EMBRACE

Manual

Revision 1E

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Contents

1.0 Introduction

EMBRACE is a wireless mesh network that has been specifically designed for use with EDMI's ATLAS and GENIUS series electricity meters.

The EMBRACE units provide directly compatible communications ports to allow quick and easy connection to EDMI meters using Cat5 patch cables. Once connected to an EDMI meter, the EMBRACE unit automatically interrogates the meters to use its site information to find and join the appropriate EMBRACE network. In one-to-one configurations (ie. where only one EMDI meter is attached to each EMBRACE router) the EMBRACE units will also automatically manage application level packet routing with no user configuration of the EMBRACE units required.

The EMBRACE mesh network is an ideal solution for retrofitting automated meter reading solutions in broad acre developments such as retirement villages, shopping centres, and marinas.

1.1 Mesh Network Topology

The EMBRACE system uses a full wireless mesh topology whereby every EMBRACE unit can act as an intermediate communication point to propagate wireless packets across the network. The mesh network topology can significantly extend the effective wireless range of the network. Perhaps more importantly, the multi-hop routing technique also mitigates troublesome wireless black spots which are a common problem for wireless networks that employ a star network topology.

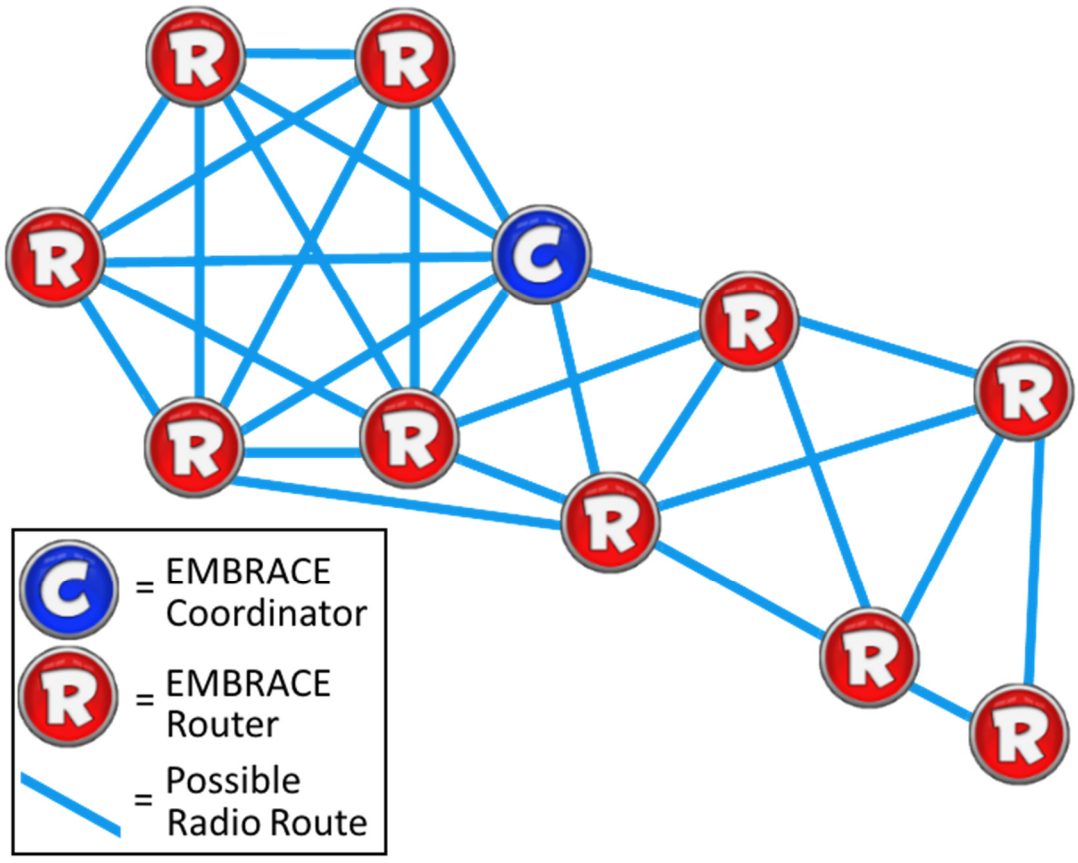


Fig 1. Example Mesh Network

In an EMBRACE network, all user-level data is sent to and from the EMBRACE Coordinator unit. The Coordinator acts as the RS232 Serial to Wireless Gateway (or Data Concentrator). In the example shown in Figure 1, the EMBRACE Coordinator is able to communicate to most Routers via a direct wireless link (a.k.a single hop). In this example the longest EMBRACE route is 3 hops, this being any one of multiple possible shortest routes between the Coordinator and the Router pictured in the bottom-right corner. This worst case hop count is an important design consideration that is discussed further in the network design section of this manual.

Multi-hop routing is handled automatically by the EMBRACE units by factoring in both route hops and the quality/reliability of each individual hop. The EMBRACE network is "self-healing" such that the resulting routing paths automatically and regularly adapt to change. The self-healing capability of a mesh network is often associated with support for mobile wireless nodes, however it still benefits fixed position networks, particularly in long term infrastructure cases. An electricity metering network is subject to significant changes over its typical lifetime of a decade or more. This may involve changes to the metering system itself - meter additions, removals, relocations, and replacements. Furthermore, the local environment is typically undergoing constant change. EMBRACE's self-healing mesh networking capability will typically mitigate any adverse effect from these ongoing changes, ultimately improving system uptime and reduced maintenance costs.

2.0 System Information

2.1 EMBRACE Device Types & Ordering Codes

Please refer to the network design section of this manual or request advice from SBS before ordering your EMBRACE units.

System	Network Protocol	Unit Type	Colour	MPN	Released
EMBRACE 2.4GHz	ZigBee	Coordinator	White	EM-24C	2nd Qtr 2014
		Router	Black	EM-24R	

Table 1. List of EMBRACE devices

Fig 2. EMBRACE 2.4GHz Coordinator

Fig 3. EMBRACE 2.4GHz Router

2.2 Interface / Pin Layout

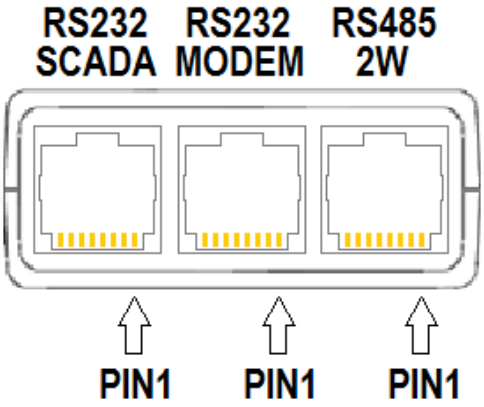


Fig 4. EMBRACE RJ45 Port Layout

RS232 SCADA PORT		
Pin #	**Cat5 (568A) Colour**	**Function**
1		Vin / Vout (Connected across ports)
2		NC
3		NC
4		Common / Ground
5		NC
6		NC
7		TX to Meter (SCADA Port)
8		RX from Meter (SCADA Port)

RS232 MODEM PORT		
Pin #	**Cat5 (568A) Colour**	**Function**
1		Vin / Vout (Connected across ports)
2		NC
3		NC
4		Common / Ground
5		TX to Meter (Modem Port)
6		RX from Meter (Modem Port)
7		NC
8		NC

RS485 2W PORT (factory use only – not for meter comms)		
Pin #	**Cat5 (568A) Colour**	**Function**
1		Vin / Vout (Connected across ports)
2		NC
3		NC
4		Common / Ground
5		NC
6		NC
7		RS485 D- (DM)
8		RS485 D+ (DP)

Table 2. EMBRACE RJ45 Pin Layouts

NC = Not Connected. Supports the presence of other signals.
Reserved = Undefined Connection. May not support the presence of other signals.

2.3 Electrical Specification

Conformity

EMC: AS/NZS 4268:2012 and AS/NZS CISPR 22:2009 Class B (Australia)

RoHS Compliance: YES

Antenna Limitation: This device may be used with a combined RF antenna + RF cable gain of 12dBi or less.

Absolute Maximum Ratings

Parameter	Rating			Unit
	Min	Typ	Max	
Storage Temperature	-20			Deg C
Supply Voltage	-0.3		+20.0	V
RS232 TX Voltage	-13.2		+13.2	V
RS232 RX Voltage	-25		+25	V
RS485 Driver/Receiver	-9		+14	V
ESD Protection (external pins exc. RF Connector)	+/- 15			kV

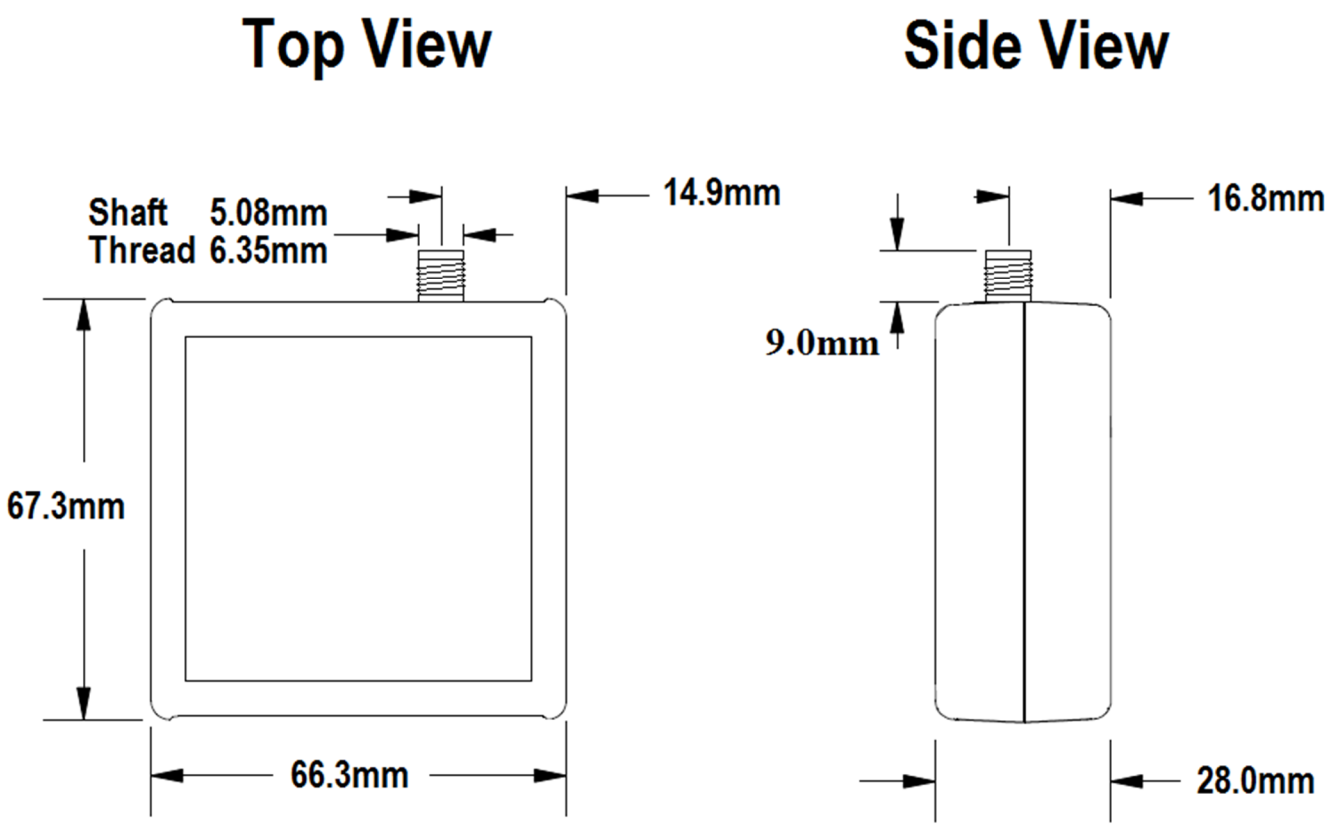
Stresses above those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to Absolute Maximum Ratings for extended periods is not recommended.

These are stress ratings only. See specifications listed under “Operating Conditions” for functional limitations.

Operating Conditions

Parameter	Rating			Unit	Notes / Conditions
	Min	Typ	Max		
Temperature				Deg C	
Supply Voltage	5.8		24.0	V	Operating Mode
	5.8		24.0	V	Programming
Operating Power		0.31	1.0	W	2.4GHz Variant (RS485 not in use)
		0.31	3.4	W	2.4GHz Variant (RS485 in use, 12Vdc Supply)
		0.31	4.2	W	2.4GHz Variant (RS485 in use, 16Vdc Supply)
Power Supply Current Rating	0.60	1.0		A	@ 6Vdc
	0.45	1.0		A	@ 12Vdc
	0.4	1.0		A	@ 18Vdc
RF Transceiver					
RF Channels	1		25	-	All 25 Channels enabled by default
RF Channel Width		2		MHz	
RF Channel Spacing		5		MHz	
Frequency	2.404		2.476	GHz	-3dB Cut off of lowest and highest channels
Transmit Power	+10		+18	dBm	10mW to 63mW
Receiver Sensitivity		-102		dBm	
RF Data Rate	250	250	250	kbps	
Indoor/Urban range			90	m	@250kbps
Outdoor elevated line-of-site range			3200	m	@250kbps
RS485 Driver					
Diff. Output Voltage (Vod)	-		5	V	R = Infinite
Diff. Output Voltage (Vod)	2		5	V	R = 50Ω
Diff. Output Voltage (Vod)	1.5		5	V	R = 27Ω
Comm. Output Voltage (Voc)			3	V	
Short Circuit Current			±200	mA	-7V < Voc < +12V
RS485 Receiver					
Diff. Input Threshold	-0.2	-0.13	-0.03	mV	-7V < Voc < +12V
Input Hysteresis		20		mV	-7V < Voc < +12V
Input Resistance	96	150		kΩ	-7V < Voc < +12V
RS232 Transmit					
Output Voltage	± 5.0	± 5.4		V	Load > 3kΩ
Short Circuit Current		± 35	± 60	mA	Vout = 0V
RS232 Receive					
Receive Voltage	-25		+25	V	
Receive Threshold Low	0.6	1.2		V	
Receive Threshold High		1.5	2.4	V	
Hysteresis		300		mV	
Input Resistance	3	5	7	kΩ	

2.4 Mechanical Specification



Enclosure	Plastic, ABS
Dimensions	67.3 x 66.3 x 28.0 mm (exc. RF Conn) 76.3 x 66.3 x 28.0 mm (inc. RF Conn)
Wire Connections	RJ45 Jack, 8p8c 15µin Gold Finish Contacts Polyester Housing Minimum 250 Connect Cycles Maximum 35N Mating Force Minimum 22.5N Retention Force Maximum 0.02Ω Contact Resistance
RF Connection	RP-SMA Jack (Female, Outer thread). Use RF Antenna/Cable with RP-SMA Plug (Male, Inner thread)

3.0 System Compatibility

3.1 Meter Compatibility

The EMBRACE system is specifically designed for use with EDMI ATLAS and GENIUS series meters. As of July 2015, the following EDMI meters are supported:

MK7A - Single Phase
Mk7C - Single Phase

Mk10 - Three Phase
Mk10A - Three Phase
Mk10D - Three Phase
Mk10E - Three Phase

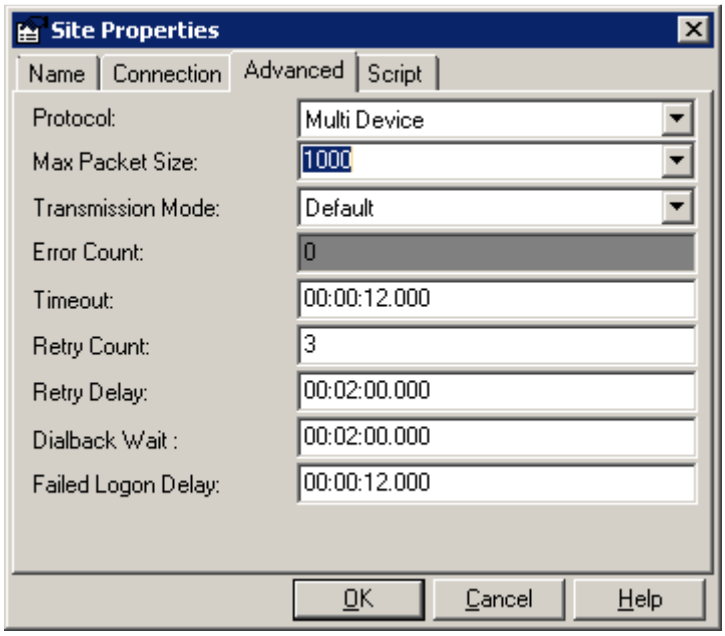
Mk6 - Three Phase
Mk6N - Three Phase

3.2 Software Compatibility

EMBRACE is a transparent communications network for the EDMI Extended CMD Line communications protocol. The EMBRACE network adds no further restrictions beyond the use of the extended ('E') packet type and therefore the network supports reading of all meter data types (Instantaneous, Time Of Use, and Load Survey data) as well as over-the-air meter configuration.

SBS recommends that software communication settings be relaxed from their default values when using EDMI EziView software in combination with an EMBRACE system. The following settings should be changed in the EziView site properties:

Max Packet Size:	1000	(Default: "Default" / 2000 Bytes)
Timeout:	12 sec	(Default: 5 sec)
Retry Count:	3	(Default: 2)
Failed Login Delay:	12 sec	(Default: 0 sec)



These recommendations are made in the context of the design recommendations discussed in this manual. The EziView default settings still work but may result in higher than desirable communication error rates in non-trivial EMBRACE networks or where slow and/or high latency backhaul communication networks are in use (eg. cellular and satellite backhaul communications).

System designers should ensure that their desired software package are not too strict / inflexible. The EMBRACE system has been confirmed to work with SBS Netstream, EDMI EziView, and EDMI MultiDrive software packages.

The “Max Packet Size” reduction is largely only applicable to large load survey downloads that may be downloaded special manual read/backup/test or as “catch-up” readings that some automatic meter reading software packages will undertake upon commissioning or after system downtime.

The reduced maximum packet size better accommodates the reliability measures implemented in the underlying wireless protocol since these measures are somewhat negated by the “all or nothing” approach to re-packetizing EDMI packets.

This maximum packet size setting primarily affects manual load survey downloads directly from the meter and catch-up readings that some automatic meter reading systems will initially process when connected to an existing metering system. If these types of readings are not proving reliable enough (perhaps due to the issue being compounded by the software using an “all or nothing” approach to the entire load survey download), the maximum packet size can be further reduced. Note that reductions to the maximum packet size result in increased data overhead and increased number of intermediate communication delays; the result is slower transfer speeds that grow exponentially as the maximum packet size is reduced. Therefore, halving the maximum packet size from 1000 to 500 will affect download speeds much more significantly than the recommended reduction from 2000 to 1000.

4.0 Network Design

The basic network configuration is 1x EMBRACE Coordinator and between 1 and 30 EMBRACE Routers per wireless mesh network. This makes for a total of 31 EDMI meters per network.

Besides “coordinating” the wireless mesh network functionality, the EMBRACE Coordinator always acts as the data concentration point. The data concentration point is an RS232 RJ45 type communications port, which can be connected to generic backhaul serial communication devices such as Ethernet device gateways or Cellular Modems.

A supported EDMI meter must be connected to each EMBRACE Coordinator and Router. The PAN ID (a.k.a. WPAN ID or WAN ID) is determined by the EDMI meter’s setup. Refer to the commissioning section of this manual on how the PAN ID is set via the EDMI meter.

The network designer may choose to install an additional low cost EDMI MK7C single phase meter in a desirable location in order to add an additional EMBRACE device. The likely reasons for this would be to install the EMBRACE Coordinator point in a more accessible location, or to add an additional EMBRACE Router to act as a “repeater” to extend the wireless mesh network range

4.1 EMBRACE Devices per EMBRACE network (PAN)

A maximum of 30 Routers is a recommendation only. Additional Routers are possible but network performance will degrade. The limit of 30 Routers has been chosen due to the limitation of the mesh network routing tables, going above this limit will cause increased network overhead due to the need for more regular route discovery packets. More generally, limiting the number of devices per mesh will avoid the exponential throughput and latency impact of growing wireless mesh network complexity – particular for endpoints requiring a large number of intermediate hops.

4.2 EMBRACE networks (PANs) in one local area

Each EMBRACE mesh network is identified by its unique PAN ID. Devices with the same PAN ID join the same EMBRACE network. Refer to the commissioning section on how the PAN ID is set on each EMBRACE device via the EDMI Meter itself.

Many EMBRACE wireless mesh networks can be installed at the same location. There is no hard limit on the number of co-existing EMBRACE wireless mesh networks. The ISM RF bands are however limited resources, in some locations issues of radio co-existence and congestion are more important.

When considering radio congestion, it is important to recognize the advanced co-existence technologies used in EMBRACE. Further to this, a single additional Wi-Fi link is likely to have more impact on local 2.4GHz ISM band congestion than an entire EMBRACE mesh network – both in terms of peak and average congestion.

4.3 EDMI Meters per EMBRACE Router

Only one RS232 meter is supported by the automated configuration technology.

Two RS232 meters per Router is possible, however a custom firmware is required in the Coordinator to map EDMI Meter serial numbers to Routers and Ports. This is currently only possible when the network is commissioned by SBS Technicians. In this case the Coordinator firmware would also need to be changed whenever any changes are made to the EMBRACE network, for example if an EDMI meter was changed.

5.0 Commissioning

5.1 Meter Configuration

All EDMI Meters attached to EMBRACE devices must be configured using EziView software with the appropriate communication settings and PAN Identifier. The PAN Identifier is read by the EMBRACE device and used to identify which wireless mesh network the unit will join. Below are the settings critical to an EMBRACE setup:

Communication Settings:

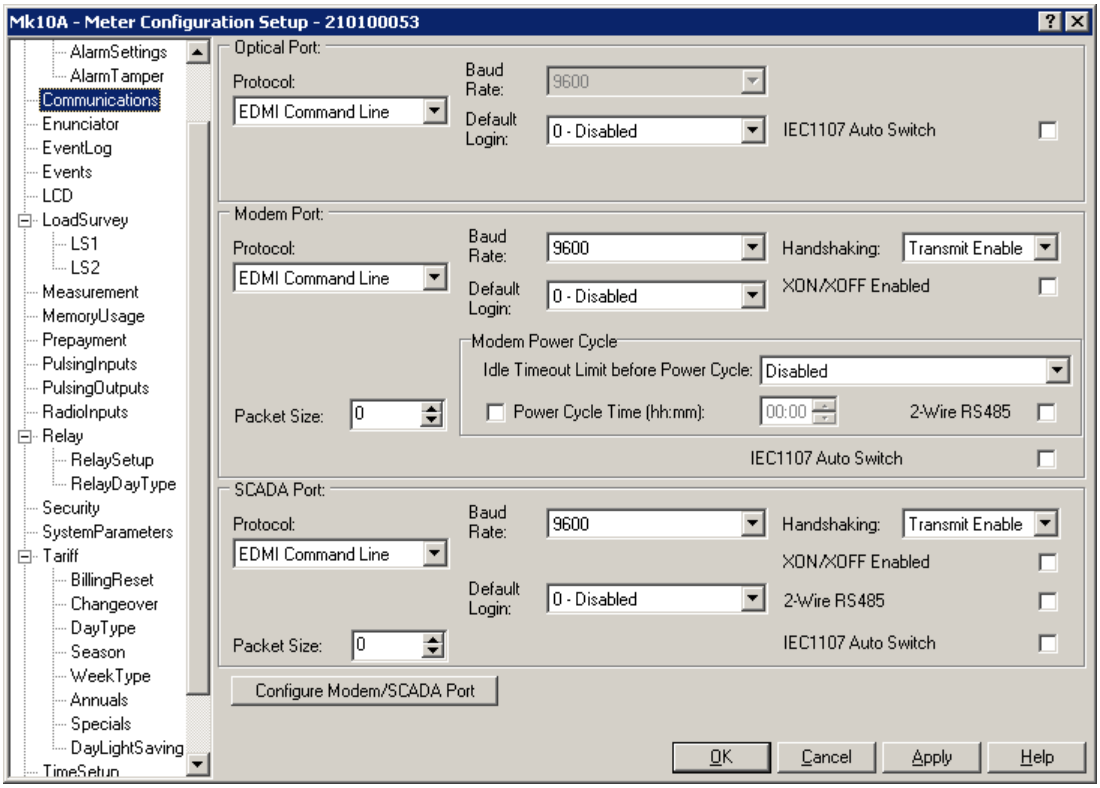
Baud Rate:	9600 bps
Data Bits:	8
Parity:	None
Stop Bits:	1
XON/XOFF:	Disabled
Handshaking:	Transmit Enable

ATLAS Series Specific Settings:

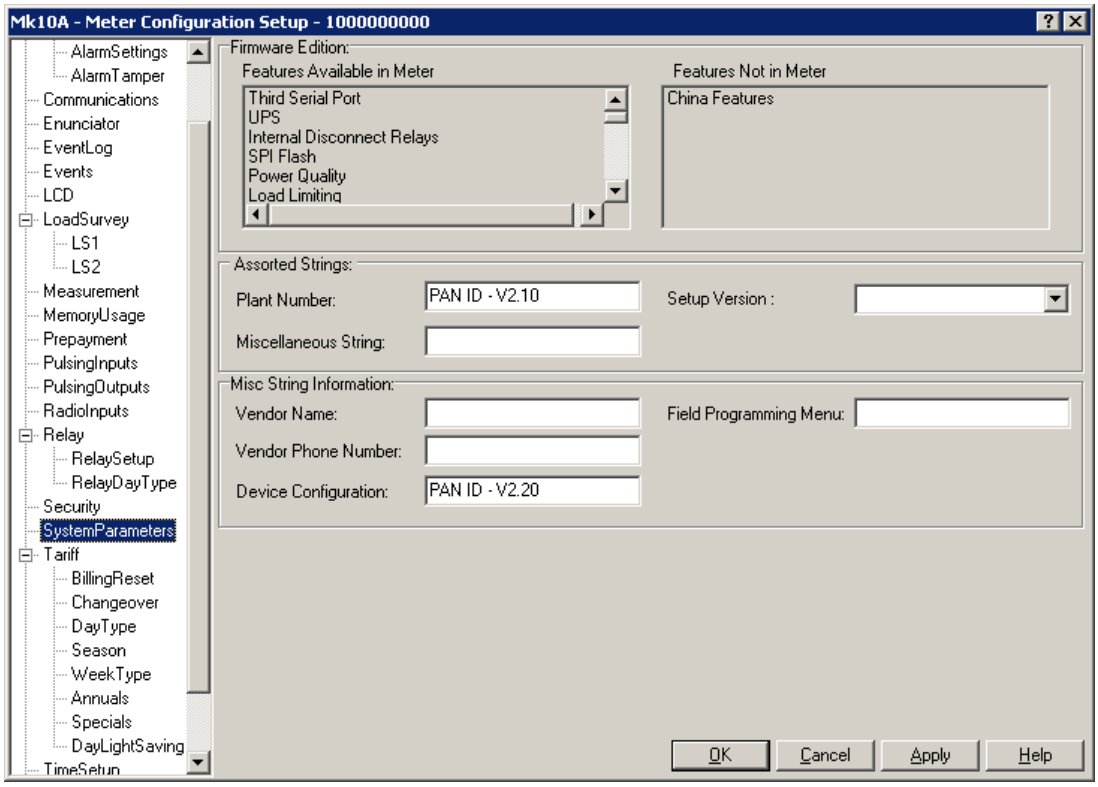
PAN Identifier:	Plant Number (Firmware V2.10 and earlier) Device Configuration (Firmware V2.20 and later)
Protocol:	EDMI Command Line

GENIUS Series Specific Settings:

PAN Identifier:	Site Name
Type:	No Modem (Genius Setting)



ATLAS series Communication Settings



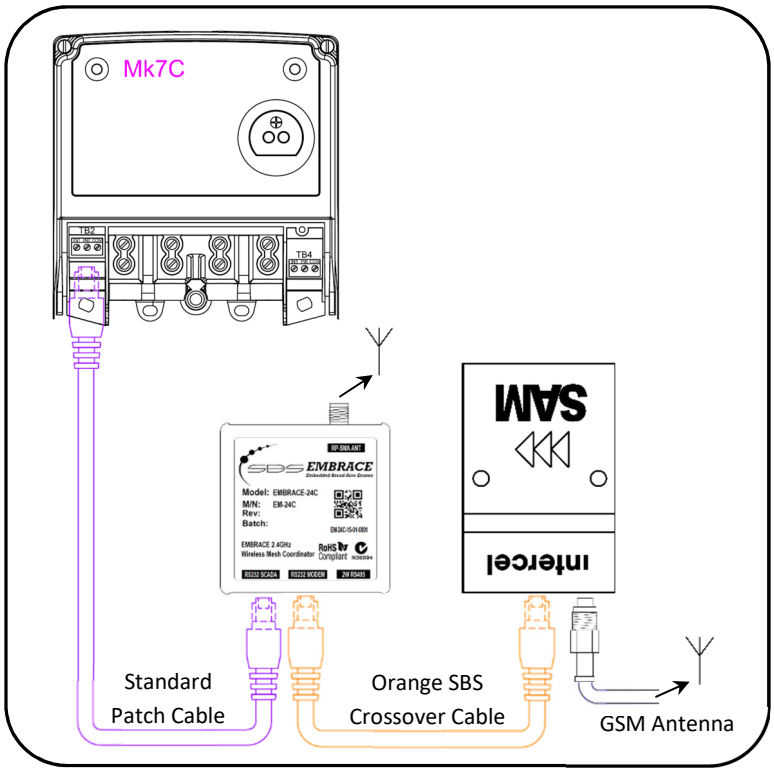
ATLAS series Plant Number / PAN ID

Regarding over-the-air meter configuration, communications will be lost if a meter re-configuration attempt changes the communications port settings such that they are no longer compatible with the attached EMBRACE unit. Furthermore, if over-the-air meter re-configuration is used to modify the site information string (PAN ID) that is used to identify the EMBRACE network (ie. an attempting to switch this unit onto a different EMBRACE network) then this change can take up to 48hrs to take effect and meanwhile the unit will still be available on the existing network.

5.2 Coordinator Installation

Following configuration of the EDMI Meters, the EMBRACE Coordinator should be installed first to establish the PAN. Later when installing the Routers their connectivity to the PAN can be easily confirmed during installation.

The Coordinator is connected via the RS232 SCADA port using a standard patch cable to an EDMI Meter with a dual-RS232 RJ45 socket. For connection to a GSM/3G Modem, such as the Intercel SAM3T, an SBS Orange Crossover cable is required. See below example:



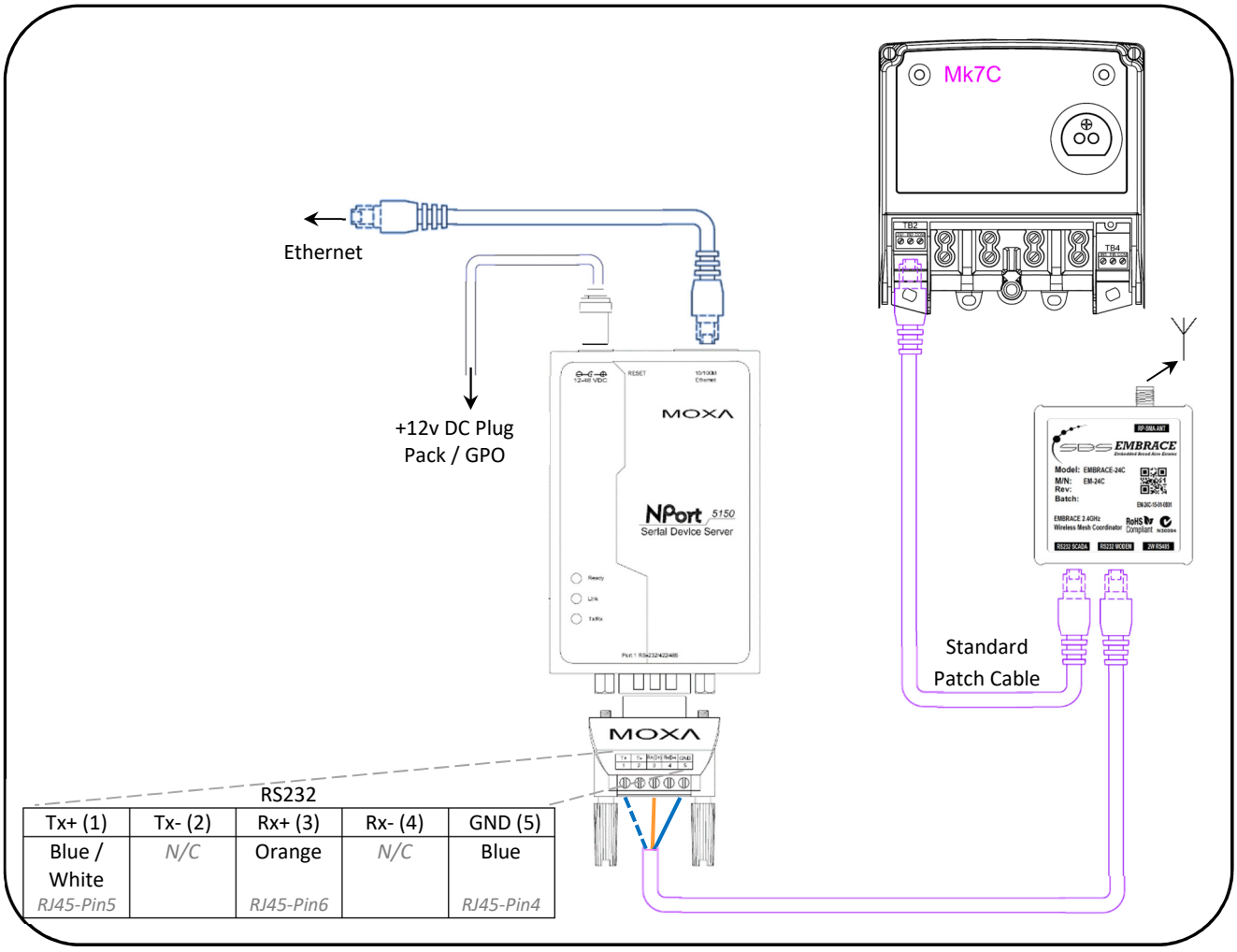
EMBRACE Coordinator Installation, with Intercel SAM3T

The Orange Crossover Cable is available as a stock item from SBS, however it can be created by following this pinout:

	EMBRACE Coordinator		Modem	
Pin #	**Cat5 (568A) Colour**		**Cat5 (568A) Colour**	**Pin #**
1		→		1
2		→		2
3		→		3
4		→		4
5		→		5
6		→		6
7		→		7
8		→		8

Crossover Cable Pinout

Connection can also be made by Ethernet using a compatible RS232 Serial Device Server, such as the Moxa 5150. See below example:

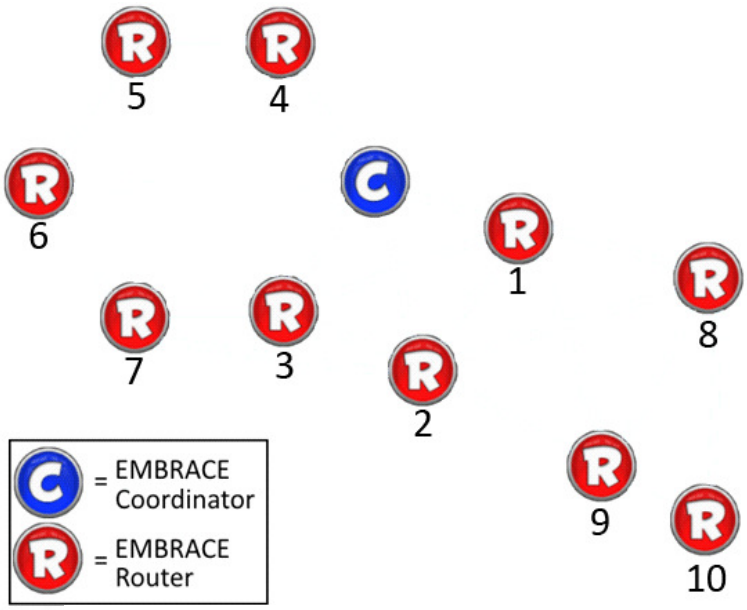


Tx+ (1)	Tx- (2)	Rx+ (3)	Rx- (4)	GND (5)
Blue / White *RJ45-Pin5*	*N/C*	Orange *RJ45-Pin6*	*N/C*	Blue *RJ45-Pin4*

EMBRACE Coordinator Installation, with connection to Ethernet via Moxa 5150 Serial Device Server

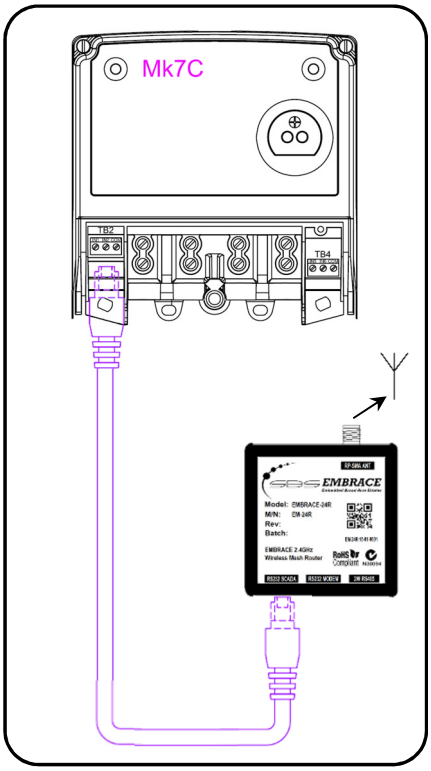
5.3 Router Installation

Following installation of the Coordinator, begin installing the Routers starting with the EDMI meter nearest to the Coordinator, moving outwards. See example below:



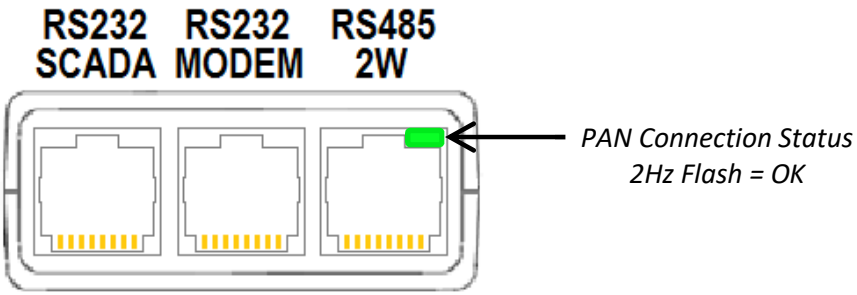
Suggested EMBRACE Router Installation Order

The EMBRACE Router is connected via the RS232 SCADA port using a standard patch cable to EDMI meters with a dual-RS232 RJ45 socket.



EMBRACE Router connection to EDMI meter

To confirm the Router has successfully found the Coordinator and joined the PAN, check the green LED indicator on the port labelled “RS485 2W”. If successful the green LED will flash at 2Hz.



6.0 Antenna Options

SBS offers the following antenna installation options. In all options, the antenna should be mounted vertically.

1. **2.4GHz RP-SMA Dipole Antenna.**

   Recommended use:

   - Indoors without enclosure.
   - Indoors or outdoors when housed within a plastic enclosure.

2. **2.4GHz N-Type (SP) Dipole Antenna**
   + RF Cable with RP-SMA to N-Type (SP) Bulkhead Jack connections
   + 90 Degree N-Type Jack to N-Type Plug Connector

   Recommended use:

   - Outdoors, when externally side-mounted to enclosure.
     - If the enclosure is metal, the bulkhead should be positioned within 8cm of the enclosures ceiling height so that a substantial portion of the antenna stands taller than the enclosure ceiling. Where this is not possible, this mesh nodes range and Omni-directionality will both be significantly impacted, consider using option (4) instead.

3. **2.4GHz N-Type (SP) Dipole Antenna**
   + RF Cable with RP-SMA to N-Type (SP) Bulkhead Jack connections
   + Right angle bracket

   Recommended use:

   - Outdoors, when externally side-mounted to enclosure.
   - This solution should use a cable gland to pass the RF cable out of the enclosure (not supplied).

Appendix A. Case Study – The Village Redcliffe

The Village Redcliffe utilises the EMBRACE wireless network system for electricity sub metering. The system consists of 178 single phase apartment meters across 89 duplex buildings. A further three meters are installed in main switch boards and one in the community building to separately meter community services.

The Village Redcliffe has Solar PV installed on all apartments. The Village chose to install two-element single-phase EDMI revenue meters on all duplex apartments, this means that all apartment meters can be metered for consumed and generated power & energy via either net or gross methods.

The EMBRACE solution supports time of use (TOU), Load Survey, and real time instantaneous data readings on all EDMI Mk7A, Mk7C, Mk10A, and Mk6N meters in the network.

The Village Redcliffe - Satellite Image (Early 2015)

Each duplex building in The Village Redcliffe has the two meters cabled to a single metering box. This solution is well supported by EMBRACE technology whereby a single EMBRACE Router connects both meters on each duplex. Therefore, 182 physical meters in total are connected via 93 EMBRACE units.

The 93 EMBRACE units are separated into 3 Wireless Local Area Networks according to the 40 unit recommended limit for individual EMBRACE networks. WAN2 & WAN3 are expecting extensions according to future site development plans. A fourth WAN is also expected and can be seen in the following WAN zoning diagram.

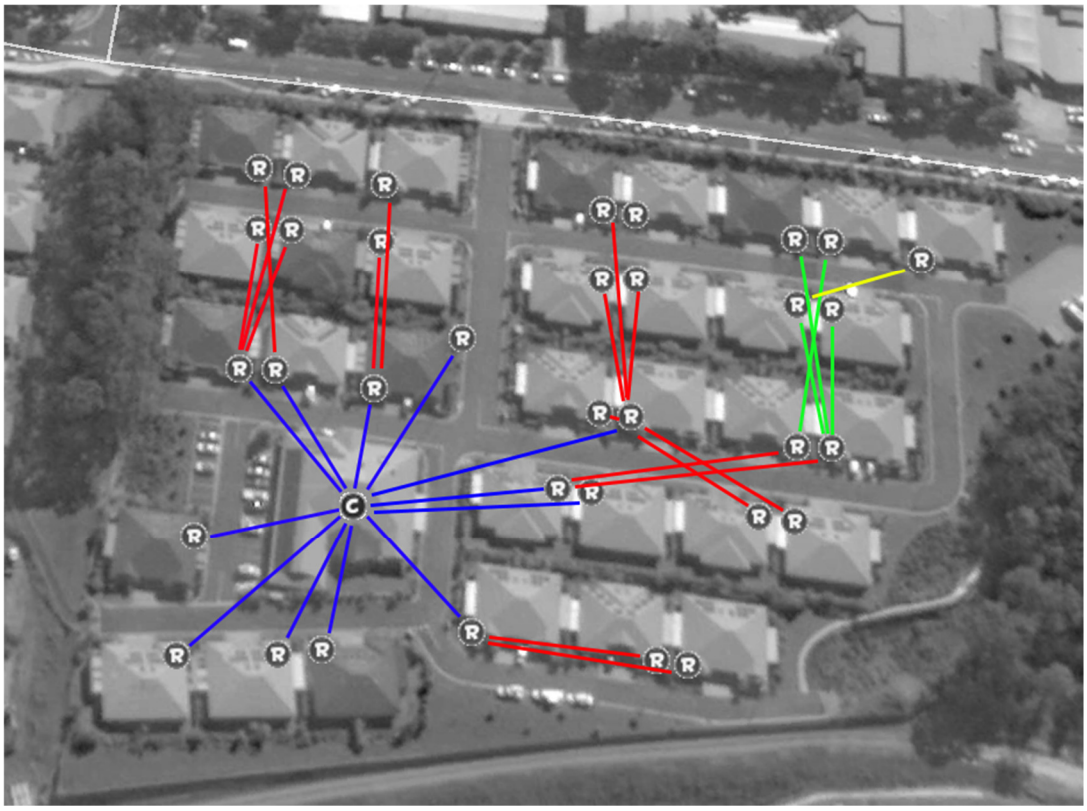
The Village Redcliffe – EMBRACE WAN Zoning

Each EMBRACE WAN connects to a backhaul network via its Coordinator unit. For The Village Rothwell, this includes a mix of fixed line internet and cellular 3G data modem connections based on individual network accessibility constraints. In both cases, the connection enables meter reading from SBS's Netstream platform.

The Village Redcliffe – EMBRACE Unit Locations
(Blue 'C' = Coordinator, Red 'R' = Router)

At the time of writing, the village consists of 89 duplex buildings totalling 178 apartments. A two-element single-phase revenue meter is installed at each apartment, whereby each duplex has these meters co-located.

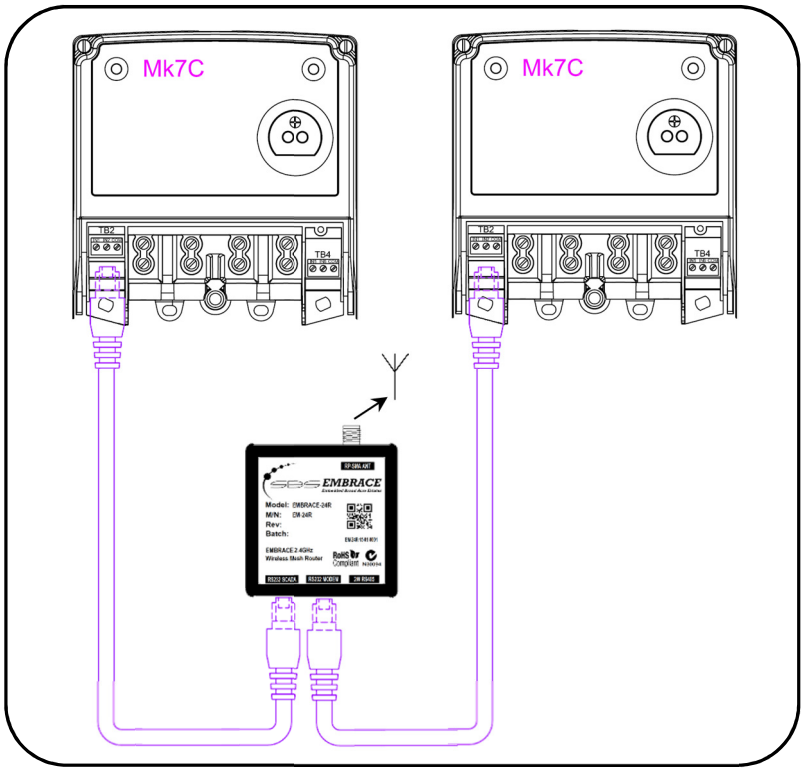
Each apartment has solar panels and the 2-element meter configuration allows the apartment to be both net and gross metered. Queensland implements a net feed in tariff rate so the 2-element meters are not strictly necessary, however the systems gross metering capability may still be desirable for future proofing and to provide consumers with a breakdown of their consumption and generation data.



The Village Redcliffe – WAN1 possible routes

Appendix B. Connecting 2 meters per EMBRACE Router

Using a special configuration in the Coordinator it is possible to connect an extra meter to each Router. There is no change to the configuration of the EDMI meters; they are still configured as per section 5.1 of this manual.



EMBRACE Router connection to 2 EDMI meters

To begin with connect only the meter on the port labelled RS232 SCADA according to section 5.3 of this manual. Then connect the second meter to port labelled RS232 MODEM. Take note of which meter serial number is attached to which port on the Router.

Then using the EMBRACE Configuration Packet spreadsheet (available from SBS) enter the serial numbers in the appropriate MODEM/SCADA Columns.

#	Group ID	Meters on MODEM port		Meters on SCADA port		Configuration Packet
		Label	Serial	Label	Serial	
1		MSB Main	211517109	MSB Lighting	213250974	02 45 00 00 00 00 FF FF 5B 5F 3F FF 53 57 43 FF FF FF
2		1	210123203	2	210123198	FF FF FF FF FF 22 22 0C 9B 7E B5 0C 86 39 C3 0C 86 39
3		3	210123210	4	210123205	CA 0C 86 39 C4 0C 87 01 CB 0C 87 01 CD 0C 86 39 C0 0C
4		5	210123204	6	210123197	87 01 D2 0C 86 39 C7 0C 86 39 C8 0C 87 01 D1 0C 87 01
5		7	210174411	8	210174412	D6 0C 87 01 D7 0C 87 01 D8 0C 87 10 42 43 0C 87 10 42
6		9	210174413	10	211513086	47 0C 87 10 42 42 0C 87 10 42 4B 0C 87 10 42 49 0C 87
7		11	210123200	12	210123199	10 42 44 0C 87 10 42 46 0C 87 10 42 3F 0C 87 10 42 40
8		13	210174418	14	210174419	0C 87 10 42 4E 0C 87 10 42 4A 0C 87 10 42 57 0C 87 10
9		15	210123207	16	210123206	42 5A 0C 87 10 42 5E 0C 87 10 42 62 0C 87 10 42 51 0C
10		17	210123208	18	210123209	87 10 42 5C 0C 87 10 42 60 0C 87 10 42 64 0C 87 10 42

EMBRACE Configuration Packet Spreadsheet

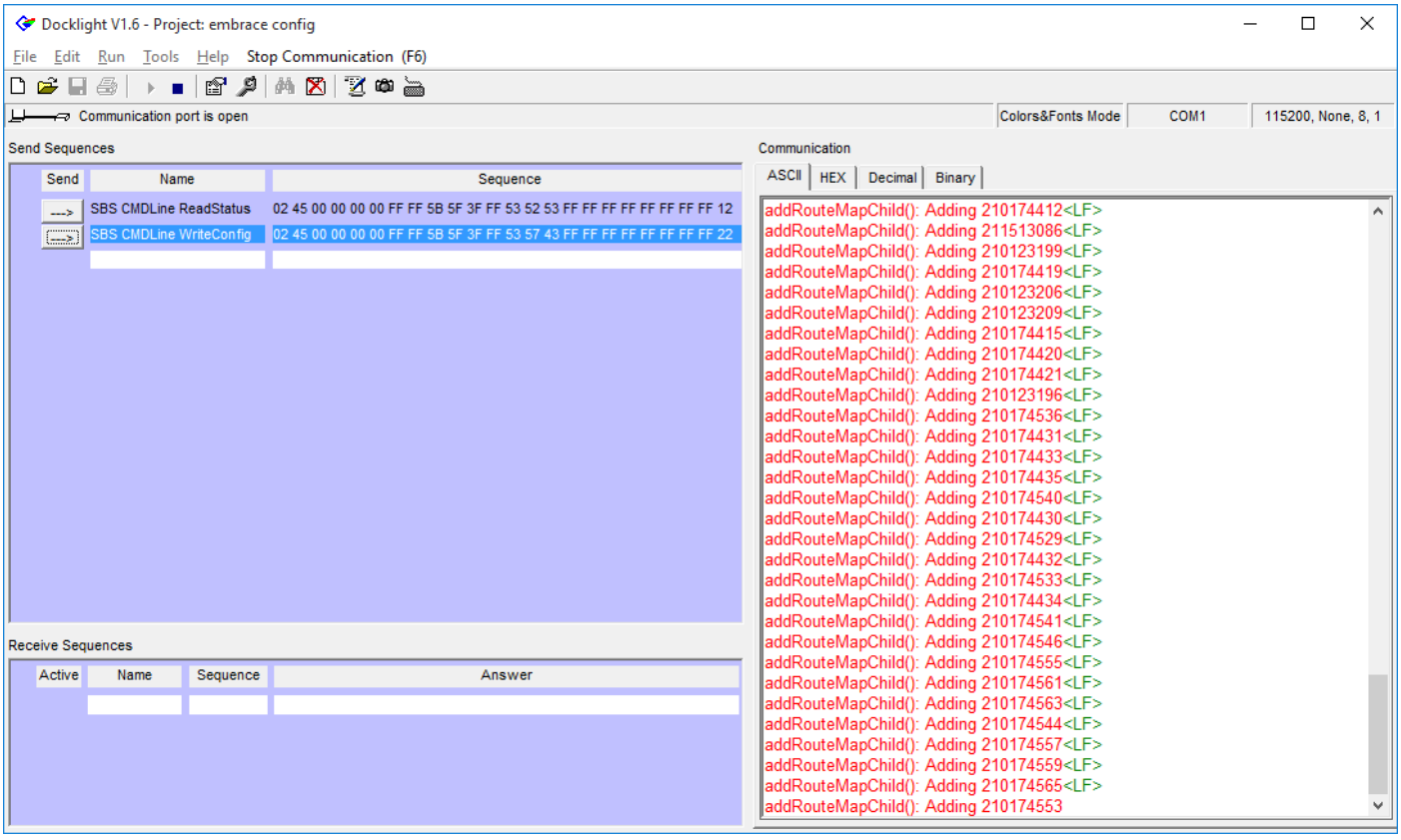
The end result of this spreadsheet is the cell under “Configuration Packet”. This string is sent to the EMBRACE Coordinator to correctly map Child (SCADA) meters to Mother (MODEM) meters.

The Configuration Packet is sent to the EMBRACE Coordinator through the port labelled 2W RS485. The pinout of this port is below. Only the brown pair (Pins 7&8) are required for communications.

RS485 2W PORT (factory use only – not for meter comms)		
Pin #	**Cat5 (568A) Colour**	**Function**
1		Vin / Vout (Connected across ports)
2		NC
3		NC
4		Common / Ground
5		NC
6		NC
7		RS485 D- (DM)
8		RS485 D+ (DP)

EMBRACE 2 wire RS485 Port Pinout

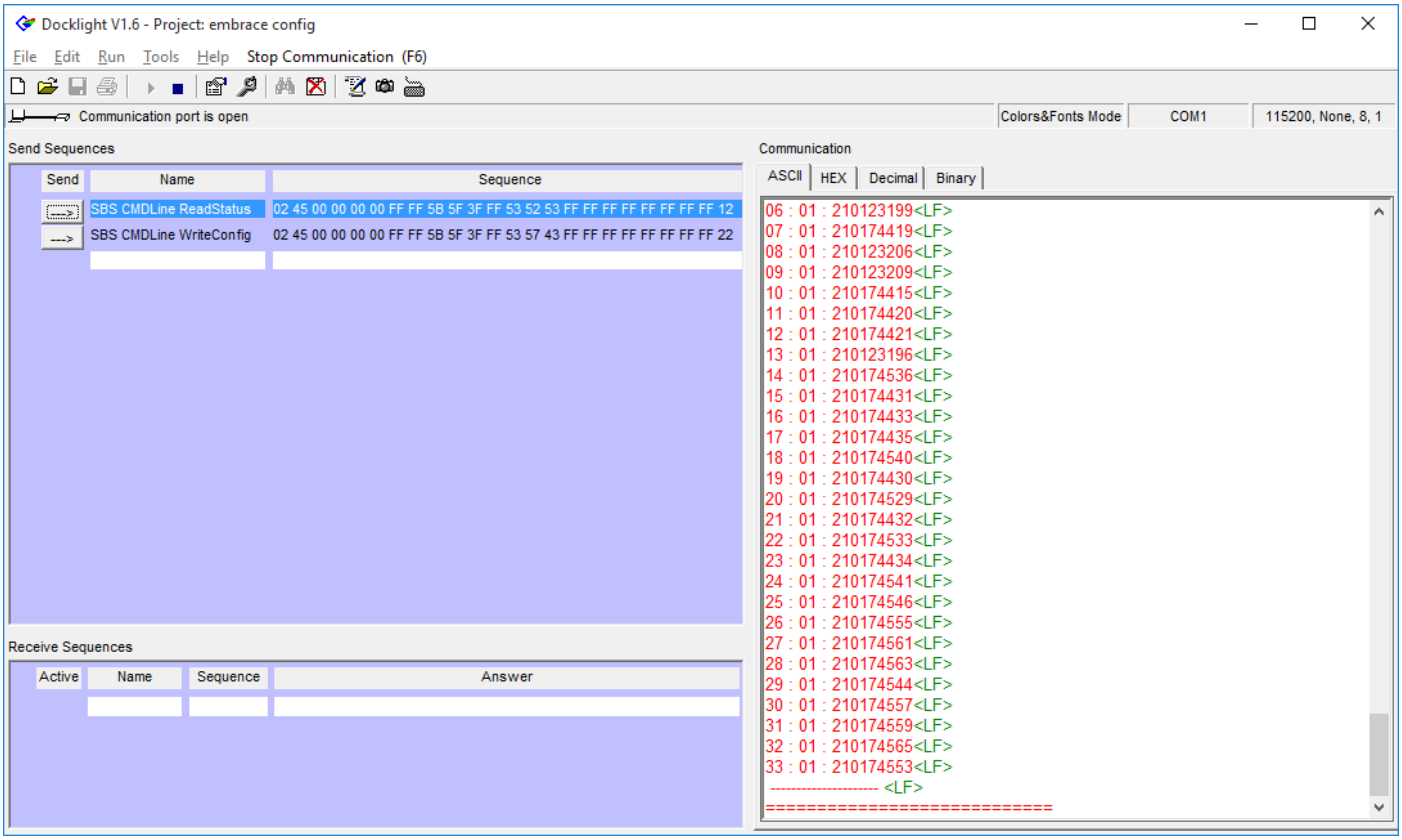
Using Docklight software, send this packet to the EMBRACE Coordinator (115200, None, 8, 1). The Coordinator will need to be powered by an EDMI meter during this process. Sending the packet can be made easier by using the template Docklight project “embrace config”. Replace the send sequence for “SBS CMDLine WriteConfig” with the Configuration Packet generated by the spreadsheet.



Sending the Configuration Packet using Docklight

After sending the Configuration Packet, power cycle the Coordinator by removing all the RJ45s connected to it, then reconnecting. The Coordinator will not begin using the new config until it is power cycled, or until the next 48hr reset occurs.

The current status of the Coordinator can also be read using Docklight. Send the “SBS CMDLine ReadStatus” sequence to Coordinator and it will return the list of Mother (Modem) and Child (SCADA) meters currently configured.



Reading the EMBRACE Coordinator status using Docklight

If this template is not available, use the below packet to read the status:

```
02 45 00 00 00 00 FF FF 5B 5F 3F FF 53 52
53 FF FF FF FF FF FF FF FF 12 34 FF FF 03
```