Smart LoRa Module

Features
- Range up to 16Km
- 8 Switch inputs
- 8 Digital outputs
- 4 acknowledged channels
- Spread spectrum technology
- No external components
- Low Rate Serial Comms
- 38.4K Host serial data comms
- Low voltage 1.8—3.6V
- ‘R’ Version 3.6—12V
- 869.5 / 915MHz Versions
- +20dBm TX / -137dBm RX
- 868MHz CE / 915Mhz FCC compliant

Applications
- Remote Control
- Remote Networking
- Remote Switching
- Remote Sensors

GAMMA LoRA provides a reliable, transceiver based industrial remote control for use as a bi-directional switch. It can also send low speed Serial Data (250byte payload). LoRa provides a long Range, low Data rate, suited to remote Sensors transmitting occasional Data packets. GAMMA is easy to use with direct no-volt Switch input and direct Switching Telemetry outputs and simple serial Data in / Data out. The GAMMA uses the latest OFDM, spread spectrum technology and extensive algorithm enhancements to achieve an industry leading 16km (10mile) range.
Part Numbering 1.8 - 3.6V Version

<table>
<thead>
<tr>
<th>Part No</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAMMA-868-SO</td>
<td>RF Telemetry module SMT package 868MHz</td>
</tr>
<tr>
<td>GAMMA-868</td>
<td>RF Telemetry module SIL package 868MHz</td>
</tr>
<tr>
<td>GAMMA-915</td>
<td>RF Telemetry module SIL package 915MHz</td>
</tr>
<tr>
<td>GAMMA-915-SO</td>
<td>RF Telemetry module SMT package 915MHz</td>
</tr>
</tbody>
</table>

Part Numbering 3.6 - 12V Version

<table>
<thead>
<tr>
<th>Part No</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAMMA-868R-SO</td>
<td>RF Telemetry module SMT package 868MHz</td>
</tr>
<tr>
<td>GAMMA-868R</td>
<td>RF Telemetry module SIL package 868MHz</td>
</tr>
<tr>
<td>GAMMA-915R</td>
<td>RF Telemetry module SIL package 915MHz</td>
</tr>
<tr>
<td>GAMMA-915R-SO</td>
<td>RF Telemetry module SMT package 915MHz</td>
</tr>
</tbody>
</table>

Pin descriptions

Notes
Pins are on 2.54mm pitch
Pin dims 0.4mm sq

Notes
SMT and SIL versions are hardware identical modules with or without pins and SMA fitted.
Castellations are on 2.54mm pitch. Use all castellations to assist reflow.
<table>
<thead>
<tr>
<th>Pin No</th>
<th>Name</th>
<th>Direction</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NC</td>
<td>-</td>
<td>Do not connect</td>
</tr>
<tr>
<td>2, 15, 24*</td>
<td>GND</td>
<td>In</td>
<td>Connect to ground (*SMT version only)</td>
</tr>
</tbody>
</table>
| 3, 4, 7, 8, 9, 11-13 | I/O 1-8   | -         | When configured as transmitter: Pins 3, 4, 7, 8, 9, 11, 12, 13  
Inputs are internally pulled high, active low  
When configured as receiver:  
Pins: 3, 4, 7, 8, 9, 11, 12, 13  
All outputs are internally pulled low, active high  
Maximum drive current per output 12.5mA (100mA total).  
Where configured as a transceiver:  
Pins: 3, 4, 7, 8 outputs and pins 9, 11-13 inputs  
Inputs and outputs act as above. |
|       | Or OP1-4 and IP1-4 |   |                                                                               |
| 11, 12 | CTS RTS       | In / Out  | RS232 flow control: Disabled as default.  
When enabled via config mode the function of these pins are as low level RS232 standard  
See RF Solutions Application Note: AN-2015-101 |
| 5     | LRN SW        | In        | Internally pulled high, active low learn switch input.  
Connect to ground to activate.  
Operation directly matches the on board learn switch.  
Leave unconnected if not required. |
| 6     | LRN LED       | Out       | Optional LED drive output which mirrors the on-board LED.  
See example LED drive circuit on page 5. |
| 10, 14 | OPT1, OPT2    | In        | Option links for module type setting - see tables on page 3 for details.     |
| 18, 17 | Serial TX RX  | In / Out  | Serial data comms for using GAMMA as a radio modem via low level RS232     |
| 16, 23* | Vcc          | In        | Supply voltage (*SMT version only)                                          |
**Mode selection**

Using the OPT option links, a GAMMA module can be configured to be a
- Telemetry Transmitter, Receiver or Transceiver.
- Serial Data Modem

For telemetry operation, two or more GAMMA modules are required to be paired together. The outputs on the GAMMA receiving will then follow the inputs on the GAMMA transmitting.

Serial data communication does not require any pairing.

<table>
<thead>
<tr>
<th>Mode</th>
<th>OPT1 (pin10)</th>
<th>OPT2 (pin14)</th>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmitter mode</td>
<td>NC</td>
<td>NC</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>Operates as a transmitter. All I/O lines are dedicated as digital inputs (open/closed contact switch) and will map directly to all 8 outputs on paired receiver(s).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receiver mode</td>
<td>NC</td>
<td>GND</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>Operates as a receiver with digital switching outputs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telemetry transceiver</td>
<td>GND</td>
<td>NC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Operates as a transceiver with digital switching inputs and outputs on the same board.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial MODEM Mode</td>
<td>NC</td>
<td>GND</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Operates as a serial modem sending and receiving serial data.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Telemetry Transmitter and Receiver modes**

One or more GAMMA module(s) set to ‘transmitter mode’, paired with one or more ‘receivers’ set to ‘receiver mode’. When paired, all I/O lines are mapped directly. Multiple GAMMA modules may be paired together to create many to many relationships.

**Telemetry Transceiver mode**

Each GAMMA configures I/O 1-4 as outputs and 5-8 as inputs allowing paired modules to send in both directions. Multiple GAMMA modules may be paired together to create many to many relationships.

**Serial output operation (in Telemetry RX Mode)**

In addition to updating the digital outputs status, when in Rx Telemetry Mode the GAMMA RX automatically outputs a serial data packet each time it receives a telemetry command from a paired GAMMA TX.

This enables connection of the GAMMA to computers / PLC or other host controllers.

The data packet contains data from the GAMMA TX including GAMMA TX serial number and the GAMMA TX Inputs’ status.

Please see the Serial data section which explains the packet structure.

**Serial output operation (in Telemetry RX Mode)**

The GAMMA module has the ability to operate as a simple radio modem module, sending and receiving data.

Further information later in this datasheet.
Telemetry mode - Transmit (TX)

GAMMA module configured as a transmitter

Operation:
When configured as a transmitter the GAMMA module will automatically default to low power sleep mode. A change on any input(s) will cause the GAMMA to wake, read all inputs and initiate RF transmission, (multiple input changes may take place simultaneously). Maximum switching frequency is dependent on the LORA™ mode in which the GAMMA is operating see Configuring a GAMMA module modem for more information on LORA™ modes.

Digital inputs:
High impedance inputs, LVCMOS/LVTTL compatible, 5V tolerant. Can be connected directly to CMOS/TTL logic or switch inputs connected to OV or VCC.

Transmitter application circuit example

Description:
This example shows a GAMMA module configured as a transmitter with all 8 inputs connected. All input switches would need to be connected to GND to activate.

Application example:
Example showing 1 transmitter paired to 3 receivers - I/O used is arbitrary.
Telemetry Mode - Receive (RX)
GAMMA module configured as a receiver

Operation:
When configured as a receiver the GAMMA module will remain in a low power listening mode. When a valid packet is received it will wake and action any output changes required.

Digital outputs:
Active high LVCMOS/LVTTL compatible outputs. Can be connected directly to CMOS/TTL logic or drive.

Receiver example application circuit

Description:
This example shows a GAMMA module configured as a receiver with all 8 outputs connected. The external learn switch and LED are also not fitted in this example.

Application example:
Example showing 4 transmitters paired to one single receiver - I/O used is arbitrary.
Telemetry Mode - **Transceiver (TRX)**

**GAMMA module configured as a transceiver**

**Operation:**
When configured as a transceiver the GAMMA module maps its I/O lines 1-4 as outputs and 5-8 as inputs (as shown below). Pairing GAMMA modules in this mode auto-maps the 4 inputs and outputs to each module. It is possible to pair systems of modules by following this format - see application examples below for more detail.

**Digital I/O:**
High impedance inputs, LVCMOS/LVTTL compatible, 5V tolerant. Can be connected directly to CMOS/TTL logic or switch inputs connected to 0V or VCC.

Outputs are active high LVCMOS/LVTTL compatible and can be connected directly to CMOS/TTL logic or drive. A change on the input will cause the GAMMA to wake, read all inputs and initiate RF transmission.

**Feedback:**
Whilst the module does not offer a feedback function it is possible to achieve this by pairing two modules together and feeding outputs back to inputs as shown in the example below.

**Transceiver application circuit example**

![Transceiver Circuit Diagram]

**Description:**
The example above shows a GAMMA module with 4 connected inputs and 4 connected outputs. Pairing modules in transceiver mode auto-maps all inputs on the remote devices to all outputs on the local device. In this way it is possible to connect modules in a chain or bi-directionally as in the below example.

**Application example:**
The below example shows two GAMMA modules paired in both directions.

![Application Example Diagram]

**Please note:**
GAMMA digital Outputs are active high, but GAMMA digital inputs are active low therefore if connecting multiple GAMMA modules directly together to extend range the outputs will require inverting before applying to GAMMA inputs.
Pairing GAMMA modules
Each GAMMA module has a unique serial number identity. GAMMA modules may be paired together using the LEARN button/input so that they operate as systems in: one-to-one, one-to-many and many-to-one formats.
Each GAMMA can store 70 GAMMA paired identities.
Pairing is applicable in all modes except serial data mode.

Pairing Process, pair one module into another:
1. Press and hold the ‘LEARN’ button (or activate the ‘LEARN’ input) on a GAMMA module (Receiver module ‘RX’) for two seconds or until the learn LED begins to flash. This places the module in pairing mode.
2. On another GAMMA module (Transmitter module ‘TX’) briefly press/activate the ‘LEARN’ button (this sends a pairing packet to the RX).
3. GAMMA RX, has now paired with the GAMMA TX.
4. Briefly press the ‘LEARN’ button to exit the mode on RX.
Note: This process must be repeated in reverse for a telemetry system using transceiver mode.

Erase Process:
1. Press and hold the ‘LEARN’ button until LED stops flashing.
2. On release of LEARN switch, LED flashes at high speed several times to confirm Erase Complete

LED Status Indication

<table>
<thead>
<tr>
<th>Mode</th>
<th>LED</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal operation</td>
<td>Flashes ON</td>
<td>Module is transmitting or receiving data</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>No RF data is being transmitted/received</td>
</tr>
<tr>
<td>Configuration/ LEARN mode</td>
<td>Brief flash</td>
<td>Learn packing being sent</td>
</tr>
<tr>
<td></td>
<td>Flashing at low speed</td>
<td>GAMMA module is in learn mode and searching for another module to pair with.</td>
</tr>
<tr>
<td></td>
<td>Flashing at high speed for 2 secs</td>
<td>GAMMA pairing successful or erase successful</td>
</tr>
</tbody>
</table>

Optional external learn switch and LED example circuit
GAMMA Module

GAMMA module Transceiver mode with feedback example

GAMMA RX WITH FEED BACK

GAMMA TX WITH ACKNOWLEDGE
GAMMA module - Serial data modem operation

GAMMA module can send and receive serial data at LVTTL level. However please note that due to the low RF Data Rate LORA can only send Data at a very low transmission rate

Operation:
The GAMMA module has the ability to operate as a simple radio modem module, sending and receiving data from point-to-point or multi-point. A GAMMA module will send data presented to the TX pin.
All GAMMA modules within range will output the data via their RX pins.
Whilst the GAMMA will work as a modem, out-of-the-box (see default settings in below) it is also possible to configure more complex operation by changing parameters of operation using configuration mode.
Note that if a GAMMA Module is paired with another module, when an RF command is received to update the digital outputs. The GAMMA module will also output a serial data string showing output status

Serial data packet (output after every packet received)

<table>
<thead>
<tr>
<th>Byte 0</th>
<th>Byte 1</th>
<th>Byte 2</th>
<th>Byte 3</th>
<th>Byte 4</th>
<th>Byte 5</th>
<th>Byte 6</th>
<th>Byte 7</th>
<th>Byte 8</th>
<th>Byte 9</th>
<th>Byte 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
<td>SN1</td>
<td>SN2</td>
<td>SN3</td>
<td>IP1-8</td>
<td>IP9-16</td>
<td>SPARE</td>
<td>SPARE</td>
<td>STATUS</td>
<td>PKT ID</td>
<td>RSSI</td>
</tr>
<tr>
<td>Serial number byte 1</td>
<td>Serial number byte 2</td>
<td>Serial number byte 3</td>
<td>Bit mapped IP1 to LSB</td>
<td>Bit mapped IP9 to LSB</td>
<td>Bit mapped IP16 to MSB</td>
<td>Changing pseudo random number to identify each packet.</td>
<td>-139 + RSSI Value received = dBm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Serial data output application circuit example
USB application circuit example - FT232 chipset

USB Application Circuit Example

U1
FT232FQ_QFN
QFP
GAMMA Module

Configuring a GAMMA module modem:
In Serial Data modem mode the GAMMA module is a transparent link, passing serial data received on the TX pin to all other GAMMA modules which in turn send the data received to their connected host via the receive pin.
In order to change the configuration settings the GAMMA module must be placed into config/Learn Mode.
Data is then processed internally by the module instead of being transmitted via RF.

Config/learn mode
Press and hold the 'LEARN' button (or activate the 'LEARN' input) on a GAMMA module for two seconds or until the learn LED begins to flash. This places the module in config mode.

Please Note: When in Config/learn mode modules will always communicate at a default baud rate of 9600kbps it does not matter what baud rate is set with #B command.

Default LVTTL Comms RS232:
Data bits: 8
Parity: None
Stop bits: 1
Flow control: Hardware CTS/RTS if enabled
Buffer size: 250bytes
Timeout: 2 bytes (time dependent on baud rate)
Data bytes: 11 bytes

GAMMA module factory defaults:
Local address: 7F7F7F
Destination address: 7F7F7F
Handshaking: OFF
LoRa™ Mode: 5
Host baud rate: 9600kbps
O/P power: +20dBm

Configuration commands:

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
<th>Options / example packet</th>
</tr>
</thead>
</table>
| #C      | Set LORA™ mode and power output | #C<LORA MODE 1:6 (SF6:12)><O/P POWER 1:5(1 - +20dBm)>
|         | GAMMA can be set to operate in different LORA™ modes, trading off range with speed of operation. | Where:
|         | With a lower LORA mode the data packet is much shorter but the maximum range achievable is also shorter. | SF6 = Short range / high speed
|         | In mode 6 the GAMMA has been tested to 16km | SF12 = Long range / low speed
|         | | Power 1 = +5dBm
|         | | Power 15 = +20dBm
|         | Output power is set in 1dbm increments from +5 to +20. | ASCII example: #C 006 015
|         | GAMMA set to longest range and max. power. | Please Note: all option values are byte decimal values.

<table>
<thead>
<tr>
<th>LORA MODE</th>
<th>Packet length</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>55ms</td>
</tr>
<tr>
<td>002</td>
<td>90ms</td>
</tr>
<tr>
<td>003</td>
<td>180ms</td>
</tr>
<tr>
<td>004</td>
<td>360ms</td>
</tr>
<tr>
<td>005</td>
<td>720ms</td>
</tr>
<tr>
<td>006</td>
<td>1.02 sec</td>
</tr>
</tbody>
</table>
### Configuration commands continued:

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
<th>Options / example packet</th>
</tr>
</thead>
<tbody>
<tr>
<td>#A</td>
<td>Sets the send to and local address: Pre-configured factory defaults: L_ADD = 7F7F7F D_ADD = 7F7F7F</td>
<td>#A&lt;L_ADD1&gt;&lt;L_ADD2&gt;&lt;L_ADD3&gt;&lt;D_ADD1&gt;&lt;D_ADD2&gt;&lt;D_ADD3&gt; Where: L_ADD are local address bytes 1-3 D_ADD destination address bytes 1-3 Example: #A 125 125 126 126 126 Sets the Local address to 125 125 125 Sets the Destination address to 126 126 126 Please note the Address must be sent as byte values. Example:</td>
</tr>
<tr>
<td>#H</td>
<td>Turn on handshaking CTS / RTS enable or disable command</td>
<td>#H 001 Enables handshaking - set 0 to disable</td>
</tr>
<tr>
<td>#B</td>
<td>Set serial baud rate</td>
<td>#B &lt;000-004&gt; Where: 000 = 9600 (default) 001 = 19200 002 = 28800 003 = 38400 004 = 56000 Example: Set the Baud to 38K4: #B 003</td>
</tr>
<tr>
<td>#?</td>
<td>Get local settings Returns all configured settings</td>
<td>#? Returns a single packet containing 11 bytes as follows: &lt;L_ADD1&gt;&lt;L_ADD2&gt;&lt;L_ADD3&gt; &lt;D_ADD1&gt;&lt;D_ADD2&gt;&lt;D_ADD3&gt; &lt;NULL Value&gt; &lt;LORA Mode&gt; &lt;RF Power&gt; &lt;Handshaking&gt; &lt;Baud rate&gt;</td>
</tr>
<tr>
<td>#Q</td>
<td>Reset device</td>
<td>All changes on the GAMMA are carried out in real time and saved after each change. However none become active until the module is reset either using this command or by power cycling</td>
</tr>
</tbody>
</table>
GAMMA Module

Mechanical Dimensions

Range Considerations

The antenna choice and position directly affects the system range, keep it clear of any large metal parts. The best position is protruding vertically from the top of the product. This is often not desirable for practical reasons and thus a compromise may be needed. Note that the space around the antenna is as important as the antenna itself, all radio systems are dependent on a radio signal being received through airspace.

The range quoted is the optimal in direct line of sight, without obstacles and in good atmospheric conditions.

Range is affected by many things, for example local environmental conditions, atmospheric conditions, interference from other radio transmitters. For evaluating the local environment please see our RF meter (DS006)

Self Test / Walk Test mode

The GAMMA module incorporates a self test which is initiated by applying power with the learn button being held down.

With the Option Link set to TRANSMITTER Mode
1. The GAMMA module will beacon out a PING signal (on board LED indicates a Transmit)
2. If a GAMMA Receiver receives this signal it will acknowledge. The on board LED indicates acknowledge with a short LED illumination
3. A reset will be required to exit.

With the Option Link set to RECEIVER Mode
1. The GAMMA module Enters RSSI (Received Signal Strength Indicator) mode where outputs 1-8 are activated as a bar graph type output according to the strength of a valid RF signal received from any carrier.
2. A reset will be required to exit.
GAMMA Module

Technical Specifications
Absolute Maximums:
Temperature range: Storage: -50 to +125°C. Operating: -10 to +50°C (tested)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage Standard version</td>
<td>2.7</td>
<td>3.6</td>
<td>V</td>
</tr>
<tr>
<td>Supply voltage high Voltage version</td>
<td>3.6</td>
<td>14</td>
<td>V</td>
</tr>
<tr>
<td>Voltage on any input</td>
<td>-0.3</td>
<td>5.8</td>
<td>V</td>
</tr>
<tr>
<td>Max input power (through RX antenna)</td>
<td></td>
<td>+10</td>
<td>dBm</td>
</tr>
<tr>
<td>Max current sourced / sunk (Per I/O)</td>
<td>15</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>Max current sourced / sunk (Total)</td>
<td>100</td>
<td></td>
<td>mA</td>
</tr>
</tbody>
</table>

DC Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min</th>
<th>Typical</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>2.7</td>
<td>3.3V</td>
<td>3.6</td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-40</td>
<td>+85</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>
| GAMMA- TX supply current:
  When transmitting                              | 145  | 155     | mA   |       |
| Low Voltage version when sleeping              | 2    |         | μA   |       |
| High Voltage version when sleeping              | 90   |         | μA   |       |
| GAMMA- RX supply current:
  When receiving                                 | 19   | 20      | 23   | mA    |

AC Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min</th>
<th>Typical</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating frequency</td>
<td></td>
<td>869.5</td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>Operating frequency for 915MHz version</td>
<td></td>
<td>915.00</td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-40</td>
<td>+85</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>GAMMA- TX output power</td>
<td></td>
<td>+20</td>
<td>dBm</td>
<td></td>
</tr>
<tr>
<td>GAMMA- RX Sensitivity</td>
<td>-121</td>
<td>-137</td>
<td>dBm</td>
<td></td>
</tr>
</tbody>
</table>
RF meter

RF Multi Meter is a versatile handheld test meter that checks radio signal strength or interference in a given area. The Multi-Meter can both transmit and receive signals making it possible to test a location for suitability before installing equipment. The Multi-Meter is very hard wearing, long lasting and simple to use. It has 4 selectable frequencies, changeable at the touch of a button. It also has an auto shut off feature for battery saving.

RF Solutions Ltd. recycling notice

Meets the following EC Directives:
DO NOT Discard with normal waste, please recycle.
ROHS Directive 2002/95/EC
Specifies certain limits for hazardous substances.
WEEE Directive 2002/96/EC
Waste electrical & electronic equipment. This product must be disposed of through a licensed WEEE collection point. RF Solutions Ltd., fulfils its WEEE obligations by membership of an approved compliance scheme.

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