Melange Systems Private Limited

Wireless controls in action

Tarang™

Product Manual

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1. Tarang

Tarang modules are designed with low to medium transmit power and for high reliability wireless networks. The modules require minimal power and provide reliable delivery of data between devices. The interfaces provided with the module help to directly fit into many industrial applications. The modules operate within the ISM 2.4-2.4835 GHz frequency band with IEEE 802.15.4 baseband.

1.1 Features

- Range - Outdoor line of sight: up to 50kms with directional antenna.
- Transmit Power: up to 1 watt / 30 dBm nominal.
- Receiver Sensitivity: up to –107 dBm.
- AT Command Modes for configuring Module Parameters
- Direct sequence spread spectrum technology.
- Analog to digital conversion and digital I/O line support.

TarangNet Features

- Acknowledgement mode communication with retries
- Each direct sequence channel has 64K unique network addresses.
- Source / destination addressing.
- Unicast and broadcast communication.
- Point to point, point to multi point and peer-to-peer topologies are possible.

TarangMesh Features

- Mesh Networking

1.2 Pin Configuration

Pin No.	Name	Direction	Description
1	V_{CC}	Input	Power Supply
2	D_{OUT}	Output	Serial Data Out
3	D_{IN}	Input	Serial Data In
4	RESERVED	_	
5	RST	Input	Module Reset
6	*RSSI	Output	RSSI Indicator
7	*PWM	Output	PWM Output
8	B_{GND}	Input	Programming Pin
9	SLEEP	Input	Sleep Control
10	GND	_	Ground
11	AD4/DIO4	I/O	Analog Input 4 or Digital I/O 4
12	CTS/DIO7	I/O	CTS or Digital I/O 7
13	*STATUS	Output	Module Status
14	V_{REF}	Input	Reference Voltage for Analog Input
15	AD5/DIO5	I/O	Analog Input 5 or Digital I/O 5
16	RTS/DIO6	I/O	RTS or Digital I/O 6
17	AD3/DIO3	I/O	Analog Input 3 or Digital I/O 3
18	AD2/DIO2	I/O	Analog Input 2 or Digital I/O 2
19	AD1/DIO1	I/O	Analog Input 1 or Digital I/O 1
20	AD0/DIO0	I/O	Analog Input 0 or Digital I/O 0

* Feature under development.

1.3 Tarang Variants

MODULE	Transmit Power	Power Supply (Typical)	Antenna Options
Tarang-F30	30 dBm/1 W	5 V	MMCX Connector
Tarang-F20	18 dBm/60 mW	3.3 V	MMCX Connector, Chip Antenna, Wire Antenna
Tarang-F4	0 dBm/1 mW	3.3 V	MMCX Connector, Chip Antenna, Wire Antenna

2. Tarang-F30

2.1 Specification

Note: Tarang-F30 has internally uses 3.3V for module operation limiting the external voltage on I/O to 3.3V.

Power	
Supply Voltage (Vcc)	5 to 5.5 V
Transmit Current	450mA
Idle/Receive Current	65mA
Power-down Current	<50uA

General	
Operating Frequency	ISM 2.4 GHz
Outdoor RF Line-of-sight Range	Up to 50km with appropriate high gain antennas and elevation
Transmit Power Output	29.2 dBm Typical
RF Data Rate	250Kbps
Receiver Sensitivity	-107 dBm
Serial Interface Data Rate	1200,2400,4800,9600,19200,38400,57600,115200 baud
Operating Temperature	-40 to 85 degree C
Antenna Options	MMCX Connector

Network	
Supported Network Topologies	Point-to-point, Point-to-multipoint & Peer-to-peer
Number of Channels	16 Direct Sequence Channels
Addressing Options	PAN ID, Channel and Addresses

2.2 Electrical Characteristics

2.2.1 DC Characteristics

Symbol	Characteristic	Condition	Minimum	Typical	Maximum	Unit
V_{DIL}	Input Low Voltage	All Digital Inputs	0	-	1.08	V
V_{DIH}	Input High Voltage	All Digital Inputs	2.5	-	3.6	V
V_{DOL}	Output Low Voltage	All Digital Outputs	0	-	0.5	V
V_{DOH}	Output High Voltage	All Digital Outputs	3.1	-	3.6	V

2.2.2 ADC Characteristics

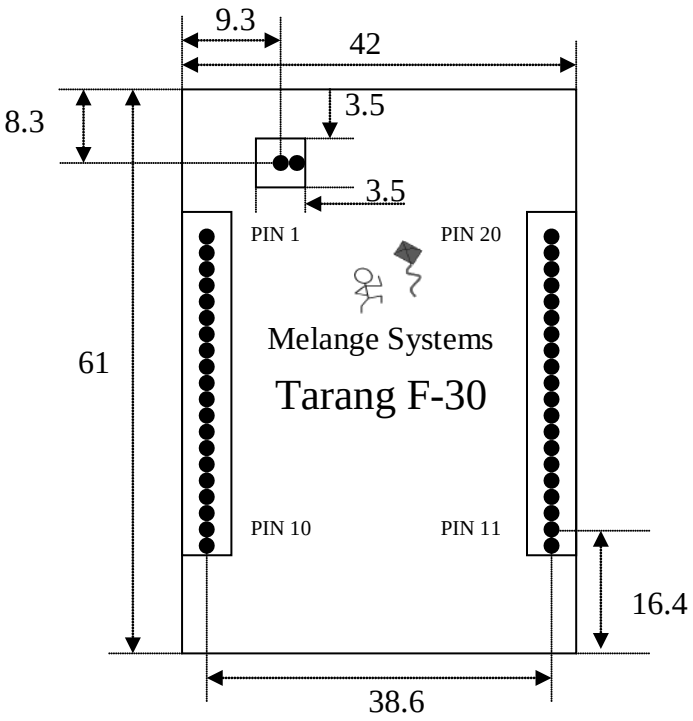
Symbol	Characteristic	Condition	Minimum	Typical	Maximum	Unit
V_{REF} #	Reference Range	-	0 (V_{REFL})	-	3.3 (V_{REFH})	V
I_{REF}	Reference Supply Current	Enabled	-	200	300	µA
		Disabled or Sleep Mode	-	<0.01	0.02	µA
V_{AIN}	Analog Input Voltage		V_{REFL}	-	V_{REFH}	V

Analog input must be between V_{REFL} and V_{REFH} for valid conversion. The Resolution is the Ideal Step Size (1LSB) = (V_{REFH} – V_{REFL})/1024

2.2.3 Modem Characteristics

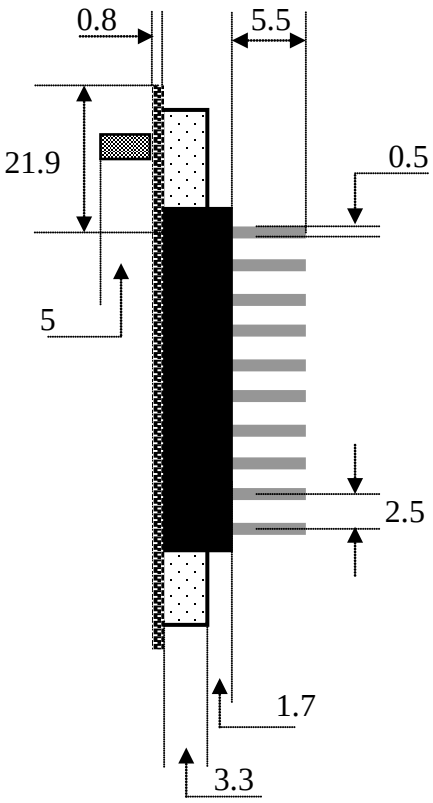
Symbol	Characteristic	Condition	Minimum	Typical	Maximum	Unit
I_{TX}	Transmit Current	V_{CC}=5V	-	450	500	mA
I_{RX}	Receive Current	V_{CC}=5V	-	65	-	mA
I_{PD}	Power-Down Current	V_{CC}=5V	-	<50	-	uA

2.3 Mechanical Drawings



All dimensions are in mm

Top View



Side View

3. Tarang-F20

3.1 Specification

Power	
Supply Voltage (Vcc)	3.3 to 3.6 V
Transmit Current	120mA
Idle/Receive Current	65mA
Power-down Current	<10µA

General	
Operating Frequency	ISM 2.4 GHz
Outdoor RF Line-of-sight Range	Up to 5km with appropriate high gain antennas and elevation
Transmit Power Output	19 dBm Typical
RF Data Rate	250 Kbps
Receiver Sensitivity	-107 dBm
Serial Interface Data Rate	1200,2400,4800,9600,19200,38400,57600,115200 baud
Operating Temperature	-40 to 85 degree C
Antenna Options	MMCX Connector, Chip Antenna, Wire Antenna

Network	
Supported Network Topologies	Point-to-point, Point-to-multipoint & Peer-to-peer
Number of Channels	16 Direct Sequence Channels
Addressing Options	PAN ID, Channel and Addresses

3.2 Electrical Characteristics

3.2.1 DC Characteristics

Symbol	Characteristic	Condition	Minimum	Typical	Maximum	Unit
V_{DIL}	Input Low Voltage	All Digital Inputs	0	-	1.08	V
V_{DIH}	Input High Voltage	All Digital Inputs	2.5	-	3.6	V
V_{DOL}	Output Low Voltage	All Digital Outputs	0	-	0.5	V
V_{DOH}	Output High Voltage	All Digital Outputs	3.1	-	3.6	V

3.2.2 ADC Characteristics

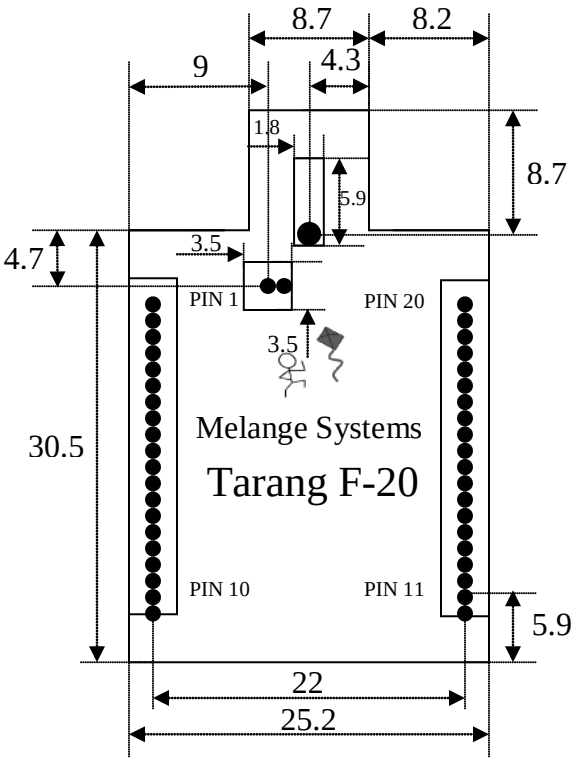
Symbol	Characteristic	Condition	Minimum	Typical	Maximum	Unit
V_{REF} #	Reference Range	-	0 (V_{REFL})	-	3.3 (V_{REFH})	V
I_{REF}	Reference Supply Current	Enabled	-	200	300	µA
		Disabled or Sleep Mode	-	<0.01	0.02	µA
V_{AIN}	Analog Input Voltage		V_{REFL}	-	V_{REFH}	V

Analog input must be between V_{REFL} and V_{REFH} for valid conversion. The Resolution is the Ideal Step Size (1LSB) = (V_{REFH} – V_{REFL})/1024

3.2.3 Modem Characteristics

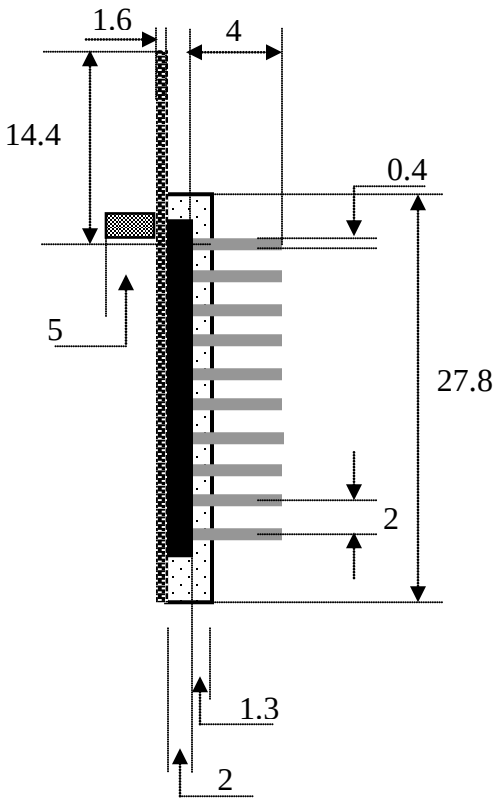
Symbol	Characteristic	Condition	Minimum	Typical	Maximum	Unit
I_{TX}	Transmit Current	V_{CC}=3.3V	-	110	120	mA
I_{RX}	Receive Current	V_{CC}=3.3V	-	65	-	mA
I_{PD}	Power-Down Current	V_{CC}=3.3V	-	<10	-	µA

3.3 Mechanical Drawings



All dimensions are in mm

Top View



Side View

4. Tarang-F4

4.1 Specification

Power	
Supply Voltage (Vcc)	3.3 to 3.6 V
Transmit Current	45 mA
Idle/Receive Current	50 mA
Power-down Current	<10 µA

General	
Operating Frequency	ISM 2.4 GHz
Outdoor RF Line-of-sight Range	Up to 1 km with appropriate high gain antennas and elevation
Transmit Power Output	0 dBm Typical
RF Data Rate	250 Kbps
Receiver Sensitivity	-92 dBm
Serial Interface Data Rate	1200,2400,4800,9600,19200,38400,57600,115200 baud
Operating Temperature	-40 to 85 degree C
Antenna Options	MMCX Connector, Chip Antenna, Wire Antenna

Network	
Supported Network Topologies	Point-to-point, Point-to-multipoint & Peer-to-peer
Number of Channels	16 Direct Sequence Channels
Addressing Options	PAN ID, Channel and Addresses

4.2 Electrical Characteristics

4.2.1 DC Characteristics

Symbol	Characteristic	Condition	Minimum	Typical	Maximum	Unit
V_{DIL}	Input Low Voltage	All Digital Inputs	0	-	1.08	V
V_{DIH}	Input High Voltage	All Digital Inputs	2.5	-	3.6	V
V_{DOL}	Output Low Voltage	All Digital Outputs	0	-	0.5	V
V_{DOH}	Output High Voltage	All Digital Outputs	3.1	-	3.6	V

4.2.2 ADC Characteristics

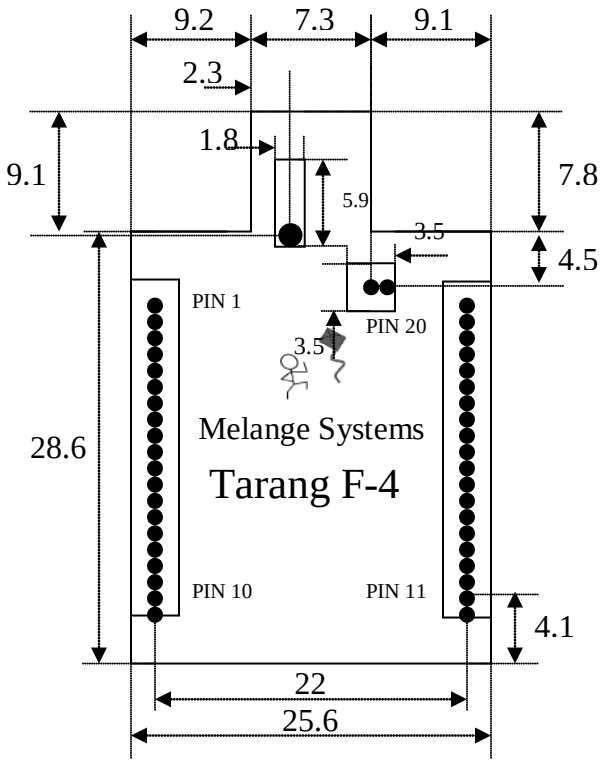
Symbol	Characteristic	Condition	Minimum	Typical	Maximum	Unit
V_{REF} #	Reference Range	-	0 (V_{REFL})	-	3.3 (V_{REFH})	V
I_{REF}	Reference Supply Current	Enabled	-	200	300	µA
		Disabled or Sleep Mode	-	<0.01	0.02	µA
V_{AIN}	Analog Input Voltage		V_{REFL}	-	V_{REFH}	V

Analog input must be between V_{REFL} and V_{REFH} for valid conversion. The Resolution is the Ideal Step Size (1LSB) = (V_{REFH} – V_{REFL})/1024

4.2.3 Modem Characteristics

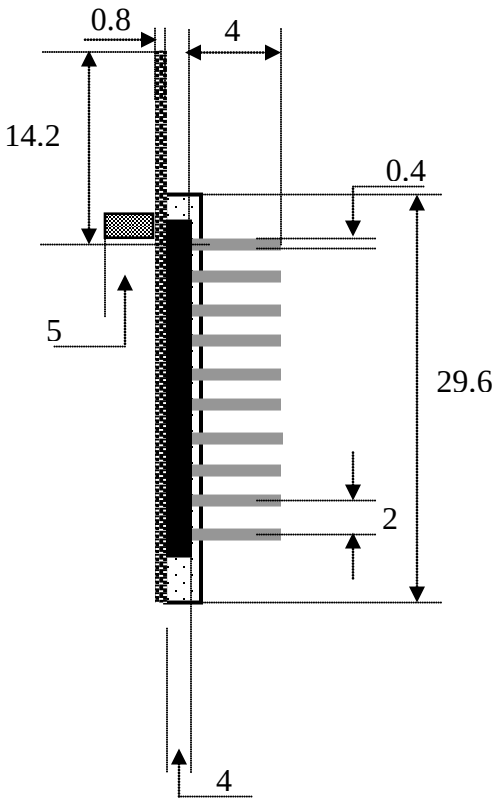
Symbol	Characteristic	Condition	Minimum	Typical	Maximum	Unit
I_{TX}	Transmit Current	V_{CC}=3.3V	-	45	50	mA
I_{RX}	Receive Current	V_{CC}=3.3V	-	50	-	mA
I_{PD}	Power-Down Current	V_{CC}=3.3V	-	<10	-	uA

4.3 Mechanical Drawings



All dimensions are in mm

Top View



Side View

5. Interface and Operation

The Tarang modules interface to a host device through a logic-level asynchronous serial port. Through its serial port, the module can communicate with any logic and voltage compatible UART or through a level translator to any serial device (For example: RS-232 or USB interface board).

5.1 Serial Interface

Tarang can be interfaced with a micro controller or a PC using serial port with the help of appropriate level conversion.

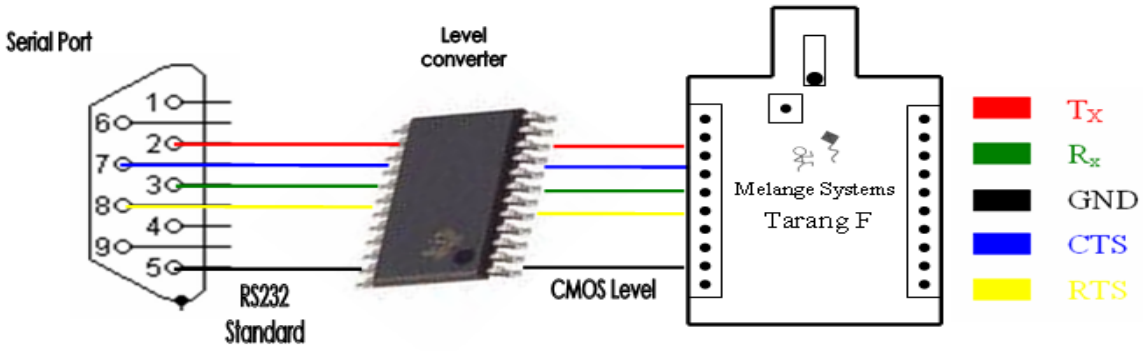


Fig 5.1 Example of Serial Interface

Note: CTS and RTS are optional. (Refer pin configuration for pin details)

Tarang supports serial data with,

- Flow Control : Hardware, None
- Parity : None
- Baud Rates : 1200,2400,4800,9600,19200,38400,57600,115200
- Data Bits : 8

To establish a successful serial communication with the module, serial parameters need to be configured properly in the module and host side. Both the module and PC settings can be

viewed and set using AT command set through popular terminal applications like 'HyperTerminal'.

5.2 I/O Interfaces

The Tarang RF modules support ADC (Analog-to-digital conversion) and digital I/O interfaces. If the parameter 'IDx' (refer 8.2.5 Input Output Controls) is set to '1' or '2', the I/O Pins are configured to Analog Input or Digital Input. The status of I/O pins in first module is carried to other module. By default I/O pins are configured as outputs.

If 'IOS' (refer 8.2.5 Input Output Controls) is set to one, then the status of I/O pins is displayed in serial port only. Normally eight pins are assigned for digital I/O interface, of which one pin is used for CTS and RTS (Hand shaking signals) if hardware handshake is enabled leaving six pins for Analog to Digital and Digital I/O.

Note: Analog to Digital pins are always six although if CTS and RTS are not enabled.

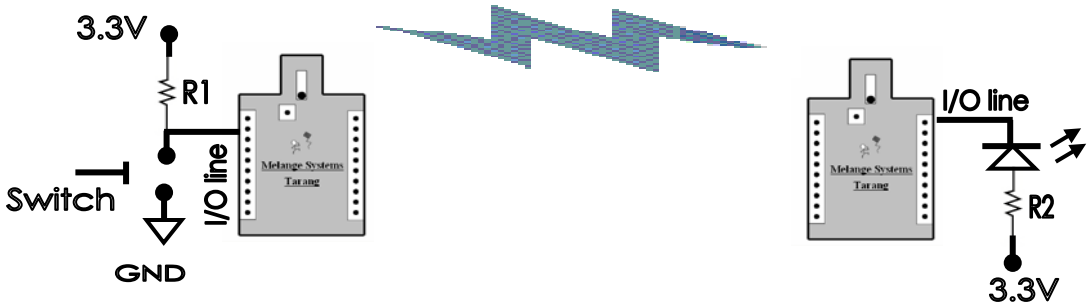


Fig 5.2 Example of I/O interface in an application

Note: Instantaneous maximum current is 20mA per pin and overall pin limit is 60mA hence set up as shown in fig 5.2 is applicable for maximum of 2 I/Os. Use appropriate current limiting resistors or alternate driving circuits when interfacing based on the application.

The I/O interface includes wide range of applications. The figure 5.2 is an example of I/O interface in an application to control the low power LED wirelessly in which ID0 (first I/O line) is used. The switch is interfaced to first I/O line (ID0) of Tarang module whose I/O pins are configured as Digital inputs with command ATID02 and a LED is interfaced to first I/O line (ID0) of another module whose I/O pins are configured as output. The change state of switch in input

side is reflected on the LED in this application. To ease the I/O and Serial interface of Tarang module 'Tarang Interface Board' is available.

Configuring the module and installation is as follows,

1. Take two Tarang modules which are configured with same Serial settings i.e. baud rate, channel, pan ID, data bits, etc.

Note: For configuring the baud rate of module use command ATSBDx (refer 8.2.3 Serial interface commands) to desired value and before writing it to memory change the baud rate configuration to 'NEW Baud rate' in 'Hyper terminal' and then send 'ATGWR' command to write it to memory.

2. In addition, one of the modules should be configured with I/O pins as input and another with I/O pins as output.

3. For setting I/O pins as input and output the following steps should be followed

   - Enter the command mode with '+++'
   - Enable the desired I/O pin as input with command ATIDxx. In this example first I/O line ID0 is used. For configuring it to Digital I/O input, send command as ATID02. Response from module should be 'OK'.
   - Write these parameters to memory with 'ATGWR' command.
   - Exit command mode with 'ATGEX' command.

     Note: Once I/O pins are configured to input their default status will be logic high (3.3V).

   - Follow the same steps for configuring another module I/O pins to output.
   - By default I/O pins act as output pins. So, send ATIOSx command to display the status in desired field (refer 8.2.5 input output commands).

- After receiving the response as 'OK' from module, write it to memory and exit command mode.

4. Once after configuring the modules make setup as in fig 5.2. Example I/O interfaces in an application with R1 as 10 K and R2 as 330 Ohms.

5. Switch on the entire setup and press the switch and see that the LED at another module is controlled wirelessly.

6. Module Configuration

Simple terminal application like Microsoft Windows® 'Hyper Terminal' can be used for configuring or reading the Tarang modules.

6.1 Command Mode

Command mode is used for reading or modifying the parameter of a module. Once the command mode is initiated, incoming characters through serial port are considered as commands.

Entering AT Command Mode

Enter 3-character command mode sequence "+++" within one second.

AT Command Syntax

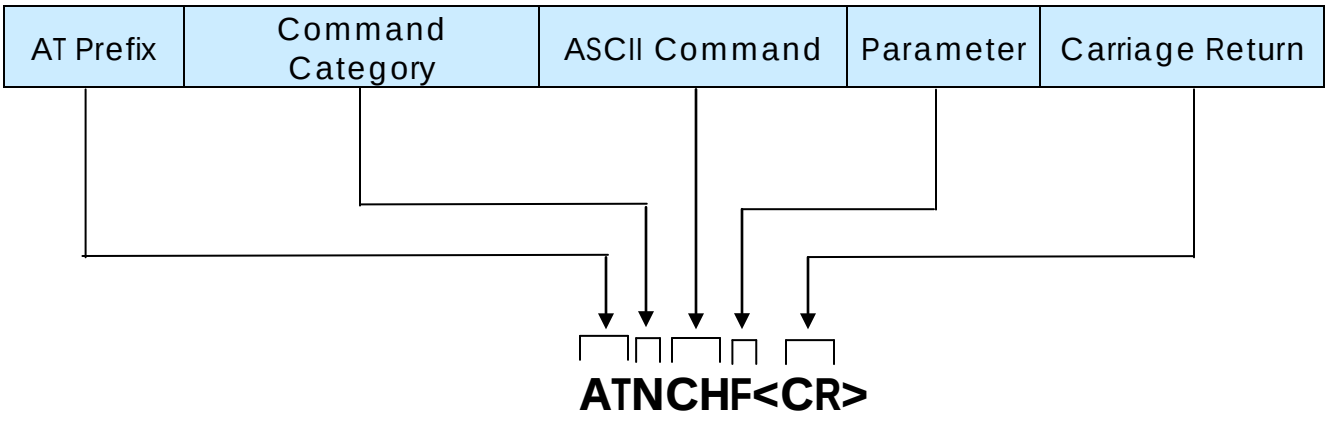


Figure 7.4.1. AT Command Syntax

The given example would change the RF module Channel to “0x0F” (15). To store the value to memory, subsequently send the Write command. Else set values will be lost once module is re-booted. When a command is sent to the module, the module will execute the command. Upon successful execution of a command, the module returns an “OK” message. If execution of a command results in an error, the module returns an “ERROR” message.

Exit AT Command Mode

1. Send “**ATGEX**” (Exit Command Mode) Command.

6.2. Module Programming

Step1: Open windows Hyper Terminal.

Step2: Connect the Tarang module to the Serial/USB Port.

Step3: Choose the appropriate Port and serial parameters in terminal software.

Step4: Configure the module, using terminal and AT commands.

Example using terminal:

Send AT Command	System Response
+++ ATNCH <Enter> ATNCHF <Enter> ATGWR <Enter> ATGEX <Enter>	OK <CR> (Enter into Command Mode) {Current value} <CR> (Read Channel) OK <CR> (Modify Channel) OK <CR> (Write to memory) OK <CR> (Exit Command Mode)

7. Tarang Networks

Tarang supports two types of networking protocols.

1. TarangNet
   - Simple configuration and operation
   - Point to point, Point to multipoint networking
2. TarangMesh
   - Supports proprietary mesh networking protocol

The user needs to specify the choice of the protocol before procuring the modules. The default protocol provided with the module is TarangNet.

8. TarangNet

TarangNet uses the simpler form of networking between Tarang modules and it supports point-to-point and point-to-multipoint networks by simple configuration.

Every RF data packet sent on air contains a Source Address and Destination Address field in its header. To send a packet to a specific module using 16-bit addressing, set the destination address parameter to the desired address. All the modules can be configured with their own unique 16-bit addresses. Nodes can be grouped to communicate among themselves with the PAN ID parameter. Tarang module provides 16 different channels for RF communication and each direct sequence channel has 64K unique network addresses.

8.1 Network Types

TARANG supports the following types of networks.

- Unicast Network
- Broadcast Network
- Peer to peer Network or Point to point Network

These topics are discussed here in detail.

8.1.1 Unicast Network

In Unicast Network the communication happens only between the two modules with respective source and destination addresses. In such network the destination address of the TARANG 1 is source address to TARANG 2, and vice versa. For any effective communication the source address and destination address should be configured properly.

Example:

PARAMETER	TARANG 1	TARANG 2
Source address(MY)	0x1000	0x2000
Destination address(DA)	0x2000	0x1000

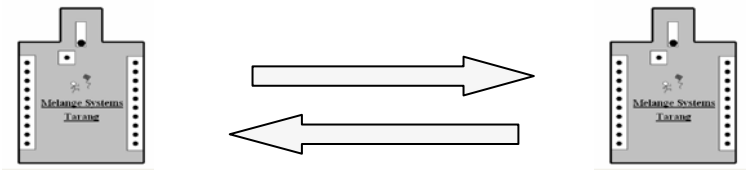


Fig 6.1.1 Unicast Network

8.1.2 Broadcast Network

In Broadcast Network only one module will broadcast the data to all other modules, and then each individual module will respond to that. There is no communication between the individual modules except “Broadcasting Module”. Consider the fig 6.1.2, only master module will broadcast to all the slave modules and then each slave module will respond to master module only. There is no communication between slave modules. The source address of the master will be destination address to all the slaves and destination address of the master is set to broadcast address 0xFFFF.

Example:

PARAMETER	Master	Slave 1	Slave 2	Slave 3
Source address(MY)	0x0004	0x0001	0x0002	0x0003
Destination address(DA)	0xFFFF	0x0004	0x0004	0x0004

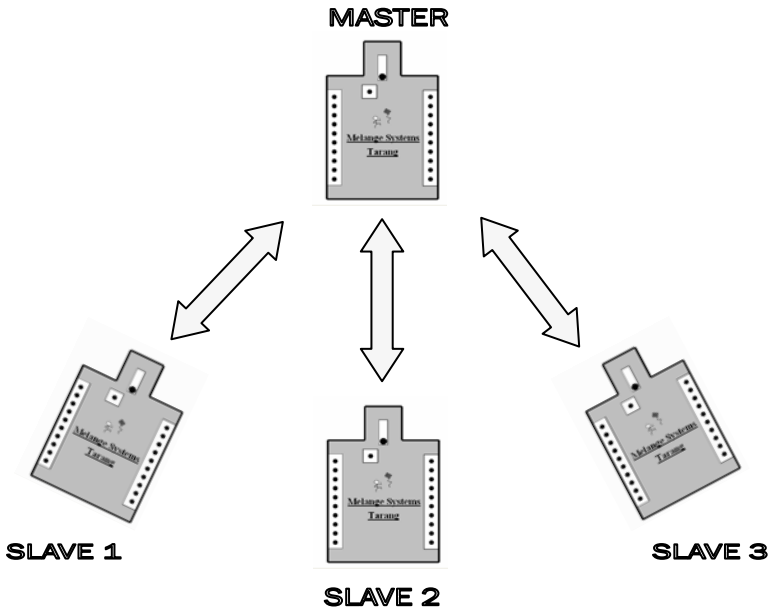


Fig 6.1.2 Broadcast Network

8.1.3 Peer to Peer or Point to point Network

In peer to peer network the modules in a network can communicate with any module without any restrictions like master and slave. Each module will share the role of both master and slave and communicate with each other. By default Tarang modules work with this mode of network. The addressing is chosen based on the application needs**.**

Example:

PARAMETER	TARANG1	TARANG2	TARANG3
Source address(MY)	0xFFFF	0xFFFF	0XFFFF
Destination address(DA)	0xFFFF	0xFFFF	0xFFFF

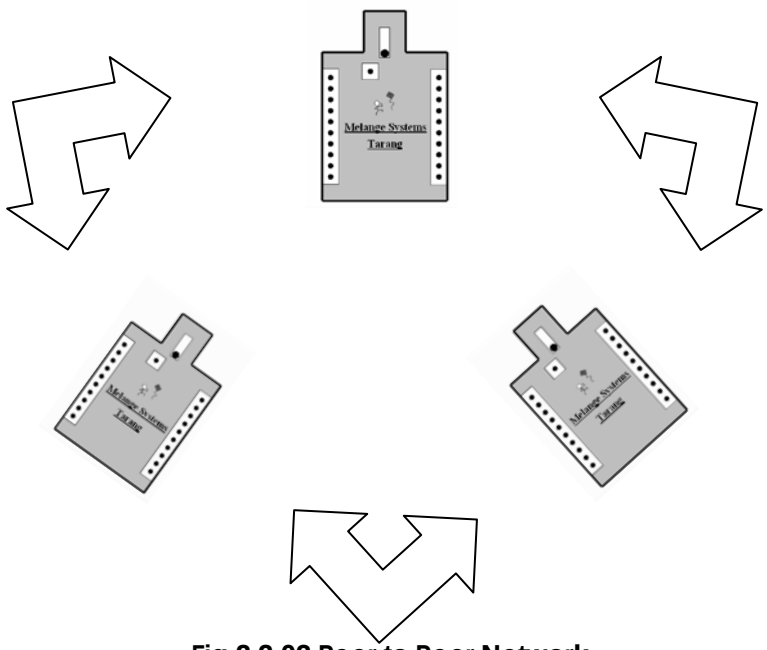


Fig 2.2.03 Peer to Peer Network

8.2. Modes of Operation

Tarang can be interfaced with a micro controller or a PC using serial port with the help of appropriate level conversion.

Tarang module operates in four different modes,

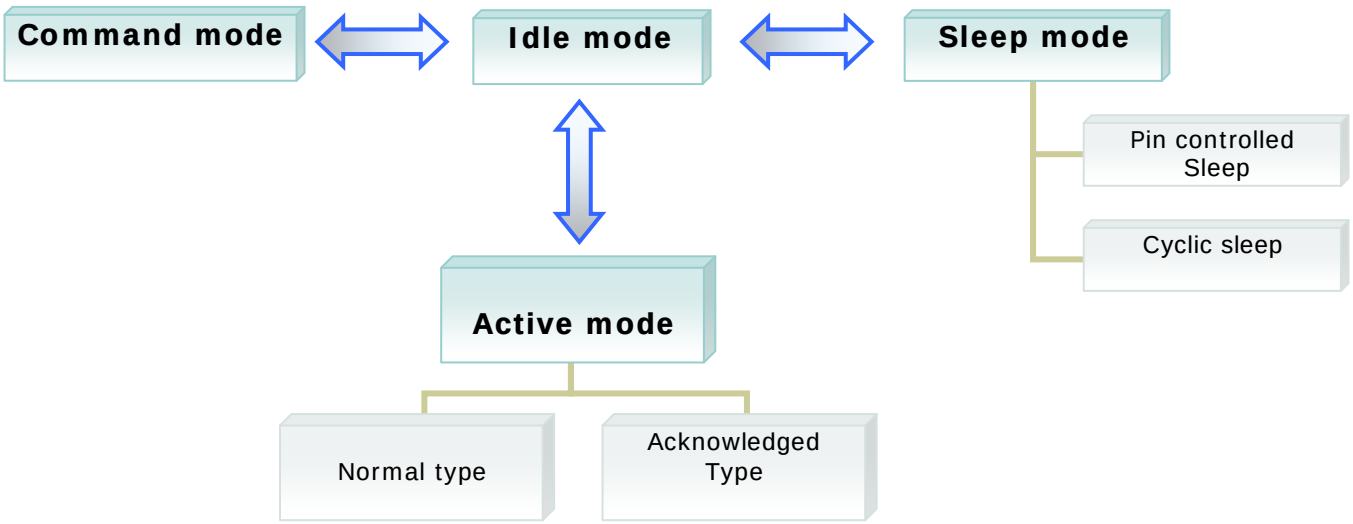


Figure 7.0 Operation Modes

8.2.1 Idle Mode

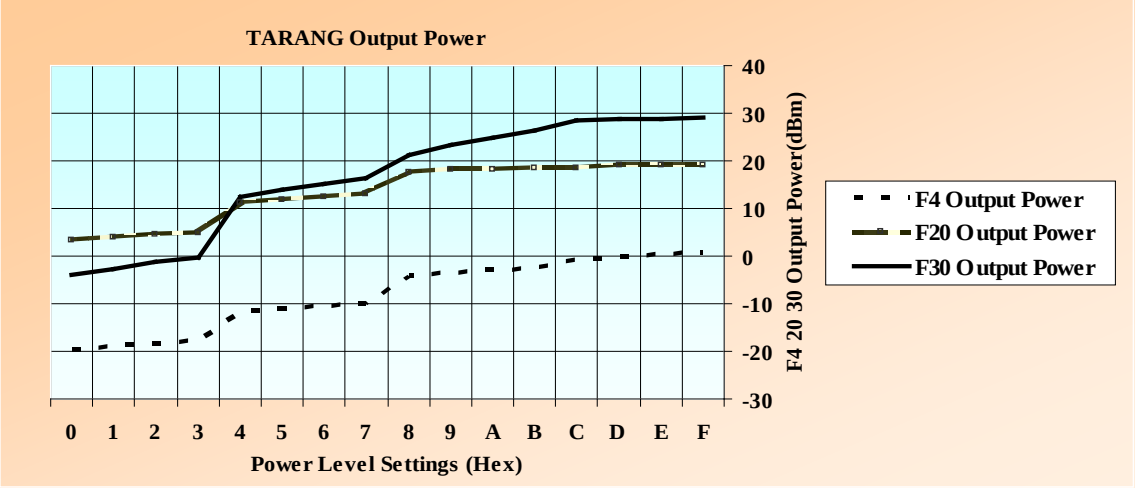
When Tarang is in Idle Mode, no operations are carried out. The module shifts to other modes under following circumstances. However, the module continues to receive the RF data in this mode.

1. Active Mode Transmit - When it receives an RF Packet or serial data present in Buffer.
2. Sleep Mode - When sleep mode condition is met
3. Command Mode - When command sequence is received.

8.2.2 Active Mode

Data Transmission

Tarang modules receive the data from host through the serial port. Next step before transmitting the data on air is packetization. This part includes adding a communication header, etc. The output power of the TARANG module can be configured through 'Output Power' (ATPOP) parameter depending upon the range of application. The out put power parameter ranges from 0 to 0x0F.



Serial Data is buffered in the Transmit buffer until one of the following causes the data to be packetized and transmitted:

1. No serial characters are received for the amount of time determined by the TO (Timeout) parameter. The TO parameter currently is a read-only parameter whose value is based on the configured baud-rate of the serial port.

2. The maximum number of characters that will fit in an RF packet is received.

The serial data is stored in the Transmit Buffer. The data is packetized and sent at any 'TO' timeout or when maximum packet size is received. The packet size can be configured by user to desired value from 0 to 90 with 'ATSPK' command (Refer to Serial Interfacing Commands [S]).

If the Transmit Buffer becomes full, hardware or software flow control must be implemented in order to prevent overflow (loss of data between the host and module). Hand shaking signals can be enabled using 'ATSHS' command, by default hand shake signals are disabled. When hand shaking signals are used I/O pins like ID6 and ID7 are dedicated to RTS and CTS.

Data Reception

Once a data packet is retrieved from air, Tarang module extracts the contents and pushes out to serial port according to the serial parameters configured. The signal strength of the received packet can be seen through RSSI (Receive Signal Strength Indicator) parameter through 'ATPRS' command (read only).

Communication Types

Tarang module communicates in multiple types

1. Normal Type

2. Acknowledged Type

Normal Type

Tarang acts as a transparent communicator. It packetizes and transmits data present in the transmit buffer when the transmission conditions are met. Broadcast and Unicast networks can be implemented based on individual module addresses. 0xFFFF is the broadcast address, within a network, the network itself has PAN ID which is a unique network ID.

Acknowledged Type

For every packet, which is transmitted out, Tarang expects an acknowledgement from the other side. If acknowledgement is not received with in a specific time, module will retransmit the packet. This mode is ideal for the applications where high reliability is needed. Number of retries is configurable.

8.2.3 Sleep Mode

Sleep Mode enables the RF module to enter the state of low-power consumption when not in use. In order to enter Sleep Mode, one of the following conditions must be met.

- Sleep Pin Asserted
- The module is idle for the amount of time defined by the ATPST and ATPBS parameters.

Sleep Mode	Sleep On	Wakeup On	Commands	Power
Pin Controlled	Sleep Pin assertion	Sleep Pin De-assertion	ATPSM = 1	
Cyclic Sleep	Transition to sleep defined by sleep time parameters.	Sleep Period (ST) elapses	ATPSM = 2 ATPST(Sleep time), ATPBS(Time Before Sleep)	

Pin Controlled Sleep

The voltage level change on Sleep Pin activates or de-activates pin controlled sleep. When sleep pin is asserted, module completes the pending activities and enters to idle mode and then to sleep mode. The voltage level is 0V and 3.3V i.e. once pin is applied with logic low it goes to sleep mode and wakes up when logic high is applied.

Cyclic Sleep

The Cyclic Sleep Modes allow modules to periodically check for RF data. When the Sleep Mode (SM) parameter is set to '2', the module is configured to cyclic sleep, then wakes once a cycle to check for data. The module remains active for time set by 'Time Before Sleep' parameter. If no data is queued for the remote, the coordinator will not transmit and the remote will return to sleep for another cycle. If queued data is transmitted back to the remote, it will stay awake to allow for back and forth communication until the 'Sleep Time' timer expires. Also note that CTS will go low each time the remote wakes, allowing for communication.

8.3. Table of Commands

Tarang module expects numerical values in hexadecimal. All AT commands used by Tarang modules are sorted by category. Tarang modules can be configured back to factory settings with a single command 'ATGRD'.

8.3.1 General Commands

AT Command	Description	Parameter and Range	Default
GRD	Restore Defaults: Module is Configured to Factory settings	-	-
GWR	Write: Stores the set parameters to memory	-	-
GEX	Exit: Exit from command mode	-	-

8.3.2 Networking Commands

AT Command	Description	Parameter and Range		Default
NCH	Channel: Set/Read the channel number used for transmitting and receiving between RF modules.	0-F		0
NMY	16-bit Source Address: Set/Read the RF module 16-bit source address.	0-0xFFFF		0x1000
NDA	16-bit Destination Address: Set/Read the RF module 16-bit destination address.	0-0xFFFF		0x1000
NRR	Number of retries: Set/Read the number of packet retries.	0-5		0
NPI	PAN ID: Set/Read the PAN (Personal Area Network) ID	0-0xFFFF		0xFFFF
NMD	Communication Mode: Set/Read the mode of operation	[0-1]	0 - Normal mode 1 - Acknowledged mode	0

8.3.3 Serial Interfacing Commands

AT Command	Description	Parameter and Range		Default
SBD	Interface data rate: Read / Set the serial interface data rate for communications between the RF module serial port and host.	[0-7]	0 - 1200 1 - 2400 2 - 4800 3 - 9600 4 - 19200 5 - 38400 6 - 57600 7 - 115200	3
SHS	Hand Shaking: Enable or disable hardware flow control.	[0-1]	0 – No flow control 1 – CTS / RTS	0
STO	Packetization Time Out: Read the packetization time out	Read only		
SPK	Packet Size: Set/Read RF packet size.	0-0x5A		0x5A

8.3.4 Power Control

AT Command	Description	Parameter and Range		Default
PSM	Sleep Mode: Read / Set Sleep Mode	[0-2]	0 - None 1 - Pin Assert 2 - Cyclic	0
PST	Sleep Time: Sleep time reference for different sleep modes	1 - 0xFFFF x32ms		10
PBS	Time Before Sleep: Set/Read the time before sleep	1 - 0xFFFF x10ms		10
PRS	RSSI: Read the RSSI(Receive Signal Strength Indicator) of last packet received	Read only		-
POP	RF Output Power: Set/Read the RF Output Power	0-0x0F		0x0F

8.3.5 Input/output Controls

AT Command	Description	Parameter and Range		Default
IOS	I/O on Serial: Enable or disable I/O data on serial port(output)	[0-2]	0 – Display output in I/O ports only 1- Display output in Serial port only 2- Display output in both serial and I/O ports	0
ID0	D0 Function: Read / Set the function of D0	[0-2]	0 - None 1 - Analog input 2- Digital input	0
ID1	D1 Function: Read / Set the function of D1	[0-2]	0 – None 1 - Analog input 2- Digital input	0
ID2	D2 Function: Read / Set the function of D2	[0-2]	0 – None 1 - Analog input 2 - Digital input	0
ID3	D3 Function: Read / Set the function of D3	[0-2]	0 - None 1 - Analog input 2 - Digital input	0
ID4	D4 Function: Read / Set the function of D4	[0-2]	0 - None 1 - Analog input 2 - Digital input	0
ID5	D5 Function: Read / Set the function of D5	[0-2]	0 - None 1 - Analog input 2 - Digital input	0
ID6	D6 Function: Read / Set the function of D6	[0-2]	0 – None 1 – NOT DEFINED 2 - Digital input	0
ID7	D7 Function: Read / Set the function of D7	[0-2]	0 - None 1 – NOT DEFINED 2 - Digital input	0
ATTDA	Sampling time	1 - 0xFFFF x10ms		0x0900

8.3.6 Version & Serial Number Commands

AT Command	Description	Parameter and Range	Default
VHW	Hardware Version: Reads the hardware version number.	Read Only	--
VFW	Firmware Version: Reads the Firmware version number.	Read Only	--
NSL	Serial Number: Reads the Serial number of module.	Read Only	--

9. TarangMesh

TarangMesh network provides for a flexible mesh network which scales very well for a large number of mesh nodes.

Key components: Root, router and mobile node. The center of the TarangMesh network is the root node. All of Mesh related configuration needs to be input at the root node – in all other nodes there is no network configuration required.

The same firmware runs on all the nodes. Any Tarang module can be configured as a root/router/mobile device. Note that all the nodes in the mesh network can be data generators or data sinks. Digital I/Os and Analog Inputs can be enabled in all mesh nodes and can be communicated to a configured destination either on timed basis or query basis.

Leaf – to leaf communication, root originated broadcasts, and user set addressing support are among the innovative features supported on TarangMesh. Non-router nodes (mobile nodes) can sleep.

9.1 Theory of Operation:

TarangMesh has three kinds of nodes. These are the root, mobile and router node(s). Root is the center of the network, allocating the internal routes, establishing the complete network, propagating the network parameters. The network builds up without any manual intervention or configuration.

The root node is configured as such by setting a parameter called "ATNMY" as 0x00000001. The root node then allocates internal network addresses as required. Once nodes are associated with root nodes send registration message to root as given below.

32bit-Network address	32bit-MAC address	32bit-Router network address	32bit-Router MAC address	32bit-User address

The Mesh network uses a root originated network address for all internal communication. For end user convenience TarangMesh network also supports two additional addressing schemes:

1. The use of factory set 32 bit serial numbers (referred as hardware address)

2. User configured 32 bit addresses (referred as user IDs)

While these kinds of addresses are convenient to use, the network address based communication is more efficient in terms of routing resources used. Users are encouraged to use the network address to hardware/user ID translation functions provided by TarangMesh for efficient mesh networking.

Additionally, a TarangMesh node can be configured as a mobile device. These do not route packets and are characterized by setting its address to FFFFFFFE. These mobile devices do not register with any router and can transmit / receive data as and when they need to. Among others, these could be useful in asset tracking and location identification solutions. Data transmitted from the mobile device is received by all routers in the vicinity and sent to the root. The root resolves duplicate data and sends it for processing.

Refer to the AT command list for a full understanding of many TarangMesh features.

Mesh protocol works best in an environment where the packet sizes are small. In a multi-hop network, large packets would have the effect of second hop interfering with the data on the first hop. If a large packet is to be transmitted over a multi-hop network, it is recommended that end application packetize the data, and transmit with some time gap between the packets. Maximum Mesh packet size is 84 bytes.

9.2 Table of AT Commands

Tarang module expects numerical values in Hexadecimal. All AT commands used by Tarang modules are sorted by category. Tarang modules can be configured back to factory settings with a single command 'ATGRD'.

9.2.1 General Commands

AT Command	Description	Parameter and Range		Default
GRD	Restore Defaults: Module is Configured to Factory settings	-		-
GWR	Write: Stores the set parameters to memory	-		-
GEX	Exit: Exit from command mode	-		-
GAP	Enable API: Enables or Disables API mode	[0-1]	0- Disable 1- Enable	0
GAD	Enable ATD/DIO: Enables or Disables ATD/DIO functionality	[0-2]	0- Disable 1- Enable ATD 2- Enable DIO	0

9.2.2 Networking Commands

AT Command	Description	Parameter and Range		Default
NCH	Channel: Set/Read the channel number used for transmitting and receiving between RF modules.	0-F		0
NMY	32-bit Source Address: Set/Read the RF module 32-bit source address.	0x00000000, 0x00000001 and 0xFFFFFFFE	0x00000000-Not Registered 0x00000001-Root 0xFFFFFFFE - Vagabond Note: Other values indicates the module is registered in the network	0x00000000
NDA	32-bit Destination Address: Set/Read the RF module 32-bit destination address.	0-0xFFFFFFFF		0x00000001

NRA	32-bit Router Address: Set/Read the RF module 32-bit router address.	0-0xFFFFFFFF		0x00000000
NPI	PAN ID: Set/Read the PAN (Personal Area Network) ID	0-0xFFFFFFFF		0x11111111
NTY	Transmission Type: Represents the mode of communication	[0-2]	0-Network address based 1-MAC address based 2-UsedID based	0
NUD	32-bit User ID: Set/Read the RF module 32-bit User ID.	0-0xFFFFFFFF		0x00000000
NNR	Network reset: This resets the entire network	-		-
NMD	Communication Mode: Set/Read the mode of operation	[0-1]	0 - Normal mode 1 - Acknowledged mode	0
NRT	Number of retries: Set/Read the number of packet retries.	3-9		3
NEP	Ping Enable: Enables or Disables the ping feature	[0-1]	0 – Disables ping 1 – Enables ping	1
NPA	Ping Attempts: Represents the number of ping failures the module can withstand	0x01 - 0x0A		3
NTR	Timed Registration: Transmits the Registration details to the Root	0x01 – 0x0F Note: multiples of 5s. i.e., 0x01- for every 5s sends the registration details		0
NSL	32-bit Hardware address/MAC address: Read the RF module 32-bit Hardware address/MAC address.	-		Factory set

9.2.3 Serial Interfacing Commands

AT Command	Description	Parameter and Range		Default
SBD	Interface data rate: Read / Set the serial interface data rate for communications between the RF module serial port and host.	[0-7]	0 - 1200 1 - 2400 2 - 4800 3 - 9600 4 - 19200 5 - 38400 6 - 57600 7 - 115200	3
SHS	Hand Shaking: Enable or disable hardware flow control.	[0-1]	0 - No flow control 1 – CTS / RTS	0
STO	Packetization Time Out: Read the packetization time out	Read only		
SPK	Packet Size: Set/Read RF packet size.	0-0x54		0x54

9.2.4 Power Control Commands

AT Command	Description	Parameter and Range		Default
PSM	Sleep Mode: Read / Set Sleep Mode	[0-1]	0 - None 1 - Cyclic	0
PST	Sleep Time: Sleep time reference for different sleep modes	1 - 0xFFFF x1Sec		1
PBS	Time Before Sleep: Set/Read the time before sleep	1 - 0xFFFF x10ms		1
PRS	RSSI: Read the RSSI(Receive Signal Strength Indicator) of last packet received	Read only		-
POP	RF Output Power: Set/Read the RF Output Power	0-0x0F		0x0D

		Tarang F4 in dbm	Tarang F20 in dbm	Tarang F30 in dbm
ATPOP	0	-19.7	+3.2	-4.0
	1	-19.1	+3.8	-2.7
	2	-18.4	+4.5	-1.3
	3	-17.9	+5.0	-0.2
	4	-11.9	+11.2	+12.4
	5	-11.2	+11.8	+13.9
	6	-10.6	+12.4	+15.1
	7	-10.0	+13.0	+16.4
	8	-4.1	+17.6	+21.2
	9	-3.6	+18.1	+23.2
	A	-3.1	+18.2	+24.8
	B	-2.7	+18.4	+26.4
	C	-1.0	+18.6	+28.4
	D	-0.3	+19.0	+28.8
	E	+0.4	+19.0	+28.8
	F	+0.5	+19.0	+29.2

9.2.5 Input/output Controls

AT Command	Description	Parameter and Range		Default
ADD	I/O on Serial: Enable or disable I/O data on serial port(output)	[0-2]	0 –Display output in I/O ports only 1-Display output in Serial port only 2- Display output in both serial and I/O ports	0
ACB	Analog Configuration Bits: Configures I/O port pins as analog inputs	0x00-0x3F	0x00 – No inputs configured 0x 01 – Ado as input 0x 02 – Ad1 as input 0x 04 – Ad2 as input 0x 08 – Ad3 as input 0x 10 – Ad4 as input 0x 20 – Ad5 as input Note: For configuring multiple pins as analog inputs user should enable the respective bits	0
DCB	Digital Input Configuration Bits: Configures I/O port pins as digital inputs	0x00-0xFF	0x00 – No inputs configured 01 – Dio0 as input 02 – Dio1 as input 04 – Dio2 as input 08 – Dio3 as input 10 – Dio4 as input 20 – Dio5 as input 40 – Dio6 as input 80 – Dio7 as input Note: For configuring multiple pins as digital inputs user should enable the respective bits	0
ADR	Rate of Transmission	0x0001-0xFFFF	0x0001-Sends the status only when queried(refer API mode) 0x0002 - Sends the status for every 40ms Note: This parameter is multiples of 20 ms	2

9.2.5 Version & Serial Number Commands

AT Command	Description	Parameter and Range	Default
VHW	Hardware Version: Reads the hardware version number.	Read Only	--
VFW	Firmware Version: Reads the Firmware version number.	Read Only	--

9.3 Application Programming Interface Mode (API Mode)

Tarang Mesh modules provide for an API mode of operation wherein, interfaced hosts or micro controllers follow a communication protocol with a Tarang Mesh node as a result of which mesh communication is more controlled and more flexible. A particularly useful configuration would be API mode operation at the root node and a non-API mode operation at the nodes where devices like sensors/meters are interfaced.

The API mode is enabled through the AT command ATGAP

9.3.1 API MODE SPECIFICATIONS

Host to Tarang Module Prototype:

Start Flag	Packet Type	Data Length	Destination	Payload

Tarang Module to Host Prototype:

Start Flag	Packet Type	Data Length	Source	Payload

9.3.2 List of API packet types:

Packet Type	**Functionality**
0x0001	Network address based regular data transfer
0x0002	Network address based Ping Request(Registration details)
0x0004	Ping Response(Registration details)
0x0008	MAC address based Ping Request(Registration details)
0x0010	User ID based Ping Request(Registration details)
0x0020	MAC address based regular data transfer
0x0040	User ID based regular data transfer

0x0080	Remote Parameter settings using Network/MAC addresses
0x0100	Network address based DIO status transfer
0x0110	MAC address based DIO status transfer
0x0120	User ID based DIO status transfer
0x0140	Network address based ATD-DIO query
0x0180	MAC address based ATD-DIO query
0x0200	User ID based ATD-DIO query
0x0400	Exit from API mode

9.3.3 Host to Tarang Module:

NW address based Regular Data Transfer:

0x2B	0x0001	0x03	0x00000003	0x31 0x32 0x33

This type sends the payload data (123) to the specified destination (0x00000003).The Destination should be the NW address and the payload should not exceed the Length, the exceeded payload will be lost.

NW address based Ping Request:

0x2B	0x0002	0x00	0x00000003

This type pings the module to send its registration details to it based on its NW address. Don't send any payload in this type as it's of no use. The Destination should be the NW address (0x00000003) of the module whose registration details is required.

Response format:

0x2D	0x0004	0x14	0x00000003	Registration message

MAC address based Ping Request:

0x2B	0x0008	0x00	0x12FE9A77

This type pings the module to send its registration details to it based on its MAC address. Don't send any payload in this type as it's of no use. The destination should be the MAC address (0x12FE9A77) of the module whose registration details is required. If network address of destination module is 0x00000003 response format is as shown below.

Response format:

0x2D	0x0004	0x14	0x00000003	Registration message

User ID based Ping Request:

0x2B	0x0010	0x00	0xCDAF1276

This type pings the module to send its registration details to it based on its User ID. Don't send any payload in this type as it's of no use. The Destination should be the User ID (0xCDAF1276) of the module whose registration details is required. If network address of destination module is 0x00000003 response formats is as shown below.

Response format:

0x2D	0x0004	0x14	0x00000003	Registration message

MAC address based Regular Data Transfer:

0x2B	0x0020	0x03	0x12FE9A77	0x31 0x32 0x33

This type sends the payload data (123) to the specified destination (0x12FE9A77).The Destination should be the MAC address and the payload should not exceed the Length, the exceeded payload will be lost.

User ID based Regular Data Transfer:

0x2B	0x0040	0x03	0xCDAF1276	0x31 0x32 0x33

This type sends the payload data (123) to the specified destination (0xCDAF1276).The Destination should be the User ID and the payload should not exceed the Length, the exceeded payload will be lost.

Remote parameter settings:

This type remotely changes some particular parameter values. The parameters that can be changed remotely are:

Channel

Ping Enable/Disable

ACK mode Enable/Disable

ATD/DIO select

ATD/DIO configuration bits

ATD/DIO sample rate

The payload field is 12 byte long and is packaged as follows.

Address	Parameter Fields	Channel	Ping E/D	ACK mode E/D	ATD/DIO select	ATD/DIO Configuration	ATD/DIO Sample rate

We can change these parameters either through NW address or MAC address.In order to set these remote parameters using NW address, send that NW address in the Destination field followed by 32 bit data of zero's in Address field in the payload. In order to set these remote parameters using MAC address, send 0xFFFFFFFF in the Destination field followed by the MAC address in Address field in the Payload.

The parameter field indicates which parameter is to be changed in the remote side.

Example:

0x01	Channel	0x00 – 0x0F
0x02	Ping Enable/Disable	0x00 – 0x01
0x04	ACK mode Enable/Disable	0x00 – 0x01
0x08	All ATD-DIO parameters	0x00 – 0x02, 0x00 – 0x3F/0xFF, 0x0001 -0xFFFF

Network address based DIO status transfer:

0x2B	0x0100	0x01	0x00000003	0x00 – 0xFF

This type sends the DIO status to the specified destination (0x00000003).The Destination should be the NW address. This type is used either to send HIGH or LOW to the Destination's DIO port pins.

MAC address based DIO status transfer:

0x2B	0x0110	0x01	0x12FE9A77	0x00 – 0xFF

This type sends the DIO status to the specified destination (0x12FE9A77).The Destination should be the MAC address. This type is used either to send HIGH or LOW to the Destination's DIO port pins.

User ID based DIO status transfer:

0x2B	0x0120	0x01	0xCDAF1276	0x00 – 0xFF

This type sends the DIO status to the specified destination (0xCDAF1276).The Destination should be the User ID. This type is used either to send HIGH or LOW to the Destination's DIO port pins.

Network address based ATD-DIO query:

0x2B	0x0140	0x00	0x00000003	Not used

This type queries the ATD-DIO status of the specified destination (0x00000003).The Destination should be the NW address. This type will be applicable only if the Destination's ATD or DIO is enabled and the sample rate must be 0x0001.in root display of DIO status in serial port must be enabled (ATADD1).

Response format:

0x2D	0x0100	Payload size	0x00000003	payload

The contents of the payload

MAC address	User address	DIO status	ATD0 status	ATD1 status	ATD2 status	ATD3 status	ATD4 status	ATD5 status

Only parameter fields corresponding to ATD's enabled will be displayed.

MAC address based ATD-DIO query:

0x2B	0x0180	0x00	0x12FE9A77	Not used

This type queries the ATD-DIO status of the specified destination (0x12FE9A77).The Destination should be the MAC address. This type will be applicable only if the Destination's ATD or DIO is enabled and the sample rate must be 0x0001. In root display of DIO status in serial port must be enabled (ATADD1).

Response format:

0x2D	0x0100	Payload size	0x00000003	payload

The contents of the payload

MAC address	User address	DIO status	ATD0 status	ATD1 status	ATD2 status	ATD3 status	ATD4 status	ATD5 status

Only parameter fields corresponding to ATD's enabled will be displayed.

User ID based ATD-DIO query:

0x2B	0x0200	0x00	0xCDAF1276	Not used

This type queries the ATD-DIO status of the specified destination (0xCDAF1276).The Destination should be the User ID. This type will be applicable only if the Destination's ATD or DIO is enabled and the sample rate must be 0x0001.

Response format:

0x2D	0x0100	Payload size	0x00000003	payload

The contents of the payload

MAC address	User address	DIO status	ATD0 status	ATD1 status	ATD2 status	ATD3 status	ATD4 status	ATD5 status

Only parameter fields corresponding to ATD's enabled will be displayed.

Exit command:

0x2B	0x0400	0x00	0x00000000	Not used

This type helps us to come out of the API mode.

Note:

DIO status transfer (NW/MAC/UserID) will change all the DIO pins. User must be aware of using this type as it changes the status of all the DIO pins.

9.3.4 Tarang Module to Host:

NW address based Regular Data Transfer:

0x2D	0x0001	0x03	0x00000003	0x31 0x32 0x33

This type specifies it's a NW address based regular data and the Source address specifies the NW address of the source.

Ping Response:

0x2D	0x0004	0x14	0x00000003	Registration message

This type specifies it's a ping response packet and the Source address specifies the NW address of the source. The contents of the Registration message are as follows.

Network Address

MAC Address

Router's Network Address

Router's MAC Address

User ID

Each parameter in the Registration message is of 32 bits.

MAC address based Regular Data Transfer:

0x2D	0x0020	0x03	0x00000003	0x31 0x32 0x33

This type specifies it's a MAC address based regular data and the Source address specifies the NW address of the source.

User ID based Regular Data Transfer:

0x2D	0x0040	0x03	0x00000003	0x31 0x32 0x33

This type specifies it's a User ID based regular data and the Source address specifies the NW address of the source.

Network address based DIO status:

0x2D	0x0100	0x01	0x00000003	0x00 – 0xFF

In case if the DIO status display (ATADD) is selected for both serial and port pins(1 or 2), this type specifies it's a Network address based DIO status data, the Source address specifies the NW address of the source and the payload contains the DIO status.

MAC address based DIO status:

0x2D	0x0110	0x01	0x00000003	0x00 – 0xFF

In case if the DIO status display (ATADD) is selected for both serial and port pins(1 or 2), this type specifies it's a MAC address based DIO status data, the Source address specifies the NW address of the source and the payload contains the DIO status.

User ID based DIO status:

0x2D	0x0120	0x01	0x00000003	0x00 – 0xFF

In case if the DIO status display (ATADD) is selected for both serial and port pins(1 or 2), this type specifies it's a User ID based DIO status data, the Source address specifies the NW address of the source and the payload contains the DIO status.

10. Placement Guidelines

For obtaining the best possible range, the following guidelines must be adhered to while using Tarang modules.

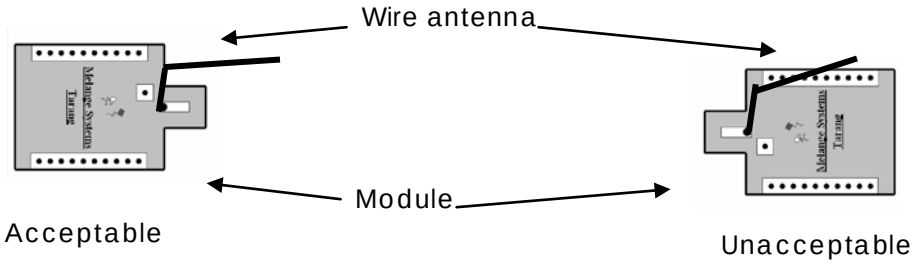
1. It is important to ensure that the antennas (chip or wire) on the modules "see" open space around them. Hence the modules must be mounted in such a way that there are no blocking obstacles immediately next to the antennas. The modules must never be put inside a metallic enclosure unless an external antenna is being connected to the module. The modules must not be placed too close to a wall, table or metallic surfaces.

2. The modules must be placed as high as possible from the ground.

3. Polarization of the antennas must be the same at both sides of the link. For modules with chip antennas, the mounting should be such that the axes of the modules are parallel to each other. For wire antenna modules, the modules must be mounted such that the wires are parallel.

4. As far as possible, obstacles should be avoided in the communication path between the modules. Metallic objects and concrete walls produce a lot of attenuation and these must be avoided to the extent possible.

5. When using wire antennas, the wire may be bent only if necessary. But in that case, the wire can be bent away from the module but never over the module itself as shown below.



11. Hardware Versions

Version no.	Supports	Additional Hardware Changes
1.0	All the listed functionalities in User Manual V 2.2	None
2.0	All the listed functionalities in user manual V2.2	I/O Pins 21,22 included for future development.

12. Firmware Versions

Version no.	Supports	Additional "AT" commands added
1.0	1. Serial interface and basic functionality	None
1.1	1. Handshaking signals 2. Sleep modes 3. Digital I/O interface	None
1.2	1.storing permanent serial number 2. Duplex communication.	None
1.3	1. Enhancement to sleep modes.	None
1.4	1. Configuring DIOs on both the side.	None
1.5	1. Changed from 8 to 10bit ADC. 2. DIO ADC can be enabled simultaneously.	ATTDA, sampling time for ATD, DIO.
1.6	1. Bulk file transfer with enabling handshake and acknowledgement.	None
0.001	Mesh functionalities	none
3.0	Mesh functionalities with enhancement in flash parameter handling.	none

13. Contact Melange Systems

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