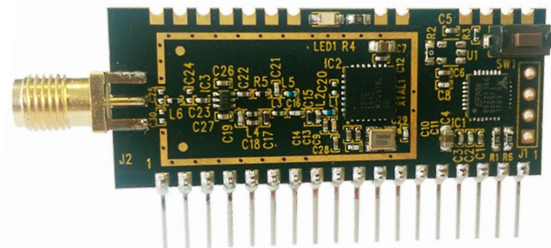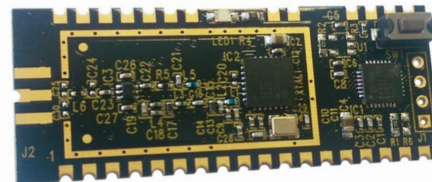# Smart LoRa Module

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—15V**

- **869.5 / 915MHz Versions**

- **+20dBm TX / -137dBm RX**

- **868MHz CE / 915Mhz FCC compliant**

- **SIL version with SMAF connector**

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

Part No	Description
GAMMA-868-SO	RF Telemetry module SMT package 868MHz
GAMMA-868	RF Telemetry module SIL package 868MHz
GAMMA-915	RF Telemetry module SIL package 915MHz
GAMMA-915-SO	RF Telemetry module SMT package 915MHz

Part Numbering 3.6 - 15V Version

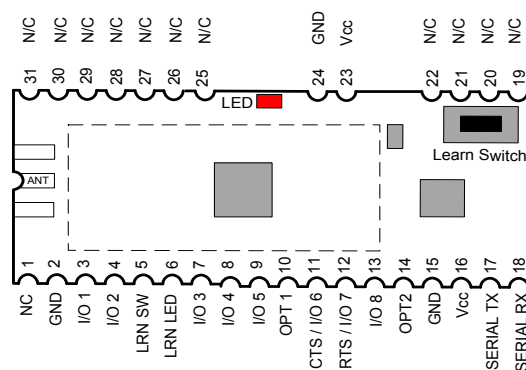| Part No	Description
GAMMA-868R-SO	RF Telemetry module SMT package 868MHz
GAMMA-868R	RF Telemetry module SIL package 868MHz
GAMMA-915R	RF Telemetry module SIL package 915MHz
GAMMA-915R-SO	RF Telemetry module SMT package 915MHz

Pin descriptions
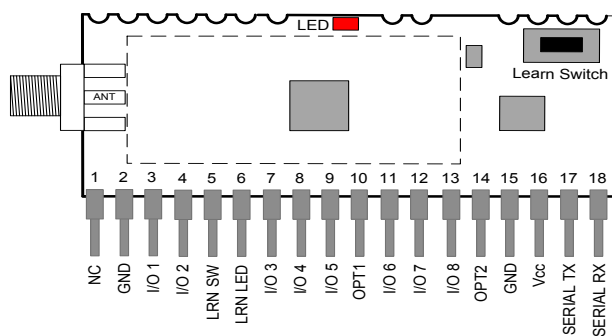
GAMMA-XXX (SIL version)

GAMMA-XXX-SO (SMT version)

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.

GAMMA Module

Pin No	Name	Direction	Description
1	NC	-	Do not connect
2, 15, 24*	GND	In	Connect to ground (*SMT version only)
3, 4, 7, 8, 9, 11- 13	I/O 1-8 Or OP1-4 and IP1-4	-	**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.
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 table later in the data sheet.
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,
- Seral 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.

	OPT1 (pin10)	OPT2 (pin14)	Inputs	Outputs
Transmitter mode 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).	NC	NC	8	-
Receiver mode Operates as a receiver with digital switching outputs.	NC	GND	-	8
Telemetry transceiver Operates as a transceiver with digital switching inputs and outputs on the same board.	GND	NC	4	4
Serial MODEM Mode Operates as a serial modem sending and receiving serial data.	NC	GND	-	-

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

GAMMA Module

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 0V or VCC.
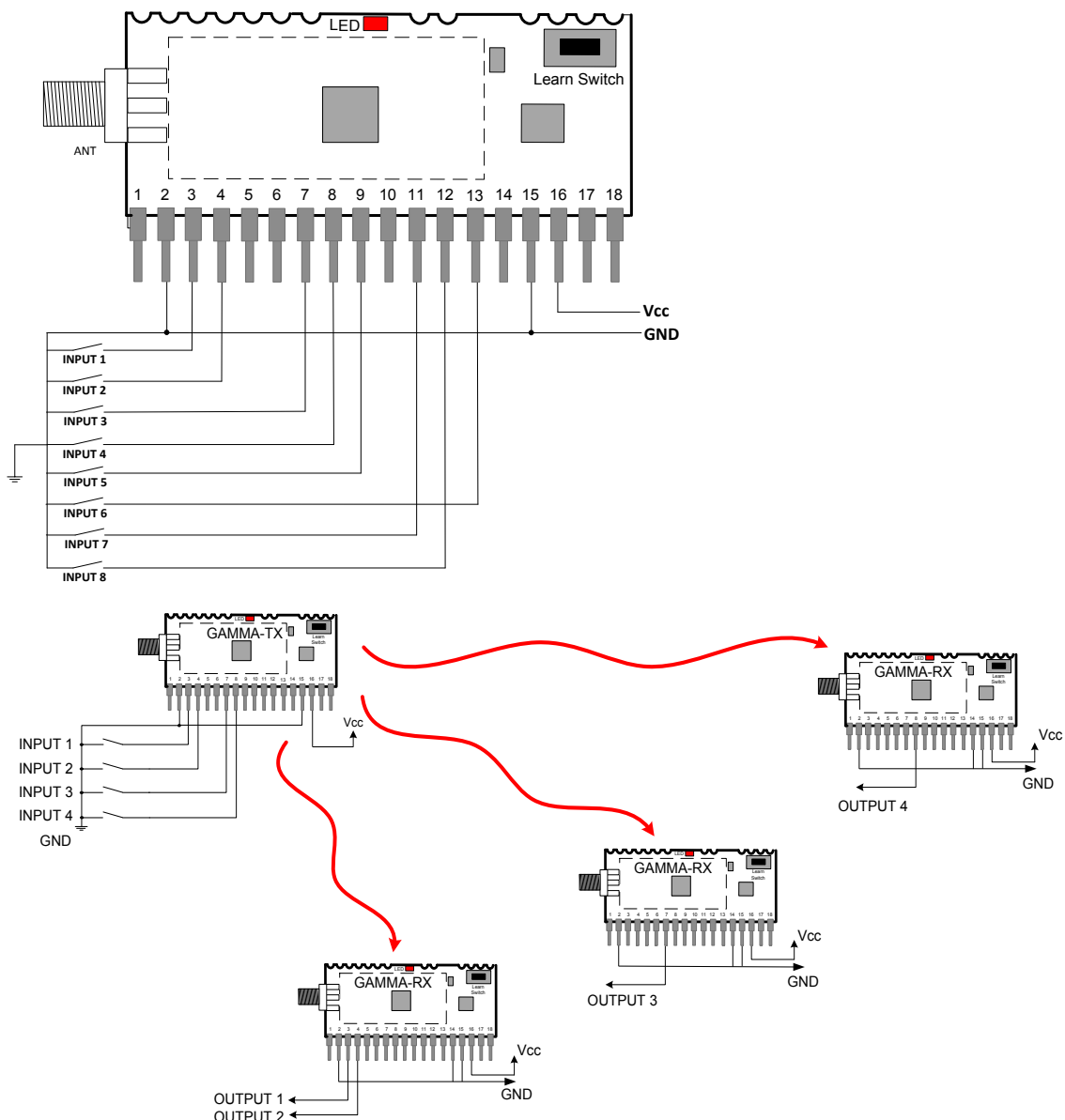
Transmitter application circuit example

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:

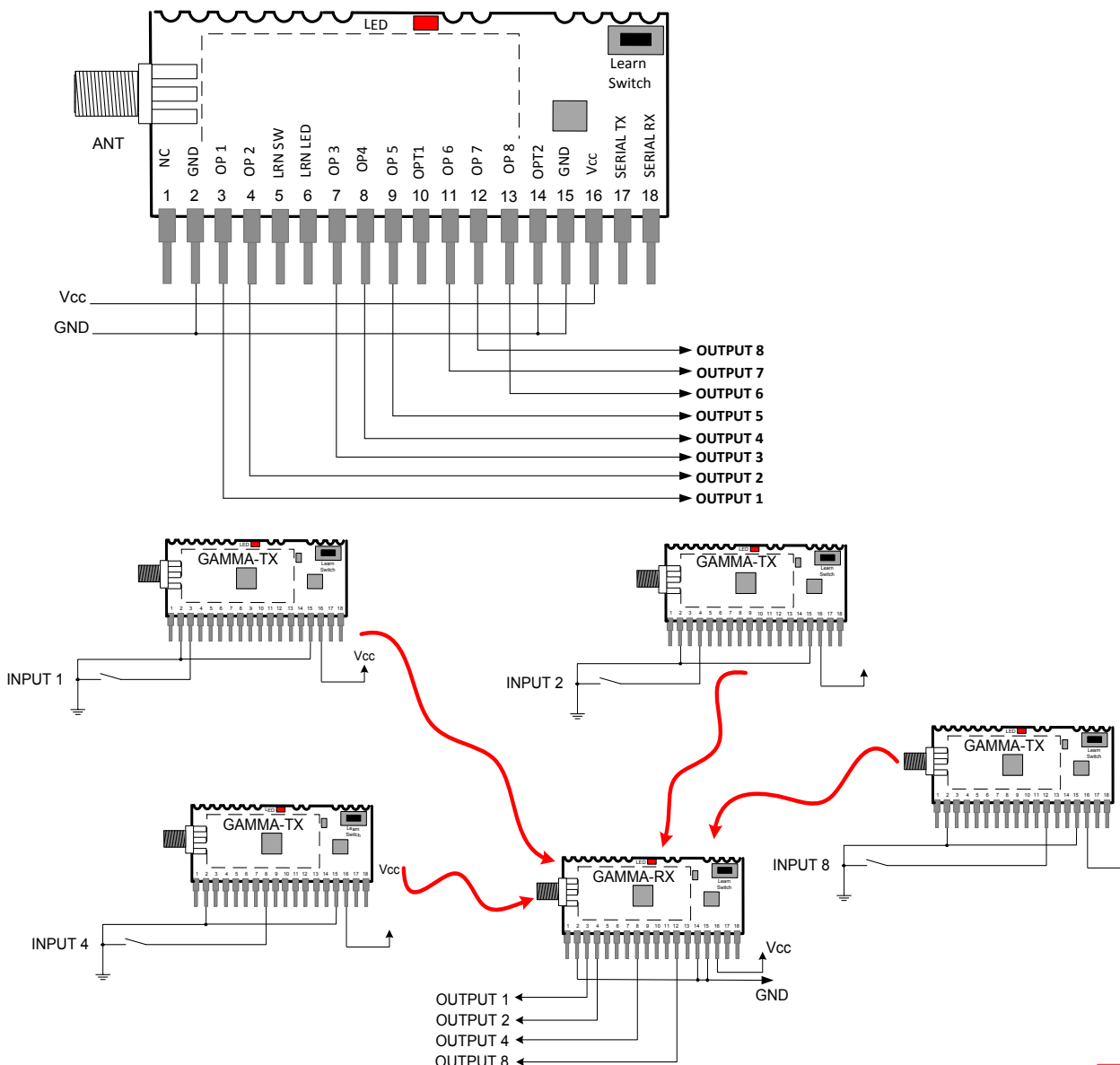Active high LVCMOS/LVTTL compatible outputs. Can be connected directly to CMOS/TTL logic or drive.

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.

GAMMA Module

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
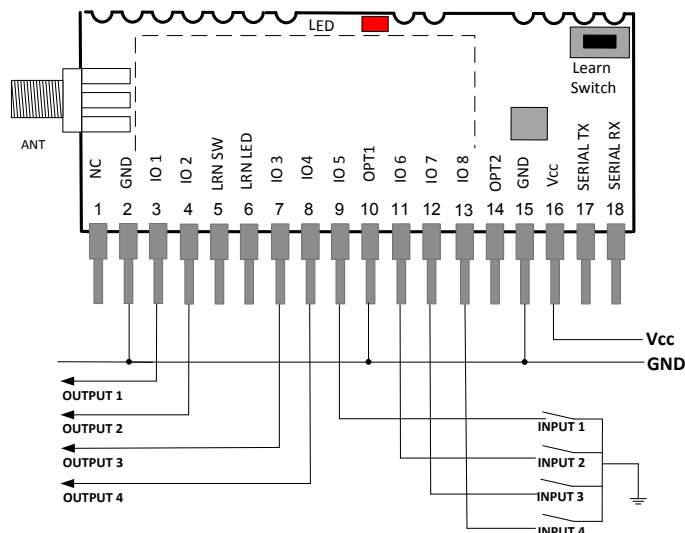
Description:

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.
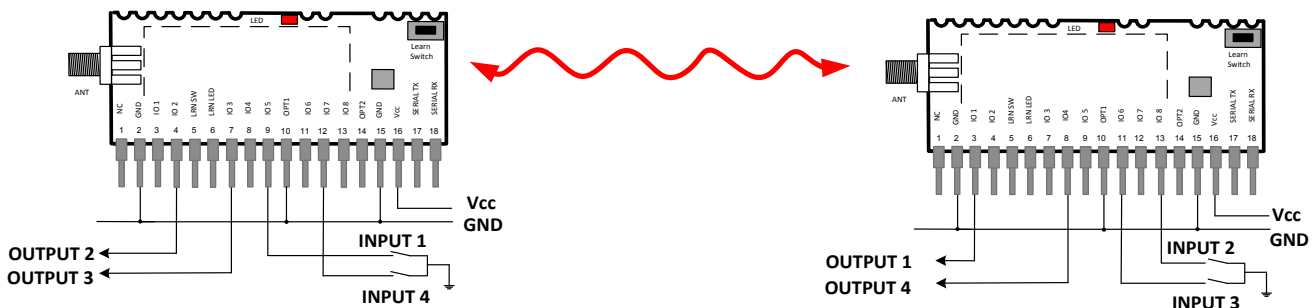
Please note:

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.

(If you wish to exit LEARN mode without pairing a transmitter, 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 (around 10secs).

2. On release of LEARN switch, LED flashes at high speed several times to confirm Erase Complete
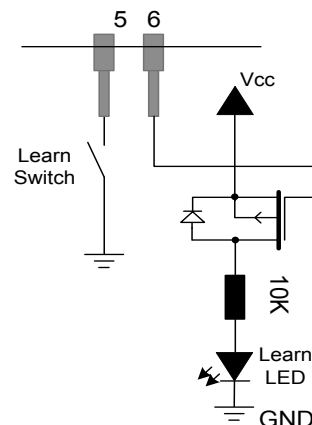
LED Status Indication

Mode	LED	Description
Normal operation	Flashes ON	Module is transmitting or receiving data
	OFF	No RF data is being transmitted/received
Configuration/ LEARN mode	Brief flash	Learn packing being sent
	Flashing at low speed	GAMMA module is in learn mode and searching for another module to pair with. Note: Learn mode does not time out
	Flashing at high speed for 2secs	GAMMA pairing successful or erase successful

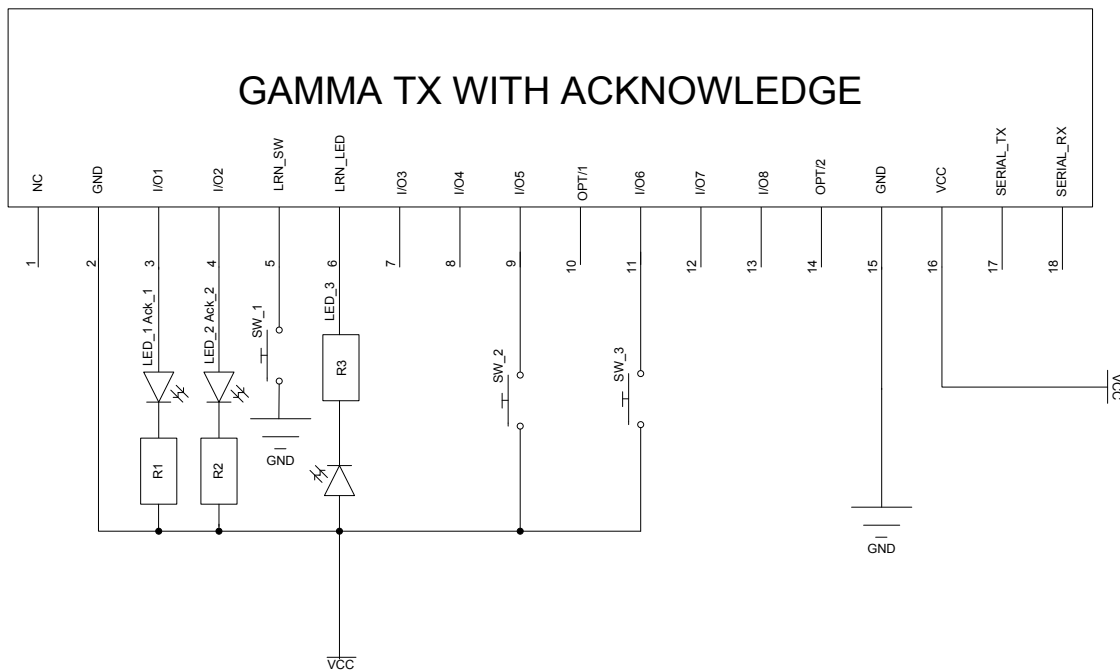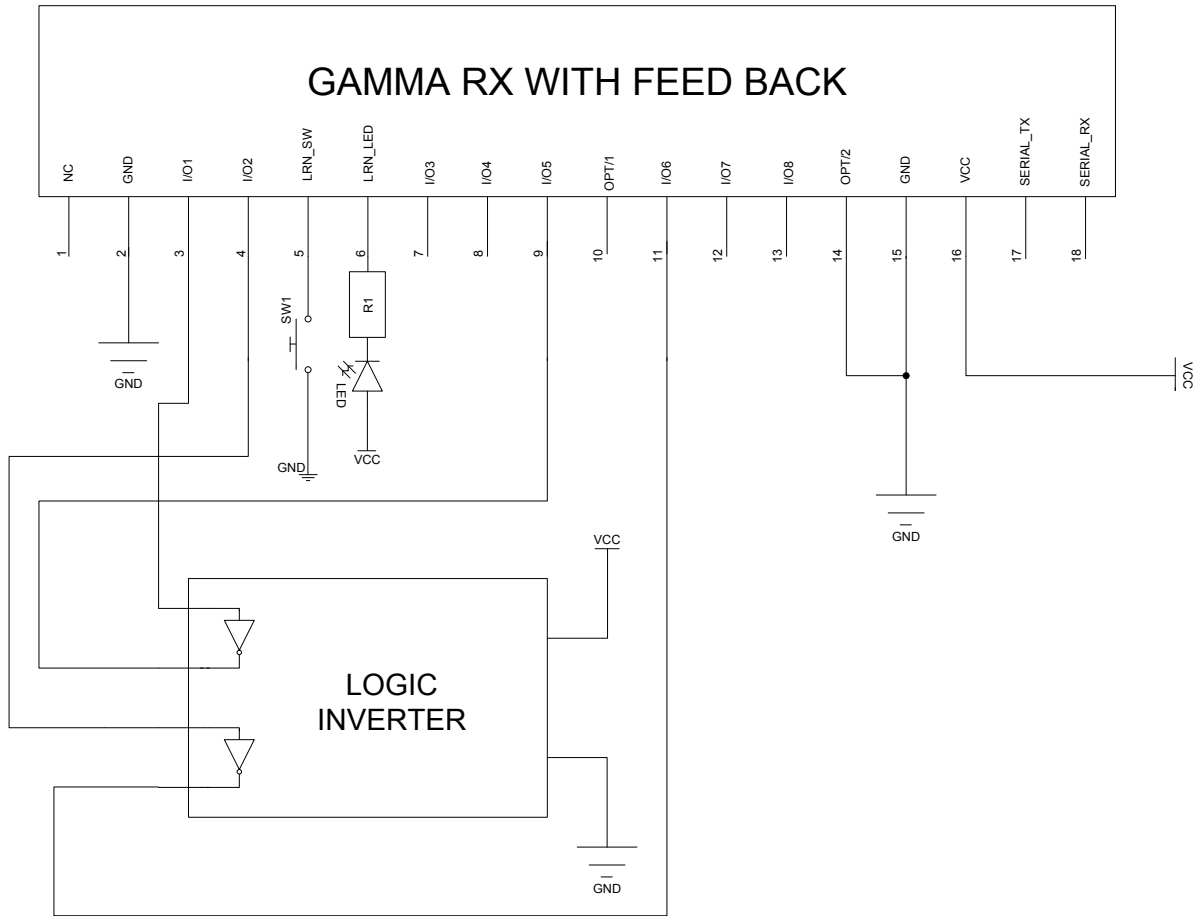## Optional external learn switch and LED example circuit
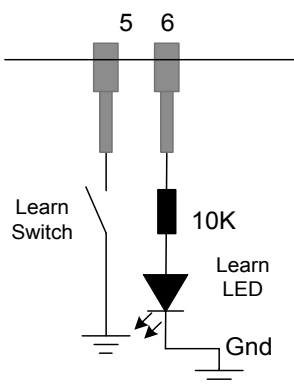
Standard Version

Regulated Version

GAMMA module Transceiver mode with feedback example

GAMMA RX WITH FEED BACK

Pin	Name
1	NC
2	GND
3	I/O1
4	I/O2
5	LRN_SW
6	LRN_LED
7	I/O3
8	I/O4
9	I/O5
10	OPT/1
11	I/O6
12	I/O7
13	I/O8
14	OPT/2
15	GND
16	VCC
17	SERIAL_TX
18	SERIAL_RX

LOGIC INVERTER

GAMMA TX WITH ACKNOWLEDGE

Pin	Name
1	NC
2	GND
3	I/O1
4	I/O2
5	LRN_SW
6	LRN_LED
7	I/O3
8	I/O4
9	I/O5
10	OPT/1
11	I/O6
12	I/O7
13	I/O8
14	OPT/2
15	GND
16	VCC
17	SERIAL_TX
18	SERIAL_RX

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.

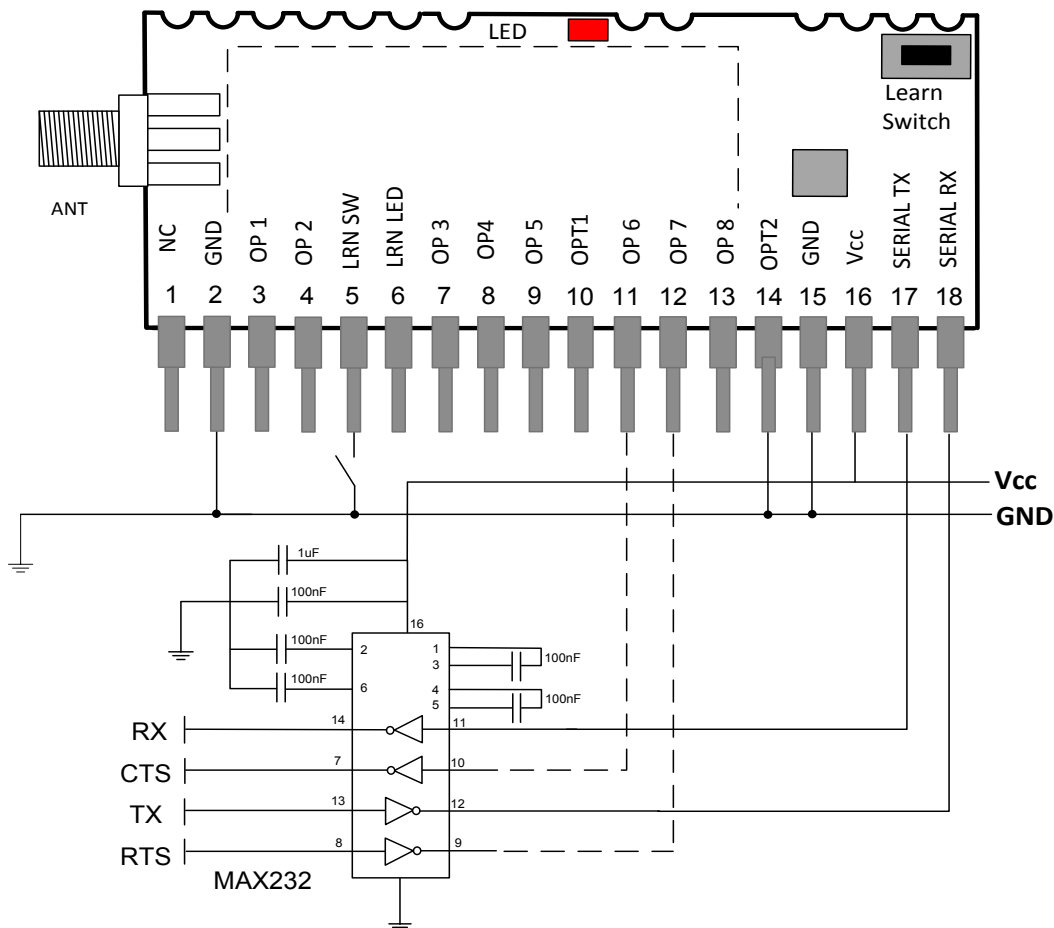All GAMMA modules within range; will output the data via their RX pins.

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
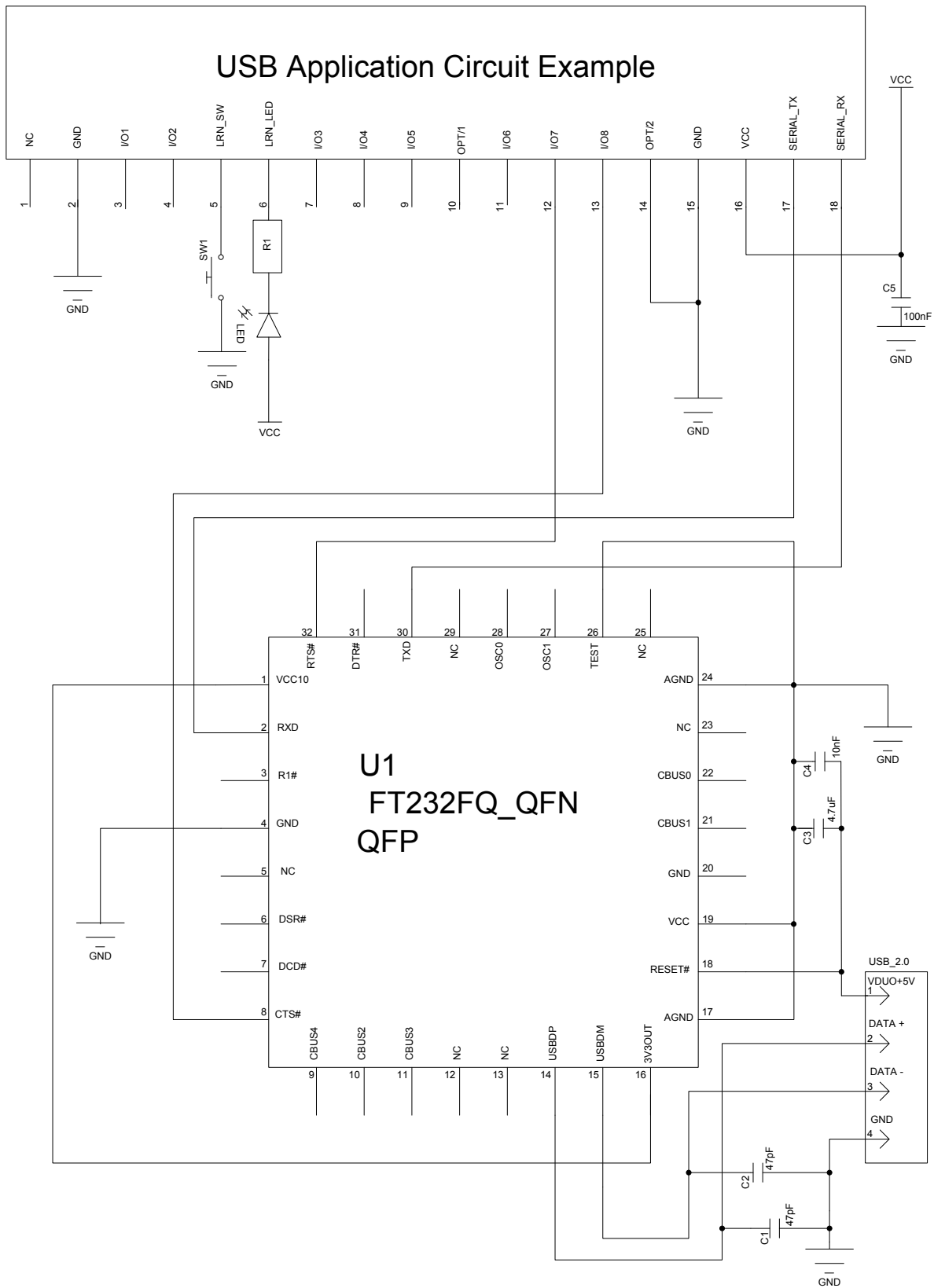
Serial data packet (output after every packet received)

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4 & 5	Byte 6	Byte 7	Byte 8 & 9	Byte 10	Byte 11	Byte 12	Byte 13
SN1	*SN2*	*SN3*	*SPARE*	*SPARE*	*IP1-8*	*IP9-16*	*SPARE*	*STATUS*	*PKT ID*	*RSSI*	*S-2-N*
Serial number byte 1	Serial number byte 2	Serial number byte 3	AA	00	Bit mapped IP1 to LSB IP8 to MSB	Bit mapped IP9 to LSB IP16 to MSB			Changing pseudo random number to identify each packet.	-139 + RSSI Value received = dBm	Signal to Noise ratio

Serial data output application circuit example

GAMMA Module

USB application circuit example - FT232 chipset

USB Application Circuit Example

Pin header (connector):

Pin	Signal
1	NC
2	GND
3	I/O1
4	I/O2
5	LRN_SW
6	LRN_LED
7	I/O3
8	I/O4
9	I/O5
10	OPT/1
11	I/O6
12	I/O7
13	I/O8
14	OPT/2
15	GND
16	VCC
17	SERIAL_TX
18	SERIAL_RX

VCC

C5 100nF — GND

SW1
R1
LED
GND
VCC

GND

U1
FT232FQ_QFN
QFP

Left pins:
1 VCC10
2 RXD
3 R1#
4 GND
5 NC
6 DSR#
7 DCD#
8 CTS#

Top pins:
32 RTS#
31 DTR#
30 TXD
29 NC
28 OSC0
27 OSC1
26 TEST
25 NC

Right pins:
24 AGND
23 NC
22 CBUS0
21 CBUS1
20 GND
19 VCC
18 RESET#
17 AGND

Bottom pins:
9 CBUS4
10 CBUS2
11 CBUS3
12 NC
13 NC
14 USBDP
15 USBDM
16 3V3OUT

C4 10nF
C3 4.7uF
GND

USB_2.0

Pin	Signal
1	VDUO+5V
2	DATA +
3	DATA -
4	GND

C2 47pF
C1 47pF
GND

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:

Command	Description	Options / example packet
#C	**Set LORA™ mode and power output** GAMMA can be set to operate in different LORA™ modes, trading off range with speed of operation. With a lower LORA mode the data packet is much shorter but the maximum range achievable is also shorter. In mode 6 the GAMMA has been tested to 16km	#C<LORA MODE 1-6 (SF7-12)><O/P POWER 0-15(-1 - +20dBm)> Where: SF7 = Short range / high speed SF12 = Long range / low speed Power 0 = +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><tr><td>LORA MODE</td><td>Packet length</td></tr><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></table>

Configuration commands continued:

Command	Description	Options / example packet
#A	Sets the send to and local address: Pre-configured factory defaults; L_ADD = 7F7F7F D_ADD= 7F7F7F	#A<L_ADD1><L_ADD2><L_ADD3><D_ADD1><D_ADD2><D_ADD3> Where: L_ADD are local address bytes 1 3 D_ADD destination address bytes 1-3 Example: #A 125 125 125 126 126 126 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: <table><tr><td>Command</td><td>#</td><td>A</td><td>7D</td><td>7D</td><td>7D</td><td>7E</td><td>7E</td><td>7E</td></tr><tr><td>ASCII Value</td><td>035</td><td>065</td><td>125</td><td>125</td><td>125</td><td>126</td><td>126</td><td>126</td></tr></table>
#H	Turn on handshaking CTS / RTS enable or disable command	#H 001 Enables handshaking - set 0 to disable

#B	Set serial baud rate	#B <000-004>
		Where: 000 = 9600(default)
		  001 = 19200
		  002 = 28800
		  003 = 38400
		  004= 56000
		
		Example: Set the Baud to 38K4: #B 003

#?	Get local settings Returns all configured settings	#? Returns a single packet containing 11 bytes as follows: <L_ADD1><L_ADD2><L_ADD3> <D_ADD1><D_ADD2><D_ADD3> <NULL Value> <LORA Mode> <RF Power> <Handshaking> <Baud rate>
#Q	Reset device	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.

Serial to Digital Mode

The Gamma module is capable of being sent commands via RS232 (TX and RX) , that will allow transmitter to relay these to the digital Outputs of the receiver:

1) Connect both TX and RX Pin 14 (GND) and Pin 10 (N/C)
2) Connect and RX (RS232 of TX to host
3) Place TX and RX in learn mode (hold learn button for 2 seconds)
4) Send the #L command from TX followed by channel number as a byte value:

i.e. #L 001 (Learn /Channel Number 1)

This will send a learn packet from the transmitter to the receiver. The receiver will flash its learn LED to signify that it has been pair correctly.

Note: Now the RX has received the learn packet it no longer requires to be in learn mode.

5) To switch the Outputs 1-8 on the receiver you will need to use the #S command followed by the channel number (the same as used in the learn process) and the outputs you wish to switch using BCD

i.e. #S 001 255 (Serial-to-Digital command / Channel number / Outputs 1-8 ALL ON)
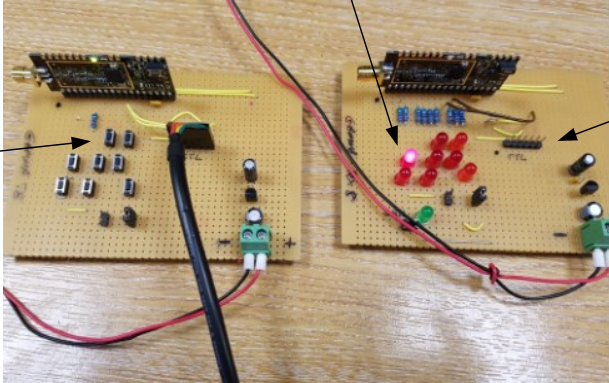
Binary Coded Decimal Table

	Output 1	Output 2	Output 3	Output 4	Output 5	Output 6	Output 7	Output 8
BCD Value	1	2	4	8	16	32	64	128

Example Outputs Using Terminal Program

The below examples show the outputs set ON/OFF via the #S command sent in a terminal program (please not that this terminal requires an additional "#" at the beginning of the line.).
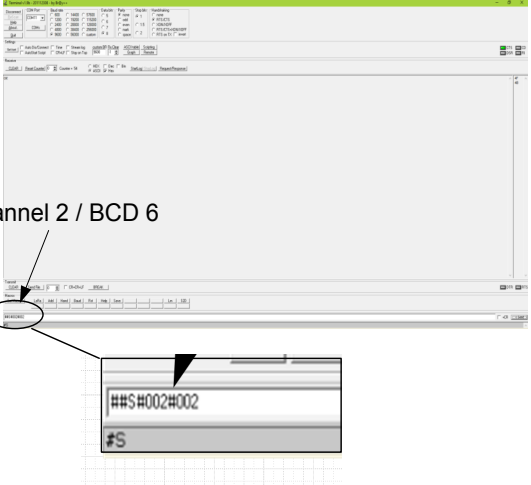
Example 1: The O/P 2 is set active by sending the value 002.

OUTPUT 2

Transmitter connected via LV232 to USB converter
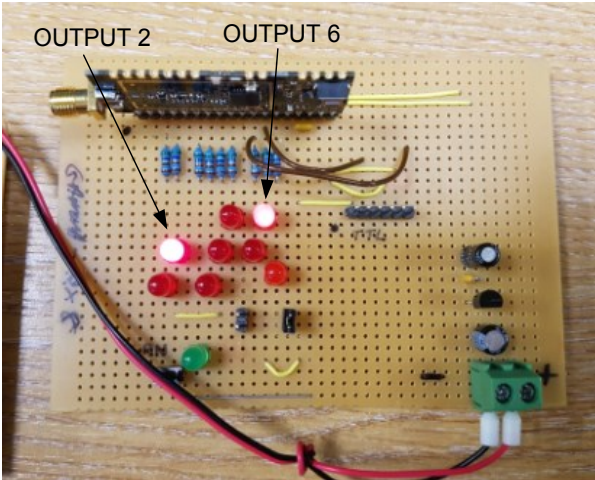
Receiver showing outputs via LEDs
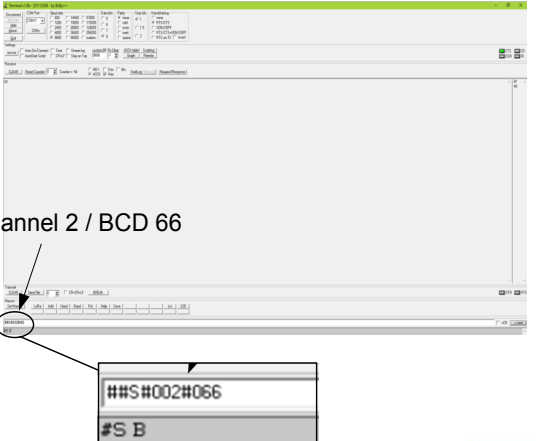
Channel 2 / BCD 6

##S#002#002

#S

Example 2: The O/P 2 and 6 are set active by sending the command 066 (64 = output 6 + 2 = output 2).

OUTPUT 2   OUTPUT 6

Channel 2 / BCD 66

##S#002#066

#S B

GAMMA Module

Mechanical Dimensions
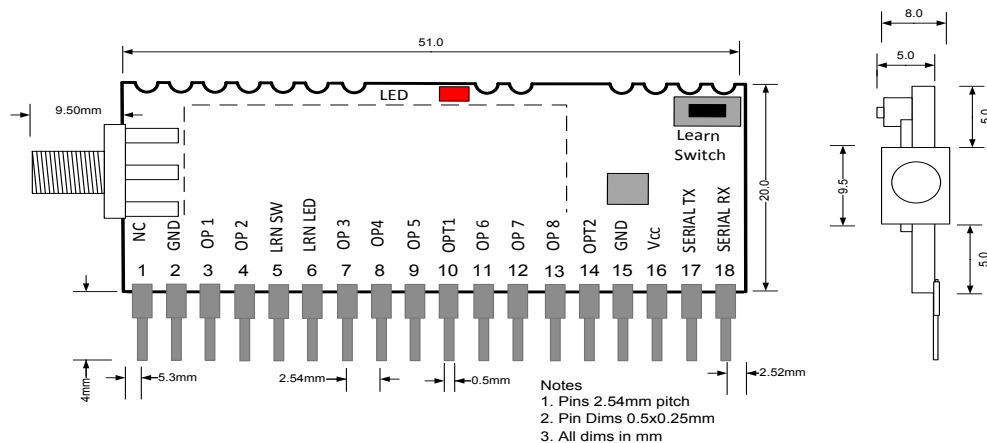
Range Considerations

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)

Parameter	Min	Max	Units
Supply voltage Standard version	2.7	3.6 *	V
Supply voltage high Voltage version	3.6	16 *	V
Voltage on any input	-0.3	5.8	V
Max input power (through RX antenna)		+10	dBm
Max current sourced / sunk (Per I/O)		15	mA
Max current sourced / sunk (Total)		100	mA

Absolute Maximum do not exceed this value

DC Characteristics

Parameter	Min	Typical	Max	Units
Supply voltage	2.7	3.3V	3.6	V
Operating temperature	-40		+85	°C
GAMMA- TX supply current: When transmitting Low Voltage version when sleeping High Voltage version when sleeping	145 2 75		155	mA uA uA
GAMMA- RX supply current: When receiving	19	20	23	mA

AC Characteristics

Parameter	Min	Typical	Max	Units
Operating frequency		869.5		MHz
Operating frequency for 915MHz version		915.00		MHz
Operating temperature	-40		+85	°C
GAMMA- TX output power			+20	dBm
GAMMA- RX Sensitivity	-121		-137	dBm

GAMMA Module

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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