequisites

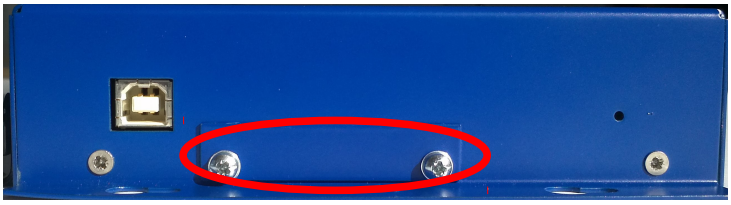
1. Turn off the RF500A/AP.
2. Remove AC power.
3. Place on a flat stable surface.
4. Remove the antenna.

Exploded View



Remove µSDHC Cards

The memory cards are located behind the metal plate located on the USB connector side of the unit:



Remove the 2 retaining screws:

The memory cards are now exposed and can be removed. To eject the card simply push the card in until a click is heard and then release:

The cards are now ready to be removed:

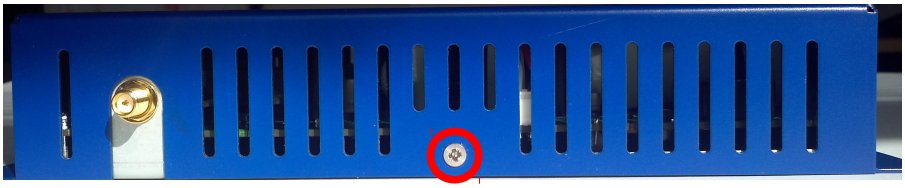
Remove Case Front

Remove the 8 case retaining screws securing the case front to the case rear:

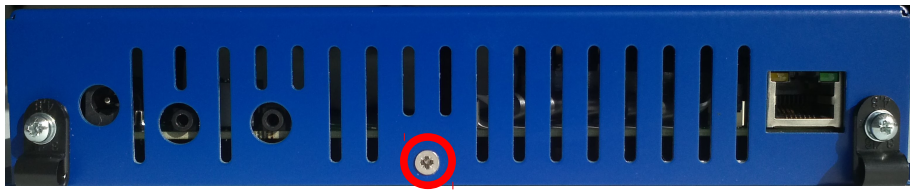
USB Side View

Serial Number Side View

Top View



Bottom View

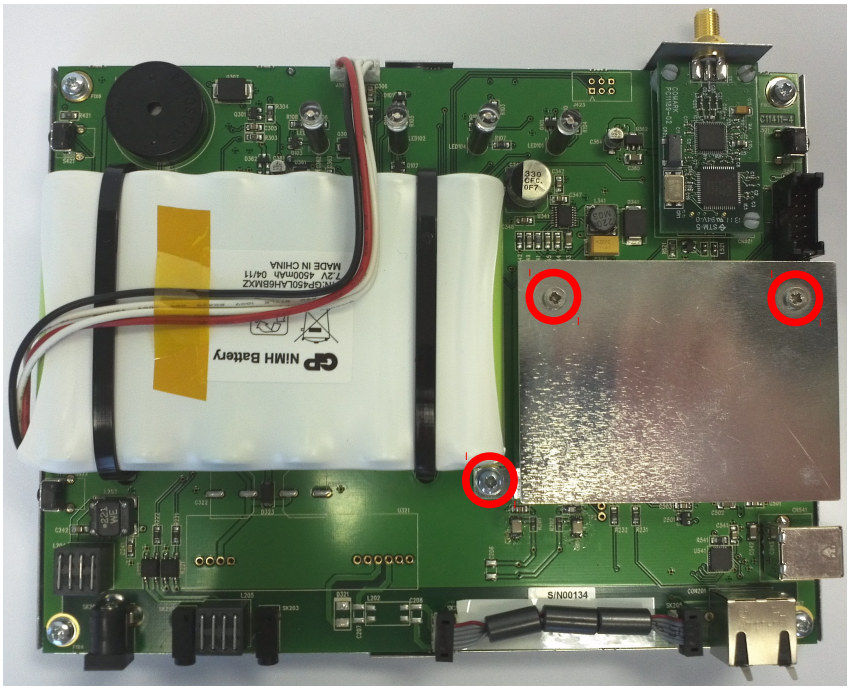


The case front can now be carefully removed.

NOTE: DISCONNECT BATTERY BEFORE PROCEEDING ANY FURTHER.

Remove RF Shield

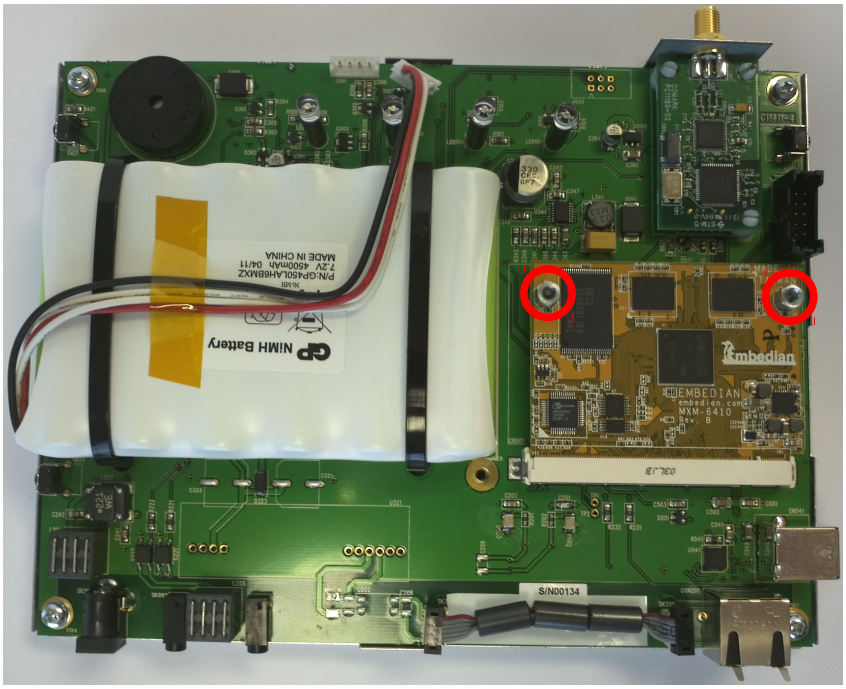
Remove the 3 retaining screws:



Once the retaining screws have been removed the shield will simply lift off.

Remove the PC Module

Remove the 2 hexagonal pillars with the 5mm box driver:

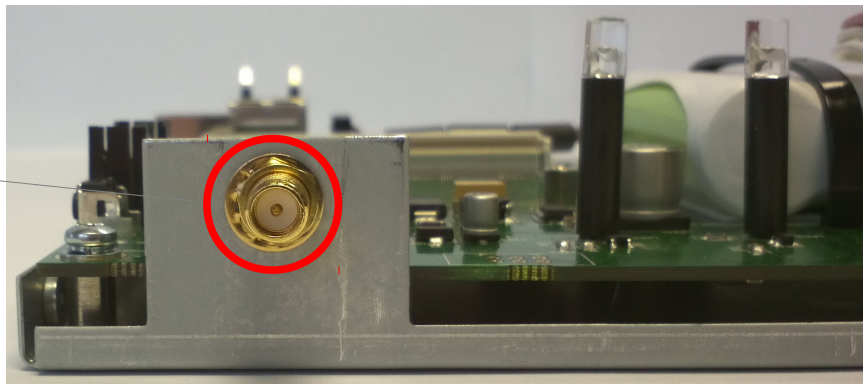


Once the pillars have been removed the module will self locate for removal.

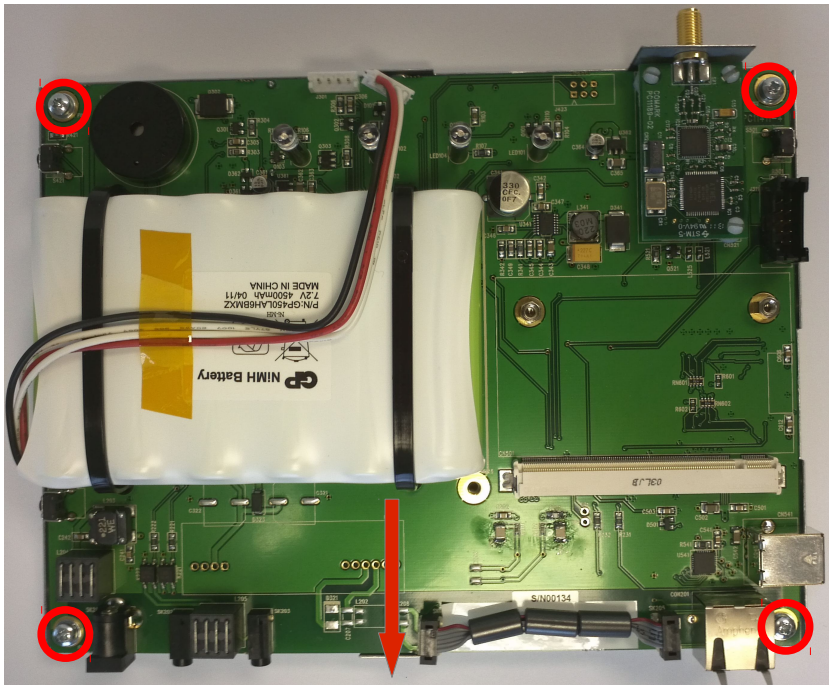
Remove the main PCB from base plate

Undo the brass nut securing the antenna connector to the base plate using the 8mm box driver:

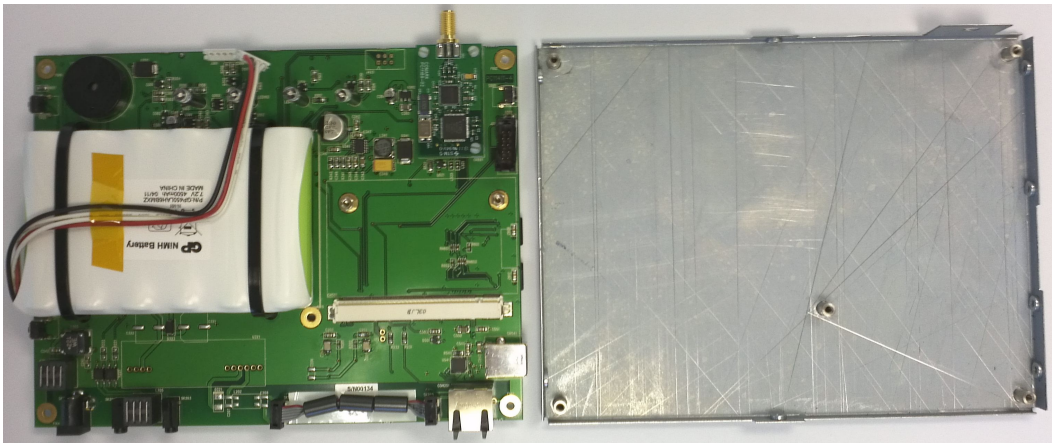
Remove Nut and Washer



Now remove the 4 remaining PCB securing screws:

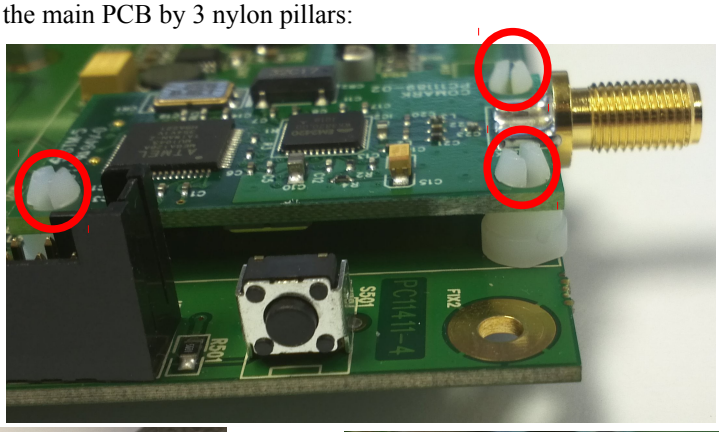


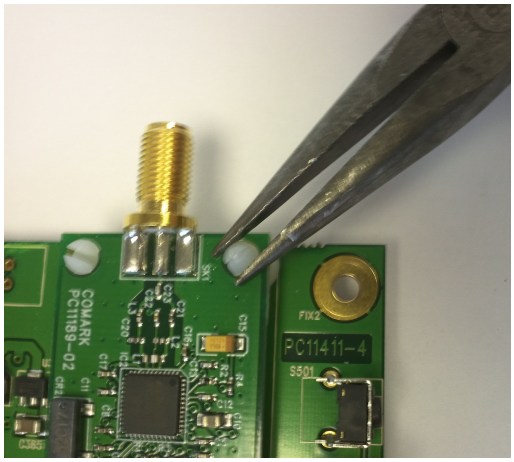
Once removed the PCB will slide away from the antenna hole as indicated. Once the antenna connector has cleared the hole the PCB can be fully removed from the chassis plate.



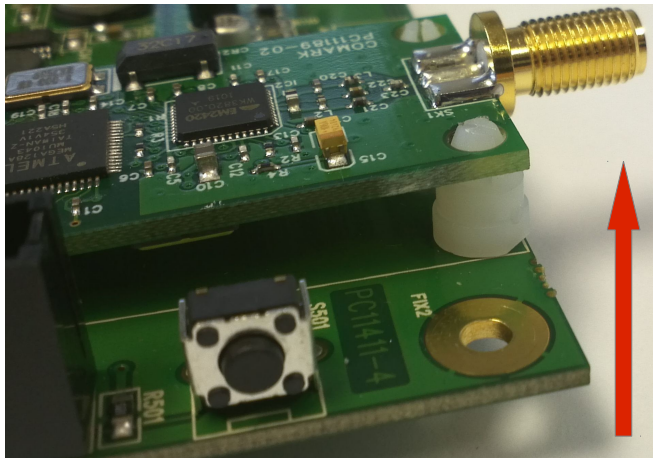
Remove RF PCB from main PCB

The RF PCB is secured to the main PCB by 3 nylon pillars:



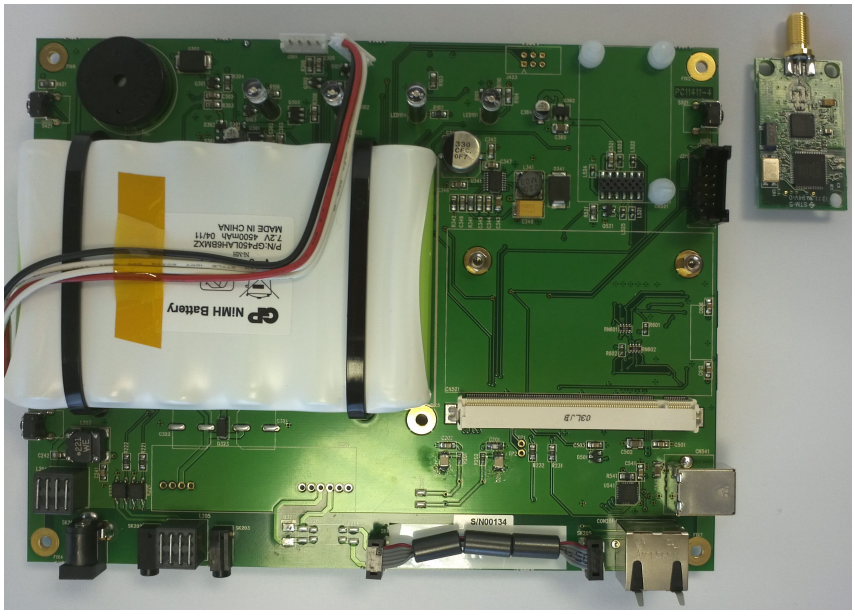


Using a pair of thin nosed pliers, compress the head of the pillar:



Now gently lift the edge of the PCB:

Repeat the process on each of the 3 pillars and then gently remove the RF PCB.



Disassembly is now complete.

Fully Disassembled Replaceable Parts

Part No.	Item	Comments
20077/2	*Case Front*	Including all labels
20078	*Case Rear*	Including all labels
20079	*Memory Card Plate*	
A20052	*Main Board*	Including Battery Pack and board level interconnect lead
A20197	*RF Board*	Including nut and washer
20169	*PC Module*	
20188/2	*Shield*	
18299	*Antenna*	Not Pictured
20080	*External PSU*	Not Pictured
A20198	µSDHC Memory Cards	Not Pictured

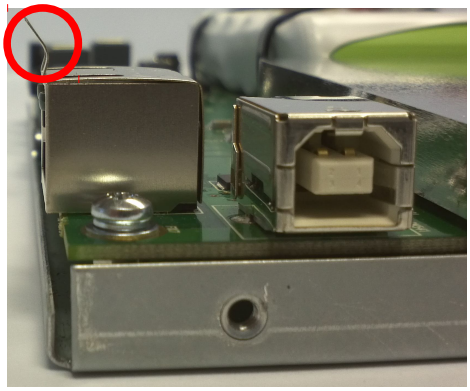
Reassembly

Reassembly is the reverse of the disassembly process:

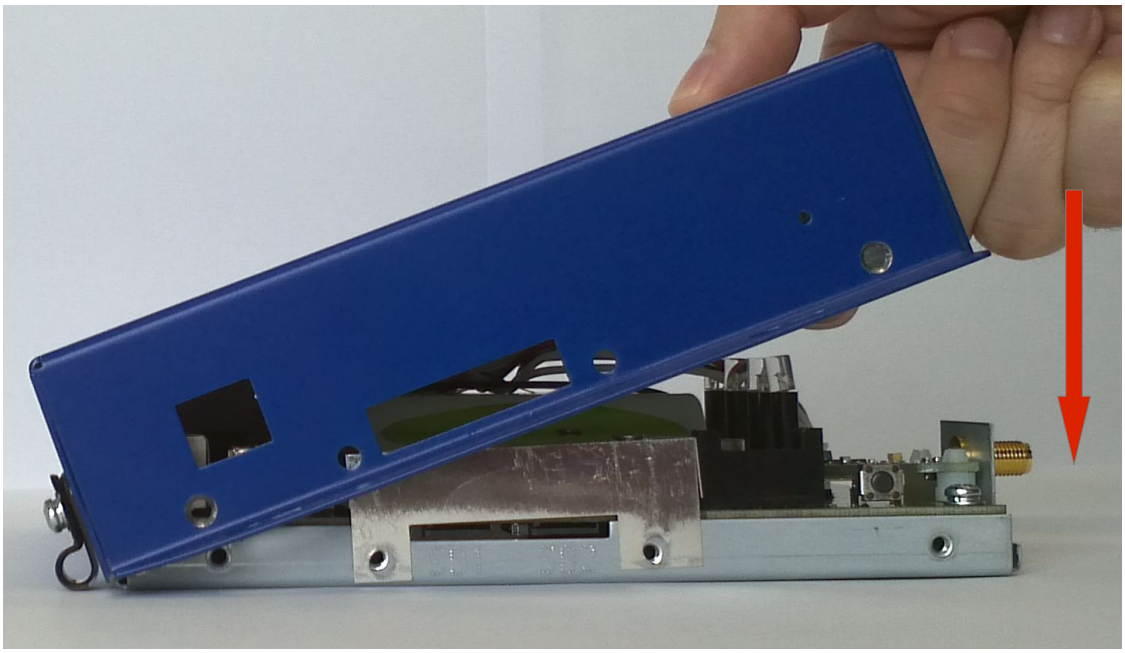
1. Replace the RF module
2. Secure the main PCB to the chassis base plate:
    - Tighten RF nut (**support the RF module when tightening the nut**).
    - Tighten the 4 corner main PCB screws.
3. Replace the PC module
4. Replace the RF shield
5. Replace the case front **(SEE NOTE BELOW)**

Replace Case Front

The Ethernet connector has 2 grounding tabs that connect to the case front forming an electrical seal:



When replacing the case front it should be initially located such that it is angled at the connector end making sure the grounding tabs are enclosed and then pushed down toward the RF module:



The memory card plate and 8 retaining screws can now be replaced.

Tier 1: RF500A Functional Testing

Operator Technical Competency

The Tier 1 section can be followed by a non-technician level operator.

Functional Test Equipment Required

- RF500A AC Adaptor
- PoE Injector Mode-A
- PoE Injector Mode-B
- 2.5mm Jack for Alarm Output (Comark P/N: RFJACK)
- Continuity Tester or DMM
- Computer running Microsoft Windows with Comark RF500ACONFIG Utility installed and Comark USB Drivers Version 3.00 or higher must also be installed.
- Cross-Over Ethernet cable
- RF51X Transmitter

Initial Observation

The RF500A Gateway may be initially observed in various states. It is important to record the details about this state before performing further tests, this information may prove useful in later fault diagnosis.

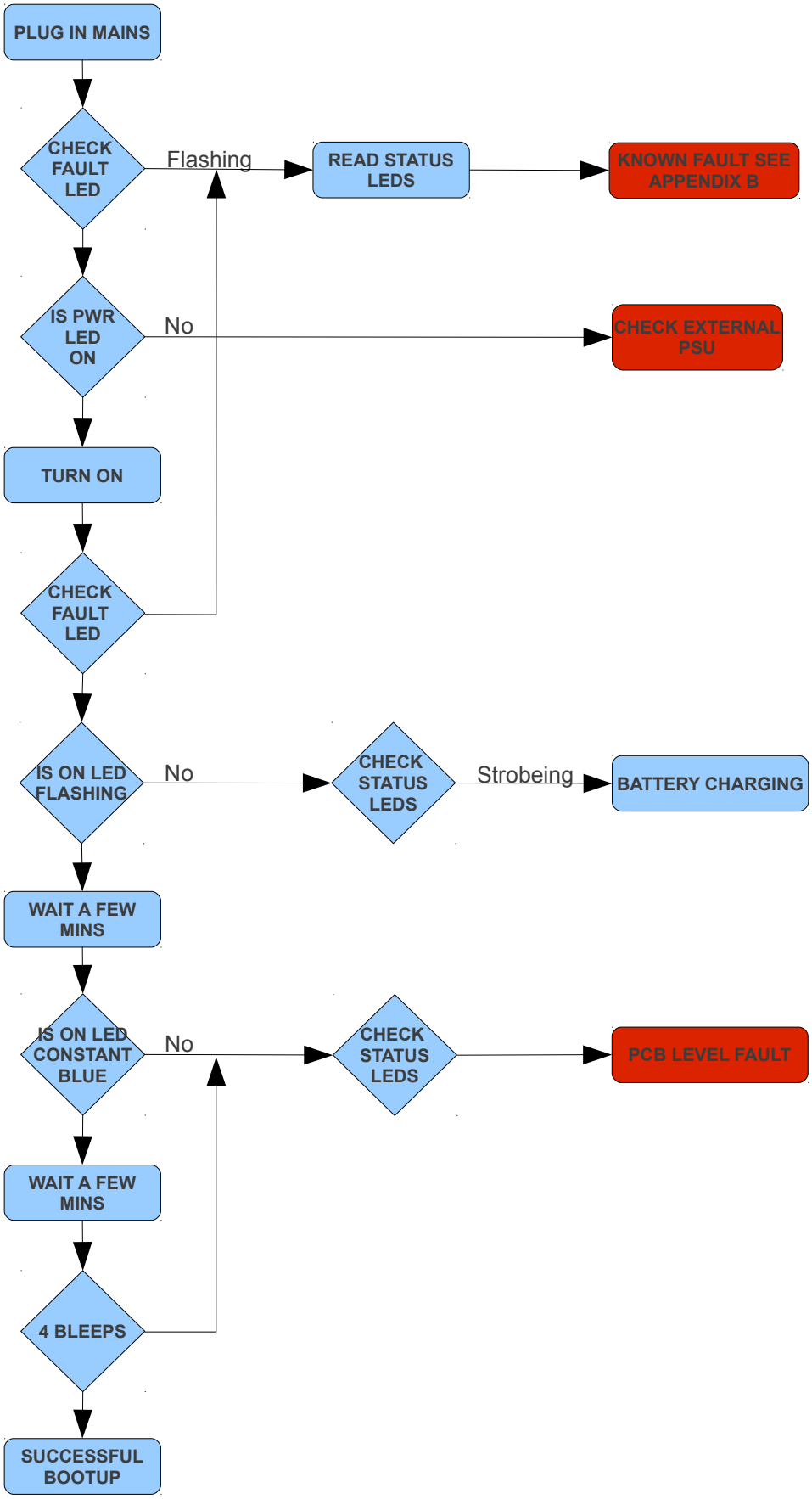
Referring to both Appendix-A – Front Panel Indicators ,Appendix B – Status Indicators and Appendix C – Website Error Messages, record carefully which indicators are showing. Of course if a recognised fault is indicated, we could continue testing to determine whether that particular fault recurs. If the device manages to boot up, Appendix C – Website Error Messages lists the possible error messages for further fault diagnosis.

Status Indicators

Note that the status indicators as described in Appendix B – Status Indicators are only capable of displaying one fault at a time. In the event that there my be multiple faults the highest priority fault will be displayed until fixed.

The status indicators are only active for fault status display while the PC module is off, once booted the module has control of these indicators for activity indication.

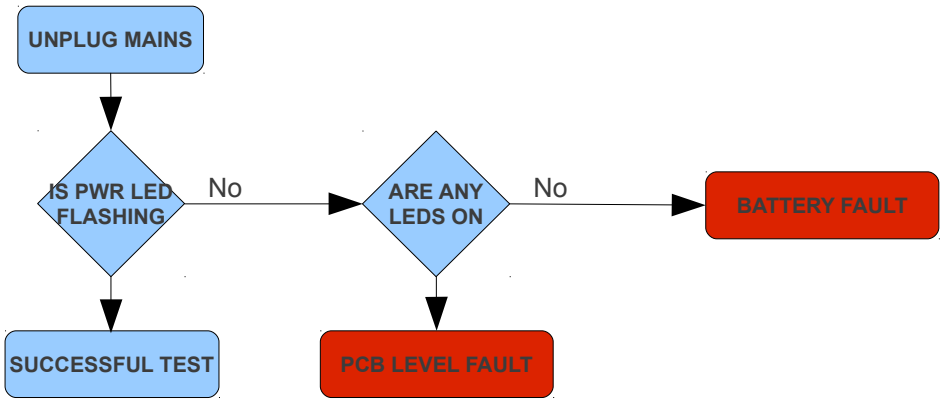
Startup Sequence



Battery Test

Initial Conditions:

- Mains Power Attached
- RF500A/AP successfully booted and website running

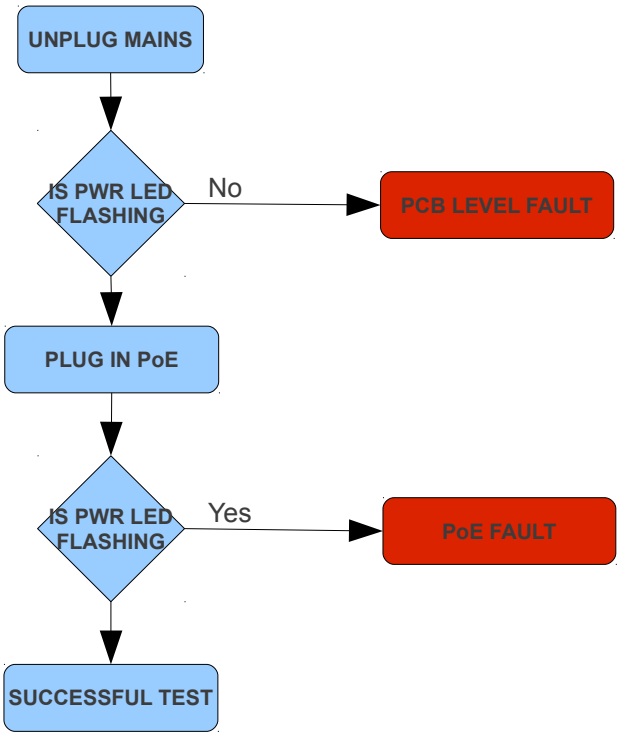


Power Over Ethernet (PoE) Testing

Initial Conditions:

- Mains Power Attached
- RF500A/AP successfully booted and website running

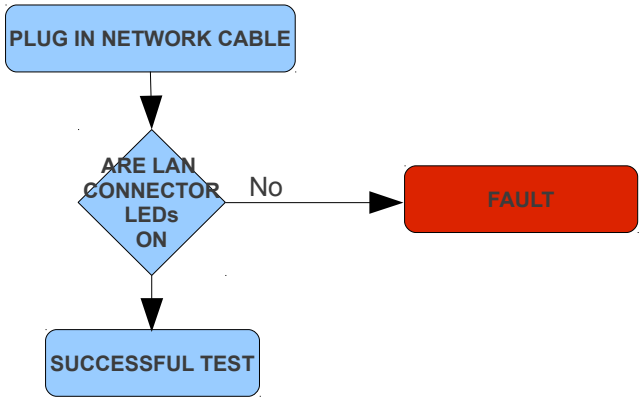
The following test should be performed with both mode A and mode B type PoE injectors.



Network Test

Initial Conditions:

- Mains Power Attached
- RF500A/AP successfully booted and website running

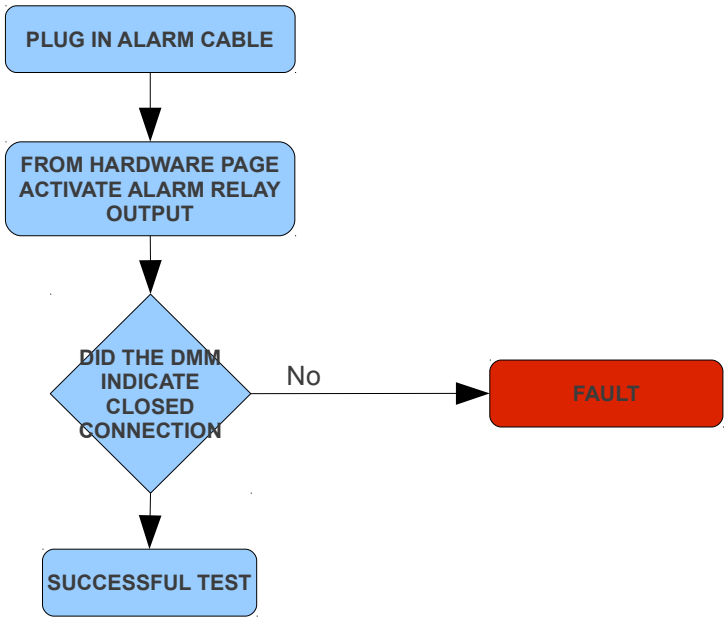


Alarm Output Test

Initial Conditions:

- Mains Power Attached
- RF500A/AP successfully booted and website running

This test requires the use of the 2.5mm jack lead (Comark P/N: RFJACK) and DMM continuity tester. The RF500A/AP should be plugged in and switched on with website running and viewable. The alarm outputs can both be configured as normally open or normally closed as per the users requirements. This procedure assumes starting with the alarm outputs configured as normally open.



This should be applied to both alarm outputs. Once the test has been completed the alarm relay outputs should be returned to their original settings. This procedure can also be used starting from the normally open initial condition just checking the connection opens instead of indicating closed.

Alarm LED Test

Initial Conditions:

- Mains Power Attached
- RF500A/AP successfully booted and website running

Add and task a transmitter to the system, ensure the task has alarm limits and force the transmitter into alarm. Configure the transmitter location to enable alarms. Ensure the alarm LED is flashing.

Radio Module Test

Initial Conditions:

- Mains Power Attached
- RF500A/AP successfully booted and website running

The easiest method of testing the radio module is to start the RF500A/AP and add a transmitter to the system, as soon as the transmitter “log's on” and shows as being “Found” it can be assumed the radio module is working correctly.

Audit Trail & System Software Test

Initial Conditions:

- Mains Power Attached
- RF500A/AP successfully booted and website running

Start up the RF500A/AP as normal, add a transmitter and program a task. Once the task has been sent to the transmitter view the audit trail from the administration menu and verify the adding and tasking information has been logged.

Shutdown Test

Initial Conditions:

- Mains Power Attached
- RF500A/AP successfully booted and website running

The RF500A/AP can be shutdown via hardware or software. Both methods should be tested:

Software

From the “Administration” tab select “Hardware”, enter password and click “Shutdown Gateway”. This will initiate the shutdown sequence which can take up to 10 mins.

Hardware

With the RF500A/AP running press and hold the On/Off button for 4 seconds until the unit acknowledges the activation via an audible indication.

Tier 2: RF500A Module Replacements

Operator Technical Competency

The Tier 2 section requires a technician level operator.

Test Equipment Required

- RF500A AC Adaptor.
- PoE Injector.
- Computer running Microsoft Windows with Comark RF500ACONFIG Utility, Driver Update Utility and Tftpd32 installed, Comark USB Drivers Version 3.00 or higher must also be installed.
- Cross-Over ethernet cable.
- RF51X Transmitter.

Initial Observation

The RF500A Gateway may be initially observed in various states. It is important to record the details about this state before performing further tests, this information may prove useful in later fault diagnosis.

Referring to both Appendix-A – Front Panel Indicators ,Appendix B – Status Indicators and Appendix C – Website Error Messages, record carefully which indicators are showing. Of course if a recognised fault is indicated, we could continue testing to determine whether that particular fault recurs. If the device manages to boot up, Appendix C – Website Error Messages lists the possible error messages for further fault diagnosis.

Status Indicators

Note that the status indicators as described in Appendix B – Status Indicators are only capable of displaying one fault at a time. In the event that there my be multiple faults the highest priority fault will be displayed until fixed.

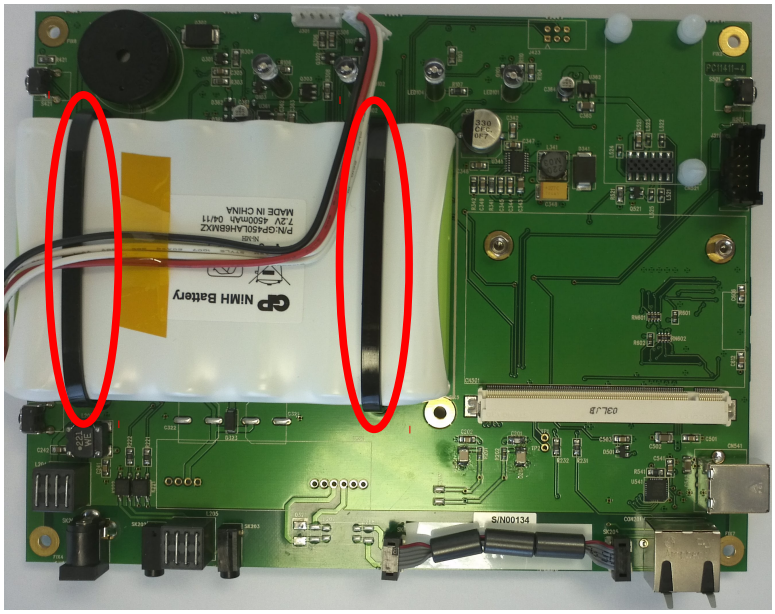
The status indicators are only active for fault status display while the PC module is off, once booted the module has control of these indicators for activity indication.

Replace the Battery Pack

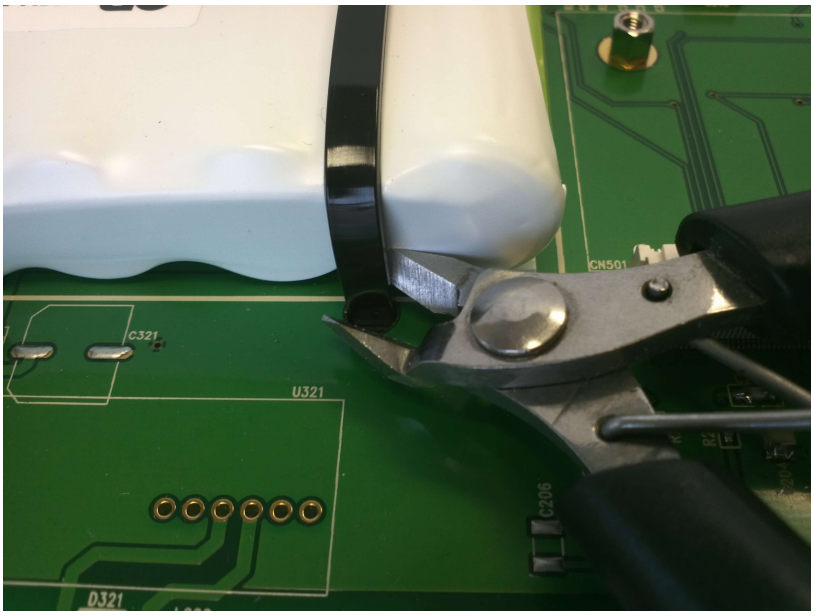
Completely disassemble the RF500A/AP as per the Disassembly section.

NOTE: Self adhesive pads should be cut with sharp knife when lifting the battery pack.

The battery pack is held in place by 2 cable ties that pass through 4 holes in the PCB. Additionally there are 4 double sided adhesive foam pads under the pack.



To remove the pack, cut the cable ties:



Finally carefully but firmly lever off the battery pack

Replace RF Module

Remove the RF module as described in the Disassembly section above. Replace with new unit (pre-configured with RF500A firmware A4/AI/11277) and reassemble into case.

Reboot the RF500A/AP and add a transmitter to the system, ensure the transmitter is found and tasks.

Replace PC Module

Remove the PC module as described in the Disassembly section above(Remove the PC Module). Replace with new unit and secure into place.

Upload latest drivers

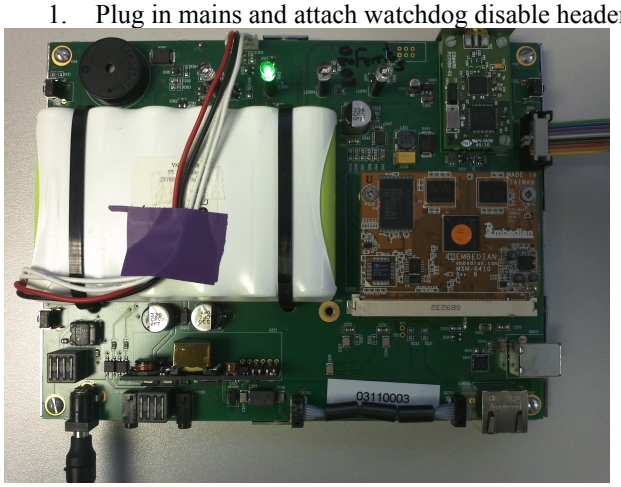
Before starting this procedure the following conditions must be met:

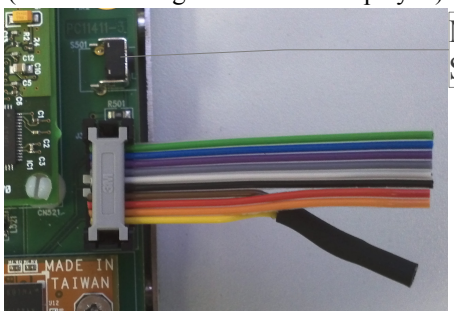
- Remove both SD cards
- Assemble into chassis plate
- Antenna must be connected
- (*Optional*) Fit RF Shield

NOTE: Make sure this is the only RF500A device plugged in during this procedure.

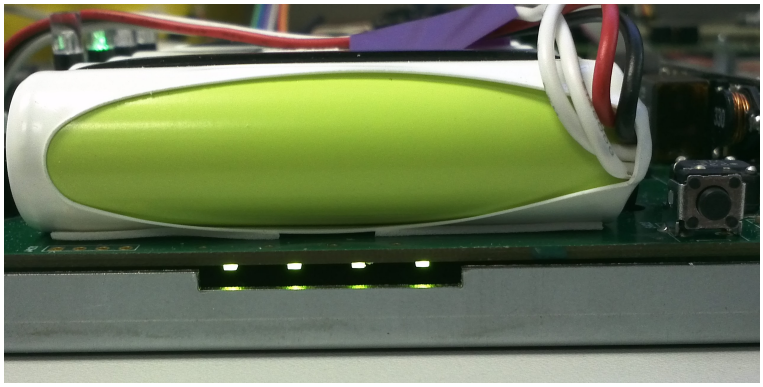
Procedure

1. Plug in mains and attach watchdog disable header (note the side lights should be displayed).



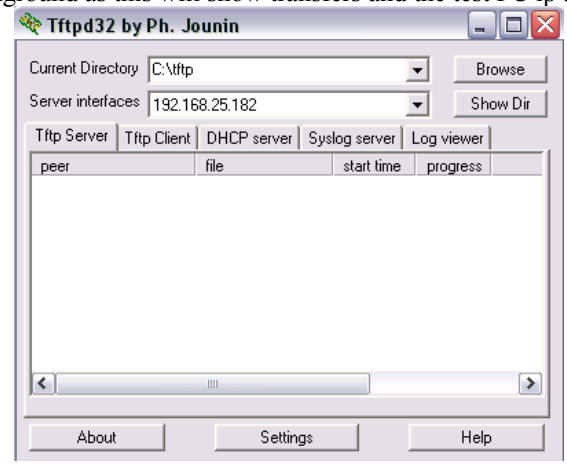


Module Reset Switch S501

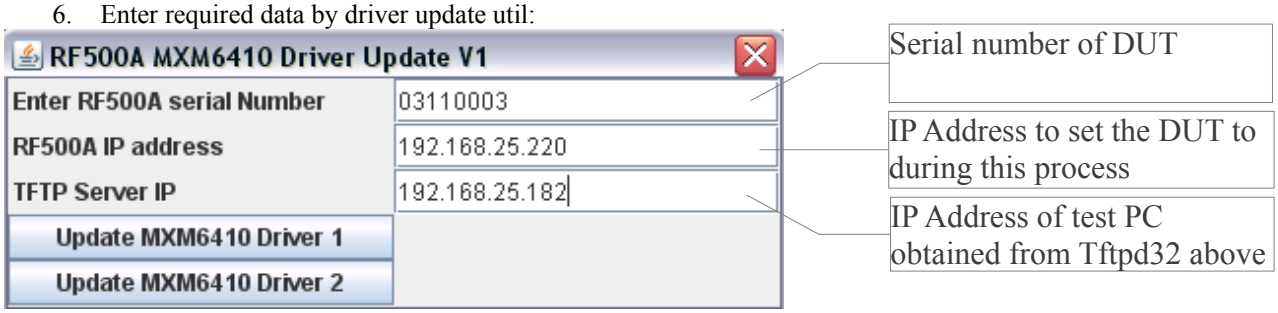


2. Turn the DUT on and wait for 2 mins.
3. Plug in the USB cable and network lead (crossover or normal depending on environment).

4. Run Tftpd32 in the background as this will show transfers and the test PC ip address needed later.

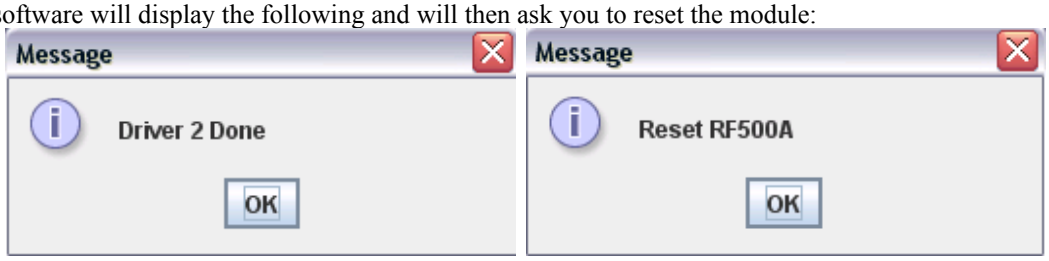


5. From the start menu go to the Comark program group and run "RF500A Driver Update Util"
6. Enter required data by driver update util:



7. Click "Update MXM6410 Driver 1 and **follow the on screen prompts carefully** (the module reset button is S501 in the top corner to the right of the RF PCB), when the update is complete the software will display the following and will then ask you to reset the module:

8. Click "Update MXM6410 Driver 2 and **follow the on screen prompts carefully**, when the update is complete the software will display the following and will then ask you to reset the module:



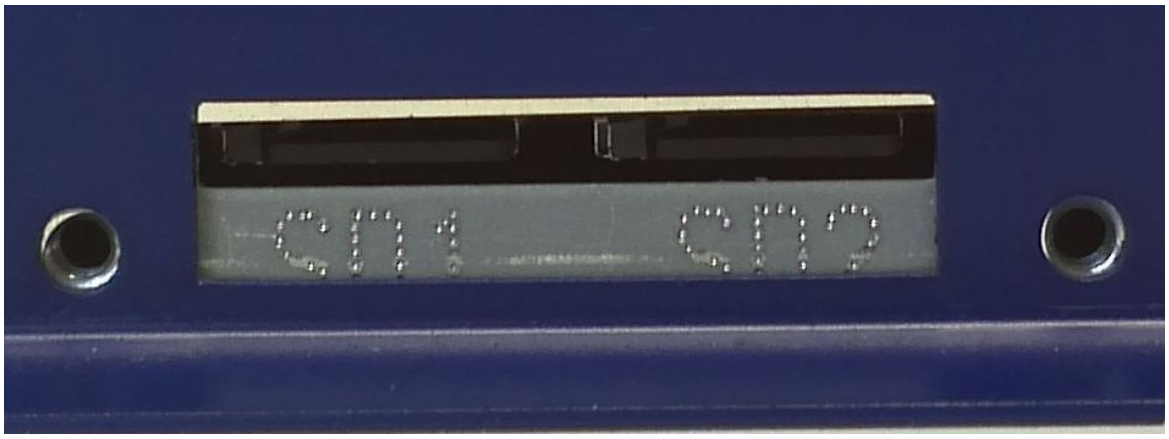
9. The DUT can now be powered down:
    - Remove USB Cable
    - Remove Ethernet Cable
    - Remove External Power
    - Finally press and hold Module Reset Button (S501) whilst removing battery pack plug
    - Wait 1 second
    - Release Module Reset Button (S501)
    - Remove Watchdog disable header
    - Plug in Battery Pack

Replace µSDHC Cards

The following procedure will describe how to change one or both of the memory cards. The RF500A/AP will inform the user of memory card problems via error messages displayed on the web interface see Appendix C – Website Error Messages.

For the purpose of this document a blank µSDHC card refers to one that is void of any data or system settings, only the operating system as programmed by Comark manufacturing is installed.

The RF500A/AP has two µSDHC cards denoted on the chassis as SD1 and SD2:



- SD1 is the *"**Slave**"* card, it mirrors the data on SD2
- SD2 is the *"**Master**"* card, the primary boot device and data storage

Replace µSDHC Card 1

1. Switch off the RF500A/AP and remove mains/PoE power.
2. Remove the memory card door as described in Remove µSDHC Cards.
3. Replace SD1 with a blank.
4. Reboot the RF500A/AP bootup may take upto a few hours depending on data size during this time.
5. Once the website is back up and running the process is complete and the RF500A/AP has successfully rebuilt the new card.

Replace µSDHC Card 2

1. Switch off the RF500A/AP and remove mains/PoE power.
2. Remove the memory card door as described in Remove µSDHC Cards.
3. Replace SD2 with a blank.
4. Reboot the RF500A/AP, the first boot may take a while. Once booted the fault LED should be flashing and the website should display the following message:

5. Type in the restore command as the message states to begin the internal restore process. This can take upto a few hours depending on the size of the data.
6. The RF500A/AP will reset once the restore process has completed.

Replacement of both µSDHC Cards

Remove both faulty memory cards and replace with two blank cards. Switch on the RF500A/AP and allow to boot, if there is data to restore use the appropriate method as described in Appendix D – Restore Data to an RF500A/AP.

Tier 3: RF500A Component Level Repair

Operator Technical Competency

The Tier 3 section requires an engineer level operator.

Functional Test Equipment Required

- RF500A AC Adaptor
- PoE Injector Mode-A
- PoE Injector Mode-B
- DMM
- Computer running Microsoft Windows with Comark RF500ACONFIG Utility, Comark USB Drivers Version 3.00 or higher, Silicon Labs USB Drivers and Silicon Labs USB manufacturing configuration software must also be installed.
- Ethernet cable

Initial Observation

The RF500A Gateway may be initially observed in various states. It is important to record the details about this state before performing further tests, this information may prove useful in later fault diagnosis.

Referring to both Appendix-A – Front Panel Indicators ,Appendix B – Status Indicators and Appendix C – Website Error Messages, record carefully which indicators are showing. Of course if a recognised fault is indicated, we could continue testing to determine whether that particular fault recurs. If the device manages to boot up, Appendix C – Website Error Messages lists the possible error messages for further fault diagnosis.

Status Indicators

Note that the status indicators as described in Appendix B – Status Indicators are only capable of displaying one fault at a time. In the event that there my be multiple faults the highest priority fault will be displayed until fixed.

The status indicators are only active for fault status display while the PC module is off, once booted the module has control of these indicators for activity indication.

Circuit Diagrams

Circuit diagrams and component layouts are available from the Comark Production support site.

- Circuit Diagram: A1/CCT/11410
- Component Layout: A2/PCL/11412

Circuit Description

Power Supply

The PSU for RF500A can be broken down into three main power sources each having ancillary electronics associated with them. The remainder of the PSU is common between these three sources.

External Mains Power

The external mains power is supplied by the in-line power adapter from Friwo (DT12 12V DC, 1A). The support electronics are simply F311 and D311 providing protection for the circuit.

Power Over Ethernet (PoE)

RF500A is capable of taking power from Ethernet (where supported). U321 converts the Ethernet power into a stable 12V DC, 1A. C321 and C322 provide additional smoothing with D323 providing circuit protection. D321 and D322 provide transient suppression to protect U321 and the rest of the circuit from spikes from the Ethernet lines. R321 provide a minimum dummy load required by PoE switches to be correctly identified as PoE capable.

Battery

The battery pack contains six GP450LAH cells with an internal thermistor to monitor temperature. F301 and D306 provide protection for the circuit. R307 and Q303 provide a method to artificially load the battery to check its current level of charge.

This pack is charged by U301 and the ancillary components clearly visible on the schematic. The charging current is 420mA, after the pack has been charged for a set amount of time (or has reached a pre-set temperature) charging will revert to duty cycle charging. Q301 provide control of the charging circuit allowing it to be turned on and off.

Main 5V Rail

The main supply for the PC module is generated by U341 (MAX1685 Switcher), this is controlled via U342 (74HC00) which is triggered by U421 (MEGA329). The output of U341 is monitored for over-voltage by Q341 and Q342. Once the 5V rail is present U362 regulates the 3VM rail which is used to power the USB hardware and the RF board.

Permanent 3.3V Rail

U361 is always powered providing a permanent 3.3V rail for U421.

Control MPU Circuit

Main system control is performed by U421, this is always powered and is responsible for monitoring all aspects of the system and user interaction, the on board ADC is used to monitor most the voltage rails and battery condition. Time keeping is done via U423 (Maxim DS3231 RTC).

The control MPU provides the PC module with information via a UART to UART connection whilst also serving as a watchdog for the PC module.

PC Module

The module is basically a credit card sized PC, all the RAM, BIOS, Networking etc are on the board. The only real connections to the host PCB are the physical connections for the RJ45 connector and power and ground. The main storage for the module (including the operating system) are the micro SDHC cards located on the host board under the module. The module has a serial terminal output which is connected to the USB circuit U541(CP2102 UART to USB bridge) for debug and recovery purposes.

USB

U541 is a Silicon Labs CP2102 UART to USB bridge, it is configured in self powered mode so will only operate when the 5V rail is active. TVS541,2 & 3 provide protection from transient spikes, it should be noted that TVS542 and TVS543 are special low capacitance type for hi speed transmission lines.

RF Module

This is the standard module used in all RF500 devices. It is a 2.4GHz transmitter/receiver using 802.15.4 physical layer to transmit wireless data with a proprietary application at the application layer. Power is supplied via 3.3V regulator (U362) and communication to the host software (running on the PC module) is via a UART to UART connection.

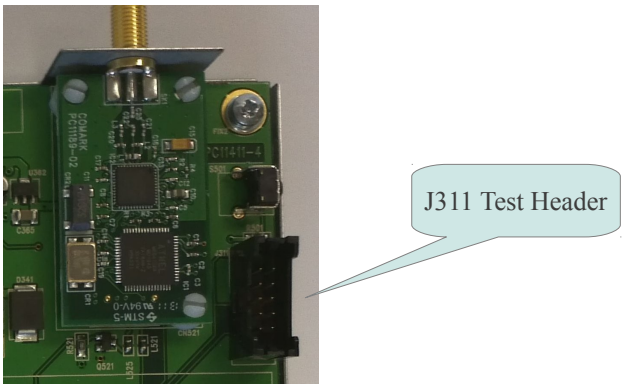
Real Time Clock (RTC)

U423 is a Maxim DS3231 RTC, it is used for date and time keeping once set via the website. It is powered from the permanent 3VC rail (U361) so that date and time is kept even with mains removed. Comms to the device is via I2C, R423 and R424 provide the pull-ups for the data and clock lines.

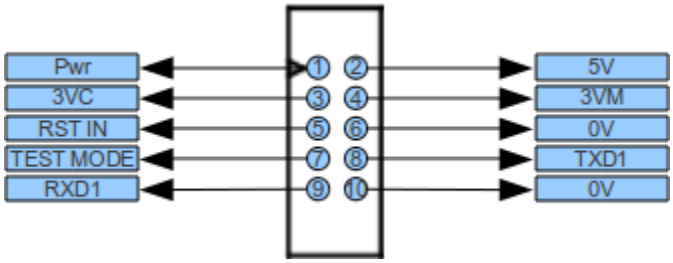
In Circuit Testing

The testing detailed here should be performed on a PCB with the PC module removed but the battery in placed and charged, any test requiring a deviation from this criteria will specify in the instructions.

The test header is a 10 pin connector located to the right of the RF module:



Most of the useful test points are accessible via the test header J311:



Name	Description
Pwr	Common power rail
3VC	3.3V permanent power rail to U421
RST IN	Reset line to PC module
TEST MODE	Not used
RXD1	Receive coms line to U421
5V	Switched 5V rail
3VM	3.3V switched rail
0V	Ground
TXD1	Transmit coms line to U421
0V	Ground

Common Power Rail (Pwr)

This is the common power rail, it will always be the input voltage (Either external supply, PoE or battery) less the diode drop of either D306, D311 or D323 (see respective data sheets for diode drop) depending on the input.

5V Rail

This is the switched power rail mainly for the PC module, it can only be measured by switching the main board on (press and hold the On/Off switch for 4 seconds). The test limits for this rail are +500mV -200mV.

3VM Rail

This rail is a sub rail of the 5V rail. As such it is only active when the 5V rail is active. This measurement should be performed at the same time as the 5V. The test limits for this rail are ±200mV.

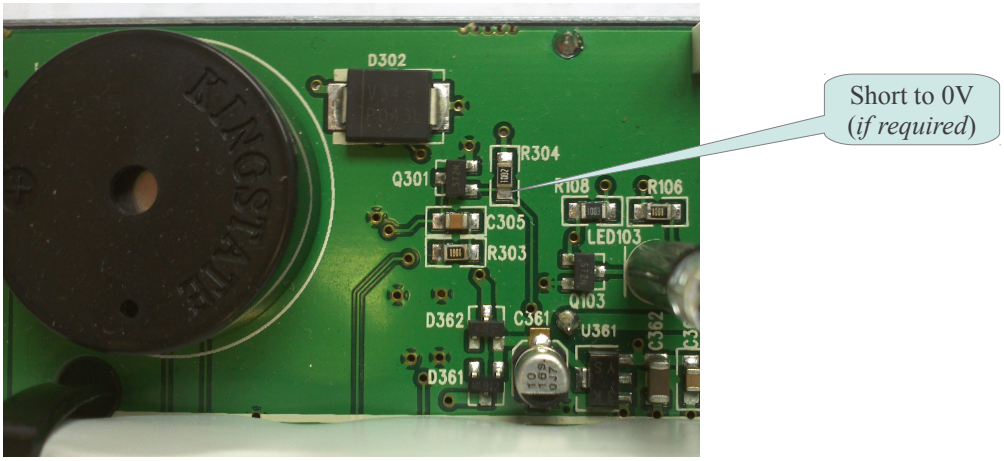
3VC Rail

This rail is always present as long as the battery pack is connected, it provide constant power for the RTC and the control MPU. The test limits for this rail are ±200mV.

Battery Charging

The charging current should be 420mA ±100mA, to measure this perform the following steps:

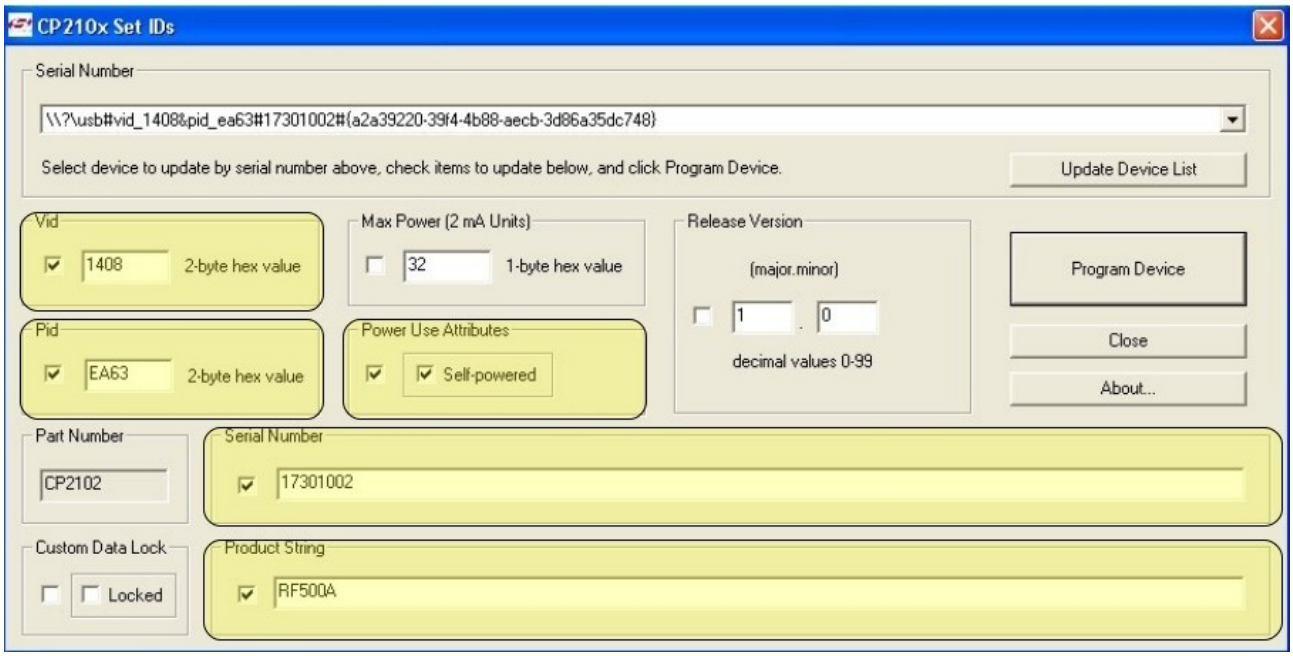
1. Set up a DMM to measure current and place on the mains input between the external PSU and the DUT.
2. Switch on the external mains.
3. If the batteries are not being charged the supply current will be less than 100mA, if this is the case hold the gate of Q301 at 0V, this will force the battery charging to turn on.



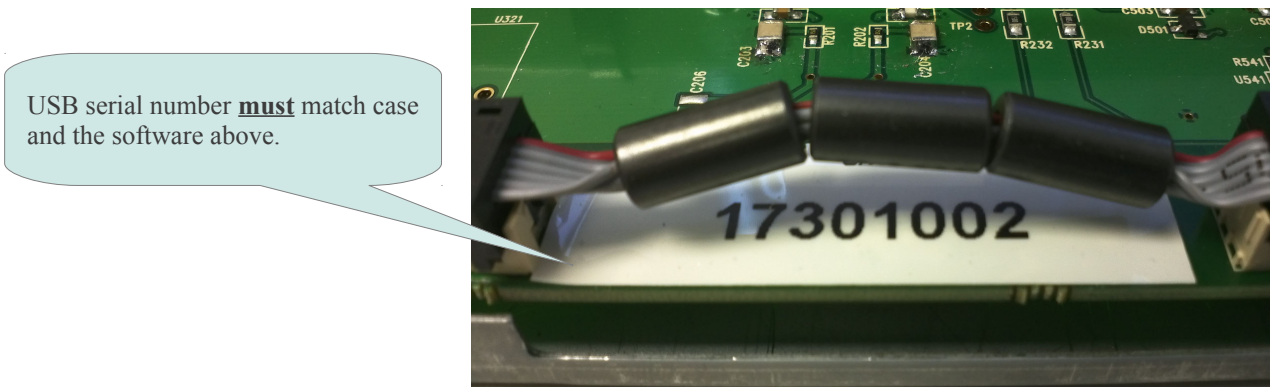
4. Verify the supply current is as specified above.

USB Chip Verification

This test requires the “N5001USB-Tools.exe” software and paired original Silicon Labs USB drivers. Ensure a charged battery pack is plugged in and turn on the main board (press and hold the On/Off switch for 4 seconds). Making sure no other RF500A/AP devices are attached to the USB port of the test PC plug in the DUT to the USB port of the PC. Start the above mentioned software and verify the following information:

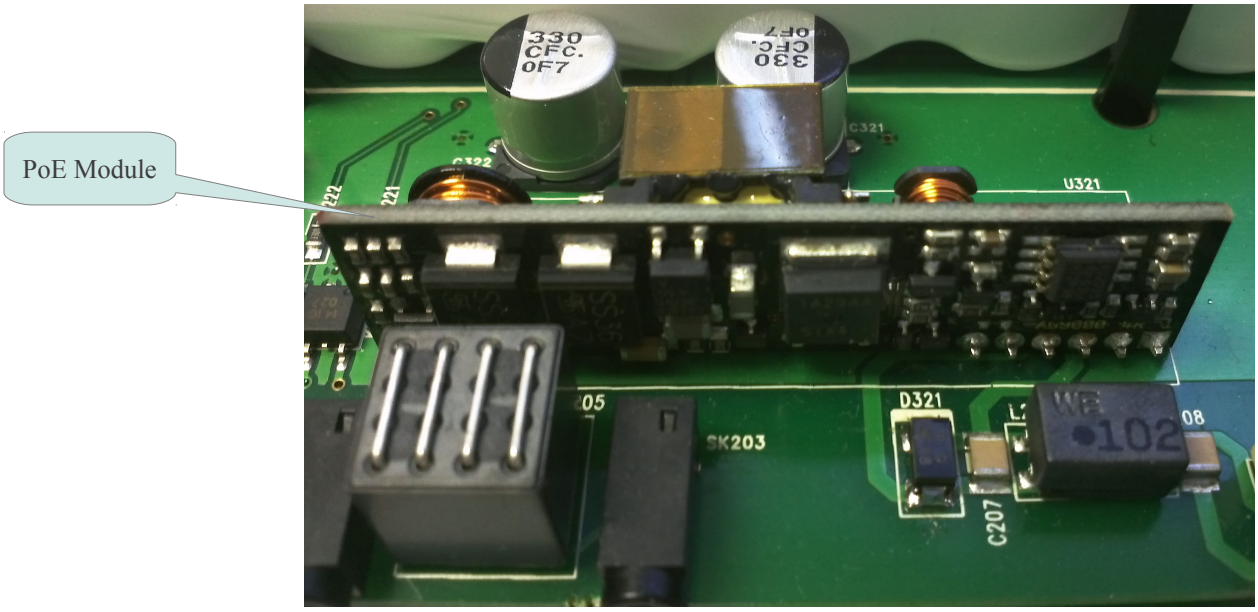


ID	Item	Comments
Vid	*Vendor Identification*	All Comark USB product contain this hex number (1408), this identifies the device on the USB bus as a Comark product.
Pid	*Product Identification*	This identifies the product to the Comark USB drivers and must be set. All Comark USB products have a different PID.
Power Use Attributes		This tells the USB host that this device provides its own power and is not required to be powered from the bus.
Serial Number		This should be the same serial number as identified on the main board (see picture below) and on the side of the case front (Side View (Serial Number Label)).
Product String		All RF500A/AP models should have this field programmed as “RF500A”.



Replace PoE Module

The PoE module (U321) is a conventional component and is soldered directly to the main PCBA:



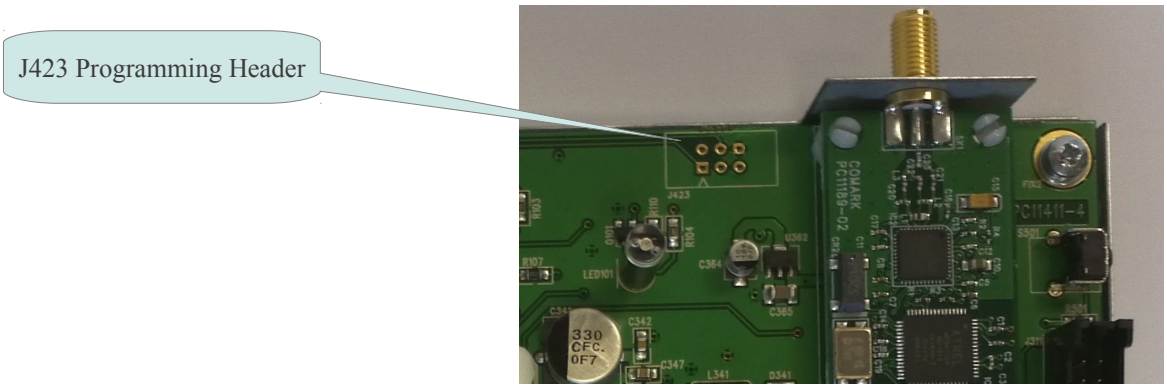
De-solder the 10 pins remove the module and replace, no further configuration is required.

Control MPU firmware upgrade

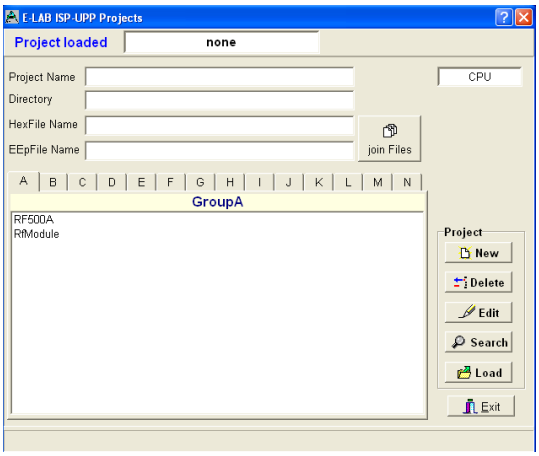
NOTE: Remove battery pack and all power before continuing!

The control MPU is an Atmega329, both an E-Lab ISP USB programmer and E-LAB AVR ISP-ICP software are required for this process. Plug the programmer into a USB port on the PC.

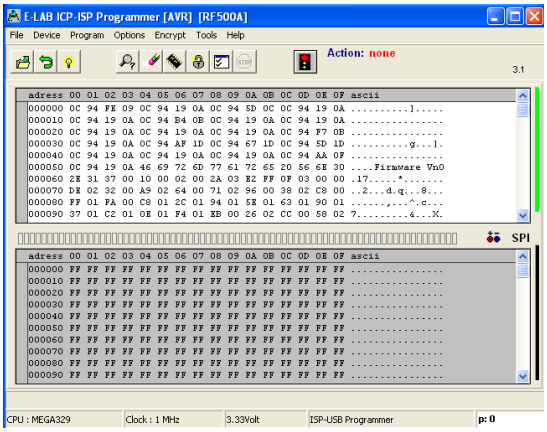
The programming header is located on the main PCBA in the top right hands side near the RF board:



1. Start up “E-LAB AVR ISP-ICP” and the “Load Project” screen appears:



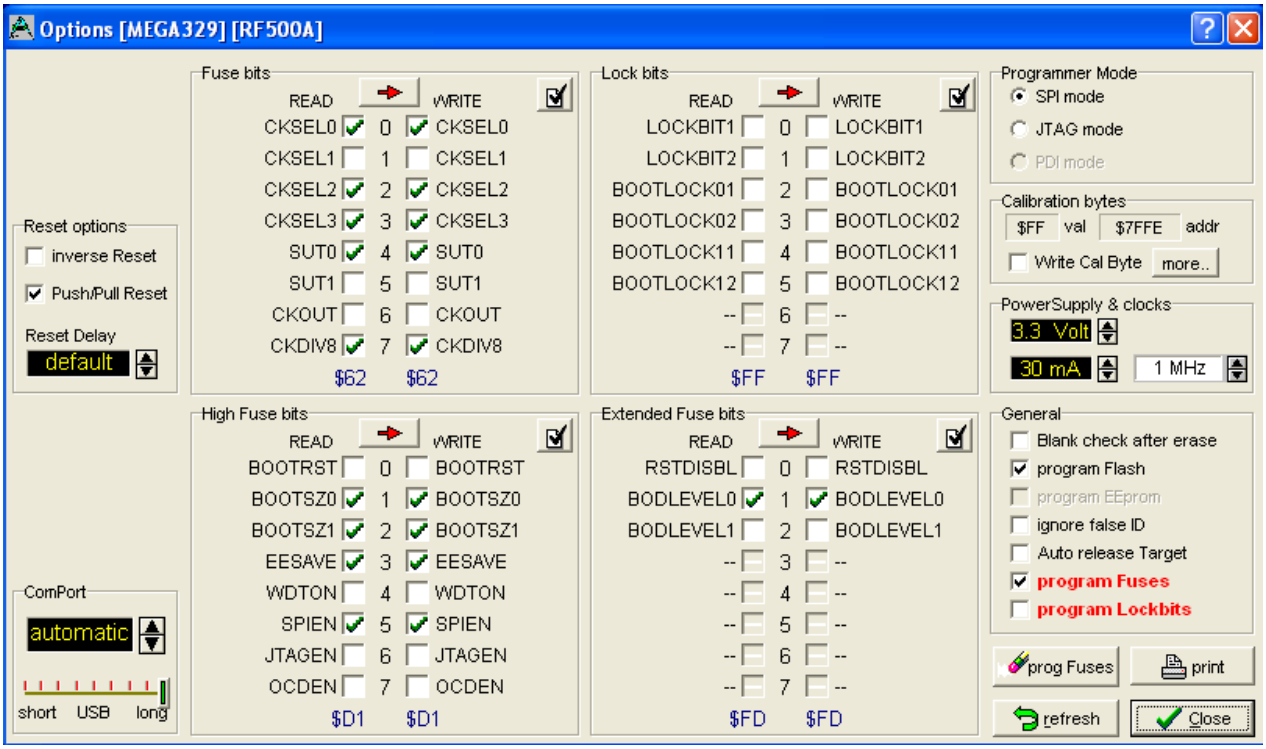
2. Select the project “RF500A” then press the “Load” button.
3. After a successful load, the programming screen will be displayed.



Check the Fuses

If only trying to upgrade the firmware this step is optional.

1. Plug the programming lead into the 6-way connector site marked J423. Make sure Pin-1 goes to the square pad.
2. Select *Options → Programmer options*
3. The fuse settings should now be displayed, below is an example of the correctly programmed fuses:



Program the Firmware

1. Follow the steps above to connect the programmer to the PCBA
2. Click the program button: The progress bar will fill in to indicate the chip is being programmed. Check that it completes with no errors.
3. Click the verify button: The progress bar will fill in to indicate the chip is being verified. Check that it completes with no errors.

Fault Finding

Before any component level fault finding the following should be checked for:

- Missing Components
- Lifted Pins
- Dry Joints
- Solder Shorts
- Ensure inter-connecting tracks reach their destination

MPU

Common faults resulting in the MPU not functioning are:

- Check power connections
- Check X421 are connected
- Ensure inter-connecting tracks reach their destination
- Replace U421

Serial Communications

If there is no comms to the board check U421

USB Communications

If there is no comms to the board check U541.

5V Rail

If the 5V rail is inoperative of out of specification, common items to check would be:

- Check supply to U341
- Check shutdown pin of U341
- Check the correct values are fitted for R341 and R342
- Check Q341 (this is the over voltage protection)
- Ensure inter-connecting tracks reach their destination

3VM Rail

If the 3VM rail is inoperative of out of specification, common items to check would be:

- Check supply to U362
- Ensure inter-connecting tracks reach their destination
- Replace U362

3VC Rail

If the 3VC rail is inoperative of out of specification, common items to check would be:

- Check supply to U361
- Check D361 and D362
- Ensure inter-connecting tracks reach their destination
- Replace U361

Battery Charging

If the battery charger is inoperative of out of specification, common items to check would be:

- Check supply to U301
- Check Q301 (this is used to turn charging on and off, if the gate is pulled hi charging is off)
- Check correct value is fitted for R301
- Ensure inter-connecting tracks reach their destination
- Replace U301

PoE (If Fitted)

If the PoE is inoperative of out of specification, common items to check would be:

- Check Cable CAB1
- Check correct components fitted for D321 and D322
- Check correct value is fitted for R321
- Ensure inter-connecting tracks reach their destination
- Replace U321

RTC

If the RTC is inoperative, common items to check would be:

- Check supply to U423
- Ensure inter-connecting tracks reach their destination
- Replace U423

Memory Cards

If the memory cards are inoperative, common items to check would be:

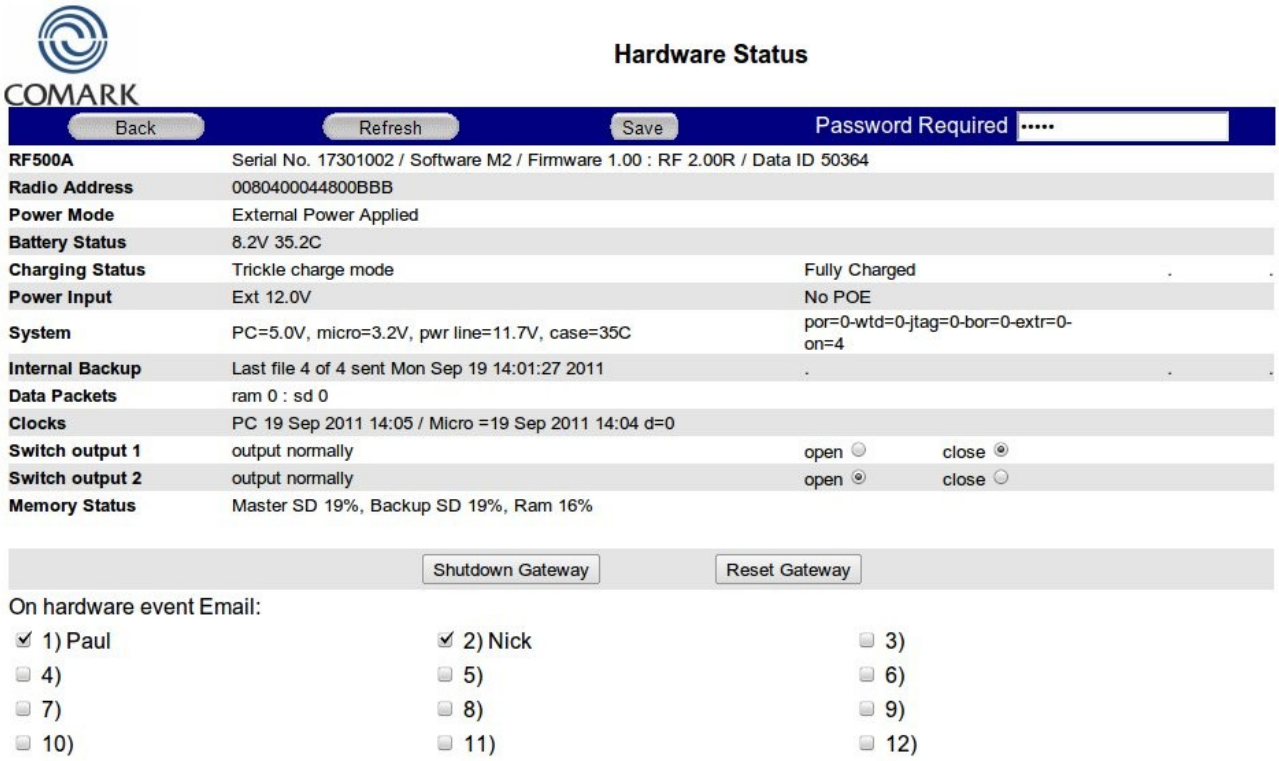
- Check RN601 and RN602
- Check both memory card connectors (J601 and J602)
- Check the supply to both cards (3VM)
- Ensure inter-connecting tracks reach their destination
- Replace cards and connectors

Additional Fault Diagnostic Information

The RF500A/AP web interface can provide additional information for intermittent type faults which can be more troublesome to identify.

Hardware Status Page

Only the "*System*" section of the hardware page will be discussed here, for further information regarding the rest of the page consult the web view manual.



ID	Item	Comments
PC	*5V Rail*	The rail voltage as measured by the ADC on the MPU for more information regarding the rail see Main 5V Rail
micro	*3VC Rail*	The rail voltage as measured by the ADC on the MPU for more information regarding the rail see Permanent 3.3V Rail
pwr line	*Common Power Rail*	The rail voltage as measured by the ADC on the MPU for more information regarding the rail see Power Supply
case	*Case Temperature*	The temperature as measured by the RTC, used to monitor the internal case temperature for more information see Real Time Clock (RTC)
por	*Power on Reset Event*	This is the number of times the MPU has been reset due to all power (including battery pack) being completely removed and restored. Once this has left production this should be always be 0, anything else would indicate a serious fault or tempering.
wtd	*Watchdog Reset Event*	This is the number of times the MPU has been reset due to a watchdog reset, this should generally be 0 but a count of less than 5 is acceptable.
jtag	*Jtag Reset Event*	This is the number of times the MPU has been reset due to a Jtag reset event, this should always be 0.

bor	*Brownout Reset Event*	This is the number of times the MPU has been reset due to a Brownout reset, the voltage threshold is set at 2.7V. This should remain at 0, anything else could imply PSU problems.
extr	*External Reset Event*	This is the number of times the MPU has been reset via the reset pin, this should be 0 after it has left production, any other value here could imply a board fault.
on	*Boot Sequence calls*	Number of times the RF500A/AP has been through the boot sequence, a high number could indicate constant resets indicating an intermittent fault. Over time this number could become high naturally.

Audit Trail Information

System messages are also displayed in the Audit trail, these messages can be used to help identify intermittent issues.

Message	Comments
RF network reset	The RF system has instantiated a new network.
Gateway switch on, from abnormal shutdown/reset (0)	The RF500A/AP has started up but not been able to detect the reason for the last shutdown.
Comms Error with HW, () "command name"	A communications error has occurred between the website software and the control MPU on the main PCBA. The actual command that failed will be listed.
Restart cipher-host 2 no1=0 no2=0	The RF software has been reset, this could be due to a crash or a handled exit point as described in the section emberlog2. If *"no2=0"* this indicates the RF software has never been able to communicate to the RF module.
Gateway SW Fault, commsmon	The RF500A/AP has detected that one of the programs that make up the system has crashed. The program name will be listed, in this case *"commsmon"* has crashed.
System Update Error	During the software update process an unexpected error occurred.
New pc mother board found	The RF500A/AP has detected that the PC module has been changed, this will mean the MAC address will also change.
Ember software stopped, possible hardware fault	The RF software on the PC module has detected a communications error with the radio module.
super user mode	The RF500A/AP has detected that a user has logged in via the command line as the root user (this could be over SSH or the USB interface).
Last Shutdown due to low batteries	The RF500A/AP shutdown due to the internal battery pack reaching critical discharge value.
Hardware Fault on Gateway, over heat	The RF500A/AP internal temperature reached the over heat temperature which will trigger the thermal shutdown event.
Hardware Fault on Gateway, battery pack temperature fault	The temperature sensor in the battery pack is faulty or the pack has overheated.
Hardware Fault on Gateway, External power fault	The RF500A/AP has detected the external PSU is faulty.

Email Output Screen

To aid with any email issues there is a button on the email setup page called output, this displays the email script and email server response of the last attempted email. The image below is an example of a successful attempt:

If there are any issues with emails this output screen can provide detailed information to help the diagnosis of the problem.

Appendix-A – Front Panel Indicators

The Front Panel Indicators show information about the Gateway under normal operation conditions.

Figure 1 - Front Panel Indicators

ON Indicator

Off	Gateway is not running.
Steady blue	Gateway on and operational
Blue flash at approx once per second interval	Gateway starting up - Not yet operational
Blue flash at approx 4 times per second interval	Gateway shutting down - Not operational
Other	Unrecognised fault

POWER/BATTERY Indicator

Off	No External Power (or PoE) connected
Steady green	External Power (or PoE) is connected
Green flash at approx twice per second interval	Gateway is running from the backup battery. - Not necessarily operational
Other	Unrecognised fault

FAULT Indicator

Off	Normal Operation
Yellow flash at approx once per second interval	A self-diagnosed fault has been detected
Other	Unrecognised fault

ALARM Indicator

Off	Normal Operation
Red flash at approx twice per second interval	An enabled Alarm Event has occurred
Other	Unrecognised fault

Appendix B – Status Indicators

The Status Indicators are found on the LHS of the Gateway and indicate self-diagnosed faults when accompanied by the Font Panel Fault indicator.

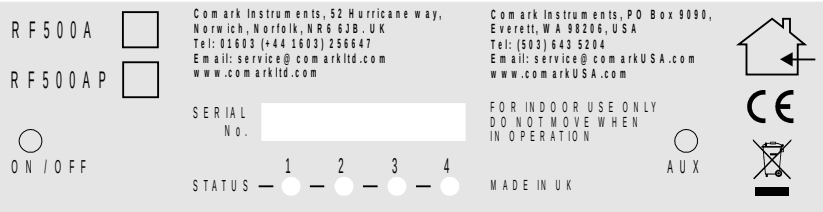
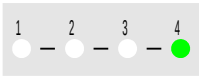
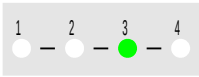
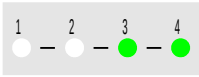
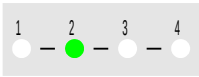
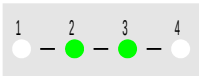
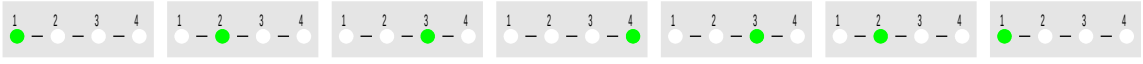


Figure 2 - Status Indicators

Fault Code	Status Indication	Fault Description
None		No Fault Detected
1		Backup Battery Voltage Fault.
2		Backup Battery Temperature Error
3		5V Power Supply Fault
4		3VM Power Supply Fault
5		Overheat Error
6		External Power Supply Fault
7		Processor Module Fault (3 successive failures)

Battery Pack Pre-Charge Indication

If on application of external power the backup battery does not have sufficient charge to run the Gateway should a power fail condition arise then Gateway will not start but instead starts a pre-charge mode. This is indicated by the following repeating pattern in the Status Indicators.



This mode lasts for a duration of 20 minutes minimum.

Appendix C – Website Error Messages

No Hardware Pass message

Actual Message:

No Hardware Pass message

The RF500A/AP has detected that the control PCBA has not been tested correctly at the manufacturing stage, the board must be returned to the PCBA manufacturer and run through the Comark PCBA test equipment.

SD cards appear to be in the wrong slots...

Actual Message:

SD cards appear to be in the wrong slots,

shutdown and swap SD cards

The RF500A/AP has detected that SD1 and SD2 have been swapped, shutdown the unit and swap the cards and reboot.

SD cards appear to have different data ID tags

Actual Message:

SD cards appear to have different data ID tags

The RF500A/AP has detected that the fitted SD cards are not a matched pair (hence have different ID tags), find the appropriate matching SD card or, if there is no data involved, replace with two new blank SD cards and reboot.

Looks like you have no data on the master SD....

Actual Message:

Looks like you have no data on the master SD card but have data on the backup card.

If you are sure this is correct and want to restore data from backup SD card type

http://your-ip-address/cgi-bin/sdbackuprestore

This is the message when replacing the master SD card (SD2) as described in the Replace µSDHC Card 2 section.

booted up from backup SD card...

Actual Message:

booted up from backup SD card,

check SD card slots possible error with SD2

The RF500A/AP has booted up from the backup SD card (SD1), this indicates there is a problem the master SD card(SD2). Replace the master SD card as described in the Replace µSDHC Card 2 section.

check SD card slots possible error with SD2...

Actual Message:

check SD card slots possible error with SD2 or card in wrong slot

The RF500A/AP has detected the master SD card but cannot access it. Replace the master SD card as described in the Replace µSDHC Card 2 section.

check SD card slots possible error with SD1...

Actual Message:

check SD card slots possible error with SD1 or card in wrong slot

The RF500A/AP has detected the slave SD card but cannot access it. Replace the slave SD card as described in the Replace µSDHC Card 1 section.

File Error

There are various different types of file error message which will not be detailed here, most are indicative of memory corruption meaning the safest option is to replace the memory cards and restore any data from a backup as described in Appendix D – Restore Data to an RF500A/AP.

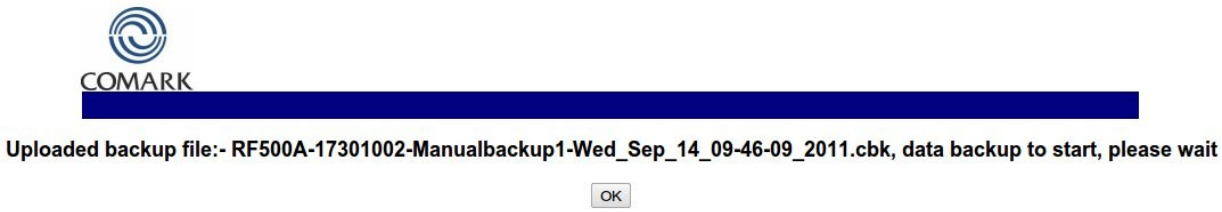
Appendix D – Restore Data to an RF500A/AP

NOTE: Network settings are not restored as part of this process and have to be entered manually.

Restore From Manual Backup

Using the latest manual back up file the procedure is as follows:

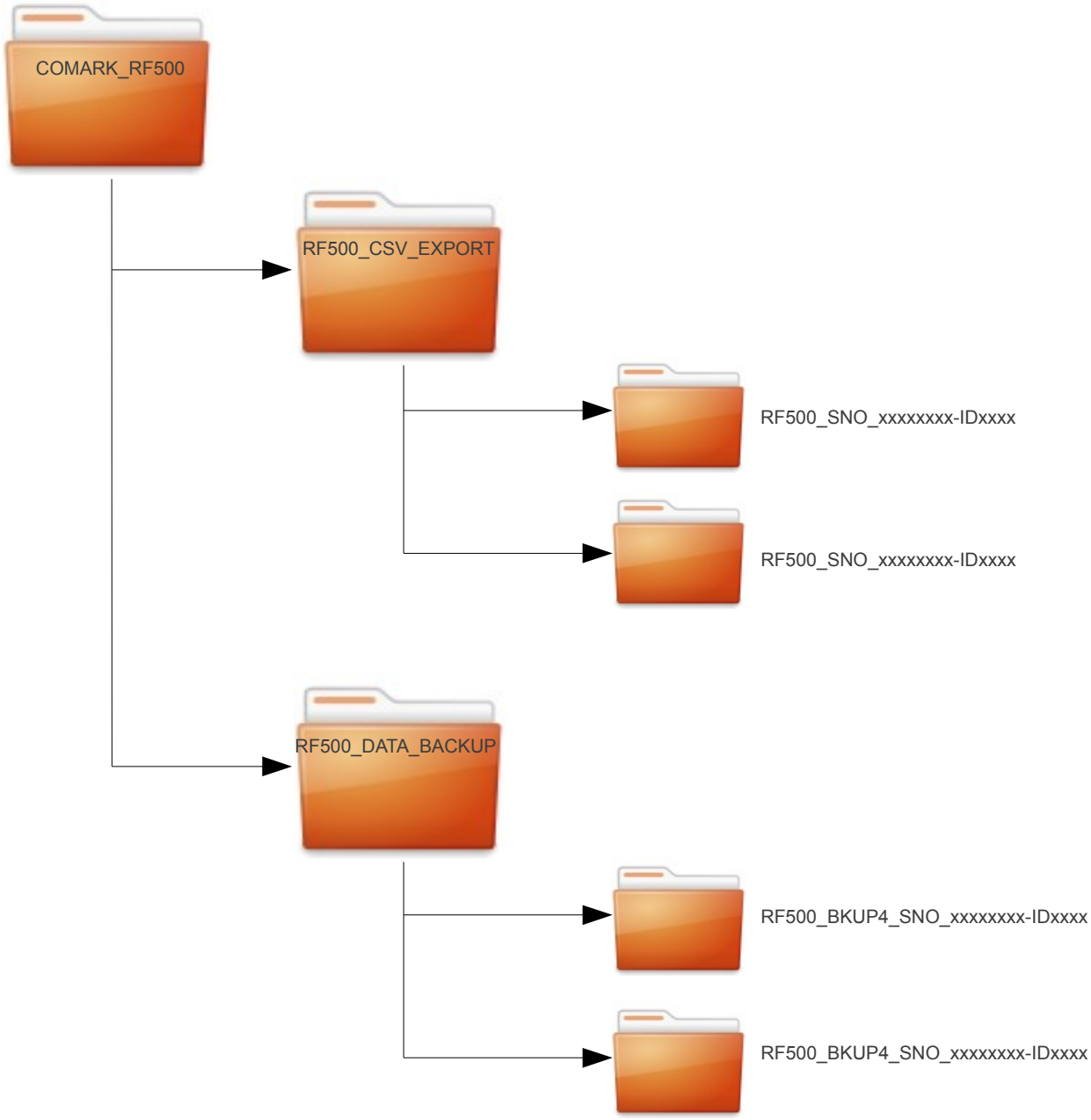
1. Login as an administrator
2. Navigate to Administration → Update Firmware
3. Select “Upload New Files”, select the backup file and click “Upload File”
4. The following message should be displayed:



5. The RF500A/AP will now restart.
6. Once the reboot has completed login as one of the users (that have now been restored) and reset the network settings, if required.

Restore From Shared Drive Backup

Navigate to the shared drive containing the backup. The folder structure will be:



1. Within the RF500_DATA_BACKUP folder find the latest folder with the correct serial number and the most recent date.
2. Create a zip file of the entire folder using the folder name for the zip file.
3. Login as Comark (using master Comark login)
4. Navigate to Administration → Update Firmware
5. Select “Upload New Files”, select the backup file and click “Upload File”

6. The following message should be displayed:

7. The RF500A/AP will now restart.
8. Once the reboot has completed login as one of the users (that have now been restored) and reset the network settings, if required.

Appendix E – RF500A/AP Hidden Commands

The RF500A/AP contains hidden service and diagnostic level commands which can be useful.

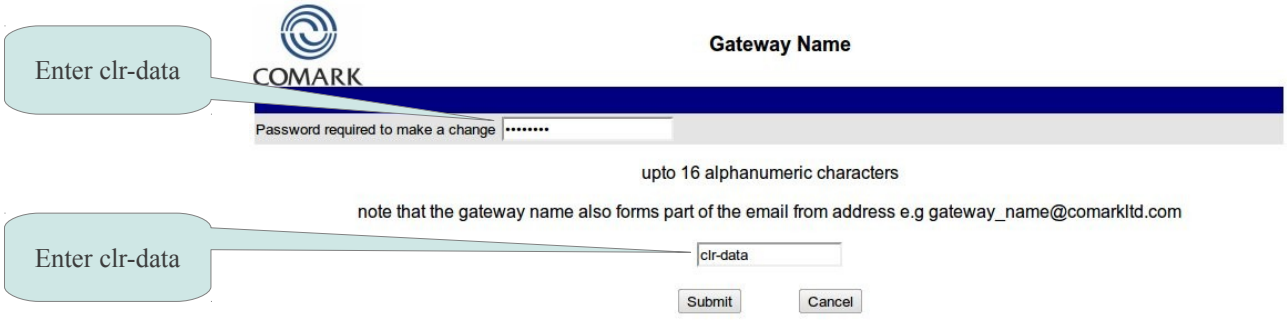
THESE COMMANDS CAN POTENTIALLY WIPE STORED DATA ON THE RF500A/AP ONLY USE IF ABSOLUTLY NECASSARY

Clear Data Commands

clr-data

This command will clear all data and settings on the RF500A/AP with the exception of the IP address and reset and reinitialise the SD cards (both cards will be given new ID's to be a matched pair). The command is called from:

- Administration → Gateway Name
- Enter the command clr-data in both the Password and Gateway Name fields



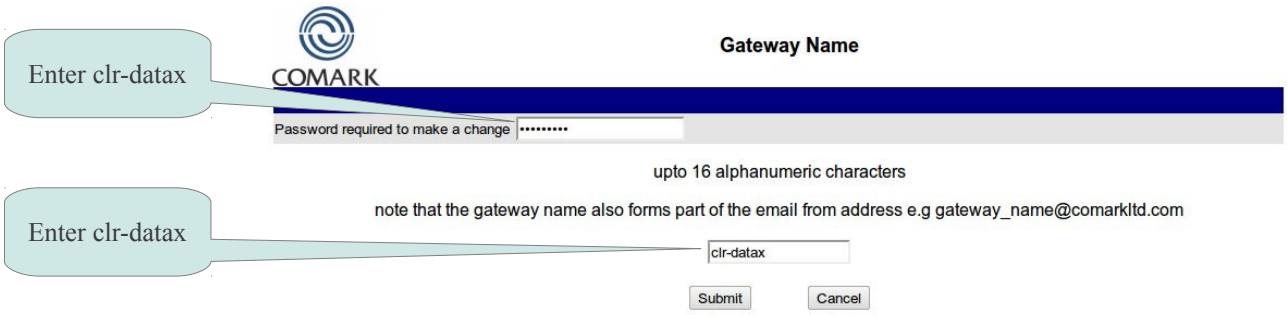
The RF500A/AP will now display the following screen and then reboot.

Once rebooted the data and settings will be cleared.

clr-datax

This command will clear all data and settings on the RF500A/AP with the exception of the IP address and shut down the gateway, since the memory cards will not be initialised they could be removed and used elsewhere. The command is called from:

- Administration → Gateway Name
- Enter the command clr-datax in both the Password and Gateway Name fields



The RF500A/AP will now display the following screen and then shutdown.

If required the memory cards can now be removed to be independently used on other RF500A/AP's.

Utility Commands

The following commands all required the same input method, using a web browser type the following:

- http://your-ip-address/cgi-bin/msg?msg=command-name

Where:

- your-ip-address is the current IP address of the RF500A/AP
- command-name selected from the list below

emberlog2

This command displays the log for the RF software running on the RF500A/AP, the excerpt below shows an example of a normal log file detailing version number and entrance and exit points for the software. Errors the software detects will be clearly stated in this log.

```
emberlog2-/home/ember/Ember/Cipher_Debug.txt----------------------------------------------/Thu Sep 15 10:34:10 2011 /----------------
Starting Cipher-host Session Version: 0 2.00R.Time Was Wed Sep 7 11:21:22 2011
networkUp has been set false 0 N/A.Time Was Wed Sep 7 11:21:22 2011
networkUp has been set false by emberStackStatusHandler 0 N/A.Time Was Wed Sep 7 11:22:22 2011
networkUp has been set true by emberStackStatusHandler 0 N/A.Time Was Wed Sep 7 11:22:30 2011
Have Been Asked to Quit 0 N/A.Time Was Wed Sep 14 09:52:42 2011
```

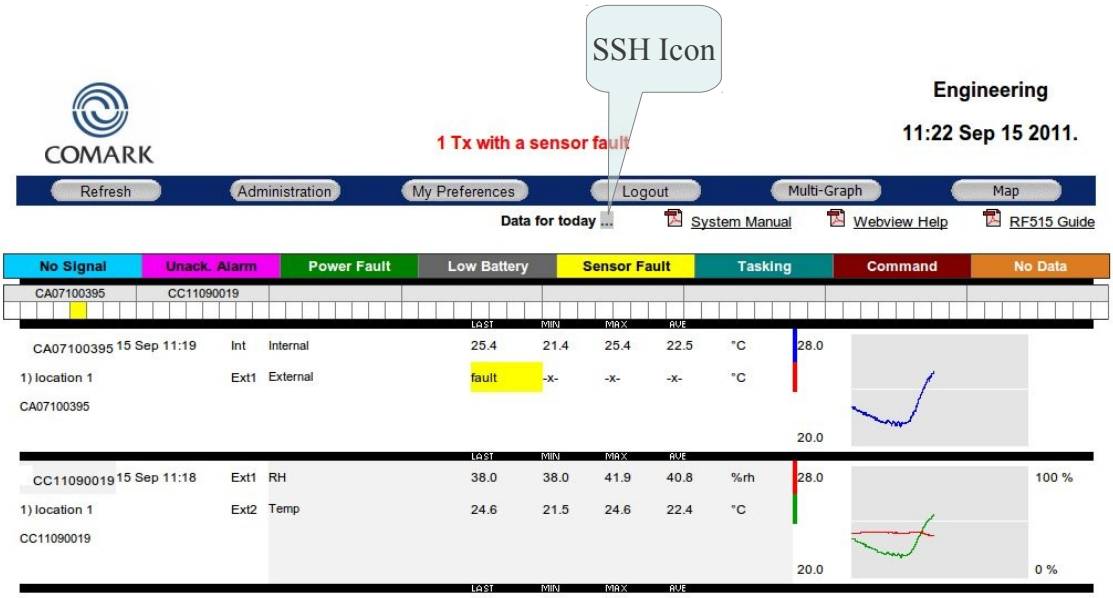
Important messages within this file are explained below.

Message	Comments
Unexpected Packet 1 Sequence Number....	An RF packet has arrived out of sequence which may contain corrupt data, the system will exit if this condition is detected to preserve data integrity.
Tired to transmit but emberstatus returned ! EMBER_NETWORK_DOWN!	The RF network stack has mysteriously gone down, the system will self recover from this event.
Too Many RNAP errors will now exit...	The RF software has detected multiple comm port errors and has decided to shutdown as there is likely a hardware fault.
Have Been Asked to Quit...	The software has been asked to quit by the webserver.
*ERROR I THINK I'VE GONE DEAF NOT HEARD FROM MESHERS OR ANYTHING NEED RESET **CODE*	The system has stopped receiving RF data, this message indicates the system has meshers and hence should be receiving information within 10 minutes. This will cause the RF sub-system to reset.
*ERROR I THINK I'VE GONE DEAF NOT HEARD FROM ANYTHING NEED RESET **CODE*	The system has stopped receiving RF data, this message indicates the system has not got any meshers. This will cause the RF sub-system to reset.

sshd

If remote access to the RF500A/AP command line/operating system is required it is possible to enable a Secure Shell (SSH) connection. Once the command has been run the RF500A/AP will respond as follows:

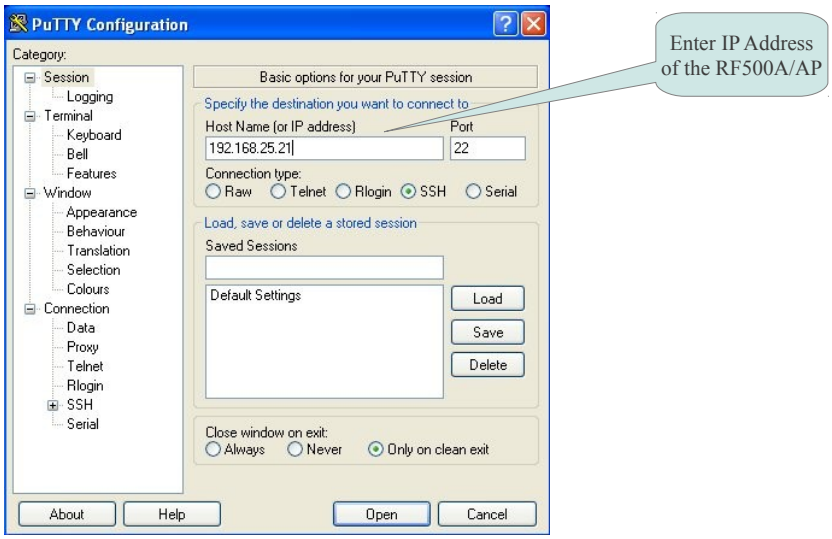
After a short period of time (within 2 minutes) the SSH icon will appear on the home page:



To access the RF500A/AP an SSH client is required, if using Linux this is already built in, however if using Windows a downloadable client such as PuTTY. **In the interest of security disable the SSH server after use by resetting the RF500A/AP via the Hardware page.**

Connecting with PuTTY

Start PuTTY and enter the IP address of the RF500A/AP you wish to connect to and click “Open”:

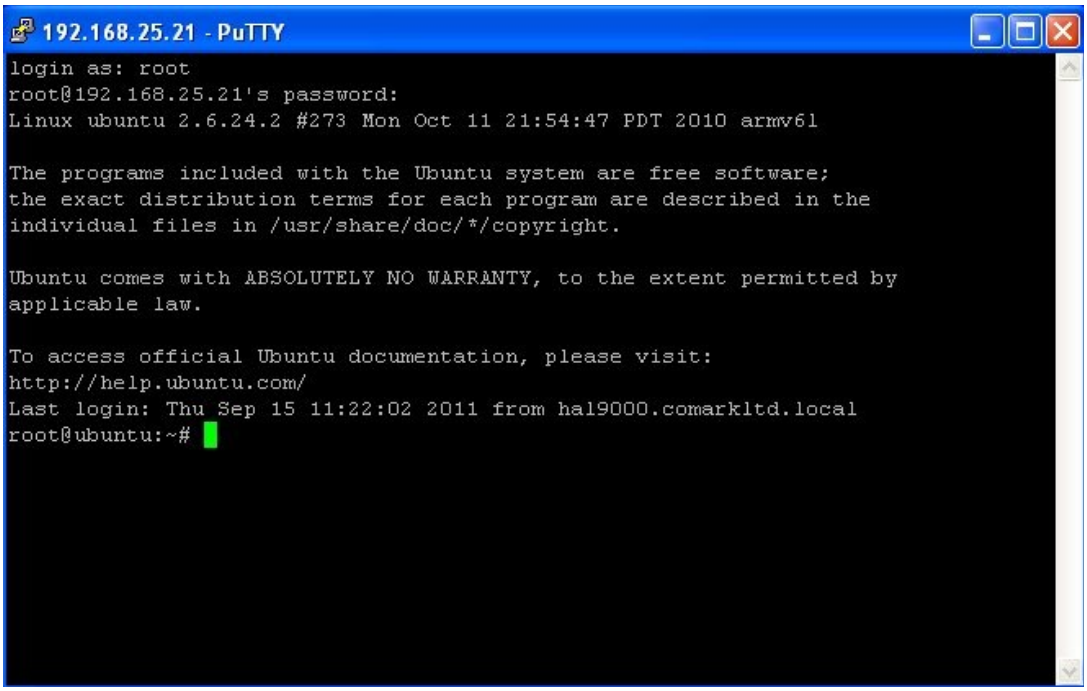


The first time PuTTY connects to a new RF500A/AP if will ask the user if it is ok to store a key fingerprint:

Select “Yes” and you will be presented with the login screen. Login to the RF500A/AP using the following details:

- User Name: root
- Password: **Please contact Comark Engineering Department**

Once the login details have been entered the following screen will be displayed, you now have “root” access to the PC module.



mbklog

This command displays the log generated when creating a manual backup, the excerpt below illustrates a successful backup request. If a manual backup fails this log will detail the error.

```
mbklog-/home/rf500/m_backup_log.txt----------------------------------------------/Wed Sep 14 09:46:45 2011 /-----------------------

start

0 mkdir /var/www/cgi-bin/backup-files

0 rm -R /var/www/cgi-bin/backup-files

0 mkdir /var/www/cgi-bin/backup-files

0 nice -n 20 tar -zpcf /var/www/cgi-bin/backup-files/cipher.tar.gz /home/cipher/*

0 nice -n 20 /var/www/cgi-bin/./ncrypt -e -r -k cipher#cipher$cipher -i /var/www/cgi-bin/backup-files/cipher.tar.gz -o /var/www/cgi-
bin/backup-files/cipher_enc

0 rm /var/www/cgi-bin/backup-files/cipher.tar.gz

0 mv /var/www/cgi-bin/backup-files/cipher_enc /var/www/cgi-bin/backup-files/xRF500A-17301002-Manualbackup1-Wed_Sep_14_09-46-09_2011

0 chmod 0777 -R /var/www/cgi-bin/backup-files/xRF500A-17301002-Manualbackup1-Wed_Sep_14_09-46-09_2011

0 cp -r -p /var/www/cgi-bin/zip /var/www/cgi-bin/backup-files/RF500A-17301002-Manualbackup1-Wed_Sep_14_09-46-09_2011.cbk

0 chmod 0777 -R /var/www/cgi-bin/backup-files/RF500A-17301002-Manualbackup1-Wed_Sep_14_09-46-09_2011.cbk

0 chmod 0777 -R /var/www/cgi-bin/backup-files

done
```

Command List

This command has a different entry format to the commands discussed above, this command is called via:

- http://your-ip-address/cgi-bin/CmdList

Where

- your-ip-address is the current IP address of the RF500A/AP

Transmitter commands generated by the user (tasking etc) waiting to be sent over the radio link will be queued here, below is an example:

01) CA07100395 000 003 003

id=004 /	C=X	/T=C_RADIORATE,	/R=C_RADIORATE,
id=008 /	C=X	/T=C_DONE,	/R=C_DONE,
id=2661 /	C=X	/T=C_DONE_RADIORATE 2661,	/R=C_DONE_RADIORATE 2661,

02) CC11090019 000 000 000

This can be useful when trying to ascertain information regarding tasking or command issues.

Appendix F – Repair Procedure for RF500 RADIO MODULE

Recovery from Transmitter Error 104 Condition

Operation of the module at Vcc below 2.7V does cause problems requiring re-flashing of the firmware. This can occur in a RF51X transmitter running firmware prior to 2.0.0 when ever the battery becomes very low.

Insert the Radio Module for recovery into a RF505 Survey Gateway Node (RS232 version only)

Start Microsoft HyperTerminal and connect to the RF505 at 38400 baud.

Switch ON the RF505. If nothing appears on the HyperTerminal screen. Press ENTER.

Check for an output similar to that below:

```
1001
8 MHz EM2420
1.program upload (.bin image)
3.run program image
7.stack and application token defaults (.ebin image)
8.application token defaults (.ebin image)
advanced mode
```

Press 1 for “program upload (.bin image)”

Await the XMODEM prompt character 'C'.

Send the file `rangetest-em2420-8mhz-mega64.bin` using XMODEM (In HyperTerminal use **Transfer - Send File**)

Upon successful upload choose option-3 “run program image”.

Check for terminal display as follows.

```
app reset...oscillator locked after 2 attempts
RXON

RESET:BL


Ember Range Test Application v1.0
Apr  8 2005:14:50:03
Set to channel 0x00

>
```

Check that the oscillator locked after <=4 attempts .

Check that no Token related errors are reported.

Check for “set to channel 0x00”.

If any of the above tests fail then return the Radio Module to Comark Service Dept.

At the '>' prompt, type the command `bootload¶` (¶ means ENTER key)

Check for an output similar to that below:

```
1001
8 MHz EM2420
1.program upload (.bin image)
3.run program image
7.stack and application token defaults (.ebin image)
8.application token defaults (.ebin image)
advanced mode
```

Press 1 for “Program Upload”

Await the XMODEM prompt character 'C'.

Send the file:

`Cipher-Meter-EM2420_RF1.1R.bin`

using XMODEM (In HyperTerminal use **Transfer - Send File**)

Upon successful upload choose option-3 “run program image”.

Switch OFF the power to the Radio Module

Disconnect HyperTerminal and change the baudrate to 19200 baud.

Switch ON the power to the Radio Module

Check for terminal display as follows.

`rf  Issue RF1.1R`

Send the command `S¶` - (¶ means ENTER key)

Check for an output as that below:

`[♥]`

Turn OFF power to RF505.

Remove Radio Module

END