UHF SpacePort Modem

The SpacePort Modem (SPM) is a low cost highly integrated intelligent radio packet modem that enables a radio network/link to be simply implemented between a number of digital devices. The SPM uses addressable data packets with error checking, packet acknowledgements and retransmissions to achieve a reliable invisible wireless data link. Built for ease of use and rapid installation, the serial interface ensures direct connection to microprocessors or to RS232 port via RS232 driver while remote configuration enables post installation setup of the modem.

Features

- Addressable point-to-point
- Point-to-Multipoint and broadcast modes
- Inverted RS232 interface at TTL level
- DTE speed 600-115200bps
- Air data speed 1200-14400bps
- Single 5V or 3.3V supply
- Flow control – Hardware, None
- Up to 200m outdoor & 50m indoor range
- Built-in command line configuration
- Built-in RF link diagnostics
- Remote over-air unit configuration
- Low operating current, Auto standby mode
- Conforms to ETSI EN 300 220-3 and EN 301 489-3
- Dimensions - 23mm X 39mm X 6.5mm

Applications

- PDAs, organisers & laptops
- Telemetry and telecontrol
- Handheld / portable terminals
- EPOS equipment, barcode scanners, belt clip printers, stock control, job allocation
- Remote data acquisition system, data loggers
- Audience response systems
- In-building, environmental monitoring and control systems
- High-end security and alarm signalling
- Restaurant ordering systems
- Fleet management, vehicle data acquisition
INTRODUCTION
The SPM2 is a self-contained radio packet modem module that requires only a simple antenna, 5V supply and a serial I/O port on a host microcontroller or PC.

The module provides all the RF circuits and processor intensive low level packet formatting and packet recovery functions required to inter-connect any number of devices with serial port in a radio network.

A continuous stream of serial data downloaded by a Host microcontroller into the SPM serial receive buffer is transmitted by the SPM’s transceiver and will "appear" in the serial buffer of the addressed SPM within radio range.

![Figure 1: SPM + Host -controller](image)

![Figure 2: Physical dimensions and pinouts](image)
TECHNICAL SPECIFICATION

General

**Operating Voltage**
5VDC

**Operating Current**
- Transmitting/Receiving: Average 40mA (Data streaming)
- Standby/Power-down: 15mA/400µA

**Operating frequency**
- Single channel: 433.920 MHz
- To be released on: 869.85MHz and 914.50MHz

**Operating Temperature**
-10°C to +55°C

**Configuring options**
Built-in command line configurator

Interface

**Serial Interface**
Inverted RS232 at TTL level

**Serial Protocol**
8 data/1 stop/no parity

**Serial Signals**
RXD, TXD, CTS, WAKE

**Power down Control**
Via WAKE signal

**Serial Handshaking**
Selectable as CTS signal or none

**DTE Interface Speed**
- 600/1200/2400/4800/9600/14400
- 19200/38400/57600/115200 bps

**Air Interface Speed**
1200/2400/14400 bps

**Overall throughput**
- Acknowledged: 18kbps (max) for standard and 28kbps for fast variant
- Unacknowledged: 30kbps (max) for standard and 55kbps for fast variant

Receiver

**Sensitivity**
-95 dBm for 1ppm BER and –90dBm for fast variant

**LO leakage (conducted)**
-70dBm

Transmitter

**Output Power**
10mW ERP

**2nd harmonics**
-46 dB

Approval

**European Standards**
ETSI EN 300-220-3 (radio) and ETSI EN 301 489-3 (EMC)
1. Functional Description

The SPM is a connection oriented modem module for sending and receiving serial data via an RF communications link.

The SPM handles all necessary protocol related functions of validation and retries to ensure error free and uninterrupted data is sent over the communications link. All data transfers between a pair of SPMs are fully acknowledged, thus preventing the loss of data. Bit coding and checksums are used on the data packets to ensure the validity of the received data at the remote end.

1.1 Operating States

The SpacePort Modem has three normal operating states:

- **Shutdown**
- **Standby**
- **Connected**

**Shutdown**

The Shutdown state is entered by asserting the Wake/DTR input pin high (Vcc). It effectively forces the SPM into a suspended state. Communications cannot be made with the SPM in this state.

**Standby**

Immediately after power up and during normal operation, the SPM will automatically enter standby mode where it is waiting for a connection request from a remote SPM module.

While in this mode a remote connection request can be received which will place the SPM into a connected state allowing it to then start receiving data from the remote unit. The connected host device can also send data to the SPM via the serial interface which will force the module to send a connection request to the remote SPM module, thus effectively setting up a logical connection between two units and allowing data to be transferred.

**Connected**

On receipt of a connection request from a remote unit, the SPM immediately enters a connected state. This effectively allows the SPM modems to start sending and receiving data.

In-coming data is sent to the host via the serial port in the same form as it was given to the remote SPM module.
2 THE HOST INTERFACE

2.1 SIGNALS

The connection to the SPM is a full duplex serial interface supporting baud rates from 600bps to 115200bps. Additional control signals are provided to assist in flow control, configuration and power saving in the SPM. Figure 3 shows an overview of the interface signals to the SPM.

<table>
<thead>
<tr>
<th>Pin name</th>
<th>Pin</th>
<th>Pin Function</th>
<th>In/Out</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF GND</td>
<td>1, 3</td>
<td>RF signal ground</td>
<td>BNC casing/coax braid connection</td>
<td></td>
</tr>
<tr>
<td>RF</td>
<td>2</td>
<td>RF signal</td>
<td>Input or Output</td>
<td>Antenna pin/coax core connection</td>
</tr>
<tr>
<td>RXSELCT</td>
<td>4</td>
<td>Receiver Select</td>
<td>Input or Output</td>
<td>Manual RF Receiver Enable or RF Receiver Active Indicator</td>
</tr>
<tr>
<td>TX SELECT</td>
<td>5</td>
<td>Transmitter Select</td>
<td>Input or Output</td>
<td>Manual RF Transmitter Enable or RF Transmitter Active Indicator</td>
</tr>
<tr>
<td>TXD/AF</td>
<td>7</td>
<td>Transmitted Data or demodulated signal</td>
<td>Input or Output</td>
<td>Transmitted Packetised Data to BiM2 Analogue Demodulated signal from BiM2</td>
</tr>
<tr>
<td>D3</td>
<td>8</td>
<td>SP2 Data line</td>
<td>NC</td>
<td>Internal data line between RPM and FRPC</td>
</tr>
<tr>
<td>D2</td>
<td>9</td>
<td>SP2 Data line</td>
<td>NC</td>
<td>Internal data line between RPM and FRPC</td>
</tr>
<tr>
<td>SIGNAL</td>
<td>10</td>
<td>Preamble Detect</td>
<td>Output</td>
<td>Valid preamble indicator</td>
</tr>
<tr>
<td>RST</td>
<td>11</td>
<td>FRPC reset</td>
<td>NC</td>
<td>Resets FRPC which also isolates BiM2</td>
</tr>
<tr>
<td>RXA</td>
<td>12</td>
<td>Receive Acknowledge</td>
<td>NC</td>
<td>Host to FRPC download request acknowledge</td>
</tr>
<tr>
<td>RXR</td>
<td>13</td>
<td>Receive Request</td>
<td>Output</td>
<td>Valid Data packet indicator</td>
</tr>
<tr>
<td>RESET</td>
<td>14</td>
<td>Reset</td>
<td>Input</td>
<td>Hardware reset of the SPM</td>
</tr>
<tr>
<td>SETUP</td>
<td>15</td>
<td>Enter Setup</td>
<td>Input</td>
<td>Enter SPM configurator after a reset</td>
</tr>
<tr>
<td>WAKE/DTR</td>
<td>16</td>
<td>Wake or Shutdown</td>
<td>Input</td>
<td>Wakes SPM when low, shuts down when high</td>
</tr>
<tr>
<td>TXD</td>
<td>17</td>
<td>Serial transmitted data</td>
<td>Input</td>
<td>Host (DTE) to SPM serial data</td>
</tr>
<tr>
<td>RXD</td>
<td>18</td>
<td>Serial Received data</td>
<td>Output</td>
<td>SPM to host (DTE) serial data</td>
</tr>
<tr>
<td>CTS</td>
<td>19</td>
<td>Flow control</td>
<td>Output</td>
<td>SPM to Host (DTE) flow control</td>
</tr>
<tr>
<td>DEFAULT</td>
<td>20</td>
<td>Force 9600bps</td>
<td>Input</td>
<td>Force the SPM serial interface to 9600bps</td>
</tr>
<tr>
<td>VCC</td>
<td>21</td>
<td>Vcc Supply</td>
<td>Input</td>
<td>+5VDC</td>
</tr>
<tr>
<td>GND</td>
<td>6, 22</td>
<td>Ground</td>
<td>-</td>
<td>Ground internally connected to RF GND</td>
</tr>
</tbody>
</table>

Notes:
1. RXD/TXD lines are true data
2. The 4 input control lines are active low
3. Logic levels are 5V CMOS. See electrical specifications
4. Input control pins must be terminated, as pull-ups are not provided
5. Indicator outputs are active low which can be connected to LEDs

2.2 SPACEPORT RESET

RESET
The Reset signal may either be driven by the host (recommended) or pulled up to Vcc via a suitable resistor (10kΩ). A reset aborts any transfers in progress and restarts the SPM.

HOST DRIVEN RESET
Minimum low time: 1.0 µs, after reset is released (returned high). The host should allow a delay 1ms after reset for the SPM to initialise itself.
2.3 Host To SpacePort Data Transfer

Data is transferred between the SPM and the Host using an asynchronous serial protocol. The default protocol settings are 8 data bits, no parity and 1 stop bit (8n1). The baud rate setting for the serial interface is user settable from 600bps to 115200bps.

- **TXD**
  Data from the connected host is received by the SPM using TXD signal.

- **CTS**
  A single handshake line, CTS, controls the flow of data into the SPM. The serial receive buffer of the SPM is 96 bytes deep. The CTS will be asserted by the SPM when the receive buffer hits approximately 66% full. It is advisable to limit the number of characters sent to the SPM after the CTS control line is asserted. This will help to reduce the possibility of lost data due to internal buffer overruns in the SPM. The SPM will clear the CTS when the internal serial receive buffer falls below 33% full.

- **RXD**
  Upon the SPM receiving data from a remote unit, the received data is sent to the connected host device using the RXD signal.

2.4 Entering SpacePort Modem Configurator

Configuring the SPM is accomplished by using a built-in command line configurator. The configurator is entered by asserting the Setup input of the SPM while resetting the SPM.

- **Setup**
  Holding Setup low during a reset cycle will force the modem into the configurator. The state of this input is checked while the SPM starts up from either power on or reset.

- **Host Driven Setup**
  The Setup pin may either be driven by the host (recommended) to enable host controlled configuration of the SPM or pulled up to VCC via a suitable resistor (10kΩ).

2.5 Forcing Default Serial Baud Rate

Asserting this pin low forces the SPM to startup with a default baud rate of 9600bps, 8 data, one stop and not parity.

- **Default**
  During a reset the Host must hold Default low to force the SPM serial interface to default to 9600bps. This is ideal if the serial baud rate has been forgotten or incorrectly set.

- **Host Driven Default**
  The Default pin may either be driven by the host (recommended) or pulled up to VCC via a suitable resistor (10kΩ).

2.6 Forcing Space Modem into Sleep Mode

Asserting the wake input high forces the modem into a low power sleep mode. This effectively shuts down the SPM and prevents it from sending or receiving any data. It is a method for conserving power when the modem is not required.

- **Wake / DTR**
  During normal operation wake pin can be pulled high to force the SPM to shutdown into low power sleep mode.

- **Host Driven Wake**
  The Wake pin may either be driven by the host (recommended) or pulled up to 0V via a suitable resistor (10kΩ).
3.0 SpacePort Configuration

3.1 Entering The Configurator

The SPM is configured by entering the built-in software configurator. Current argument can be displayed by entering parameter / command without argument

3.2 User configurable parameters

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
<th>Valid range</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONFIG</td>
<td>Display a list of the current SPM configuration. This will also set FLOW control to none to enable simple 3 wire communication</td>
<td>None</td>
</tr>
<tr>
<td>DEFAULT</td>
<td>Set all SPM configuration settings to their factory default values.</td>
<td>None</td>
</tr>
<tr>
<td>RESET</td>
<td>Exit the modem and force a software reset. Any changed parameters will take effect after the modem has restarted. When exiting the configurator, the HOST device must ensure the SETUP pin is high otherwise the configurator will be re-entered after the reset.</td>
<td>None</td>
</tr>
<tr>
<td>UNIT</td>
<td>Sets the unit number. Two SPM modules can communicate with each other provided they have matching Unit numbers and Site codes.</td>
<td>0 to 15</td>
</tr>
<tr>
<td>SITE</td>
<td>Sets the Site address. The site number is used to distinguish between groups of operating modems. The site code is an address extension to the unit number.</td>
<td>0 to 7</td>
</tr>
<tr>
<td>ADDR</td>
<td>Updates the unit number value. This command is used for changing the unit number without updating the stored value. This enables the SpacePort to support point-to-multipoint communications. Upon using this command the configurator is exited and the modem operation is resumed. The modem is not reset when the configurator is exited.</td>
<td>0 to 15</td>
</tr>
<tr>
<td>BAUD</td>
<td>Sets the host interface baud rate. The changed baud rate will take effect after resetting the SPM.</td>
<td>9600</td>
</tr>
<tr>
<td>THRUPUT</td>
<td>Sets the on-air data throughput. Three possible settings are provided. max: sets the maximum data throughput of the SPM. slots: effectively reduces the on-air throughput. This opens up ‘time slots’ allowing other SPM pairs, operating within close proximity, equal opportunity to transmit data. fcc: sets the on-air throughput to a rate which is compatible with FCC regulations (max 10% air time) for use in the US.</td>
<td>max, slots, fcc</td>
</tr>
</tbody>
</table>
**FLOW**  
Sets the serial flow control between the host and **SPACEPORT**.
Using no flow control enables the SPM to be used with a 3 wire serial link (TXD, RXD, GND). Care must be taken in order to prevent overflowing the 96 byte serial receive buffer in the SPM.
Using hardware flow control enables the SPM to control the flow of serial data being received.

- default: hw
- valid range: hw, none

**SERDLY**  
Sets the serial data receive to packet transmit delay.
When the SPM receives the first byte of data from the host, it starts a timer running. Either a full buffer of data to send or a timeout of this timer will allow the packet to be transmitted.
Fine tuning this delay for the baud rate the SPM is operating at can significantly increase throughput while reducing unnecessary transmissions.

- default: 2 (x10ms)
- valid range: 2 to 255 (x10ms)

**SHDN**  
Sets the action of the **WAKE** input.
Setting shutdown to **ON** will cause the SPM to monitor the **WAKE** input. When **WAKE** is taken high the SPM will be forced into low power sleep mode, thus reducing current consumption. Subsequently lowering the **WAKE** input will bring the SPM out of low power sleep mode.

- default: On
- valid range: on, off

**RETRY**  
Sets the number of data retry attempts.
RF interference can cause a transmitted data packet to be lost or corrupt on reception. If this happens the SPM will retransmit any unacknowledged transfer. The transmission will be retried the specified number of times before the link to the remote unit is considered ‘lost’ and the data purged.

- default: 5
- valid range: 1 to 63

**STRTMG**  
Enables the startup message.
The startup message is enabled by default, thus giving an immediate indication of the operation of the SPM. The message can be disabled prior to deployment of the SPM module.

- default: On
- valid range: on, off

**ACKMODE**  
Enables transfer acknowledgements.
This function enables packet transfer acknowledgements to be returned for every outgoing packet. Packet acknowledgements aid in the delivery of error free and consistent data transfers between a pair of modems. Disabling the acknowledgements results in higher data throughput between modems, but does not protect against lost data due to RF interference. It should be disabled while using SPM in a broadcast mode.

- default: On
- valid range: on, off

**REMOTE**  
Enables remote configuration.
Over-air remote configuration of a SPM module is possible once it has been enabled. The remote command is used to send remote configuration commands. See the following chapter for a overview of remotely configuring a SPM module.

- default: On
- valid range: on, off
**RADAR**

**Starts the radar test.**

Used as a range or confidence test between SPM modules within the same **site**.

**parameter**

Unit number between 0 and 15.

---

**Figure 4: SPM2 configuration using HyperTerminal**

**Note:** To configure the SPM the HyperTerminal should be set with the following settings. Hardware flow control should be disabled. Default baud rate of the SPM is 9600bps. However if the default baud rate of the SPM is changed then the baud rate of the HyperTerminal should be matched or DEFAULT jumper should be connected to force the SPM baud rate to 9600bps.
4.0 Extended SpacePort Features

4.1 Throughput

The SPM supports two rates, \textit{MAX} and \textit{SLOTS}, of over-air throughput. A third rate is also provided which can be used during normal operation, but is specifically supplied for compliance with FCC regulations.

\textbf{MAX:} When set to \textit{MAX}imum and streaming data at the SPM, the data is sent as quick as possible. For host baud rates of 19200 and above, data is transmitted continuously with minimal delay between sequential packets. When this occurs, there is effectively no airtime for another pair, operating in close proximity, to transmit without causing collisions. The maximum over-air throughput that can be achieved is 14400bps.

\textbf{SLOTS:} Setting the throughput to \textit{SLOTS} provides a method of opening ‘time slots’ for other SPM pairs operating in close proximity. The effective streaming on-air throughput between a pair of SPM is effectively reduced to approximately 2400bps.

\textbf{FCC:} This setting is effectively the same as \textit{SLOTS}, however it further slows the over-air throughput to approximately 1200bps. This mode is provided to enforce the modem to comply with FCC regulations of 10% maximum airtime usage. The \textit{THRUPUT} should be set to \textit{FCC} for all SPM modules used in all equipment subject to FCC regulations.
4.2 REMOTE CONFIGURATION

Remote configuration of a SPM module is possible using the REMOTE command from within the configurator. The remote SPM unit should be on or in auto-standby mode.

Initially the REMOTE command is used to enable and disable the ability to remotely configure a module, as described in section 3.2: User Configurable Command.

Once remote configuration is enabled the REMOTE command is then used to issue configuration commands to a remote SPM. The format for the remote command then becomes:

\textit{REMOTE <SERIAL NUM> <COMMAND> <PARAMTER>}

The \textit{<SERIAL NUMBER>} of the remote SPM must be known in order for the remote configuration request to be executed on the appropriate SPM module.

The \textit{<COMMAND>} to be executed can be any of the following:

- Baud 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200
- Unit 0 to 15
- Site 0 to 7
- Shdn on/off
- Flow hw/none
- Serdly 2 to 255
- Retry 1 to 63
- Strtmsg on/off

The \textit{<PARAMETER>} is optional, and if not specified the setting for that command is returned and displayed.

4.3 POINT-TO-MULTIPOINT

The \textit{SPM} can be used for point-to-multipoint communications. One module must be considered to be the master, which is used to address up to 15 remote units in any one site.

During normal operation, the base unit can be set to address another unit dynamically by entering the configurator and using the ADDR command to change the unit address. Upon execution of this command, provided the parameters are correct, the configurator is exited immediately. A period (‘.’) is sent to the connected host device to indicate that the change has been registered and the SPM is now ready for communications to the new unit address.

ADDR is very similar to the Unit command, except that ADDR does not update the stored EEPROM unit value. As the EEPROM has a limited number of write cycles, using ADDR for addressing multiple units in a point to multipoint network is recommended. Also, the ADDR command will exit the configurator immediately, which is required to resume communications very quickly.

4.4 BROADCAST MULTIDROP

The SPM has a broadcast mutidrop mode which provides a mechanism for building a large networks. This mode of operation is determined by the configuration command keyword \textit{ACKMODE} being set to \textit{OFF}.

In broadcast multidrop mode, the SPM does not implement network layer functionality related to data packet routing, acknowledgement and retries. The connected host device should provide network layer functionality.

The site code and unit address is still used by the radio modem when working in broadcast multidrop mode. For a given multipoint network all radio modems within a group must contain the same site code and unit address.
4.5 Radar: Diagnostic Test

Built into the configurator is a diagnostic test suitable for range testing and link confidence testing. The Radar test effectively sends a small request packet to a remote unit then waits for a reply. The remote unit must not be in the configurator otherwise it will not respond.

Upon receipt of a positive response from the remote unit, a success is recorded before the process is repeated. This test will continue indefinitely until it is ended by a key press.

4.6 SpacePort Modem Error Handling

The SPM's radio decoder module is deliberately non bit error tolerant, i.e. no attempt is made to repair corrupt data bits. All of the redundancy in the code is directed towards error checking. For an FM radio link using short packet lengths, packets are either 100% or so grossly corrupt as to be unrecoverable. By the same reasoning, the Host is not informed or sent corrupt data since corrupt information is of little value. The SPM implements packet acknowledges, timeouts and re-transmission to accomplish reliable error handling.

Ordering information

<table>
<thead>
<tr>
<th>Part number</th>
<th>Throughput</th>
<th>Sensitivity</th>
<th>Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPM2-433-18</td>
<td>18kbps</td>
<td>-95dBm</td>
<td>5V</td>
</tr>
<tr>
<td>SPM2-433-18-3V</td>
<td>18kbps</td>
<td>-90dBm</td>
<td>3.3V</td>
</tr>
<tr>
<td>SPM2-433-28</td>
<td>30kbps</td>
<td>-90dBm</td>
<td>5V</td>
</tr>
</tbody>
</table>
Figure 7: Example circuit to make radio modem with DCE type RS232 interface
Appendix B

### Fast Radio Packet Controller (FRPC)
Package type: 18-Lead Plastic Surface Mount
(SOIC - 300mil wide body)

<table>
<thead>
<tr>
<th></th>
<th>TXD</th>
<th>RXD</th>
<th>SIGNAL</th>
<th>RESET</th>
<th>Vss (0V)</th>
<th>TXR</th>
<th>RXR</th>
<th>TXA</th>
<th>RXA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 8**

### Radio Packet Modem (RPM)
Package type: 28-Lead Plastic Surface Mount
(SOIC - 300mm wide body)

<table>
<thead>
<tr>
<th></th>
<th>RESET</th>
<th>D0</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>NC</th>
<th>NC</th>
<th>Vss</th>
<th>OSC1</th>
<th>OSC2</th>
<th>NC</th>
<th>NC</th>
<th>NC</th>
<th>WAKE/DTR</th>
<th>TXD</th>
<th>RXD</th>
<th>CTS</th>
<th>DEFAULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>2</td>
<td>27</td>
<td>26</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>3</td>
<td>24</td>
<td>23</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>4</td>
<td>21</td>
<td>20</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>5</td>
<td>18</td>
<td>17</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>6</td>
<td>15</td>
<td>14</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>7</td>
<td>14</td>
<td>13</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 9**
Copyright notice

This product data sheet is the original work and copyrighted property of Radiometrix Ltd. Reproduction in whole or in part must give clear acknowledgement to the copyright owner.

Limitation of liability

The information furnished by Radiometrix Ltd is believed to be accurate and reliable. Radiometrix Ltd reserves the right to make changes or improvements in the design, specification or manufacture of its subassembly products without notice. Radiometrix Ltd does not assume any liability arising from the application or use of any product or circuit described herein, nor for any infringements of patents or other rights of third parties which may result from the use of its products. This data sheet neither states nor implies warranty of any kind, including fitness for any particular application. These radio devices may be subject to radio interference and may not function as intended if interference is present. We do NOT recommend their use for life critical applications. The Intrastat commodity code for all our modules is: 8542 6000.

R&TTE Directive

After 7 April 2001 the manufacturer can only place finished product on the market under the provisions of the R&TTE Directive. Equipment within the scope of the R&TTE Directive may demonstrate compliance to the essential requirements specified in Article 3 of the Directive, as appropriate to the particular equipment.
Further details are available on The Office of Communications (Ofcom) web site: http://www.ofcom.org.uk/licensing_numbering/radiocomms/licensing/licensing_policy_manual/

Information Requests
Ofcom
Riverside House
2a Southwark Bridge Road
London SE1 9HA
Tel: +44 (0)845 456 3000 or 020 7981 3040
Fax: +44 (0)20 7783 4033
information.requests@ofcom.org.uk

European Radiocommunications Office (ERO)
Peblingehus
Nansensgade 19
DK 1366 Copenhagen
Tel. +45 33896300
Fax +45 33896330
ero@ero.dk
www.ero.dk