RT-HUB User Manual

Revision 1.3

August 2025

Contents

The RT-Hub is a custom-made communications hub specifically designed for use on motorsport events. It can be used on any control to pass or receive timing information.

Specification:

- Lora long range duplex RF
    - 30Km range
    - 868Mhz
    - 8 independent channels
    - Spread spectrum 6 to 12 channels
    - Passive or active retry mechanism
- Quad band GSM modem. Or LTE-4G/GSM modem
- Clear indication of connection status and message delivery
- Rechargeable polymer battery 2.0 Ah
- Typical battery life 120 hours (5 days)
- USB rechargeable
- Waterproof (IP 56)
- Lightweight 170g
- Autonomous operation

Battery life will depend entirely on how much data is being transmitted and the quality of the mobile phone signal available. In a good signal area the hub can hold a GSM connection to the server for 4 days continuous use.

In all cases, a hub can operate for a full 12 hour event with a full battery.

If the units are in store for more than 7 days it is recommended that they receive a few hours charge before use to top up the batteries.

Not all units will have either RF or GSM modules fitted and therefore will not be able to operate in all modes listed. This is indicated on a sticker on the front of the unit.

Any ECM clock connected to a comms hub should be configured in CSV or LNK comms mode (NOT RF)

Power control

The unit is powered on by pressing the Mode key followed by the RF select key.

Power off by pressing Mode until mode 0 is selected. The unit will then shut down all connections and switch to low power mode.

Location.

The unit must be located at least 1m off the ground with the antennae in a vertical orientation. Where a display is being used (Arrival, start or stop) this is best achieved sticking the unit to the back of the display with the Velcro provided.

On a flying finish, the unit can be placed on top of a vehicle, fence post, wall or whatever is available. The range will be massively impacted if the unit is left on the ground.

Mag mount whip antennae are available for both the RF and GSM comms. These give improved range / sensitivity when attached to the roof of a vehicle but will not give any benefit if a suitable ground plane is not present.

The 4G units require a larger antennae

Controls and Indicators

Press and hold the MODE key to see the GSM/4G signal strength. This will keep displaying until the RF Select key is pressed.

To change RF mode, press and hold the RF Select key until a low tone is heard, then press Rf select to pick the channel.

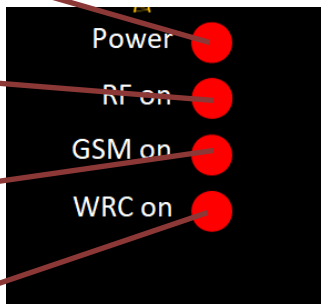
Unit active & powered on.

Flashes when battery is low

RF module is enabled for either receive or transmit

connection to cellular network is enabled

Connection to ECM timer is active



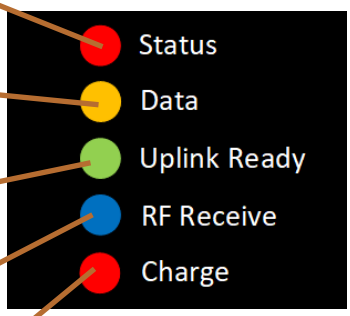
Indicates an error with GSM connection, data or module

Lit if data to be sent is still in the unit. Off when all data sent

Lit when connection to the server is ready and active.

Flashes for each packet sent of received on the RF network

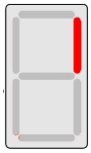
Lit whilst the internal battery is being charged



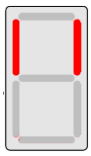
GSM / 4G initialisation

When one of the GSM modes are selected, the unit will run through a connection sequence which can take up to 2 minutes. If the sequence fails, the display will briefly show the selected mode again and the sequence will restart. In most cases, a failure will be because there was insufficient signal to make a connection. Try a different antennae arrangement, re-position the unit or try a unit with a different SIM fitted.

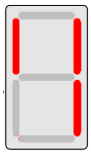
The sequence is displayed using individual segments on the display:



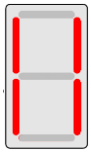
Initialise the hardware



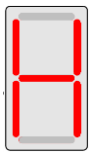
Establish comms with the hardware



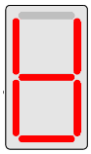
Check if the SIM is working



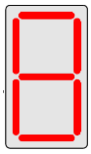
Open PDP session (mobile transport layer)



Open TCP connection



Open server connection



Server connection established.

Operating modes

1. RF transmit only
2. GSM transmit only
3. RF receive, GSM Transmit
4. RF & GSM Transmit
5. RF receive only
6. RF repeater (send and receive)
7. RFID Tag reader to GSM
8. GSM Modem
9. RF test mode
10. A GSM & RF receive (Stop line)
0. Power off

1. RF Transmit only.

This is used to send data from one control to another using the long-range RF module.

This is typically from the Flying finish to the stop line but can be from any control to a location where there is a GSM signal to allow results to be passed back to results.

It can also be used to directly pass data to the results office on a single venue without using the cellular network.

The RF channel must be set the same on all devices that intend to communicate with each other.

When sending times between ECM clocks, ensure that the stage number on the flying finish is set the same as the stop line.

2. Mobile transmit only.

This should be used for any control where the clock times want to go straight to results. This is typically stage Arrival, stage Start, service controls and regroup but can also be used on a stop line if directly connected to a beam.

After selecting mode 2 it can take up to 1 minute to connect to the cellular network and open a connection to the server. Once this is working the green led will come on. Any data received by the unit up to this point will then be quickly uploaded.

The yellow data led will come on briefly for each time received from the clock and go off once it has been sent successfully.

If the red status led comes on instead of the green led a connection could not be made. Consider using a different antenna, get the unit/antennae higher off the ground or move to a different location.

This mode can be used to buffer data during the vehicle runs and then moved to a known good signal location to quickly upload the data. It could also be used for a unit held by the sweeper car to collect any missing data.

3. RF receive, GSM transmit

This should be used where the control location does not have any mobile phone signal but a suitable location has been identified a few hundred meters away. It will also send data from a clock if one is connected and allows controls to be linked, such as arrival and start, see later section. It is not necessary to plug in a clock if being used as a relay point.

It can also be used on the STOP line if there is a cellular signal and car numbers are to be entered at the stop rather than the flying finish.

The green led should be on as per mode 2 for successful operation.

4. RF and GSM Transmit

This mode will send any clock times directly to results and to a remote clock so is normally reserved for the flying finish control.

Sending times from FF directly to results is the recommended operation because it does not rely on the communications to the stop line working, it does however have the disadvantage that the stop line cannot correct any mis-types car numbers.

The green led should be on as per mode 2 for successful operation. If there is no workable cellular signal at the flying finish mode 1 should be used instead and a clock in mode 3 positioned where a signal is available.

5. RF receive only.

This mode should be used on the STOP line where mode 4 is being used on the flying finish and will pick up times sent over RF and pass them to a connected clock.

The mode can also be used to pass information directly to a PC in the results office. Several controls can all transmit data over RF back to a mode 5 receiver.

6. RF repeater.

This mode is used to increase the range of an RF transmission or to avoid an obstacle.

The hub will listen on the selected channel for messages and re-transmit anything it receives. It is not necessary to plug in a clock for this to operate.

Only one repeater can be used on a given run to avoid messages being pinged back and forth between units.

Repeater operation works best in active retry mode

7. RFID reader.

This allows an RFID reader head to be plugged directly into the hub with no clock required.

This configuration requires the tag data to be uploaded to the hub and the clock setting before use and used when monitoring vehicle movement, for example counting the number of times round a loop in the track or into the service area.

8. GSM Modem

This is for development use only and connects the hub data port directly to the GSM modem so its command set can be tested directly.

No clock data will be processed in this mode.

9. RF Test mode

In RF test mode the hub will transmit a test message over RF every 3 seconds using the current RF channel selection. Any hubs in range, in RF receive modes (3 or 5) and on the same channel will beep three times when they receive the message and briefly display the signal strength.

The signal strength is shown in Hexadecimal (0-9, A-F) where F is the strongest signal and 0 the lowest. This allows different positioning and antenna configuration to be tested without someone pressing buttons at the sending unit.

The receiving unit will reply and the signal strength from stop back up will be shown on the Flying Finish unit

No data will be sent to or from a clock in this mode.

Test mode can be switched off from the flying finish by selecting the required mode (1 or 3) or from the stop line by holding down the mode button for 3s. this will send a command back to the flying finish to return to mode 1 if the stop is configured as mode 3 and 4 if configured in mode 5.

A. GSM receive mode. (mirror mode)

This mode should be used on the STOP line as an alternative to mode 3 where RF communication is likely to be difficult. The flying finish unit should still be in mode 4 since this mode will receive both RF and GSM information and ignore duplicates.

When the mode is selected and the connection to the server established, the mode A will flash on the display unit the unit can determine the stage number being used. Simply press STOP on the stop

clock, enter any car number and enter to send a time to the communication hub. The current stage number setting will then be used. Any clock sending times of this stage number to the sever will be mirrored back to this stop line. There is no restriction on distance, provided the fling finish and stop are connected to the mobile phone network and the stage numbers set the same times will be passed.

Recommended operating modes

Mode 2

ATC

START

Stand-alone MTC, Arrival, Start, Service and regroup controls. This is to pass times directly from a clock back to results. The RF sections are not enabled in this mode.

Press the mode button until 2 is displayed on the unit.

The unit will seek for a suitable mobile signal which can take up to 1 minute. The green “Server ready” light will come on when the link is established

The unit will auto-reconnect if the signal is lost.

The red status light will come on if the unit has been unable to connect after several attempts. Try a larger antenna or reposition the unit to get a better signal.

Mode 4 and 3

Flying finish to stop

Mode 4 should be used on the Flying finish and mode 3 on the stop line where a GSM signal is available on the flying finish.

This means that if the signal is lost at either location, it is still sent to results.

RF Channels.

There are 8 independent RF channels available to ensure stages and controls do not interfere with each other. The 8 channels have different characteristics so one channel may operate correctly in a heavily forested area where another may give better range in open ground.

To change the channel. Press and hold the RF select key until a low tone is heard. Then press RF Select until the desired channel is found.

Please give feedback if you get particularly good / bad results in any set of conditions to help improve this guide.

Channel	Spreading factor	Bandwidth	Comments
0	5	31.25 kHz	Fast data
1	6	15.63 kHz	
2	7	31.25 kHz	
3	8	250 kHz	
4	9	250 kHz	
5	10	125 kHz	Best open field range
6	11	250 kHz	
7	12	500 kHz	

RF retries.

The RF transmission system uses 100% redundancy and a polynomial checksum to ensure only valid data is decoded and passed on. This means that if a packet is corrupted it will be thrown away so a system to retry each message is required for successful communication.

The hub has three retry methods:

Method	Display	Meaning
Active	A	The receiving unit must actively reply to say it has received the message
Passive	P	Each message is sent repeatedly over a few seconds without checking
None	-	Each message is just sent once with no checking.

By default, active mode will be enabled on all units so it is not normally necessary to adjust.

To select the retry method, press and hold the RF channel key until the unit boops and one of the three letters appear on the display. Keep the button held and the unit will cycle through all three settings. Let go of the key when the desired setting is shown.

Active mode should be selected on both the unit transmitting and the unit receiving messages for correct operation and is the default recommended mode.

Passive retries can be used when the range is long or difficult, or there are multiple units receiving the same information

No retry should only be used when line of sight comms is possible and data loss would not be a problem.

Command interface

The hub has a simple command interface to allow various settings to adjusted by plugging in a laptop to the serial port.

The laptop should be configured for 9600 baud, 8 data, no parity and you may need to enable character echo so you can see what you have typed as well as sending CR with LF

All commands start with a % and finish with a <CR> and are in uppercase.

Each command requires a parameter, separated by a : which can be between 1 and 32 characters. Sending too few characters is likely to result in an unexpected value being written.

Parameter changes are permanent and can only be reset by sending a new value or re-flashing the code.

Several commands can be stacked on one line with a maximum of 128 characters

e.g.

%STAGE:20,OPMODE:2,SIM:1234
Sets the stage, operation mode and SIM number.

Any changes to the server connection (APN, username, port) will require a restart to apply.

Name	**Length**	**default**	**Use**
APN_APN	32	Wlan.com	Cellular network access APN
APN_PAS	8	RABTimin	Password to access APN
APN_USR	8	RABTimin	Username for APN
DUPES	1	Y	Allow duplicate messages over GSM
OPMODE	1	1	Unit operation mode 1-9
PKTID	2	AA	Cyclic ID for packets over RF
PORT	5	49152	Port number for socket connection to server
RETRYM	1	A	RF retry mode Auto, Passive or None
RFFREQ	1	1	RF channel 0-7
SERVER	32	Clocks.rallies.info	Results server name
SIM	4	9999	SIM number for GSM connection
STAGE	2	90	Stage number used when in TAG mode
TAGHOLD	2	0500	MM:SS holdoff for tag reads of same tag
TAGSTOP	1	3	Filter for tag info routing, see below
BLANKS	1	7	Filter for times with no car number, see below
TEAM	4	9999	Team number for tracking
VOLUME	1	7	Limit beeps and boops, see below

Command			
REBOOT	1		Set to Y to make unit reboot
CONFIG	1		Set to Y to list all config items
SLEEP	1		Set to Y to put unit to sleep
CLRTAG	1		Set to Y to clear all RFID tag data
VERSION	1		Set to Y to return version string

%BLANKS:x

The BLANKS command can be used to stop unassigned beam breaks (or anything with no car number) being sent to results, or elsewhere if required.

The default is 7 so blank records will be sent everywhere.

Setting to 3 would filter out beam breaks being sent to results until the car number was entered at the stop line.

X	Over GSM	Over RF	To Timer
0	N	N	N
1	N	N	Y
2	N	Y	N
3	N	Y	Y
4	Y	N	N
5	Y	N	Y
6	Y	Y	N
7	Y	Y	Y

%TAGSTOP:x

Similar to the above, but to stop unnecessary tag data being transmitted to the stop clock. The same table applies.

If the flying finish unit is sending to results, use setting 4 to send just to results and not to the stop line.

If the stop line unit is sending to results, use setting 7 on the FF unit and setting 6 on the stop.

VOLUME:y

Y	
0	All sound off
1	Just key press sound
2	Just command action commands
3	Key press and command sounds
4	Message received beep enabled
5	Message received beep enabled, key press sounds

6	Message received beep enabled, command sounds
7	All sounds enabled

Software versions

1.0 January 2021

Limited to mode 2 operation only.

1.1 August 2021

GSM and RF operation.

1.2 8 January 2022

- Allow RF comms whilst connecting to GSM
- Comms re-initialised when coming out of sleep mode
- RF Ch6 changed to B/5 from B/3
- default retry set to Active
- RF test mode (PING) will now go through a repeater
- Beeps and Boops can now be switched off
- Sleep command added
- RFID tags can now be inhibited over RF link or to clock
- Times with un-assigned vehicle (blanks) can now be inhibited from any comms
- option to inhibit possible duplicates on GSM if no reply from server,
- low battery indicator led
- receiver RF and LNK mode as well as CSV
- Tag reader interface
- Drop out of test mode command from stop line
- lora RF preamble increased from 12 to 142 symbols
- Work on sleep (0) to ensure GSM if fully off

1.3 17 January 2022

- In ping mode, stop feedback loop between two units receiving
- added protocol for multi-layer repeaters
- RF Channel 1 changed to 41K bandwidth

1.4 19 July 2022

- Increased symbol detect on RX to 12 from 4
- check for RXTimeout and reset on error

1.5 8 August 2022

- Above timeout seemes to cause more issues that it fixes! removed
- Check for in an rF rx mode before replying to ping to stop howl

1.6 13/09/22

- Improvements to start sequence

1.7 21 January 2024

- added support for receiving and sending SP speed records
- clear all memory on wakeup
- bugfix for more than 21 items in config list

1.8 7 November 2024

- sleep improved from 650uA to 10uA
- default RF to 5
- forces SIM800 on at power up to ensure it gets switched off

1.9 10 January 2025

- Mode A to request a mirror of times from a control
- Async receive of % commands to pass onto clock
- RF Chanel now locked until RF moded pressed and held
- GSM signal strength displayed when connected to GSM & long press of MODE
- % Interface is now case insensitive

2.0 22 Feb 2025

- Added holdoff of 7.5s on speed events arriving over serial comms - speed displays issue

2.5 01 June 2025

- Support for SIM7080 4G module.
- Leds stay on to power module
- Lots of work with 4G start sequence
- Fixed bug with Blip

2.60 11 June 2025

- testing & debugging MIRROR

2.70 15 June 2025

- SIM800 (GSM) now waits for ACCEPTED from the server

2.71 16 June 2025

- SIM7080 sequencing adjustments...
- SIM7080 mode A

2.72 15 August 2025

- Mirror command now captures control letters to allow SS, SF FF or RT(RG) use

2.80 01 September 2025

- support for A7682E LTE modem
- timeout on any packet of 12s

RAB Timing Ltd

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