WTS Technical Manual

Programming guide and advanced documentation Document No: 23352 Rev a



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Introduction / Overview

This manual contains advanced information on WTS telemetry range of devices. This includes more detailed information than supplied in the device manuals and also programming information.

To communicate with WTS devices a base station is required. Base stations will offer RS232, RS485 and USB interfaces.

Refer to the Base Station section WTS-BSi and WTS-BSU for details on connections and interfacing.

2.4GHz Radio General

Communicating with WTS Devices

To communicate with WTS devices a base station is required. Base stations offer RS232, RS485 and USB interfaces. In this section we will describe the interfaces and how data shall be sent to and retrieved from other WTS devices via the base station.

For details regarding device specific communications you will need to refer to the appropriate device section of the manual.

Packet Types

There are several different packet types, which are used depending on the type of data carried. Read and Write packets are used to communicate with a device (When it is awake) and can read or write parameter values.

Some devices transmit data at regular intervals and this data does not need requesting.

Woken packets are received when a device is successfully woken.

Packet Structure

All packets conform to the following structure. The Data Packet part changes depending on what packet is being transported.

| **Length | **Length | Base | Packet | Data Packet Structure | *CRC1 LSB | *CRC2 MSB |
|----------------------------------|----------|---------|--------|-----------------------|-----------|-----------|
| | | Address | Туре | | | |
| 1 Byte | 1 Byte | 1 Byte | 1 Byte | Variable Bytes | 1 Byte | 1 Byte |
| * CRC calculated on this part | | | | | | |
| ** Length refers to this section | | | | | | |

This Transport Packet is used to carry the Data Packets into and out of the target device via the base station.

Where:

- Length bytes are identical and contain the length of just the Data Packet section.
- The CRC bytes are CRC 16 values of all bytes from Length up to and including Data section.
- Base Address is the address of the base station used where multiple base stations are deployed. Base station addresses can range from 1 to 16 and is set by DIP switches on the base station. NOTE: The WTS-BSU is fixed at address 1.
- The Packet Type byte defines the packet type thus defining the Data Packet Structure. In received packets this byte also indicates Error, Low Battery and Broadcast status.

Handling Base Station Data

The packets arriving at the base station serial or USB port are not hand shaken. Data may arrive as a partial packet or many packets may arrive together. Therefore the recommended best practice to handle data is to place arriving data into a circular buffer and to detect the packets from this buffer by looking for a length byte pair. Then look forward in the buffer at the CRC position (if the buffer contains enough bytes) and check whether the CRC is valid. If so you can extract and use the packet. If not then advance the start of the circular buffer until you find a matching byte pair then check for a valid CRC again.

CRC

The CRC algorithm is identical to that used in Modbus communications and should be calculated for outgoing packets and checked on incoming packets. The following BASIC example is of a function that will calculate the CRC of a string and append the two CRC bytes to the end of the string

```
SUB GenerateCRC16(sTarget AS STRING)
    'reads from buffer
    DIM CRC AS LONG
    DIM LSB AS INTEGER
    DIM C AS LONG
    DIM D AS INTEGER
    DIM Res(1) AS BYTE
    CRC = 65535
    FOR C = 1 TO LEN(sTarget)
         'xor byte
        CRC = CRC XOR ASC(MID$(sTarget, C, 1))
        FOR D = 1 TO 8
             'get lsb
            LSB = (CRC AND 1) = 1
             'move right
            CRC = INT(CRC / 2)
            'if LSB was 1 xor with polynomial
IF LSB THEN CRC = CRC XOR (&HA001&)
        NEXT D
    NEXT C
    sTarget = sTarget & CHR$((CRC AND 255))
    sTarget = sTarget & CHR$(INT(CRC / 256))
END SUB
```

Packet Type Byte

The Packet Type bytes indicates the type of packet and holds information regarding Error, Low Battery and Broadcast status of received packets.

| bit7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 | bit 0 |
|-------|--------|-----------|-------|-------|--------|--------|-------|
| Error | LoBatt | Broadcast | | | Packet | t Туре | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | |

| Bit | Function | Value | Туре | Description |
|-----------|---|-------|--------------------------|--|
| Error | Error Bit indicated an error is present. This is set and reset by the | | Data Provider | Used to provide unrequested data. |
| | device, which will include this information in the packet sent to | 5 | Read | Read data from a specific device. |
| LoBatt | the module.BattBit indicated a low battery. This is set and reset by the device, which will include this information in the packet sent to | | Write/command | Write a value or execute a command to a specific device |
| | | | Response ACK | Response - Acknowledged. May also contain data. Response - Not |
| Broadcast | Used to indicate that a routed packet was broadcast so the receiver knows not to respond. | | | Acknowledged. The command was not recognised. |
| | | 9 | Response Timeout | Response Timed out. A response was not received by the device. |
| | | 10 | Response Data Invalid | Response - Data invalid. The device has reported |

that the data in a Write was invalid or out of range.

Data Packet Structures

The following structures show how the data is defined within the Data Packet Structure of the overall packet.

Data Provider

These packets are sent at intervals by some devices and contain data. There is no need to request these packets as they arrive automatically. If you have multiple base stations and these are within the range of the transmitting device the packets will arrive from each base station.

| Packet Type | Data Tag | | Status Data Type | | Data | RSSI | CV |
|-------------|-------------|----|---------------------|----|------|------|----|
| 03 | 00 | 00 | 00 | 00 | [] | 00 | 00 |

Packet Type

This is 0x3 hex (3 decimal) and may have higher bits set which indicate Error, Low Battery and Broadcast.

Data Tag

Every device that transmits **Data Provider** packets has a configurable 2 byte **Data Tag**. Devices that consume Data Provider Packets can be configured to look for specific Data Tags. The reason we use Data Tags and not just rely on a devices ID for identification is that in a working system multiple devices may be relying on data from a single device. If that device were ever replaced then its unique ID would change and therefore multiple devices would have to be reconfigured. By using a Data Tag we only need to change this tag on the replacement device and the rest of the system will work as required.

Status

The bit values in this byte are used to indicate certain things. Only two bits are allocated a global meaning. The rest are device specific and you will need to refer to the device manual for clarification.

| Status Byte | | | | | | | |
|-------------|-------|-------|-------|-------|-------|-----------|-----------|
| bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 | bit0 |
| Х | Х | Х | Х | Х | Х | Integrity | Shunt Cal |

Data Type

This byte defines how the data is formatted in this packet and also indicates the best way to represent the data.

| Function | Display As | | | | Data Type | | | |
|----------|------------|---|---|---|-----------|---|---|---|
| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Sample | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |

| Display As | Туре | Description |
|------------|----------------------|---|
| 0 | Undefined | |
| 1 | Numeric | Numeric representation based on Data Type |
| 2 | Boolean | The data may be in any format but represents a boolean result where non zero numeric is True and string length > 1 or > 0 is True |
| 3 | Text | Can display as ascii text |
| 4 | Binary (unprintable) | Unprintable characters |
| 5 | Hex | Best represented as hex |
| 6 | Bit Map (10110101) | Each bit value should be shown |
| 7 | Percent | Numeric or string value has a value 0 - 100 |

| Data Tura | Description | Cine In Destan |
|-----------|--------------------|----------------|
| Data Type | Description | Size in Bytes |
| 0 | No content/unknown | 0 |
| 1 | UINT8 | 1 |
| 2 | UINT16 | 2 |
| 3 | INT32 | 4 |
| 4 | Float | 4 |
| 5 | String | 0-64 |
| 6 | Binary | 0-64 |

NOTE: See Data Type Formats in Appendix A

The Display As bits should be used where possible as this can help in presenting the data for display purposes.

Data

This will be of variable length and will depend on the data type.

RSSI

This indicates the signal strength that this packet was received at. See RSSI & CV in Appendix A.

CV

This indicates correlation value which equates to the quality of the signal when this packet was received. See **RSSI & CV** in **Appendix A**.

See Advanced Data Provider Interface in

Read

The read packets are used to read parameters from a remote device or the base station itself. To talk to the base station just use the base station ID.

| Packet Type | To ID | | | Command |
|-------------|-------|----|----|---------|
| 05 | 00 | 00 | 00 | 00 |

Packet Type

This is 0x5 hex (5 decimal).

To ID

This is the ID of the device to read from (MSB first).

Command

The command number of the parameter you want to read. You will need to refer to the device manual for this information.

Write

The write packet is used to write parameter values to a device or execute commands.

You can write any supported data format to any other data format parameter but some formats are not very suitable. i.e. You can write an INT32 formatted value to a parameter that is just a UINT8 but if the value exceeds either the target data type limits or any other bounded limits imposed by the device you will receive an INVALID_DATA response.

When executing a command you do not need any data so it is usual to specify the data type as No Content (zero) and not include any data.

| Packet Type | | To ID | | Command | Data Type | Data |
|-------------|----|-------|----|---------|-----------|------|
| 06 | 00 | 00 | 00 | 00 | 00 | [] |

Packet Type

This is 0x6 hex (6 decimal).

To ID

This is the ID of the device to write to from (MSB first). You can use the broadcast ID here of 0xFFFFFF (255 decimal for each of the To ID bytes) but be careful as this will write the value to all devices on the same channel and encryption key. You may have mixed device types so command numbers between devices may be different. Use broadcast with care.

Command

The command number of the parameter you want to write to. You will need to refer to the device manual for this information.

Data Type

Specify the data type of the data you are sending. Data types are as follows:

| Data Type | Description | Size In Bytes |
|-----------|--------------------|---------------|
| 0 | No content/unknown | 0 |
| 1 | UINT8 | 1 |

| 2 | UINT16 | 2 |
|---|--------|------|
| 3 | INT32 | 4 |
| 4 | Float | 4 |
| 5 | String | 0-64 |
| 6 | Binary | 0-64 |

NOTE: See Data Type Formats in Appendix A

Responses to Read and Write...

The response to either a read or write can be as follows: Responses to Read: ACK, NAK, TIMEOUT Responses to Write: ACK, NAK, TIMEOUT, DATAINVALID

ACK

If the ACK response is for a write then it will not contain data:

| Packet Type | From ID | | | RSSI | C۷ |
|-------------|---------|----|----|------|----|
| 07 | 00 | 00 | 00 | 00 | 00 |

Packet Type

This is 0x7 hex (7 decimal) and may have higher bits set which indicate Error, Low Battery and Broadcast.

From ID

This contains the ID of the device that sent the packet.

RSSI

This indicates the signal strength that this packet was received at. See RSSI & CV in Appendix A.

CV

This indicates correlation value which equates to the quality of the signal when this packet was received. See **RSSI & CV** in **Appendix A**

If the ACK is in response to a READ then it will contain data:

| Packet Type | From ID | | Data Type | Data | RSSI | C۷ | |
|-------------|---------|----|-----------|------|------|----|----|
| 07 | 00 | 00 | 00 | 00 | [] | 00 | 00 |

Packet Type

This is 0x7 hex (7 decimal) and may have higher bits set which indicate Error, Low Battery and Broadcast.

From ID

This contains the ID of the device that sent the packet.

Data Type

This byte defines how the data is formatted in this packet and also indicates the best way to represent the data.

| Function | Display As | | | | | Data | Туре | |
|----------|------------|---|---|---|---|------|------|---|
| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Sample | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |

| Display As | Туре | Description |
|------------|----------------------|---|
| 0 | Undefined | |
| 1 | Numeric | Numeric representation based on Data Type |
| 2 | Boolean | The data may be in any format but represents a boolean result where non zero numeric is True and string length > 1 or > 0 is True |
| 3 | Text | Can display as ASCII text |
| 4 | Binary (unprintable) | Unprintable characters |
| 5 | Hex | Best represented as hex |
| 6 | Bit Map (10110101) | Each bit value should be shown |
| 7 | Percent | Numeric or string value has a value 0 - 100 |

| Data Type | Description | Size In Bytes |
|-----------|--------------------|---------------|
| 0 | No content/unknown | 0 |
| 1 | UINT8 | 1 |
| 2 | UINT16 | 2 |
| 3 | INT32 | 4 |
| 4 | Float | 4 |
| 5 | String | 0-64 |
| 6 | Binary | 0-64 |

NOTE: See Data Type Formats in Appendix A

RSSI

This indicates the signal strength that this packet was received at. See RSSI & CV in Appendix A.

CV

This indicates correlation value, which equates to the quality of the signal when this packet was received. See **RSSI & CV** in **Appendix A**

NAK

This packet is returned if the device receiving the read or write does not recognize the command number.

| Packet Type | From ID | | | RSSI | CV |
|-------------|---------|----|----|------|----|
| 08 | 00 | 00 | 00 | 00 | 00 |

Packet Type

This is 0x8 hex (8 decimal) and may have higher bits set which indicate Error, Low Battery and Broadcast.

From ID

This contains the ID of the device that sent the packet.

RSSI

This indicates the signal strength that this packet was received at. See RSSI & CV in Appendix A.

CV

This indicates correlation value, which equates to the quality of the signal when this packet was received. See **RSSI & CV** in **Appendix A**

TIMEOUT

This packet is returned if the device does not respond.

| Packet Type | From ID | | | RSSI | C۷ |
|-------------|---------|----|----|------|----|
| 09 | 00 | 00 | 00 | 00 | 00 |

Packet Type

This is 0x9 hex (9 decimal) and may have higher bits set which indicate Error, Low Battery and Broadcast.

From ID

This contains the ID of the device that sent the packet.

RSSI

This indicates the signal strength that this packet was received at. See RSSI & CV in Appendix A.

CV

This indicates correlation value, which equates to the quality of the signal when this packet was received. See **RSSI & CV** in **Appendix A**

DATA INVALID

This packet is returned if the device has been written to and the data written is invalid.

| Packet Type | From ID | | | RSSI | C۷ |
|-------------|---------|----|----|------|----|
| 0A | 00 | 00 | 00 | 00 | 00 |

Packet Type

This is 0xA hex (10 decimal) and may have higher bits set which indicate Error, Low Battery and Broadcast.

From ID

This contains the ID of the device that sent the packet.

RSSI

This indicates the signal strength that this packet was received at. See RSSI & CV in Appendix A.

CV

This indicates correlation value, which equates to the quality of the signal when this packet was received. See **RSSI & CV** in **Appendix A**

Pairing...

Pairing is a method of communicating between two devices so that they configure themselves to one or another's radio settings and enables them to identify each other by means of ID and default Data Tag. Additionally the pairing mechanism can pause a device from performing its default behaviour as some devices operate in a low power mode where they are mostly asleep. This makes communications impossible so the pairing process stops the low power behaviour.

The pairing process is usually initiated by one device (a handheld for example or PC software using a base station) and this enters pairing master mode and is ready to pair for a user defined time period.

Next the other device is put into its pair mode at which time it negotiates with the other device and they will decide on what to do based on their function. Devices are normally put into pair mode by power cycling them. Please refer to the device documentation.

For the scope of this document we are concerned with manually controlling the pairing using a base station. You would use pairing for the following reasons:

- You have a device whose communications settings are unknown.
- You want to connect to a device that operates in low power mode and is mostly asleep.
- The device you want to talk to may have a normal operational function that you want pausing while you configure it.
- You just want to change the communications settings of a device to match it to a base station settings.

Pair Request

| Packet Type | Data Tag | | Direction | Config | Duration (optional) |
|-------------|----------|----|-----------|--------|---------------------|
| 13 | 00 | 00 | 00 | 00 | 00 |

Packet Type

This is 0x13 hex (19 decimal).

Data Tag

You need to supply a Data Tag, which may be useable by the device to which you are pairing. Usually from a base station this is not required and can be set to 0x00, 0x00.

This is present as the same mechanism is used when two devices pair together and in that case they will each want to give the other their default Data Tag.

Direction

The value of this byte determines whether the remote device radio settings are configured to match the base station or if the base station is changed to match the remote device. Both the Channel and the encryption key are matched once pairing has completed.

| Value | Meaning |
|-------|---|
| 0 | The settings in the remote device are changed to match the base station settings. |
| 1 | The base station settings are changed to match the remote device. |

Config

The value of this byte determines whether the remote device will enter configuration mode, which will inhibit any low power operation, transmission of data provider packets and the ability to enter deep sleep mode. This mode is required otherwise communication whilst configuring could be very poor or impossible.

| Value | Meaning |
|-------|--|
| 0 | Do not change operation. |
| 1 | Cause the device to enter config mode to enable it to be configured. |

NOTE: after pairing with a device and using the **Config** option it is recommended that the device be power cycled after so that it resumes its normal operation.

Duration

The value of this byte determines whether the base station will be in pair mode for the default time of 5 seconds or whether to use the user defined duration in seconds.

To use the default just omit this byte. If this byte is present its ASCII value will be used to determine how long it will be in pairing mode.

NOTE: While in pairing mode the base station will not operate as normal.

If the remote device enters its own pair mode (non master) then the communications negotiations will take place and the device may come out of any low power modes and a response will be sent to the base station.

Pair Response

This packet will arrive at the base station if another device enters pair mode while the base station is waiting to pair. Once this packet has arrived the base station will be free to talk to the device. It can also determine the device ID and Default Data Tag if it needs this information.

| Packet Type | Fro | m ID | | Data | Tag | RSSI | CV |
|----------------|-----|------|----|------|-----|------|----|
| 14 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |

Packet Type

This is 0x14 hex (20 decimal) and may have higher bits set which indicate Error, Low Battery and Broadcast.

From ID

This contains the ID of the device that paired.

Data Tag

This contains the default Data Tag of the paired device.

RSSI

This indicates the signal strength that this packet was received at. See RSSI & CV in Appendix A.

CV

This indicates correlation value, which equates to the quality of the signal when this packet was received. See **RSSI & CV** in **Appendix A**

NOTE: After configuration or calibration you should power cycle the paired device to return it to normal operation.

WTS-BSi and WTS-BSu [Base Station]

Overview

These devices are base stations and interface between the radio and a physical interface for a connection to a PC, PLC or other device.

Addressing

Usually only a single base station is required in a telemetry installation. If a telemetry device is outside the range of the base station a repeater may be deployed.

Some complex topologies may only be realized by using multiple base stations, which may require changes to the **Address** switches. See Multipoint Base Station Section.

Multipoint Base Stations

Sometimes more than one base station is required in a system. This may simply be a central PC with two base stations wired off in opposite directions.



Where one base station handles devices on the left and the other those on the right.

Multiple base stations allow flexibility in routing requests from a PC as each time a packet is sent to a base station it is targeted to a particular base station **Address**. When a packet arrives back at a PC it contains the **Address** of the base station that routed it.

If a base station is the only one connected to a particular serial port then every base station can have **Address** 1 as the PC will send packets to a particular port to select which base station handles a packet, likewise packets arriving back at the PC will be identified by the port that they arrive on.

RS232 devices can only be connected one at time anyway but RS485 allows multiple devices on the same bus. This is where the **Addressing** is vital as it is this that distinguishes between base stations.

When using USB base stations you may only ever have one WTS-BSu connected to a PC at any time. Using WTS-BSi will allow multiple USB base stations to be connected to single PC. Unique Addresses are again required in this instance.

Note that broadcast packets can be received by multiple base stations so packets may appear duplicated at the PC end.

It is also possible for the PC to route a packet through all connected base stations by **Addressing** a packet to Address 0.

NOTE: Although it is possible to connect multiple USB base stations to a PC the **T24drv.dll** driver supplied only supports one Base Station **Addressed** as 1.

So when using a WTS-BSi which supports USB but also has a DIP switch to allow Address setting the Address must be set to 1. The WTS-BSu devices are manufactured with a fixed Address of 1.

Connection

The interface can be selected from the DIP switches SW1 as can baud rates for serial interfaces and the Address of the base station.

SW1 Settings (WTS-BSi only)

Switch positions 1 to 4 select the base station Address. This should normally be 1.

| | 1 | 2 | 3 | 4 |
|---------|-----|-----|-----|-----|
| Address | | | | |
| 1 | Off | Off | Off | Off |
| 2 | On | Off | Off | Off |
| 3 | Off | On | Off | Off |
| 4 | On | On | Off | Off |
| 5 | Off | Off | On | Off |
| 6 | On | Off | On | Off |
| 7 | Off | On | On | Off |
| 8 | On | On | On | Off |
| 9 | Off | Off | Off | On |
| 10 | On | Off | Off | On |
| 11 | Off | On | Off | On |
| 12 | On | On | Off | On |
| 13 | Off | Off | On | On |
| 14 | On | Off | On | On |
| 15 | Off | On | On | On |
| 16 | On | On | On | On |

Switch positions 5 to 7 set whether serial or USB is used. If USB is not selected then the chosen switch settings control the baud rate for the serial interface. Whether the serial interface is RS485 or RS232 is selected by switch position 8.

| | 5 | 6 | 7 | | | |
|-----------|-----------------|-----|-----|--|--|--|
| Baud rate | Baud rate / USB | | | | | |
| USB | Off | Off | Off | | | |
| 9600 | On | Off | Off | | | |
| 19200 | Off | On | Off | | | |
| 38400 | On | On | Off | | | |
| 57600 | Off | Off | On | | | |
| 115200 | On | Off | On | | | |
| 230400 | Off | On | On | | | |
| 460800 | On | On | On | | | |

NOTE:

A baud rate of 9600 (and in some cases 19200) is not suitable for 2 way communication with remote devices as it is too slow and causes timeouts. This baud rate has been included to enable the base station to be connected to a 9600 baud device to allow low rate Data Provider packets to be received.

At any rate below 230400 is may be possible to lose packets at high data rates as the serial cannot keep pace with the radio transmissions.

If USB is not selected as the interface (Switch positions 5 to 7) then this switch position selects whether the serial interface is RS232 or RS485.

| | 8 |
|---------|-----|
| 232/485 | |
| RS232 | Off |
| RS485 | On |

Interfaces

RS232

The RS232 interface uses TX, RX and GND to connect to a PC, PLC etc and uses standard RS232 voltage levels.

| Handshaking | None |
|-------------|--------|
| Data Size | 8 bits |
| Stop Bits | 1 bit |
| Parity | None |

The baud rate can be selected by setting the DIP switches stated above. NOTE: the base station will require power cycling to utilise a baud rate change.

Example connection to a PC 9 way D serial connector.

| PC 9 Way D Plug Pin | Signal Direction | Ba | ase Station Connection |
|---------------------|---------------------|-----|------------------------|
| 3 (TX) | -> | RX | J6 Pin 2 or J7 Pin 3 |
| 2 (RX) | <- | TX | J6 Pin 3 or J7 Pin 2 |
| 5 (Gnd) | | GND | J6 Pin 4 or J7 Pin 5 |
| 8 (CTS) | <- | CTS | J6 Pin 1 or J7 Pin 8 |

RS485

The RS485 interface (This is a 2 wire 485 interface and will not work with 4 wire 485 buses) uses TX, RX and GND to connect to a PC, PLC etc and uses standard RS485 voltage levels.

| Handshaking | None |
|-------------|--------|
| Data Size | 8 bits |
| Stop Bits | 1 bit |
| Parity | None |

The baud rate can be selected by setting the DIP switches stated above. NOTE: the base station will require power cycling to utilise a baud rate change.

Example connection

Depending on the RS485 interface or hardware the connections vary and are not standard therefore we can only show the connections to the base station. You must refer to the user manual regarding your RS485 connection to ascertain the correct connections.

| PC / PLC Connection | Signal Direction | Ba | ase Station Connection |
|-----------------------------------|---------------------|-----|------------------------|
| Refer to RS485 Device User Manual | | A | J4 Pin 3 or J5 Pin 3 |
| Refer to RS485 Device User Manual | | В | J4 Pin 4 or J5 Pin 4 |
| Refer to RS485 Device User Manual | | GND | J4 Pin 5 or J5 Pin 5 |

NOTE: There are two connectors for RS485, J4 and J5. This is to facilitate easy daisy chaining of devices if required.

Serial Limitations

- When using RS232 or RS485 you should use the fastest baud rate possible. At lower rates data can be lost because it can arrive from the radio faster than the base station can send it serially.
- At 9600 baud you will experience communications problems when configuring devices. This baud rate is too slow for anything other than monitoring data provider packets from devices and even then these should be at a low rate (around 20 per second). The slow baud rates are provided to get low rate data into older systems.
- RS485 is a bus master system and is not ideally suited to full communications with devices when multiple devices are providing data. This is fine for the normal operation of data acquisition but it is recommended that only the device to be configured is active during configuration.

USB

Connection to the base station will be either a captive USB cable (WTS-BSu) or a USB socket B for connection using a standard USB A-B cable (WTS-BSi). There is an optional cable assembly for the WTS-BSi to provide for a USB connection while the device is still fitted to the ABS case.

To communicate with the base station the connected device must use the USB HID Device Class and support USB 2.0 full speed interface (12mbits).

The USB connection will also power the base station.

USB Communications

Using the supplied **T24drv.dll** driver is the easiest way to communicate with the base station. However, if you want to write your own communications software you will need the following information:

Vendor ID: 6017 (0x1781 hex)

Product ID: 2980 (0xBA4 hex)

Incoming packets are read from report 0 and contain 64 bytes of data. There will always be 64 bytes even if there are only a few bytes of valid data. These bytes will need placing into a buffer and your software will need to detect and extract complete packets.

Outgoing data is written to report 0 and must always contain 64 bytes of data. Any unused bytes should be set to zero.

Please note that 65 bytes of data are actually sent and received but the first byte indicates the report number so this is always zero.

| Parameter | Value |
|--------------|-----------------------|
| Vendor ID | 0x1781 (6017 decimal) |
| Product ID | 0xBA4 (2980 decimal) |
| Setup Class | HIDClass |
| Service Name | HidUsb |

| Parameter | Value | | | |
|---------------------------|-----------------------------------|--|--|--|
| Connection Information | | | | |
| ConnectionIndex | 0x1 | | | |
| CurrentConfigurationValue | 0x1 | | | |
| LowSpeed | FALSE | | | |
| DeviceIsHub | FALSE | | | |
| DeviceAddress | 0x1 | | | |
| NumberOfOpenPipes | 0x2 | | | |
| | Pipe #0 | | | |
| E | ndpoint Descriptor | | | |
| bLength | 0x7 | | | |
| bEndpointAddress | 0x1 [OUT] | | | |
| bmAttributes | 0x3 (USB_ENDPOINT_TYPE_INTERRUPT) | | | |
| wMaxPacketSize | 0x40 | | | |
| binterval | 0x1 | | | |
| | Pipe #1 | | | |
| E | ndpoint Descriptor | | | |
| bLength | 0x7 | | | |
| bEndpointAddress | 0x82 [IN] | | | |
| bmAttributes | 0x3 (USB_ENDPOINT_TYPE_INTERRUPT) | | | |
| wMaxPacketSize | 0x40 | | | |
| bInterval | 0x1 | | | |
| Device Descriptor | | | | |
| bLength | 0x12 | | | |
| bcdUSB | 0x110 | | | |
| bDeviceClass | 0x0 | | | |
| bDeviceSubClass | 0x0 | | | |
| bDeviceProtocol | 0x0 | | | |
| bMaxPacketSize0 | 0x8 | | | |
| idVendor | 0x1781 | | | |
| idProduct | 0xBA4 | | | |
| bcdDevice | 0x100 | | | |
| iManufacturer | 0x1 | | | |
| iProduct | 0x2 | | | |
| iSerialNumber | 0x3 | | | |
| bNumConfigurations | 0x1 | | | |

| Parameter | Value |
|--------------------|-----------------------------------|
| Con | figuration Descriptor |
| bLength | 0x9 |
| bDescriptorType | USB_CONFIGURATION_DESCRIPTOR_TYPE |
| wTotalLength | 0x29 |
| bNumInterfaces | 0x1 |
| iConfiguration | 0x0 |
| bmAttributes | 0x80 (Bus_Powered) |
| MaxPower | 0x64 |
| Ir | terface Descriptor |
| bLength | 0x9 |
| bInterfaceNumber | 0x0 |
| bAlternateSetting | 0x0 |
| bNumEndpoints | 0x2 |
| bInterfaceClass | 0x3 (Human Interface Device) |
| bInterfaceSubClass | 0x0 (No Subclass) |
| bInterfaceProtocol | 0x0 (None) |
| iInterface | 0x0 |
| E | ndpoint Descriptor |
| bLength | 0x7 |
| bEndpointAddress | 0x1 [OUT] |
| bmAttributes | 0x3 (USB_ENDPOINT_TYPE_INTERRUPT) |
| wMaxPacketSize | 0x40 |
| bInterval | 0x1 |
| E | ndpoint Descriptor |
| bLength | 0x7 |
| bEndpointAddress | 0x82 [IN] |
| bmAttributes | 0x3 (USB_ENDPOINT_TYPE_INTERRUPT) |
| wMaxPacketSize | 0x40 |
| bInterval | 0x1 |

NOTE: If you do not want to use the supplied communications DLL (T24drv.dll) you may be interested in the following:

We have successfully tested Easy HID, which supplies the mcHID.dll, which is a great generic way of connecting to HID devices. This library is free and was written to ease both the programming of PIC devices and create sample code for VB, Delphi and Visual C++.

The USB interface has also been successfully used with Windows CE but we do not supply any drivers for this operating system.

LED Indication

Two LEDS indicate Power/Mode and Activity.

The red LED indicates mode and should flash at a 2Hz rate. If any errors are detected with the radio then the LED will remain lit.

The green LED flashes once for each packet received or transmitted via radio, USB or serial.

Communications

To configure the base station, you will use the Read and Write mechanisms described in the **Data Packet Structures** section to read and write parameters and execute commands.

The base station may also be receiving packets from other devices. These will be Data Provider Packets and these may arrive at any time.

Parameter List

| Parameter | Command | Description | Native Data | Read / |
|---------------|---------|--|-------------|--------|
| | Number | | Туре | Write |
| ID | 3 | Read the unique identifier ID for this device. (3 bytes) | BINARY 3 | R |
| | | | byte | |
| Channel | 11 | The radio channel to operate on. (1-16) Requires | UINT8 | RW |
| | | power cycle or Reset to enable. | | |
| EncKey | 15 | The radio encryption key to operate on. Requires | BINARY 16 | RW |
| | | power cycle or Reset to enable. (16 bytes) Not | bytes | |
| | | supported in this release. | | |
| UseCSMA | 18 | Select whether to use Carrier Sense Multiple Access | UINT8 | RW |
| | | techniques on transmission. | | |
| | | | | |
| | | value Description | | |
| | | U Disabled | | |
| | | The Carrier Sense Multiple Access will be | | |
| | | | | |
| | | The Corrier Sense Multiple Assess will be | | |
| | | anabled | | |
| | | enabled. | | |
| | | See Unslotted CSMA/CA in Appendix A | | |
| Power | 12 | Set or read the output power level. (0-100%) | UINT8 | RW |
| Name | 10 | Set or read a user defined name. (11 characters) | STRING 11 | RW |
| | | | bytes | |
| WakerDuration | 17 | Set or read the duration in milliseconds to wait for a | UINT16 | RW |
| | | device to wake. Although WAKE commands are sent to | | |
| | | the target device the base station actually intercepts | | |
| | | this and handles the wake itself. Default = 12000 | | |
| - | | milliseconds. | | |
| Save | 24 | Save any changes made to parameters. Required | Command | |
| | | before power cycling or issuing a Reset command. | | |
| | 25 | Requires 200ms recovery time after executing. | | |
| Reset | 25 | Restarts the device and utilises new channel and | Command | |
| | | encryption keys if those have been changed and saved. | | |
| | | Note after a Reset the device will be asleep. | | |

NOTE: All changes require a SAVE command to enable them to survive through power cycle or RESET command.

Installation

The base WTS-BSi should be mounted horizontally on a wall or ceiling so that the side face containing the PCB antenna faces the general direction of the target devices.



The WTS-BSu should also be positioned to present itself to the other radios in a 'landscape' aspect.

Specification

| Parameter | Minimum | Typical | Maximum | Units | Notes |
|--|---------|---------|---------|-------|--|
| WTS-BSi External Supply voltage Range | 9 | 12 | 32 | Volts | |
| WTS-BSi, WTS-BSu USB Supply Range | 4.875 | 5 | 5.125 | Volts | As defined by USB 2.0 Specification |
| Average Operational Current (WTS-BSi) | - | TBD | 500 | mA | |
| USB Bus Powered Operational Current | 100 | | 200 | | |
| Operating Temperature Range | -40 | - | 65 | Deg C | |
| Storage Temperature Range | -40 | - | 65 | Deg C | |
| Reverse polarity Protection | | - | -32 | Volts | Maximum Supply level |

WTS Wireless Inclinometer

Overview

The WTS-n-nn is a "sine of angle" acquisition module. This allows wireless remote viewing of "sine of angle" information using 2.4GHz radio and periodically transmits it.

Between transmissions the device is optionally in a power saving sleep mode to conserve batteries.

Communications

To configure the device you will use the Read and Write mechanisms described in the **Data Packet Structures** section to read and write parameters and execute commands.

Parameter List

| Number Data Type Write Type ID 3 Read the unique identifier ID for this device. (3 bytes) bytes BINARY 3 bytes R Version 53 Read the firmware version. STRING 11 Bytes R Channel 11 Radio Channel UINT8 RW EncKey 15 The radio encryption key to operate on. Requires power cycle or Reset to enable. Not supported in this release. BINARY 16 Bytes RW Power 12 Set or read the output power level. (0-100%) UINT8 RW Name 10 Set or read the output power level. (0-100%) UINT8 RW Model 51 Read the model number of the device. STRING R MakeChkInt 16 Set or read the interval in milliseconds that a sleeping device will wake to request a full wake from the base station. (default 3000) UINT8 RW UseCSMA 18 Select whether to use Carrier Sense Multiple Access will be disabled. NOT RECOMMENDED UINT8 RW BattLevel 69 The voltage measured on the battery. FLOAT R BattLevel 69 The voltage measured on the battery. FLOAT RW BattLevel 69 The voltage measured on the battery. FLOAT RW battry flag will be set in all received packets and | Parameter | Command | Description | Native | Read / |
|--|----------------|---------|--|----------|--------|
| ID3Read the unique identifier ID for this device. (3 bytes)BiNARY 3 bytesRVersion53Read the firmware version.STRINGR11 Bytes11Radio ChannelUINT8RWEncKey15The radio encryption key to operate on. Requires power cycle or Reset to enable. Not supported in this release.BINARY 16 BytesRWPower12Set or read the output power level. (0.100%)UINT8RWName10Set or read a user defined name. (11 characters)STRING 11 BytesRWModel51Read the model number of the device.STRING 11 BytesRWWakeChkInt16Set or read the interval in milliseconds that a sleeping device will wake to request a full wake from the base station. (default 300)UINT6RWUseCSMA18Select whether to use Carrier Sense Multiple Access techniques on transmission.UINT8RWValueDescription 0 disabled The Carrier Sense Multiple Access will be disabled.UINT8RWBattLevel69The voltage measured on the battery.FLOATRBattLevel69The voltage measured on the battery.FLOATRWBattLevel75Defines paver save mode. 0 = Awake all the time and transmit at TxInterval. 1 = Steep. Wake at TXInterval, acquire value, transmit value, sleep.UINT8RW | | Number | | Data | Write |
| ID 3 Read the unique identifier ID for this device. (3 bytes) bytes BINARY 3 R Version 53 Read the firmware version. STRING R Channel 11 Radio Channel UINT8 RW EncKey 15 The radio encryption key to operate on. Requires power cycle or Reset to enable. Not supported in this release. BINARY RW Power 12 Set or read the output power level. (0-100%) UINT8 RW Name 10 Set or read a user defined name. (11 characters) STRING RW Model 51 Read the model number of the device. STRING R WakeChkint 16 Set or read the interval in milliseconds that a sleeping device will wake to request a full wake from the base station. (default 3000) UINT6 RW UseCSMA 18 Select whether to use Carrier Sense Multiple Access will be disabled. NOT RECOMMENDED UINT8 RW Value Description 0 Disabled FLOAT R BattLevel 69 The voltage measured on the battery. FLOAT R BattLevel 69 The voltage at which the low battery flag will be set in all received packets and in th | | | | Туре | |
| Version53Read the firmware version.bytesChannel11Radio Channel11 Bytes11 BytesChannel11Radio ChannelUINT8RWEncKey15The radio encryption key to operate on. Requires power cycle or Reset to enable. Not supported in this release.If BytesRWName10Set or read the output power level. (0-100%)UINT8RWName10Set or read a user defined name. (11 characters)STRING 11 BytesRWModel51Read the model number of the device.STRING 11 BytesRWakeChkInt16Set or read the interval in milliseconds that a sleeping device will wake to request a full wake from the base station. (default 3000)UINT8RWUseCSMA18Select whether to use Carrier Sense Multiple Access techniques on transmission.UINT8RWValueDescription The Carrier Sense Multiple Access will be disabled The Carrier Sense Multiple Access will be enabled.FLOATRBattLevel69The voltage measured on the battery.FLOATRWBattLevel69The voltage measured on the battery.FLOATRWLowPowerMode75Defines power save mode.UINT8RW0Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep.WINT8RW | ID | 3 | Read the unique identifier ID for this device. (3 bytes) | BINARY 3 | R |
| Version53Read the firmware version.STRING 11 BytesRChannel11Radio ChannelUINT8RWEncKey15The radio encryption key to operate on. Requires power cycle or Reset to enable. Not supported in this release.BINARY 16 BytesRWPower12Set or read the output power level. (0-100%)UINT8RWName10Set or read a user defined name. (11 characters)STRING STRING It BytesRWModel51Read the model number of the device.STRING TI BytesRWakeChkInt16Set or read the interval in milliseconds that a sleeping device will wake to request a full wake from the base station. (default 3000)UINT8RWUseCSMA18Select whether to use Carrier Sense Multiple Access disabled. NOT RECOMMENDEDUINT8RW1Enabled The Carrier Sense Multiple Access will be enabled.IRBattLevel69The voltage measured on the battery.FLOATRBattLevel69The voltage measured on the battery.FLOATRWLowPowerMode75Defines power save mode. 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep.UINT8RW | | | | bytes | |
| Channel11Radio ChannelUINT8RWEncKey15The radio encryption key to operate on. Requires power cycle or Reset to enable. Not supported in this release.BINARY BINARY 16 BytesRWPower12Set or read the output power level. (0-100%)UINT8RWName10Set or read a user defined name. (11 characters)STRING 11 BytesRWModel51Read the model number of the device.STRING 11 BytesRWWakeChkInt16Set or read the interval in milliseconds that a sleeping device will wake to request a full wake from the base station. (default 3000)UINT8RWUseCSMA18Select whether to use Carrier Sense Multiple Access disabled.UINT8RWValueDescription 0Disabled The Carrier Sense Multiple Access will be disabled.UINT8RWBattLevel69The voltage measured on the battery.FLOAT RRBattLevel69The voltage wave mode.FLOAT 0RWLowPowerMode75Defines power save mode.UINT8RWValue0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep.UINT8RW | Version | 53 | Read the firmware version. | STRING | R |
| Channel11Radio ChannelUIN18RWEncKey15The radio encryption key to operate on. Requires power cycle or Reset to enable. Not supported in this release.16 BytesRWPower12Set or read the output power level. (0-100%)UINT8RWName10Set or read a user defined name. (11 characters)STRING STRINGRWModel51Read the model number of the device.STRING 11 BytesRWakeChkint16Set or read the interval in milliseconds that a sleeping device will wake to request a full wake from the base station. (default 3000)UINT8RWUseCSMA18Select whether to use Carrier Sense Multiple Access techniques on transmission.UINT8RWValueDescription 0Disabled The Carrier Sense Multiple Access will be disabled. NOT RECOWMENDEDFLOATRBattLevel69The voltage measured on the battery.FLOATRBattLowLevel110Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter).FLOATRLowPowerMode75Defines power save mode. 0 = Awake alt the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep.RW | | 11 | | 11 Bytes | |
| Enckey15The radio encryption key to operate on, Requires power cycle or Reset to enable. Not supported in this release.BinARY 16 BytesRWName10Set or read the output power level. (0-100%)UINT8RWName10Set or read a user defined name. (11 characters)STRING STRINGRWModel51Read the model number of the device.STRING 11 BytesRWakeChkInt16Set or read the interval in milliseconds that a sleeping device will wake to request a full wake from the base station. (default 3000)UINT6RWUseCSMA18Select whether to use Carrier Sense Multiple Access techniques on transmission.UINT8RWValueDescription 0Disabled The Carrier Sense Multiple Access will be disabled. NOT RECOMMENDEDIEnabled1Enabled The Carrier Sense Multiple Access will be enabled.Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter).FLOATRLowPowerMode75Defines power save mode. 0 = Awake all the time and transmit at TxInterval. ta UINT8RW | Channel | 11 | Radio Channel | UIN18 | RW |
| power cycle of Reset to enable. Not supported in this release.To BytesPower12Set or read the output power level. (0-100%)UINT8RWName10Set or read a user defined name. (11 characters)STRINGRWModel51Read the model number of the device.STRINGRWakeChkInt16Set or read the interval in milliseconds that a sleeping device will wake to request a full wake from the base station. (default 3000)UINT6RWUseCSMA18Select whether to use Carrier Sense Multiple Access techniques on transmission.UINT8RWValueDescription 0Disabled The Carrier Sense Multiple Access will be disabled. NOT RECOMMENDEDUINT8RWBattLevel69The voltage measured on the battery.FLOATRBattLowLevel110Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter).FLOATRWLowPowerMode75Defines power save mode. 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep.UINT8RW | Enckey | 15 | The radio encryption key to operate on. Requires | BINARY | RW |
| Power12Set or read the output power level. (0-100%)UINT8RWName10Set or read a user defined name. (11 characters)STRING 11 BytesRWModel51Read the model number of the device.STRING 11 BytesRWakeChkInt16Set or read the interval in milliseconds that a sleeping device will wake to request a full wake from the base station. (default 3000)UINT6RWUseCSMA18Select whether to use Carrier Sense Multiple Access techniques on transmission.UINT8RWValueDescription 0Disabled The Carrier Sense Multiple Access will be disabled. NOT RECOMMENDEDUINT8RWBattLevel69The voltage measured on the battery.FLOATRBattLevel69The voltage measured on the battery.FLOATRWLowPowerMode75Defines power save mode. 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep.UINT8RW | | | power cycle of Reset to enable. Not supported in this | To bytes | |
| Name 12 Set of read the output power levet. (0*100%) UNT3 NW Name 10 Set or read a user defined name. (11 characters) STRING RW Model 51 Read the model number of the device. STRING R WakeChkInt 16 Set or read the interval in milliseconds that a sleeping device will wake to request a full wake from the base station. (default 3000) UINT16 RW UseCSMA 18 Select whether to use Carrier Sense Multiple Access techniques on transmission. UINT8 RW Value Description 0 Disabled UINT8 RW Set Unslotted CSMA/CA in Appendix A See Unslotted CSMA/CA in Appendix A Econ read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter). FLOAT RW LowPowerMode 75 Defines power save mode. 0 = Awake alt the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep. UINT8 RW | Power | 12 | Set or read the output power level (0, 100%) | | D\\/ |
| Nume Set of read a user defined number of the device. String Model 51 Read the model number of the device. STRING R WakeChkInt 16 Set or read the interval in milliseconds that a sleeping device will wake to request a full wake from the base station. (default 3000) UINT16 RW UseCSMA 18 Select whether to use Carrier Sense Multiple Access techniques on transmission. UINT8 RW Value Description 0 Disabled The Carrier Sense Multiple Access will be disabled. NOT RECOMMENDED UINT8 RW BattLevel 69 The voltage measured on the battery. FLOAT R BattLevel 69 The voltage measured on the battery. FLOAT RW battLowLevel 110 Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter). LowPowerMode 75 Defines power save mode. 0 = Awake alt the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep. UINT8 RW | Name | 10 | Set or read a user defined name (11 characters) | | RW |
| Model51Read the model number of the device.STRING 11 BytesRWakeChkInt16Set or read the interval in milliseconds that a sleeping device will wake to request a full wake from the base station. (default 3000)UINT16RWUseCSMA18Select whether to use Carrier Sense Multiple Access techniques on transmission.UINT8RWValueDescription 0Disabled The Carrier Sense Multiple Access will be disabled. NOT RECOMMENDEDUINT8RWBattLevel69The voltage measured on the battery.FLOATRBattLevel69The voltage measured on the battery.FLOATRWbattLowLevel110Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter).UINT8RWLowPowerMode75Defines power save mode. 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep.UINT8RW | name | | Set of read a user defined hame. (IT characters) | 11 Bytes | |
| WakeChkInt 16 Set or read the interval in milliseconds that a sleeping device will wake to request a full wake from the base station. (default 3000) UINT16 RW UseCSMA 18 Select whether to use Carrier Sense Multiple Access techniques on transmission. UINT8 RW Value Description 0 Disabled RW 0 Disabled The Carrier Sense Multiple Access will be disabled. NOT RECOMMENDED II Enabled 1 Enabled The Carrier Sense Multiple Access will be enabled. See Unslotted CSMA/CA in Appendix A FLOAT R BattLevel 69 The voltage measured on the battery. FLOAT RW battLowLevel 110 Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter). FLOAT RW LowPowerMode 75 Defines power save mode. UINT8 RW | Model | 51 | Read the model number of the device | STRING | R |
| WakeChkInt 16 Set or read the interval in milliseconds that a sleeping device will wake to request a full wake from the base station. (default 3000) UINT16 RW UseCSMA 18 Select whether to use Carrier Sense Multiple Access techniques on transmission. UINT8 RW Value Description 0 Disabled UINT8 RW 0 Disabled The Carrier Sense Multiple Access will be disabled. NOT RECOMMENDED I Enabled 1 Enabled The Carrier Sense Multiple Access will be enabled. FLOAT R BattLevel 69 The voltage measured on the battery. FLOAT R BattLowLevel 110 Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter). UINT8 RW LowPowerMode 75 Defines power save mode. UINT8 RW 0 = Awake all the time and transmit at TxInterval. 1 Sleep. Wake at TXInterval, acquire value, transmit value, sleep. RW | modet | | neud the model humber of the device. | 11 Bytes | , it |
| device will wake to request a full wake from the base station. (default 3000)UseCSMA18Select whether to use Carrier Sense Multiple Access techniques on transmission.UINT8RWValueDescription 0Disabled The Carrier Sense Multiple Access will be disabled. NOT RECOMMENDEDUINT8RW1Enabled The Carrier Sense Multiple Access will be enabled.1Enabled3See Unslotted CSMA/CA in Appendix AFLOATRBattLevel69The voltage measured on the battery.FLOATRBattLowLevel110Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter).FLOATRWLowPowerMode75Defines power save mode. 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep.UINT8RW | WakeChkInt | 16 | Set or read the interval in milliseconds that a sleeping | UINT16 | RW |
| UseCSMA18Select whether to use Carrier Sense Multiple Access techniques on transmission.UINT8RWValueDescription 0Disabled The Carrier Sense Multiple Access will be disabled. NOT RECOMMENDEDUINT8RW1Enabled The Carrier Sense Multiple Access will be disabled. NOT RECOMMENDED1Enabled The Carrier Sense Multiple Access will be enabled.8See Unslotted CSMA/CA in Appendix AFLOATRBattLevel69The voltage measured on the battery.FLOATRWBattLowLevel110Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter).FLOATRWLowPowerMode75Defines power save mode. 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep.UINT8RW | | | device will wake to request a full wake from the base | | |
| UseCSMA 18 Select whether to use Carrier Sense Multiple Access techniques on transmission. UINT8 RW Value Description 0 Disabled The Carrier Sense Multiple Access will be disabled. NOT RECOMMENDED 1 Enabled 1 Enabled The Carrier Sense Multiple Access will be enabled. See Unslotted CSMA/CA in Appendix A Value See Unslotted CSMA/CA in Appendix A BattLevel 69 The voltage measured on the battery. FLOAT R BattLowLevel 110 Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter). FLOAT RW LowPowerMode 75 Defines power save mode. UINT8 RW 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep. RW | | | station. (default 3000) | | |
| ValueDescription0DisabledThe Carrier Sense Multiple Access will be disabled. NOT RECOMMENDED1Enabled The Carrier Sense Multiple Access will be enabled.BattLevel6969The voltage measured on the battery.BattLowLevel110Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter).LowPowerMode75Defines power save mode. 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep. | UseCSMA | 18 | Select whether to use Carrier Sense Multiple Access | UINT8 | RW |
| ValueDescription0DisabledThe Carrier Sense Multiple Access will be disabled. NOT RECOMMENDED1EnabledThe Carrier Sense Multiple Access will be enabled.See Unslotted CSMA/CA in Appendix ABattLevel6969The voltage measured on the battery.BattLowLevel110Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter).LowPowerMode75Defines power save mode. 0 = Awake alt TXInterval, acquire value, transmit value, sleep.UINT8RW | | | techniques on transmission. | | |
| ValueDescription0Disabled The Carrier Sense Multiple Access will be disabled. NOT RECOMMENDED1Enabled The Carrier Sense Multiple Access will be enabled.1Enabled The Carrier Sense Multiple Access will be enabled.BattLevel6969The voltage measured on the battery.BattLowLevel110Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter).LowPowerMode75Defines power save mode. 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep.UINT8 | | | | | |
| 0Disabled The Carrier Sense Multiple Access will be disabled. NOT RECOMMENDED1Enabled The Carrier Sense Multiple Access will be enabled.1Enabled The Carrier Sense Multiple Access will be enabled.BattLevel6969The voltage measured on the battery.BattLowLevel110110Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter).LowPowerMode750 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit | | | Value Description | | |
| Image: See Unslotted CSMA/CA in Appendix ABattLevel69The voltage measured on the battery.BattLowLevel110See Unslotted CSMA/CA in Appendix ABattLowLevel69100Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter).LowPowerMode75Defines power save mode. 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep.UINT8RW | | | 0 Disabled | | |
| disabled. NOT RECOMMENDED1EnabledThe Carrier Sense Multiple Access will be enabled.See Unslotted CSMA/CA in Appendix ABattLevel69The voltage measured on the battery.BattLowLevel110Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter).LowPowerMode75Defines power save mode. 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep.UINT8 | | | The Carrier Sense Multiple Access will be | | |
| 1Enabled The Carrier Sense Multiple Access will be enabled.See Unslotted CSMA/CA in Appendix ABattLevel6969The voltage measured on the battery.BattLowLevel110Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter).LowPowerMode75Defines power save mode. 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep.UINT8 | | | disabled. NOT RECOMMENDED | | |
| Ine Carrier Sense Multiple Access will be enabled.See Unslotted CSMA/CA in Appendix ABattLevel69The voltage measured on the battery.BattLowLevel110Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter).LowPowerMode75Defines power save mode. 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep.UINT8 | | | 1 Enabled | | |
| BattLevel69The voltage measured on the battery.FLOATRBattLowLevel110Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter).FLOATRWLowPowerMode75Defines power save mode. 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep.UINT8RW | | | The Carrier Sense Multiple Access will be | | |
| See Unslotted CSMA/CA in Appendix AFLOATBattLevel69The voltage measured on the battery.FLOATRBattLowLevel110Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter).FLOATRWLowPowerMode75Defines power save mode. 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep.UINT8RW | | | | | |
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| BattLowLevel 110 Set or read the battery voltage at which the low battery flag will be set in all received packets and in the Status parameter). FLOAT RW LowPowerMode 75 Defines power save mode. 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep. UINT8 RW | Battlevel | 69 | The voltage measured on the battery | FLOAT | R |
| LowPowerMode 75 Defines power save mode. 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep. UINT8 RW | Battl owl evel | 110 | Set or read the battery voltage at which the low | FLOAT | RW |
| LowPowerMode 75 Defines power save mode. UINT8 RW 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep. 0 <td>Datteomeever</td> <td>110</td> <td>battery flag will be set in all received packets and in</td> <td></td> <td></td> | Datteomeever | 110 | battery flag will be set in all received packets and in | | |
| LowPowerMode75Defines power save mode. 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep.UINT8RW | | | the Status parameter). | | |
| 0 = Awake all the time and transmit at TxInterval. 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep. | LowPowerMode | 75 | Defines power save mode. | UINT8 | RW |
| 1 = Sleep. Wake at TXInterval, acquire value, transmit value, sleep. | | | 0 = Awake all the time and transmit at TxInterval. | | |
| value, sleep. | | | 1 = Sleep. Wake at TXInterval, acquire value, transmit | | |
| | | | value, sleep. | | |
| TxInterval76Time Interval between Transmissions. Set mSUINT16RW | TxInterval | 76 | Time Interval between Transmissions. Set mS | UINT16 | RW |
| SampleTime78Set or read the SampleTime in milliseconds forUINT16RW | SampleTime | 78 | Set or read the SampleTime in milliseconds for | UINT16 | RW |
| acquiring a reading at each TxInterval interval. The | | | acquiring a reading at each TxInterval interval. The | | |
| larger the SampleTime the more accurate the reading | | | larger the SampleTime the more accurate the reading | | |
| Dut at the expense of battery life. (Default 5) | CleanDalay | 77 | Dut at the expense of battery life. (Default 5) | | D)+/ |
| SteepDetay // Time period before switching to low power steep mode UINT16 RW | Sieepuelay | 11 | i fine period before switching to low power sleep mode | UIN I 16 | KW |
| Setting to zero disables | | | Setting to zero disables | | |
| DataTag 119 Set or read the 2 byte Data Tag that is used when UIINT16 DW | DataTag | 110 | Set or read the 2 byte Data Tag that is used when | LIINT16 | R\// |
| transmitting the weight in a Data Provider Packet | Duturuz | | transmitting the weight in a Data Provider Packet | | 1.144 |
| Note that default value is set to last 2 bytes of ID. | | | Note that default value is set to last 2 bytes of ID. | | |

| NumCalPoints | 79 | Number of calibration points required. Range 2 to 9 | UINT8 | RW |
|--|---|---|--|--|
| CalPoint1 | 80 | The % full scale value of this calibration point. | FLOAT | RW |
| CalPoint2 | 81 | The % full scale value of this calibration point. | FLOAT | RW |
| CalPoint3 | 82 | The % full scale value of this calibration point. | FLOAT | RW |
| CalPoint4 | 83 | The % full scale value of this calibration point. | FLOAT | RW |
| CalPoint5 | 84 | The % full scale value of this calibration point. | FLOAT | RW |
| CalPoint6 | 85 | The % full scale value of this calibration point. | FLOAT | RW |
| CalPoint7 | 86 | The % full scale value of this calibration point. | FLOAT | RW |
| CalPoint8 | 87 | The % full scale value of this calibration point. | FLOAT | RW |
| CalPoint9 | 88 | The % full scale value of this calibration point. | FLOAT | RW |
| CalPointGain1 | 89 | The gain to apply to the input at this calibration point. | FLOAT | RW |
| CalPointGain | 90 | The gain to apply to the input at this calibration point. | FLOAT | RW |
| CalPointGain | 91 | The gain to apply to the input at this calibration point. | FLOAT | RW |
| CalPointGain | 92 | The gain to apply to the input at this calibration point. | FLOAT | RW |
| CalPointGain | 93 | The gain to apply to the input at this calibration point. | FLOAT | RW |
| CalPointGain | 94 | The gain to apply to the input at this calibration point. | FLOAT | RW |
| CalPointGain | 95 | The gain to apply to the input at this calibration point. | FLOAT | RW |
| CalPointGain | 96 | The gain to apply to the input at this calibration point. | FLOAT | RW |
| CalPointGain | 97 | The gain to apply to the input at this calibration point. | FLOAT | RW |
| CalPointOffset1 | 98 | point. | FLOAT | RW |
| CalPointOffset2 | 99 | The offset to apply to the input at this calibration point. | FLOAT | RW |
| CalPointOffset3 | 100 | The offset to apply to the input at this calibration point. | FLOAT | RW |
| CalPointOffset4 | 101 | The offset to apply to the input at this calibration point. | FLOAT | RW |
| CalPointOffset5 | 102 | The offset to apply to the input at this calibration point. | FLOAT | RW |
| CalPointOffset6 | 103 | The offset to apply to the input at this calibration point. | FLOAT | RW |
| CalPointOffset7 | 104 | The offset to apply to the input at this calibration | FLOAT | RW |
| | | point. | | |
| CalPointOffset8 | 105 | point. The offset to apply to the input at this calibration point. | FLOAT | RW |
| CalPointOffset8 CalPointOffset9 | 105 106 | point.The offset to apply to the input at this calibration point.The offset to apply to the input at this calibration point. | FLOAT FLOAT | RW |
| CalPointOffset8 CalPointOffset9 Value | 105 106 72 | point. The offset to apply to the input at this calibration point. The offset to apply to the input at this calibration point. Reads the calibrated output. | FLOAT FLOAT FLOAT | RW RW |
| CalPointOffset8 CalPointOffset9 Value Counts | 105 106 72 70 | point.The offset to apply to the input at this calibration point.The offset to apply to the input at this calibration point.Reads the calibrated output.Raw A/D counts | FLOAT FLOAT FLOAT INT32 | RW RW R R |
| CalPointOffset8 CalPointOffset9 Value Counts PFS | 105 106 72 70 71 | point.The offset to apply to the input at this calibration point.The offset to apply to the input at this calibration point.Reads the calibrated output.Raw A/D countsFactory calibrated percent full scale (0=0V, 100=10V) | FLOAT FLOAT FLOAT INT32 FLOAT | RW RW R R R R |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 | point.The offset to apply to the input at this calibration point.The offset to apply to the input at this calibration point.Reads the calibrated output.Raw A/D countsFactory calibrated percent full scale (0=0V, 100=10V)Read or set the digital output state | FLOAT FLOAT FLOAT INT32 FLOAT | RW RW R R R R R W |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 | point.The offset to apply to the input at this calibration point.The offset to apply to the input at this calibration point.Reads the calibrated output.Raw A/D countsFactory calibrated percent full scale (0=0V, 100=10V)Read or set the digital output state.ValueDefinition | FLOAT FLOAT FLOAT INT32 FLOAT FLOAT | RW RW R R R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 | point. The offset to apply to the input at this calibration point. The offset to apply to the input at this calibration point. Reads the calibrated output. Raw A/D counts Factory calibrated percent full scale (0=0V, 100=10V) Read or set the digital output state. Value Definition 0 Turn digital output off | FLOAT FLOAT FLOAT INT32 FLOAT FLOAT | RW RW R R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 | point.The offset to apply to the input at this calibration point.The offset to apply to the input at this calibration point.Reads the calibrated output.Raw A/D countsFactory calibrated percent full scale (0=0V, 100=10V)Read or set the digital output state.ValueDefinition0Turn digital output off1 | FLOAT FLOAT FLOAT INT32 FLOAT FLOAT | RW RW R R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 | point. The offset to apply to the input at this calibration point. The offset to apply to the input at this calibration point. Reads the calibrated output. Raw A/D counts Factory calibrated percent full scale (0=0V, 100=10V) Read or set the digital output state. Value Definition 0 Turn digital output off 1 Turn digital output on | FLOAT FLOAT FLOAT INT32 FLOAT FLOAT | RW RW R R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 | point.The offset to apply to the input at this calibration point.The offset to apply to the input at this calibration point.Reads the calibrated output.Raw A/D countsFactory calibrated percent full scale (0=0V, 100=10V)Read or set the digital output state.ValueDefinition0Turn digital output off1Turn digital output on2Make digital output mirror the LED | FLOAT FLOAT INT32 FLOAT FLOAT | RW RW R R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 | point.The offset to apply to the input at this calibration point.The offset to apply to the input at this calibration point.Reads the calibrated output.Raw A/D countsFactory calibrated percent full scale (0=0V, 100=10V)Read or set the digital output state.ValueDefinition0Turn digital output off1Turn digital output on2Make digital output mirror the LED state (V1.05 and later) | FLOAT FLOAT INT32 FLOAT FLOAT | RW RW R R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 | point.The offset to apply to the input at this calibration point.The offset to apply to the input at this calibration point.Reads the calibrated output.Raw A/D countsFactory calibrated percent full scale (0=0V, 100=10V)Read or set the digital output state.ValueDefinition0Turn digital output off1Turn digital output on2Make digital output mirror the LED state (V1.05 and later) | FLOAT FLOAT INT32 FLOAT FLOAT | RW RW R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 | point. The offset to apply to the input at this calibration point. The offset to apply to the input at this calibration point. Reads the calibrated output. Raw A/D counts Factory calibrated percent full scale (0=0V, 100=10V) Read or set the digital output state. Value Definition 0 Turn digital output off 1 Turn digital output on 2 Make digital output mirror the LED state (V1.05 and later) | FLOAT FLOAT INT32 FLOAT FLOAT | RW RW R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 74 | point.The offset to apply to the input at this calibration point.The offset to apply to the input at this calibration point.Reads the calibrated output.Raw A/D countsFactory calibrated percent full scale (0=0V, 100=10V)Read or set the digital output state.ValueDefinition0112Make digital output on state (V1.05 and later) | FLOAT FLOAT INT32 FLOAT FLOAT | RW RW R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 74 | point.The offset to apply to the input at this calibration point.The offset to apply to the input at this calibration point.Reads the calibrated output.Raw A/D countsFactory calibrated percent full scale (0=0V, 100=10V)Read or set the digital output state.ValueDefinition0Turn digital output off1Turn digital output on2Make digital output mirror the LED state (V1.05 and later)Live status where the bit values indicate status. The following table shows the decimal bit values and their | FLOAT FLOAT INT32 FLOAT FLOAT | RW RW R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 74 | point.The offset to apply to the input at this calibration point.The offset to apply to the input at this calibration point.Reads the calibrated output.Raw A/D countsFactory calibrated percent full scale (0=0V, 100=10V)Read or set the digital output state.ValueDefinition0Turn digital output off1Turn digital output on2Make digital output mirror the LED state (V1.05 and later)Live status where the bit values indicate status. The following table shows the decimal bit values and their meaning. | FLOAT FLOAT INT32 FLOAT FLOAT | RW RW R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 74 | point. The offset to apply to the input at this calibration point. The offset to apply to the input at this calibration point. Reads the calibrated output. Raw A/D counts Factory calibrated percent full scale (0=0V, 100=10V) Read or set the digital output state. Value Definition 0 Turn digital output off 1 Turn digital output on 2 Make digital output mirror the LED state (V1.05 and later) Live status where the bit values indicate status. The following table shows the decimal bit values and their meaning. | FLOAT FLOAT INT32 FLOAT FLOAT | RW RW R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 74 | point. The offset to apply to the input at this calibration point. The offset to apply to the input at this calibration point. Reads the calibrated output. Raw A/D counts Factory calibrated percent full scale (0=0V, 100=10V) Read or set the digital output state. Value Definition 0 Turn digital output off 1 Turn digital output on 2 Make digital output mirror the LED state (V1.05 and later) Live status where the bit values indicate status. The following table shows the decimal bit values and their meaning. Bit Value Definition | FLOAT FLOAT INT32 FLOAT FLOAT | RW RW R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 74 | point. The offset to apply to the input at this calibration point. The offset to apply to the input at this calibration point. Reads the calibrated output. Raw A/D counts Factory calibrated percent full scale (0=0V, 100=10V) Read or set the digital output state. Value Definition 0 Turn digital output off 1 Turn digital output on 2 Make digital output mirror the LED state (V1.05 and later) Live status where the bit values indicate status. The following table shows the decimal bit values and their meaning. Bit Value Definition 1 STATUS_SHUNT_CAL | FLOAT FLOAT INT32 FLOAT FLOAT | RW RW R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 74 | point. The offset to apply to the input at this calibration point. The offset to apply to the input at this calibration point. Reads the calibrated output. Raw A/D counts Factory calibrated percent full scale (0=0V, 100=10V) Read or set the digital output state. Value Definition 0 Turn digital output off 1 Turn digital output on 2 Make digital output mirror the LED state (V1.05 and later) Live status where the bit values indicate status. The following table shows the decimal bit values and their meaning. Bit Value Definition 1 STATUS_SHUNT_CAL 2 STATUS_INPUT_INTEGRITY | FLOAT FLOAT INT32 FLOAT FLOAT | RW RW R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 74 | point. The offset to apply to the input at this calibration point. The offset to apply to the input at this calibration point. Reads the calibrated output. Raw A/D counts Factory calibrated percent full scale (0=0V, 100=10V) Read or set the digital output state. Value Definition 0 Turn digital output off 1 Turn digital output on 2 Make digital output mirror the LED state (V1.05 and later) Live status where the bit values indicate status. The following table shows the decimal bit values and their meaning. Bit Value Definition 1 STATUS_SHUNT_CAL 2 STATUS_INPUT_INTEGRITY 4 Reserved | FLOAT FLOAT INT32 FLOAT FLOAT FLOAT | RW R R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 74 | point. The offset to apply to the input at this calibration point. The offset to apply to the input at this calibration point. Reads the calibrated output. Raw A/D counts Factory calibrated percent full scale (0=0V, 100=10V) Read or set the digital output state. Value Definition 0 Turn digital output off 1 Turn digital output on 2 Make digital output mirror the LED state (V1.05 and later) Live status where the bit values indicate status. The following table shows the decimal bit values and their meaning. Bit Value Definition 1 STATUS_SHUNT_CAL 2 STATUS_INPUT_INTEGRITY 4 Reserved 8 Reserved | FLOAT FLOAT INT32 FLOAT FLOAT FLOAT | RW R R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 74 | point. The offset to apply to the input at this calibration point. The offset to apply to the input at this calibration point. Reads the calibrated output. Raw A/D counts Factory calibrated percent full scale (0=0V, 100=10V) Read or set the digital output state. Value Definition 0 Turn digital output off 1 Turn digital output on 2 Make digital output mirror the LED state (V1.05 and later) Live status where the bit values indicate status. The following table shows the decimal bit values and their meaning. Bit Value Definition 1 STATUS_SHUNT_CAL 2 STATUS_INPUT_INTEGRITY 4 Reserved 8 Reserved 16 STATUS POWER UP | FLOAT FLOAT INT32 FLOAT FLOAT FLOAT | RW R R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut | 105 106 72 70 71 108 74 | point. The offset to apply to the input at this calibration point. The offset to apply to the input at this calibration point. Reads the calibrated output. Raw A/D counts Factory calibrated percent full scale (0=0V, 100=10V) Read or set the digital output state. Value Definition 0 Turn digital output off 1 Turn digital output on 2 Make digital output mirror the LED state (V1.05 and later) Live status where the bit values indicate status. The following table shows the decimal bit values and their meaning. Bit Value Definition 1 STATUS_SHUNT_CAL 2 STATUS_POWER_UP 32 STATUS BATT LOW | FLOAT FLOAT INT32 FLOAT FLOAT FLOAT | RW R R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut Status | 105 106 72 70 71 108 74 | point. The offset to apply to the input at this calibration point. The offset to apply to the input at this calibration point. Reads the calibrated output. Raw A/D counts Factory calibrated percent full scale (0=0V, 100=10V) Read or set the digital output state. Value Definition 0 Turn digital output state. Value Definition 1 Turn digital output off 1 Turn digital output on 2 Make digital output mirror the LED state (V1.05 and later) Live status where the bit values indicate status. The following table shows the decimal bit values and their meaning. Bit Value Definition 1 STATUS_SHUNT_CAL 2 STATUS_INPUT_INTEGRITY 4 Reserved 8 Reserved 16 STATUS_POWER_UP 32 STATUS_DIGITAL_INPUT | FLOAT FLOAT INT32 FLOAT FLOAT FLOAT | RW R R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut Status | 105 106 72 70 71 108 74 | point. The offset to apply to the input at this calibration point. The offset to apply to the input at this calibration point. Reads the calibrated output. Raw A/D counts Factory calibrated percent full scale (0=0V, 100=10V) Read or set the digital output state. Value Definition 0 Turn digital output off 1 Turn digital output on 2 Make digital output mirror the LED state (V1.05 and later) Live status where the bit values indicate status. The following table shows the decimal bit values and their meaning. Bit Value Definition 1 STATUS_SHUNT_CAL 2 STATUS_POWER_UP 32 STATUS_DIGITAL_INPUT 128 STATUS_DIGITAL_OUTPUT | FLOAT FLOAT INT32 FLOAT FLOAT FLOAT | RW R R R RW |
| CalPointOffset8 CalPointOffset9 Value Counts PFS DigitalOut Status | 105 106 72 70 71 108 74 | point.The offset to apply to the input at this calibration point.The offset to apply to the input at this calibration point.Reads the calibrated output.Raw A/D countsFactory calibrated percent full scale (0=0V, 100=10V)Read or set the digital output state.ValueDefinition0Turn digital output off1Turn digital output on2Make digital output mirror the LED state (V1.05 and later)Live status where the bit values indicate status. The following table shows the decimal bit values and their meaning.Bit ValueDefinition1STATUS_SHUNT_CAL2STATUS_INPUT_INTEGRITY4Reserved8Reserved16STATUS_POWER_UP32STATUS_DIGITAL_INPUT128STATUS_DIGITAL_OUTPUT | FLOAT FLOAT INT32 FLOAT FLOAT FLOAT | RW R R R RW |

| Reset | 54 | Restarts the device and utilises new channel and encryption keys if those have been changed and saved. | Comi | mand |
|---------------------|-----|--|--------|------|
| Save | 55 | Save any changes made to parameters. Required | Com | mand |
| | | Requires 500mS recovery time after executing. | | |
| Sleep | 56 | Sends the TSC into Sleep | Com | nand |
| Pause | 57 | Stops the output streaming to allow configuration | Com | nand |
| Resume | 59 | Streaming continues. | Com | nand |
| StayAwake | 58 | No function other than to reset SleepDelay timer | Comi | mand |
| SleepTrigger | 120 | Enter Data Tag to watch for that will trigger sleep mode | UINT16 | RW |
| PauseTrigger | 121 | Enter Data Tag to watch for that will trigger pause mode | UINT16 | RW |
| ResumeTrigger | 123 | Enter Data Tag to watch for that will trigger resume mode | UINT16 | RW |
| StayAwakeTrigger | 122 | Enter Data Tag to watch for that will reset SleepDelay timer. | UINT16 | RW |
| DoSystemZeroTrigger | 125 | Enter Data Tag to watch for that will reset SleepDelay timer. | UINT16 | RW |

NOTE: All changes require a SAVE command to enable them to survive through power cycle or RESET command.

Parameters in grey are for factory calibration only - any changes will invalidate calibration and warranty

Data Provider Format

At every TXInterval a Data Provider packet is transmitted that holds 1 value in FLOAT format (See Appendix A).



Measurement Resolution

The noise free resolution is dependent on the Sample Time (SampleTime)

| SampleTime (mS) | Noise Free Resolution | Ratio |
|-----------------|-----------------------|-----------|
| > 0 | 15.5 bits | 1:50,000 |
| > 9 | 16 bits | 1:65,000 |
| > 49 | 17.25 bits | 1:150,000 |
| > 99 | 18 bits | 1:250,000 |
| > 999 | 18.75 bits | 1:400,000 |

WTS-HS [Handheld Reader Simple]

Overview

The WTS-HS captures Data Provider data and displays it. The WTS-HS also performs the function of waking the remote device when it is turned on and sending it to deep sleep mode when it is turned off. If no buttons are pressed on the WTS-HS it will turn off after 5 minutes.

Communications

To configure the device you will use the Read and Write mechanisms described in the **Data Packet Structures** section to read and write parameters and execute commands.

Parameter List

| Parameter | Command | Description | Native | Read / |
|---------------|---------|--|--------------------|--------|
| | Number | | Data | Write |
| | | | Туре | |
| ID | 3 | Read the unique identifier ID for this device. (3 bytes) | BINARY 3 | R |
| | | | bytes | |
| Version | 53 | Read the firmware version. | STRING | R |
| | | | 11 Bytes | |
| Channel | 11 | Radio Channel | UINT8 | RW |
| EncKey | 15 | The radio encryption key to operate on. Requires | BINARY | RW |
| | | power cycle or Reset to enable. Not supported in this | 16 Bytes | |
| | 10 | release. | | |
| Power | 12 | Set or read the output power level. | UIN18 | RW |
| | 10 | (range:0 to 100 default:100) | CTDING | D) // |
| Name | 10 | Set or read a user defined name. (11 characters) | STRING | RW |
| Ale del | F4 | Dead the medal number of the device | TT Bytes | P |
| model | 21 | Read the model number of the device. | STRING 11 Bytes | к |
| InputValue | 40 | The value that is being read by the device | | D |
| Display/Jaluo | 61 | The value triat is being read by the device. | FLOAT | R D |
| | 18 | Select whether to use Carrier Sense Multiple Access | | |
| USECJIMA | 10 | techniques on transmission | UNITO | 17.64 |
| | | | | |
| | | Value Description | | |
| | | | | |
| | | The Carrier Sense Multiple Access will be | | |
| | | disabled. NOT RECOMMENDED | | |
| | | 1 Enabled | | |
| | | The Carrier Sense Multiple Access will be | | |
| | | enabled. | | |
| | | | | |
| | | See Unslotted CSMA/CA in Appendix A | | |
| BattLevel | 69 | The voltage measured on the battery. | FLOAT | R |
| OffDelay | 62 | Time period in minutes before switching off if no | UINT16 | RW |
| | | button is pressed. Setting to zero disables. | | |
| | | (range:0 to 1440 default:5) | | |
| BoundDataTag | 68 | Set or read the 2 byte Data Tag that is used to match a | UINT16 | RW |
| | | Data Provider packet to use as the display value. | | |
| BoundID | 69 | Set or read the ID of the bound device. Used to wake | BINARY 3 | RW |
| | 10 | the remote device. | Bytes | |
| AutoZero | 63 | Set or read the value limit which may be automatically | FLOAT | RW |
| | | zeroed on start-up. | | |
| | | when the nanoneld powers up and the input value is | | |
| | | value of the input will be placed in AutoZoro i a from | | |
| | | this time onwards until powered off the display will | | |
| | | show | | |
| | | input value - AutoZero | | |
| DoSleepWake | 64 | Set or read whether to perform wake and sleep on the | UINT8 | RW |
| | | paired device when the handheld is powered up and | | |

| | | down. (range:0 to 1 default:1) | | |
|----------------|----|--|-------------------|------|
| Timeout | 65 | Set or read the time in seconds that if exceeded between receiving Data Provider packets from the paired device will cause the display to show Default = 3 (range:0 to 65535 default:3) | UINT16 | RW |
| KeepAwakeInt | 66 | Set or read the interval in seconds between the handheld transmitting StayAwake signals to the paired device. (range:0 to 65535 default:5) | UINT16 | RW |
| DisplayUpdate | 74 | Set or read the interval between LCD updates. Default = 300 | UINT16 | RW |
| PairWait | 67 | Set or read the period in seconds that the handheld will wait for another device to pair when placed into pair mode. (range:0 to 65535 default:5) | UINT8 | RW |
| Format | 70 | Set or read the format for the display. Here you can define how the value will be displayed and where the decimal point will appear. By including a non zero value this will define the resolution of the displayed value. i.e. the smallest step size of value changes. Default = 0000.001 | STRING 8 bytes | RW |
| ZeroSupp | 71 | Set or read whether to show the value on the display with zero suppression. 0 = No zero suppression 1 = Zero suppression | UINT8 | RW |
| ZeroBand | 72 | Set or read the band within which zero will be displayed. As soon as the value exceeds ±ZeroBand the actual value will be displayed. This will effectively mask small changes after taring the device. | FLOAT | RW |
| Overload | 73 | Set or read the value of the display above which instead of the value being displayed 'Overload' will be displayed. | FLOAT | RW |
| ScaleInLo | 75 | Set or read a low input value at which you know what display you require. Default = 0 | FLOAT | RW |
| ScaleInHi | 77 | Set or read a high input value at which you know what display you require. Default = 1 | FLOAT | RW |
| ScaleDisplayLo | 76 | Set or read a low display value for the input value stated in ScaleInLo. Default = 0 | FLOAT | RW |
| ScaleDisplayHi | 78 | Set or read a high display value for the input value stated in ScaleInHi. Default = 1 | FLOAT | RW |
| Reset | 54 | Restarts the device and utilises new channel and encryption keys if those have been changed and saved. | Comn | nand |
| Save | 55 | Save any changes made to parameters. Required before power cycling or issuing a Reset command. Requires 500mS recovery time after executing. | Comn | nand |

NOTE: All changes require a SAVE command to enable them to survive through power cycle or RESET command.

Power Supply

Recommend using alkaline AA cells as rechargeable are too low voltage and lithium may not be able to supply the current for the radio to start up.

Installation

There are no specific installation instructions.

WTS-HA [Handheld Reader Advanced]

Overview

The WTS-HS captures Data Provider data from multiple devices and displays it. The WTS-HS also performs the function of optionally waking the remote device when it is turned on and sending it to deep sleep mode when it is turned off. If no buttons are pressed on the WTS-HS it will turn off after 5 minutes.

The handheld can operate in two modes. The operation of the buttons and the automatic sleep/wake functions are dependent on these modes.

To attach devices to the handheld we must first ensure that the appropriate devices are transmitting their values at a suitable rate such as the default of 3 per second. Then we can tell the handheld which devices we want to communicate with by either automatic pairing or manual setting of the parameters.

Automatic Pairing

The handheld supports pairing replace an existing device. i.e. initially the handheld would be configured using manual configuration.

If then a WTS-SA device required replacing and this was item 3 in the handheld we would follow the following procedure:

- First select this device even though the display may show ----- because of no communications. (In Result mode you would have to hold the Next key to enable selection of individual devices.)
- Next turn off the handheld then press and hold the Power key then press and hold the Tare key. Now both keys are held down until PAIRING is seen on the display. The keys can now be released.
- Now apply power to the WTS-SA within 10 seconds.
- If unsuccessful the display will show failed. If successful the Data Tag and ID of the new device will have been configured within the handheld.
- Depending on how the replacement device was configured it **may** be necessary to reapply the system zero.

Manual Configuration

Use the parameters ValueDataTag1 through to ValueDataTag12 and ValueID1 through to ValueID12 and enter the Data Tags and IDs of the devices to connect to.

For example, to sum two WTS-H-NR devices whose Ids are FFF123 and FFFABC.

The default data tags for these devices would be F123 and FABC so we would set the following:

ValueDataTag1=F123 ValueID1=FFF123 ValueDataTag2=FABC ValueID2=FFFABC

We would ensure that the other unused ValueDataTagx and ValueIDx parameters were set to zero.

Available Modes

Item Mode

Opmode = 0.

Up to 12 individual devices can be connected to and the user can step through each one in sequence. If DoSleepWake is set then the handheld will wake all configured devices when turned on and send them all to sleep again when turned off. NOTE: When the handheld wakes devices this achieved through the transmission of a broadcast wake. i.e. all devices on the same channel and with the same encryption key will wake.

Key Operation

| Кеу | Operation |
|-------|---|
| Sleep | Send the currently selected device to sleep. |
| Wake | Will attempt to wake the currently selected device. |
| Tare | Toggle between |
| Next | Step to the next device. |
| F1 | If motion detection is activated then the reading must be steady to enable this key. Pressing this key with an unstable reading will do nothing. This transmits a Data Provider packet marked with a Data Tag held in F1DataTag and can also contain data as defined by F1Data . |

Result Mode

OpMode = 1.

Up to 12 individual devices can be summed and the result displayed.

If **DoSleepWake** is set then the handheld will wake all configured devices when turned on and send them to sleep again when turned off. NOTE: When the handheld wakes devices this achieved through the transmission of a broadcast wake. i.e. all devices on the same channel and with the same encryption key will wake.

In this mode there is an option of retrieving a system zero value from an external source. This is activated by supplying the Data Tag to the **ExtZeroDataTag** parameter. When activated the value supplied by the Data Provider packet marked with this tag will be used as the system zero and will be subtracted from the sum of all contributing inputs.

Usually in this mode only the result is displayed (In the initial devices the result will just be the sum) but by holding the **Next** key for 65 seconds will activate the ability to step through each contributing input using the **Next** key. See **AllowNext**

Key Operation when viewing the sum

| Key | Operation |
|-------|--|
| Sleep | No effect |
| Wake | Will attempt to wake any sleeping devices. |
| Tare | Toggle between displaying gross sum or tared sum. |
| Next | No effect unless held for 5 seconds to activate individual item view. This can be disabled by |
| | setting NoNext parameter. |
| F1 | If motion detection is activated then the reading must be steady to enable this key. Pressing this |
| | key with an unstable reading will do nothing. |
| | This transmits a Data Provider packet marked with a Data Tag held in F1DataTag and can also |
| | contain data as defined by F1Data. |
| Power | Toggles between on and off. Hold for 2 seconds to activate. |

Key Operation when viewing an individual item

| Кеу | Operation |
|-------|--|
| Sleep | No effect |
| Wake | Will attempt to wake any sleeping devices. |
| Tare | If sum was currently tared then this key will toggle between displaying gross or tared value of current device. If sum view was displaying gross then this key has no effect. If an external system zero is used then only gross values actually supplied to the handheld can be displayed. |
| Next | Selects next device to view. |
| F1 | If motion detection is activated then the reading must be steady to enable this key. Pressing this key with an unstable reading will do nothing. This transmits a Data Provider packet marked with a Data Tag held in F1DataTag and can also contain data as defined by F1Data. |
| Power | Toggles between on and off. Hold for 2 seconds to activate. |

Communications

To configure the device you will use the Read and Write mechanisms described in the **Data Packet Structures** section to read and write parameters and execute commands.

Parameter List

| Parameter | Command Number | Description | Native Data Type | Read / Write |
|---------------|-------------------|---|------------------------|-----------------|
| ID | 3 | Read the unique identifier ID for this device. (3 bytes) | BINARY 3 | R |
| Version | 53 | Read the firmware version. | STRING 11 Bytes | R |
| Channel | 11 | Radio Channel | UINT8 | RW |
| EncKey | 15 | The radio encryption key to operate on. Requires power cycle or Reset to enable. Not supported in this release. | BINARY 16 Bytes | RW |
| Power | 12 | Set or read the output power level. (0-100%) | UINT8 | RW |
| Name | 10 | Set or read a user defined name. (11 characters) | STRING 11 Bytes | RW |
| Model | 51 | Read the model number of the device. | STRING 11 Bytes | R |
| UseCSMA | 18 | Select whether to use Carrier Sense Multiple Access techniques on transmission. Value Description 0 Disabled The Carrier Sense Multiple Access will be disabled. NOT RECOMMENDED 1 Enabled The Carrier Sense Multiple Access will be enabled. See Unslotted CSMA/CA in Appendix A | UINT8 | RW |
| OffDelay | 62 | Time period in seconds before switching off if no button is pressed. Setting to zero disables. Default = 5 | UINT16 | RW |
| AutoZero | 63 | Set or read the value limit which may be automatically zeroed on start-up. When the handheld powers up and the input value is within ±ZeroBand then the display will be zeroed. The value of the input will be placed in AutoZero. i.e. from this time onwards until powered off the display will show input value - AutoZero | FLOAT | RW |
| DoSleepWake | 64 | Set or read whether to perform wake and sleep on the paired device when the handheld is powered up and down. Default = 1 | UINT8 | RW |
| Timeout | 65 | Set or read the time in seconds that if exceeded between receiving Data Provider packets from the paired device will cause the display to show Default = 3 | UINT16 | RW |
| KeepAwakeInt | 66 | Set or read the interval in seconds between the handheld transmitting StayAwake signals to the paired device. Default = 5 | UINT16 | RW |
| DisplayUpdate | 74 | Set or read the interval between LCD updates. Default = 300 | UINT16 | RW |
| PairWait | 67 | Set or read the period in seconds that the handheld will wait for another device to pair when placed into pair mode. Default = 5 | UINT8 | RW |
| Format | 70 | Set or read the format for the display. Here you can define how the value will be displayed and where the decimal point will appear. By including a non zero value this will define the resolution of the displayed value. i.e. the smallest step size of value changes. Default = 0000.001 | STRING 8 bytes | RW |
| ZeroSupp | 71 | Set or read whether to show the value on the display with zero suppression. | UINT8 | RW |

| | | 0 = No zero suppression | | |
|----------------|-----|---|-------------------|----|
| | | 1 = Zero suppression | | |
| ZeroBand | 72 | Set or read the band within which zero will be displayed. As soon as the value exceeds ±ZeroBand the actual value will be displayed. This will effectively mask small changes after taring the device. | FLOAT | RW |
| Overload | 73 | Set or read the value of the display above which instead of the value being displayed 'Overload' will be displayed. | FLOAT | RW |
| ScaleInLo | 75 | Set or read a low input value at which you know what display you require. Default = 0 | FLOAT | RW |
| ScaleInHi | 77 | Set or read a high input value at which you know what display you require. Default = 1 | FLOAT | RW |
| ScaleDisplayLo | 76 | Set or read a low display value for the input value stated in b . Default = 0 | FLOAT | RW |
| ScaleDisplayHi | 78 | Set or read a high display value for the input value stated in ScaleInHi . Default = 1 | FLOAT | RW |
| 54Date | 122 | Value Description 0 Items Mode Each of the configured input values are displayed one at a time and the Next button can be used to step through them. 1 Result Mode The input values are summed and displayed. | | |
| F1Data | 128 | Set or read what data to transmit when the F1 key is pressed. Value Description 0 Always Gross The gross value will be transmitted even if the display shows a zeroed net reading. 1 As Displayed The gross or net value will be transmitted depending on what is selected at the time. | UINT8 | RW |
| F1DataTag | 127 | Set or read the 2 byte Data Tag to use in the Data Provider packet that is transmitted when the F1 key is pressed. | UINT16 | RW |
| ExtZeroDataTag | 80 | Set or read the 2 byte Data Tag of the Data Provider Packet that will supply a system zero value. This value will be subtracted from the gross or net summed values. This allows the same handheld to be used with different sets of data providers each supplying its own system zero value. | UINT16 | RW |
| ExtZeroID | 100 | Set or read the ID of the device acting as external system zero. | BINARY 3 Bytes | RW |
| MotionBand | 123 | Specify an engineering units band that the readings must stay within for the duration of the MotionTime for the reading to be considered steady. | FLOAT | RW |
| MotionTime | 124 | Specify the duration in seconds for the motion | UINT8 | RW |
| | | detection to operate. | | |

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| | | are displayed. i.e. the message that shows Input 1 or | | |
|--------------------|---------|---|----------|--------------|
| Item Duration | 12/ | Input 2 as items are selected. | | D\4/ |
| Itempuration | 126 | specifies the duration in seconds that individual item | UINT8 | RW |
| | | automatically switching back to display the sum | | |
| ValueDataTag1 | <u></u> | Set or read the 2 byte Data Tag that is used to match a | LUNT16 | D\// |
| ValueDalaTagi | 01 | Data Provider packet to use as the input value 1 | UNTIO | 17.64 |
| ValueID1 | 101 | Set or read the ID of the device acting as input 1. Used | BINARY 3 | RW/ |
| ValueiDi | 101 | to wake the remote device when Wake key pressed in | Bytes | 17.64 |
| | | Items Mode | Dytes | |
| ValueDataTag2 | 82 | Set or read the 2 byte Data Tag that is used to match a | | D\// |
| ValueDalaTagz | 02 | Data Provider packet to use as the input value 1 | UNTIO | 17.64 |
| ValuelD2 | 102 | Set or read the ID of the device acting as input 1. Used | BINADV 3 | D\\/ |
| ValueiDZ | 102 | to wake the remote device when Wake key pressed in | Bytes | 17.64 |
| | | Items Mode | Dyces | |
| ValueDataTag3 | 83 | Set or read the 2 byte Data Tag that is used to match a | LIINT16 | RW |
| Valaebalarago | 05 | Data Provider packet to use as the input value 1 | Giltino | |
| ValueID3 | 103 | Set or read the ID of the device acting as input 1. Used | BINARY 3 | RW |
| Valueibs | 105 | to wake the remote device when Wake key pressed in | Bytes | |
| | | Items Mode | Dyces | |
| ValueDataTag4 | 84 | Set or read the 2 byte Data Tag that is used to match a | LIINT16 | RW |
| Valaebalaragi | 01 | Data Provider packet to use as the input value 1 | Giltino | |
| ValueID4 | 104 | Set or read the ID of the device acting as input 1. Used | BINARY 3 | RW |
| Valueib | 101 | to wake the remote device when Wake key pressed in | Bytes | |
| | | Items Mode | bytes | |
| ValueDataTag5 | 85 | Set or read the 2 byte Data Tag that is used to match a | UINT16 | RW |
| , aldebala , ago | 00 | Data Provider packet to use as the input value 1. | U | |
| ValueID5 | 105 | Set or read the ID of the device acting as input 1. Used | BINARY 3 | RW |
| Valacibo | 100 | to wake the remote device when Wake key pressed in | Bytes | |
| | | Items Mode. | | |
| ValueDataTag6 | 86 | Set or read the 2 byte Data Tag that is used to match a | UINT16 | RW |
| · ······ | | Data Provider packet to use as the input value 1. | | |
| ValueID6 | 106 | Set or read the ID of the device acting as input 1. Used | BINARY 3 | RW |
| | | to wake the remote device when Wake key pressed in | Bytes | |
| | | Items Mode. | | |
| ValueDataTag7 | 87 | Set or read the 2 byte Data Tag that is used to match a | UINT16 | RW |
| | | Data Provider packet to use as the input value 1. | | |
| ValueID7 | 107 | Set or read the ID of the device acting as input 1. Used | BINARY 3 | RW |
| | | to wake the remote device when Wake key pressed in | Bytes | |
| | | Items Mode. | | |
| ValueDataTag8 | 88 | Set or read the 2 byte Data Tag that is used to match a | UINT16 | RW |
| | | Data Provider packet to use as the input value 1. | | |
| ValueID8 | 108 | Set or read the ID of the device acting as input 1. Used | BINARY 3 | RW |
| | | to wake the remote device when Wake key pressed in | Bytes | |
| | | Items Mode. | | |
| ValueDataTag9 | 89 | Set or read the 2 byte Data Tag that is used to match a | UINT16 | RW |
| | | Data Provider packet to use as the input value 1. | | |
| ValueID9 | 109 | Set or read the ID of the device acting as input 1. Used | BINARY 3 | RW |
| | | to wake the remote device when Wake key pressed in | Bytes | |
| | | Items Mode. | | |
| ValueDataTag10 | 90 | Set or read the 2 byte Data Tag that is used to match a | UINT16 | RW |
| | 110 | Data Provider packet to use as the input value 1. | | D 144 |
| ValueID10 | 110 | Set or read the ID of the device acting as input 1. Used | BINARY 3 | RW |
| | | to wake the remote device when wake key pressed in | Bytes | |
| ValueDate Territ 4 | 01 | Items Mode. | | D)4/ |
| valuevataTag11 | 91 | Set or read the 2 byte Data Tag that is used to match a | UIN116 | ĸw |
| Value D11 | 444 | Data Provider packet to use as the input value 1. | | D\\/ |
| valueiDTT | 111 | set of read the D of the device acting as input 1. Used | DINARY 3 | RW |
| | | to wake the remote device when wake key pressed in | bytes | |
| | | Itoms Modo | | |
| ValuoDataTag12 | 02 | Items Mode. | | D\\/ |
| ValueDataTag12 | 92 | Items Mode. Set or read the 2 byte Data Tag that is used to match a Data Provider packet to use as the input value 1 | UINT16 | RW |
| ValueDataTag12 | 92 | Items Mode. Set or read the 2 byte Data Tag that is used to match a Data Provider packet to use as the input value 1. | UINT16 | RW |

| | | to wake the remote device when Wake key pressed in Items Mode. | Bytes | |
|--------------|-----|--|---------|------|
| AllowNext | 129 | Determines whether to allow the ability to view individual items when in Result mode. Set to zero to disable or set to a number representing the number of seconds to hold down the Next key to activate this feature. Once activated the Next key steps through all input values. Once the device is powered off this feature would have to be activated again. (range:0 to 30 default:6) | UINT8 | RW |
| AllowSysZero | 130 | Determines whether to allow the ability to perform system zero by pressing and holding the Tare key. Set to zero to disable or set to a number representing the number of seconds to hold down the Tare key to perform the system zero. (range:0 to 30 default:12) | UINT8 | RW |
| Reset | 54 | Restarts the device and utilises new channel and encryption keys if those have been changed and saved. | Comr | mand |
| Save | 55 | Save any changes made to parameters. Required before power cycling or issuing a Reset command. Requires 500mS recovery time after executing. | Command | |
| DoSysZero | 120 | Perform a system zero on all devices. This will remove the current input values so from this point on the current input will give a value of zero. This can be removed by issuing the RmSysZero command. | Command | |
| RmSysZero | 121 | Reset the system zero settings so values will represent the actual inputs. | Comr | nand |

NOTE: All changes require a SAVE command to enable them to survive through power cycle or RESET command.

Power Supply

Recommend using alkaline AA cells as rechargeable are too low voltage and lithium may not be able to supply the current for the radio to start up.

Installation

There are no specific installation instructions.

WTS-HR [Handheld Reader Roaming]

Overview

The WTS-HR is a roaming handheld that can be used to view the reading supplied by an unlimited number of acquisition modules. The acquisition Data Tags or IDs do not need to be known beforehand.

The handheld will automatically wake any device on the same channel and encryption key.

An internal list is maintained of the top n number of acquisition modules ordered by signal level and a Next key on the handheld allows cycling through this list.

The list size (n) is variable between 2 and 20 and this enables the viewing experience to be tailored to particular applications.

The acquisition modules are identified by their 4 character hexadecimal Data Tags.

When in communication with a particular acquisition module the LED on that module is activated. This provides visual feedback of the selected and currently viewed module. The LED output can also appear optionally on the digital output.

Communications

To configure the device you will use the Read and Write mechanisms described in the **Data Packet Structures** section to read and write parameters and execute commands.

Parameter List

| Parameter | Command | Description | Native | Read / |
|--------------|---------|--|----------|--------|
| | Number | | Data | Write |
| | | | Туре | |
| ID | 3 | Read the unique identifier ID for this device. (3 bytes) | BINARY 3 | R |
| | | | bytes | |
| Version | 53 | Read the firmware version. | STRING | R |
| | | | 11 Bytes | |
| Channel | 11 | Radio Channel | UINT8 | RW |
| EncKey | 15 | The radio encryption key to operate on. Requires | BINARY | RW |
| | | power cycle or Reset to enable. Not supported in this | 16 Bytes | |
| | | release. | | |
| Power | 12 | Set or read the output power level. | UINT8 | RW |
| | | (range:0 to 100 default:100) | | |
| Name | 10 | Set or read a user defined name. (11 characters) | STRING | RW |
| | | | 11 Bytes | |
| Model | 51 | Read the model number of the device. | STRING | R |
| | | | 11 Bytes | |
| InputValue | 60 | The value that is being read by the device. | FLOAT | R |
| DisplayValue | 61 | The value being displayed by the device. | FLOAT | R |
| UseCSMA | 18 | Select whether to use Carrier Sense Multiple Access | UINT8 | RW |
| | | techniques on transmission. | | |
| | | | | |
| | | Value Description | | |
| | | 0 Disabled | | |
| | | The Carrier Sense Multiple Access will be | | |
| | | disabled. NOT RECOMMENDED | | |
| | | 1 Enabled | | |
| | | The Carrier Sense Multiple Access will be | | |
| | | enabled. | | |
| | | | | |
| | | See Unslotted CSMA/CA in Appendix A | | |
| BattLevel | 69 | The voltage measured on the battery. | FLOAT | R |
| OffDelay | 62 | Time period in minutes before switching off if no | UINT16 | RW |
| | | button is pressed. Setting to zero disables. | | |
| | | (range:0 to 1440 default:5) | | |
| KeyTest | 64 | Set or read the state of the keys. Each time the keys | UINT8 | RW |
| | | are pressed the equivalent bit will be set. | | |
| | | Set to zero to reset. This property is used in ATE to | | |
| | | test the keypad. | | |
| | | | | |

| Timeout | 65 | Set or read the time in seconds that if exceeded between receiving Data Provider packets from the paired device will cause the display to show Default = 3 (range:0 to 65535 default:3) | UINT16 | RW |
|----------------|----|--|-------------------|------|
| PairWait | 67 | Set or read the period in seconds that the handheld will wait for another device to pair when placed into pair mode. (range:0 to 65535 default:5) | UINT8 | RW |
| Format | 70 | Set or read the format for the display. Here you can define how the value will be displayed and where the decimal point will appear. By including a non zero value this will define the resolution of the displayed value. i.e. the smallest step size of value changes. Default = 0000.001 | STRING 8 bytes | RW |
| ZeroSupp | 71 | Set or read whether to show the value on the display with zero suppression. 0 = No zero suppression 1 = Zero suppression | UINT8 | RW |
| Overload | 73 | Set or read the value of the display above which instead of the value being displayed 'Overload' will be displayed. | FLOAT | RW |
| DisplayUpdate | 74 | Set or read the interval between LCD updates. Default = 300 | UINT16 | RW |
| ScaleInLo | 75 | Set or read a low input value at which you know what display you require. Default = 0 | FLOAT | RW |
| ScaleInHi | 77 | Set or read a high input value at which you know what display you require. Default = 1 | FLOAT | RW |
| ScaleDisplayLo | 76 | Set or read a low display value for the input value stated in ScaleInLo. Default = 0 | FLOAT | RW |
| ScaleDisplayHi | 78 | Set or read a high display value for the input value stated in ScaleInHi. Default = 1 | FLOAT | RW |
| ListSize | 79 | Set or read the size of the internal list of Data Tags. Can be between 1 and 20. | UINT8 | RW |
| Reset | 54 | Restarts the device and utilises new channel and encryption keys if those have been changed and saved. | Comn | nand |
| Save | 55 | Save any changes made to parameters. Required before power cycling or issuing a Reset command. Requires 500mS recovery time after executing. | Comn | nand |

NOTE: All changes require a SAVE command to enable them to survive through power cycle or RESET command.

Power Supply

Recommend using alkaline AA cells as rechargeable are too low voltage and lithium may not be able to supply the current for the radio to start up.

Installation

There are no specific installation instructions.

Windows Driver DLL

Overview

A standard Windows driver DLL is supplied which can be used by many development tools.

This DLL has been created to simplify communications with the WTS range of telemetry devices.

This handles circular buffers for incoming data and provides signalling to the host application of incoming packets via a callback mechanism.

The DLL can be used with a serial port or a USB bus.

Where strings are used these are in a format that can be used by Visual Basic. If used in Delphi or C Builder these functions need to be declared as StdCall.

Below you will find the API declarations for Visual Basic which may be used as a guide for other languages:

Public Declare Function VERSION Lib "T24Drv.dll" () As Single

Public Declare Sub INITIALISE Lib "T24Drv.dll" (ByRef iCallbackAddress As Long)

Public Declare Function OPENPORT Lib "T24Drv.dll" (ByVal ComPort As Integer, ByVal Baudrate As Long) As Integer

Public Declare Function CLOSEPORT Lib "T24Drv.dll" () As Integer

Public Declare Function OPENUSB Lib "T24Drv.dll" () As Integer

Public Declare Sub ENUMUSB Lib "T24Drv.dll" ()

Public Declare Function BIND Lib "T24Drv.dll" (ByVal BaseStation As Byte, ByVal UseRemoteSettings As Byte, ByVal ConfigMode As Byte, ByVal Duration As Byte, ByRef ID As Long, ByRef DataTag As Long) As Integer

Public Declare Function BINDASYNC(ByVal BaseStation As Byte, ByVal UseRemoteSettings As Byte, ByVal ConfigMode As Byte, ByVal Duration As Byte) As Integer

Public Declare Function BINDASYNCPOLL(ByRef ID As Long, ByRef DataTag As Long) AS Integer

Public Declare Function READREMOTE Lib "T24Drv.dll" (ByVal BaseStation As Byte, ByVal ID As Long, ByVal Command As Byte, ByRef sData As Byte, ByRef Length As Long, ByRef RSSI As Integer, ByRef CV As Integer, ByRef flags As Integer) As Integer

Public Declare Function WRITEREMOTE Lib "T24Drv.dll" (ByVal BaseStation As Byte, ByVal ID As Long, ByVal Command As Byte, ByRef sData As Byte, ByVal Length As Long, ByRef RSSI As Integer, ByRef CV As Integer, ByRef flags As Integer) As Integer

Functions and Subs

INITIALISE

Initialise the DLL and setup the callback address so that when packets arrive the hosting application receives a callback.

SUB INITIALISE (BYREF iCallbackAddress AS LONG)

Where:

| Parameter | Description |
|------------------|--|
| iCallbackAddress | long pointer to the address of the callback procedure. |

Required before OPENUSB or OPENPORT is called. Pass the address of the callback function. The format of the function (In Visual Basic) is

Sub CallBack(ByRef StringPtr As Long, Length As Long)

To extract the packet data the following Visual Basic example may prove useful:

```
Sub CallBack(ByRef StringPtr As Long, Length As Long)
Dim PacketString As String
Dim PacketByteArray(128) As Byte
'To get the packet into a byte array
CopyMemory PacketByteArray(0), ByVal StringPtr, Length
'To get the packet into a string
PacketString = Left$(StrConv(PacketByteArray(), vbUnicode), Length)
End Sub
```

VERSION

Return the driver version.

FUNCTION VERSION() AS SINGLE

Returns:

The version number in floating point format.

OPENPORT

Open a serial port for communications.

FUNCTION OPENPORT (BYVAL ComPort AS INTEGER, BYVAL Baudrate AS LONG) AS INTEGER

Where:

| Parameter | Description |
|-----------|--|
| ComPort | Long variable indicating the COM port to open. |
| Baudrate | Long value representing the actual required baudrate. The PC port will generate to closest available baudrate to this value. |

Returns:

| Integer Value | Description |
|---------------|---|
| 0 | Port opened OK. |
| -1 | Invalid settings. The serial port exists but could not be configured to the required settings including the requested baudrate. |
| -2 | Could not open serial port at all. Either the port does not exist or another application has opened this port. |

This function must be called before transmitting any packets and once called will activate the callbacks as packets are received by the base station.

OPENUSB

Opens communications with the USB bus. This function does not rely on a base station being present to be a success.

FUNCTION OPENUSB() AS INTEGER

Returns:

| Integer Value | Description |
|---------------|-----------------------------------|
| 0 | USB bus opened OK. |
| -2 | Could not initialize the USB bus. |

This function must be called before transmitting any packets and once called will activate the callbacks as packets are received by the base station.

ENUMUSB

This sub **can** be called every few seconds to allow changes on the USB bus to be enumerated. Most of the time this will change nothing but if a device has been plugged or unplugged from the bus calling this will enumerate the remaining devices and gracefully cope with additions or removals of the base stations. As this can take up to

250mS to complete (When a change has been detected) it is recommended that this be called only every few seconds.

SUB ENUMUSB()

This should only be called after OPENUSB has been successful. If a base station is present when OPENUSB is called and it is going to stay connected then there is no need to call this method.

CLOSEPORT

Close any open serial ports or USB bus connection.

FUNCTION CLOSEPORT() AS INTEGER

Returns:

| Integer Value | Description |
|---------------|--|
| 0 | Closed OK. |
| -2 | An error occurred while closing the ports. |

This function should be called before closing the hosting application.

BIND

Also known as **Pairing**. The BIND function allows connection information to be retrieved from an unknown remote device and to configure the communications settings between that device and the base station. Most devices activate their binding mechanisms by being power cycled but refer to the device manual for details. This function is blocking and does not return until a bind is successful or the duration has expired. For a non blocking Bind function see BINDASYNC.

FUNCTION BIND (BYVAL BaseStation AS BYTE, BYVAL UseRemoteSettings AS BYTE, BYVAL ConfigMode AS BYTE, BYVAL Duration AS BYTE, BYREF ID AS LONG, BYREF DataTag AS LONG) AS INTEGER

Where:

| Parameter | Description |
|-------------------|--|
| BaseStation | Represents the base station address. This should be 1. |
| UseRemoteSettings | Determines whether the remote device will be configured to the base station communications settings or vice versa. Set to 1 to change the base station settings to match those of the remote device or zero to change the remote device settings to match the base station. |
| ConfigMode | Determines whether the remote device will enter configuration mode. This mode is dependent on the actual device but will generally mean it will stop any automatic transmissions, inhibit low power modes and not act on any automatic sleep mechanisms. This ensures that the binding application can communicate and configure it. |
| Duration | Sets the duration of the bind attempt in seconds. i.e. how long the base station will wait for the remote device to enter bind mode. |
| ID | The ID of the bound device. |
| DataTag | The default Data Tag of the bound device. |

Returns:

| Integer Value | Description |
|---------------|---|
| 0 | Bind was successful. |
| 1 | Bind was not successful. No remote device was detected. |
| 99 | Thread conflict detected! Yield (sleep, doevents etc) and retry the function. |

Once a successful bind has occurred the hosting application may communicate with the device using READREMOTE and WRITEREMOTE using the ID returned from the bind function.

BINDASYNC

This bind function is non blocking and is useful when you need to control the power supplied to your device to trigger the bind. This function is called first then use BINDASYNCPOLL to test the status and outcome of the bind.

FUNCTION BINDASYNC (BYVAL BaseStation As BYTE, BYVAL UseRemoteSettings As BYTE, BYVAL ConfigMode As BYTE, BYVAL Duration As BYTE) As Integer

Where:

| Parameter | Description | | | | |
|-------------------|--|--|--|--|--|
| BaseStation | Represents the base station address. This should be 1. | | | | |
| UseRemoteSettings | Determines whether the remote device will be configured to the base station communications settings or vice versa. Set to 1 to change the base station settings to match those of the remote device or zero to change the remote device settings to match the base station. | | | | |
| ConfigMode | Determines whether the remote device will enter configuration mode. This mode is dependent on the actual device but will generally mean it will stop any automatic transmissions, inhibit low power modes and not act on any automatic sleep mechanisms. This ensures that the binding application can communicate and configure it. | | | | |
| Duration | Sets the duration of the bind attempt in seconds. i.e. how long the base station will wait for the remote device to enter bind mode. | | | | |

Returns:

| Integer Value | Description |
|---------------|---|
| 0 | Bind initiation was successful. |
| 99 | Thread conflict detected! Yield (sleep, doevents etc) and retry the function. |

Now call BINDASYNCPOLL to determine when the bind has completed or failed.

BINDASYNCPOLL

Called after BINDASYNC to determine whether the bind is busy or has completed.

FUNCTION BINDASYNCPOLL (BYREF ID As LONG, BYREF DataTag As LONG) As INTEGER

Where:

| Parameter | Description |
|-----------|---|
| ID | The ID of the bound device. |
| DataTag | The default Data Tag of the bound device. |

Returns:

| Integer Value | Description |
|---------------|---|
| 0 | Bind was successful. |
| 1 | Bind was not successful. No remote device was detected. |
| 99 | Busy. Binding is still in progress. |

If successful the ID and DataTag parameters will contain the ID and Data Tag of the bound device.

READREMOTE

Reads a parameter from a remote device. The radio modules transparently handle retries. This function is blocking and execution will not continue until a response has been received or the function has timed out.

FUNCTION READREMOTE (BYVAL BaseStation AS BYTE, BYVAL ID AS LONG, BYVAL Command AS BYTE, BYREF sData AS BYTE, BYREF Length AS LONG, BYREF RSSI AS INTEGER, BYREF CV AS INTEGER, BYREF Flags AS INTEGER) AS INTEGER

| Where: | | | | |
|-------------|---|--|--|--|
| Parameter | Description | | | |
| BaseStation | The address of the base station through which to route this packet. | | | |
| ID | The ID of the remote device. | | | |
| Command | The command number of the parameter to read. | | | |
| sData | Pointer to the result data. There must be enough bytes allocated to avoid buffer overflows. Recommend 128 bytes. The first byte indicates the data type. This will be set by the device and you cannot request data of a specific type. See Data Types and Formats later. | | | |
| Length | The number of bytes returned. | | | |

| RSSI | The radio signal level in dB of the received packet. This parameter will be set on return from this function. |
|-------|---|
| CV | The correlation value of the received packet. A value of 55 is a poorly formed signal whereas 110 is a perfectly formed signal. This parameter will be set on return from this function. |
| Flags | Contains extra information regarding this packet. The binary value of the flags indicate the following: 1=This packet was broadcast. 2=Remote device reports low battery. 4=Remote device reports an error. This parameter will be set on return from this function. |

Returns:

| Integer Value | Description |
|---------------|---|
| 0 | Received response OK |
| 1 | No response from base station. |
| 2 | No response from remote device. |
| 3 | NAK response from remote device. |
| 99 | Thread conflict detected! Yield (sleep, doevents etc) and retry the function. |

WRITEREMOTE

Writes a parameter to a remote device. This function is blocking and execution will not continue until a response has been received or the function has timed out.

FUNCTION WRITEREMOTE (BYVAL BaseStation AS BYTE, BYVAL ID AS LONG, BYVAL Command AS BYTE, BYREF sData AS BYTE, BYVAL Length AS LONG, BYREF RSSI AS INTEGER, BYREF CV AS INTEGER, BYREF Flags AS INTEGER) AS INTEGER

| Where: | | | | | |
|-------------|--|--|--|--|--|
| Parameter | Description | | | | |
| BaseStation | The address of the base station through which to route this packet. | | | | |
| ID | The ID of the remote device. | | | | |
| Command | The command number of the parameter to read. | | | | |
| sData | Pointer to the data to write. The first byte indicates the data type. See Data Types and Formats later. You can write any data type to any parameter and if possible the data will be converted when written. For example you could use strings to write all data if desired. | | | | |
| Length | The number of bytes returned. | | | | |
| RSSI | The radio signal level in dB of the received packet. This parameter will be set on return from this function. | | | | |
| CV | The correlation value of the received packet. A value of 55 is a poorly formed signal whereas 110 is a perfectly formed signal. This parameter will be set on return from this function. | | | | |
| Flags | Contains extra information regarding this packet. The binary value of the flags indicate the following: 1=This packet was broadcast. 2=Remote device reports low battery. 4=Remote device reports an error. | | | | |

Returns:

| Integer Value | Description |
|---------------|---|
| 0 | Received response OK |
| 1 | No response from base station. |
| 2 | No response from remote device. |
| 3 | NAK response from remote device. |
| 4 | Invalid Data response from remote device. |
| 99 | Thread conflict detected! Yield (sleep, doevents etc) and retry the function. |

Data Types and Formats

The first byte in the data written to and read from devices indicates the data type and thus the format of the data that follows.

| Value | Data Type |
|-------|---|
| 0 | Unknown data type. Can be used when executing commands. |
| 1 | UINT8 |
| 2 | UINT16 |
| 3 | INT32 |
| 4 | FLOAT |
| 5 | STRING |
| 5 | BINARY |

See Appendix A - Data Type Formats for details on the formatting.

Thread Conflicts

The DLL has been designed to allow the host IDE to debug through the callback routines. To achieve this there is a situation where sometimes calls to the functions will not able to be handled correctly (i.e. a callback to the host IDE is in progress and to continue would violate the integrity of the threading). In this case the returned value will be 99 and the host program needs to yield processing if it to succeed in getting a response. The suggested technique is as follows:

```
Variable = 99
While Variable = 99
Variable = DLLFUNCTION()
If Variable = 99 Then Yield
Wend
```

Where **DLLFUNCTION()** is where you would place the **ReadRemote** or **WriteRemote** call. You will need to find the appropriate command in your language to Yield. In **Visual Basic** this is **DoEvents** and in **Delphi** this is **Application.ProcessMessage**.

Notes

You should only use data from a function if it has returned a zero (0). All other responses indicate an error.

DLL Limitations

- When connecting via USB only one base station is supported and this must be address 1 (set by DIP switches on industrial version).
- This DLL can only open one serial port per host thread.

Appendix A

Data Type Formats

The following data formats are used when communicating with the base station. These formats apply to the raw data in the packets and also to the data parts of the supplied T24drv.dll driver.

| Value | Data Type | Number Of Bytes | Example | Notes |
|-------|-----------|-----------------|-------------|-------------------------|
| 1 | UINT8 | 1 | 01 | |
| 2 | UINT16 | 2 | 00 01 | MSB First |
| 3 | INT32 | 4 | 00 00 00 01 | MSB First |
| 4 | Float | 4 | 3F 80 00 00 | See Floating Point IEEE |
| 5 | String | 0-64 | Hello World | |
| 6 | Binary | 0-64 | "£\$%^&*(| |

UINT8

Represents an unsigned numeric value from 0 to 255 and consists of a single byte.

| | | | By | te | | | |
|---|---|---|----|----|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

UINT16

Represents an unsigned numeric value from 0 to 65535 and consists of 2 bytes. The bytes are in order of significance MSB first.

| MSByte | | | | | | | | | LSByte | | | | | | | | |
|--------|----|----|----|----|----|---|---|---|--------|---|---|---|---|---|---|--|--|
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | |

INT 32

Represents a signed numeric value from -2,147,483,648 to positive 2,147,483,647 and consists of 4 bytes and is stored in 2's compliment form. The bytes are in order of significance MSB first.

| MSByte | | | | | | | | | | | | | | | | | | | | | | LSByte | | | | | | | | | |
|--------|------|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--------|---|---|---|---|---|---|---|---|---|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 16 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | Sigr | ı Bit | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Float

Represents a numeric value from n to n and consists of a 4 byte in IEEE 754 format.

| MSByte | | | | | | | | | | | | | | | | | | | | | | LSByte | | | | | | | | | |
|--------|-------------------------------|----|----|----|----|----|----|-------|--|---------|--------|-------|-------|--------|----|--|---|---|---|---|---|--------|---|---|--|--|--|--|--|--|--|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 3 22 21 20 19 18 16 16 15 14 13 12 11 10 9 8 | | | | | | | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | | |
| | Exponent (7-bit excess-127) M | | | | | | | antis | sa (-t | oit fra | actior | ו wit | h imp | olicit | 1) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Sign Bit

The byte containing the sign and exponent is sent first, with the LS byte of the mantissa being last. The value of the number is thus

(-1)Sign * 2(Exponent-127) * 1.Mantissa

Note the 'assumed 1' before the mantissa. The exception to this is the special value 0.0, which is represented as 4 zeroes.

The precision of this format is to 7 digits.

eg. a floating-point number of -12345.678 is represented as - [hex] C640E6B6

String

Represents a textual string and is terminated by a NULL (ASCII 0).

Binary

The bytes have no set meaning and are just a string of bytes. These bytes can be any value and may contain non ASCII characters.

RSSI, CV and LQI

Packets received from remote devices have RSSI and CV bytes present at the end of the packet.

RSSI is Received Signal Strength Indication

This indicates the strength of the received signal. This approximates to dB and can be calculated from the RSSI byte which is stored in 2's compliment format. This value also has an offset of 45. To convert the byte value to RSSI use the following algorithm.

RSSI = RSSIBYTE If RSSI > 127 Then RSSI = ((RSSI - 1) Xor 0xFF) * -1 RSSI = RSSI - 45

CV is Correlation Value

This indicates the quality of the signal. The value of the CV byte (0-255) needs the most significant bit masking off (AND with & H7F) where a poor CV is around 55 and a good CV is 110.

```
CV = CVBYTE
CV = CV AND \& H7F
```

LQI is Link Quality Indication

Sherborne may also refer to Link Quality which is derived from the RSSI and CV values:

LQI = (((94 + RSSI) + (CV - 55)) / 2) * 3.9

Which gives an operational range of approximately 0 to 255.

This operational range covers the extremes of very poor to very good connection quality so we usually take a portion of this to represent the **usable** range which gives the user a better representation of usable, real-world quality.

The LQI range from 50 to 128 can be thought of as to represent 0-100% usable quality.

This reduced portion of the range represents the **usable** range and may be represented, for example, by a signal strength indicator as found on a mobile/cell phone.



The charts below indicate the operational and usable combinations of RSSI and CV where black is poor and white is good.



Unslotted CSMA/CA

Most of the WTS range of devices will allow you to turn off the CSMA (Carrier Sense - Multiple Access). This is recommended to be turned on but in some circumstances turning it off will increase data rate and reduce latency. For example a single deice transmits at 200Hz. With no other device on this channel CSMA can be disabled giving a more accurate 200Hz transmission.

CSMA is implemented to reduce the collisions between packets from different devices.

With CSMA Disabled

When a device wants to transmit it checks the channel to see if another device is transmitting. If not then the transmission takes place immediately. If the channel is busy then the transmission will occur as soon as the channel has been detected as clear.

With CSMA Enabled

When a device wants to transmit it checks the channel to see if another device is transmitting. If the channel is busy then we wait until it is clear.

Now we back off for a random period.

The first time we back off one of the following periods is randomly selected:

320uS 640uS 960uS

If the channel is now clear then the transmission takes place. If the channel is busy then a new random backoff period is selected from the following:

320uS 640uS 960uS 1.28mS 1.600mS 1.920mS 2.240mS

If the channel is now clear then the transmission takes place. If the channel is busy then a new random backoff period is selected from the wider range and the procedure repeated.

Certain packets are transmitted as if CSMA is disabled regardless of the device setting. These include the sleep/wake packets and responses to requests.

Data Tag Control Interface (Advanced)

When acquisition devices are operating in low power mode it is not easy to communicate using the full read/write packets as most of the time the device is asleep. Also in some cases the consumer of the data only knows the Data Tag from the Data Provider packet and does not know the ID of the sender. Therefore we need to utilise a control interface within the Data Provider packet scheme whereby devices such as a handheld can perform rudimentary control on another device while knowing no more than that devices default Data Tag. Each device supplying data to a consumer only has one defined default data tag. We reuse that tag to enable communicating back to the data provider. This will not affect other consumers of the data as the data provider packet will contain a data type of FF which indicates our internal control interface.

All other consumers will automatically reject the FF data type anyway.

So to control the provider we simply send a data provider packet using the same data tag but containing data of type **FF** the data consists of a single **Function Byte** which has fixed functionality depending on its value. The status byte is not used and may be left at zero.

| Value | Fixed Universal Function |
|-------|--------------------------|
| 0 | None |
| 1 | SLEEP |
| 2 | PAUSE |
| 3 | STAYAWAKE |
| 4 | CONTINUE |
| 5 | DOSYSTEMZERO |
| 6 | REMOVESYSTEMZERO |
| 7 | SHUNTCALON |
| 8 | SHUNTCALOFF |
| 9 | DOTARE |
| А | REMOVETARE |
| В | LEDONUNTILNEXTTX |

Using a Data Tag of FFFF will act as a broadcast data provider control interface and all recipients of an FFFF data tag will check the data type and if this is FF the device may perform the specified function. To use this interface the sender must reply with the control interface packet within 8 milliseconds of receiving a

Data Provider packet.

| Packet | Da | ta | Status | Data | Function |
|--------|----|----|--------|------|----------|
| Туре | Ta | ag | | Туре | Byte |
| 03 | 00 | 00 | 00 | FF | 00 |

Appendix B

Radio Range

When planning the installation of a radio net it is useful to consider a number of different arrangements and compare their relative merits before deciding on a final layout. One aspect to be considered is the useable signal strength at the receiver input represented by the Received Signal Strength Indicator (RSSI) figure.

RSSI is a negative number related to signal strength in dBm; a smaller number represents a stronger signal so -70 is much better than -80. To obtain a reliable link using Rad24 radios RSSI must be no worse than -85 to -90, beyond this figure packet loss rate increases and link quality drops off sharply. A table illustrating the relationship between receiver input power and RSSI is reproduced at Table 1 below.

Radiated energy diminishes over distance with an inverse square law; signal power is also lost due to absorption and scattering in the air between the transmit and receive antennas, these losses are referred to as Free Space Path Loss and vary according to the wavelength of the signal. At 2.4GHz Free Space Path Loss is given by:

Path Loss = $32.4+20Log_{10} d$

Where: Path Loss is expressed in dB d = Path length in metres

Example 1

Path Loss over 80metres = 32.4+20Log₁₀80

 $20Log_{10} 80 = 38.06$

Path Loss = 32.4+38.06 = <u>70.46 dB</u>

For convenience, Table 2 below gives path losses at range intervals of 5 metres.

Example 2

An estimate of signal power at the receiver input can be made by considering two Rad24i radios in the open separated by a distance of 80m. Rad24i output power is 0dBm and the peak gain of the integral antenna is 3dB as shown at Figure 1 below.



 G_T = Gain of transmit antenna

 G_R = Gain of receive antenna

Figure 1

Calculation of signal power at the receiver input is achieved by summing all the gains and then subtracting the sum of all the losses, in this case:

Signal power at the receiver input = (G_T+G_R) - Path Loss

or

6 - 70.46 = -64.46dBm

Signal power at the input of the receiver = -64.46 dBm

Note that although the manufacturer's data sheet for the chip antenna gives gain as 3dBi Peak, this figure is rarely achieved in practice; between 1 and 1.5dBi is more usual.

Example 3

In practice the radios would be fitted inside enclosures and the antenna may be either inside the enclosure or mounted some distance from the radio and connected to it by an extended feeder. A practical example of this type is illustrated at Figure 2 below.



Sum of the gains = G_T+G_R

or: 4.5 + 6.0 = 10.5

Sum of the losses = Feeder Loss + Path Loss + Enclosure Loss

or: 1.5 + 70.46 + 6.0 = 77.96

Signal strength at the receiver input is: 10.5 - 77.96 = <u>-67.46dBm</u>

Refer to Table 1 below that relates receiver input power to RSSI, an input level of -67.46dBm will give an RSSI of around -74.

In this example the gain of the receive antenna and the receiver enclosure loss are identical and therefore cancel out.

Antenna Basics

Gain

For a particular antenna the stated gain figure applies only along the antenna bore-sight and often only in one plane; if the remote point is off-axis relative to the antenna electrical centre-line or bore-sight then the gain will depend on the degree of offset according to the polar diagram for that antenna.

For example, an antenna is advertised as having a gain of 12dBi and a beam-width of 60 degrees; this is normally taken to refer to the half power or -3dB beam-width. In other words the antenna gain at \pm 30degrees off the bore-sight will be 3db down on the peak gain or 9dBi. Beyond \pm 30 degrees off-axis the gain will be very much less.

For short vertical antennas of the "rubber duck" type the gain is fairly constant in the horizontal plane but the vertical beam-width may be as little as 12 degrees for a 9dB antenna making it necessary to mount the antenna slightly off vertical for best signal strength in a specific area; this of course means that the pattern on the opposite side might now be pointing into the ground or up in the air.

Polarisation

Antenna polar diagrams show coverage in terms of variations in gain over vertical and horizontal planes relative to the antenna. Depending on its method of construction the antenna will radiate the electric component of the Electro-Magnetic (EM) wave in one plane and the magnetic component in the other (Polar diagrams identify these two components as E for electric and H for magnetic). If the electric component of the EM wave is vertical then the antenna is said to be vertically polarised and vice-versa.

There are some exceptions to this (such as crossed and circular polarisation) but for the sake of simplicity they are not considered here.

For maximum power transfer all antennas on the same radio net must be mounted so that their signals have the same polarisation; it is sometimes possible to take advantage of this to allow operation of adjacent but otherwise unconnected radio nets on the same channel by having the antennas on one net vertically polarised and the other horizontally polarised.

Mounting Requirements

Objects or structures within the operating region of the antenna will distort the horizontal and vertical space pattern so that the antenna polar diagram no longer represents the actual coverage. For this reason, antennas should be mounted to maximise separation from buildings or structures and away from areas where large objects may be temporarily placed. This is usually achieved by fixing the antenna to a mast or tower by means of a bracket that allows adjustment of antenna orientation. The mounting method should also allow for adjustment of height as, very often, a small change in antenna elevation will improve signal strength.

Receiver Input Power and RSSI Relationship

During development of the Rad24 radio it was necessary to understand the relationship between signal power at the receiver input and the indicated RSSI figure. A calibrated signal source was used to set RSSI readings at intervals of 10 and the corresponding input levels recorded at each step. Figures in italics were not measured but extrapolated from the measured values.

| Input signal power | Indicated RSSI |
|--------------------|----------------|
| (dBm) | Value |
| -7 | -10 |
| -17 | -20 |
| -28.5 | -30 |
| -36.5 | -40 |
| -44.5 | -50 |
| -54 | -60 |
| -64 | -70 |
| -74 | -80 |
| -79 | -85 |
| -84 | -90 |

Path Loss at 2.4GHz

Free Space Path Loss in dB = $32.4+20Log_{10} d$ Where d = Free space path length in metres

| Path length (metres) | Loss (dB) |
|-------------------------|--------------|-------------------------|--------------|-------------------------|--------------|-------------------------|--------------|
| 5 | 46.37 | 70 | 69.30 | 135 | 75.00 | 200 | 78.42 |
| 10 | 52.40 | 75 | 69.90 | 140 | 75.32 | 205 | 78.63 |
| 15 | 55.92 | 80 | 70.46 | 145 | 75.62 | 210 | 78.84 |
| 20 | 58.42 | 85 | 70.98 | 150 | 75.92 | 215 | 79.04 |
| 25 | 60.35 | 90 | 71.48 | 155 | 76.20 | 220 | 79.24 |
| 30 | 61.94 | 95 | 71.95 | 160 | 76.48 | 225 | 79.44 |
| 35 | 63.28 | 100 | 72.40 | 165 | 76.74 | 230 | 79.63 |
| 40 | 64.44 | 105 | 72.82 | 170 | 77.00 | 235 | 79.82 |
| 45 | 65.46 | 110 | 73.22 | 175 | 77.26 | 240 | 80.00 |
| 50 | 66.37 | 115 | 73.61 | 180 | 77.50 | 245 | 80.18 |
| 55 | 67.20 | 120 | 73.98 | 185 | 77.74 | 250 | 80.35 |
| 60 | 67.96 | 125 | 74.33 | 190 | 77.97 | 255 | 80.53 |
| 65 | 68.65 | 130 | 74.67 | 195 | 78.20 | 260 | 80.69 |

These figures are for free-space path loss only, when estimating signal power at the receiver input, take the sum of all the gains and then subtract the sum of all the losses.

Power Density

From the radar equation, power density at the target is given by:

 $Pd = \frac{PT \ GT}{4\pi \ r2}$

Where:

Pd = Power density in W/m2 PT = Transmitter output power in Watts GT = Antenna gain as a multiple of input power r = Range to target in metres

From the Rad24 radio specifications:

Power output is 1mW Peak Chip antenna peak gain is 3dBi or 2 times the input power

Measurement range is 20cm or 0.2m

```
Pd = 1x10-3 X 2
12.568 X 0.22
Pd = 3.978x10-3 W/m2
Pd at 20cm range is 3.978mW/m2
```

Dividing this by 10,000 to express power density in W/cm2 gives:

397.8nW/cm2

This is the peak power density assuming the RF output is 1mW Continuous Wave; multiply this figure by the duty cycle and the average power density is reduced proportionately. Further, this calculation uses the peak gain of the chip antenna stated as 3dBi in the manufacturers data sheet, in practice this gain is rarely achieved being nearer to 1 to 1.5dBi.

RF Exposure Limits

Power density at the Rad24 Antenna is well below the Whole Body Average SAR (Specific Absorption Rate) of 80mW/Kg exposure limit given at ANSI/IEEE C95.1-2005 and OET Bulletin 65 Edition 97-01 dated August 1997. Under the terms of FCC CFR Title 47 Volume 1 Part 2.1091 and Part 2.1093 this equipment is categorically excluded from routine environmental evaluation for RF exposure.

Article 3(1) of Directive 2004/40/EC of the European Parliament and of the Council dated 29 April 2004 (The Physical Agents Directive) gives an Exposure limit for Whole Body Average SAR as 400mW/Kg. Rad24 Peak ERP is not more than 4mW assuming a 6dB antenna.