SW-AO1i analogue output base station. Setup and user guide.

V2.00

Introduction / Overview

The SW-AO1I and SW-AO1i provides an analogue output for the acquisition modules such as T24-SAx and T24-SAFx. The SW-AO1i is housed in an IP67 housing for industrial installation whilst the SW-AO1I is designed for desktop mounting.
The output can be selected from the following pre-calibrated Voltage and Current ranges. 0- 10Volts, +/-10Volts, 0-5Volts, +/-5Volts, 0-20mA, 4-20mA both of which can be used in a 'sink' or source mode.
The SW-AO1I is configured by entering engineering values against the Output Minimum and Maximum Values.
The analogue output is updated at a rate configured by the acquisition module's 'TXInterval'.

LEDs and, in the case of the SW-AO1i, open collector outputs, provide indication of the state of the radio link, remote battery life and remote status.

A 'Volt-free' digital Input on the SW-AO1i version allows for zeroing of the incoming data value.

The SW-AO1i is configured by the T24 Toolkit.

Version 1.1 brings the ability to wake the paired acquisition module when the analog output device is turned on and to keep it awake while it remains powered up.

Communications Overview

Our telemetry devices each have a factory set unique **ID**.
Data is shared between devices using **Data Provider** messages. A device generates these messages which can then be used by many other devices simultaneously.
These messages (or packets) of information contain a single value of data and each is identified by a **Data Tag**.
The **Data Tag** should be unique for each message.

ID — **Identifies each device**
Each device has a unique **ID** that is factory set. This is represented as a 6 character hexadecimal number consisting of the digits 0 to 9 and the letters A to F.
I.e. **`FFD3BE`**

Data Tag — **Identifies each Data Provider message**
A **Data Tag** consists of a 4 character hexadecimal number consisting of the digits 0 to 9 and the letters A to F. The **Data Tag** can be changed by the user but the factory default is to match the last 4 characters of the device **ID**.
I.e. An acquisition device of **ID** **`FFC12B`** would have a default **Data Tag** of **`C12B`**.

When a device consumes data (i.e. a handheld displaying data from an acquisition device) all it is doing is listening to all of the **Data Provider** messages and selecting the one it wants to use. It then extracts the data and displays it.

Some devices that use **Data Provider** messages also need to know the **ID** of the device providing the data. This is necessary if that device needs to specifically wake the data providing device as opposed to using a broadcast wake that will wake all devices on the same channel and using the same encryption key.

Pairing offers an automated method of hooking a provider and consumer of data together. However, some devices may require you to manually enter **Data Tag** and **ID** information so it would be beneficial to the user to understand the above mechanism.

Configuration Overview

The SW-AO1i is configured by setting the Data Tag of the device whose data you wish to reflect onto the analog output.
Once you know the data tag you then need to work out which calibrated values from the acquisition module you want represented by the selected analog output minimum and maximum levels.
For example: A T24-SAx has been calibrated to give 0 to 10 tonnes output. You have selected a 4-20mA analog output and want the output to give 4mA at 0 tonnes and 20mA at 8 tonnes. Simply set the **In Minimum** to 0 and **In Maximum** to 8.
Next you set the desired actions when errors occur.

Getting Started

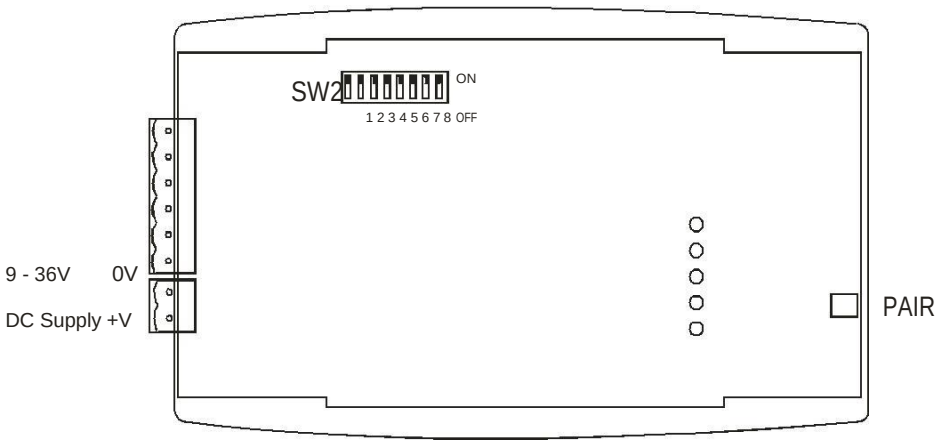
Required Items

You will need an acquisition module to provide data to the analog output. Ensure that for testing you can access the module's power supply and have some way of changing its input.

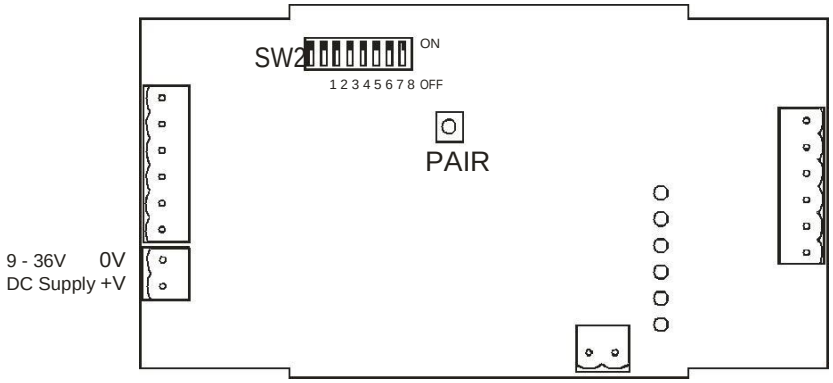
Connecting Power

You will need to connect a power supply to the SW-AO1I for it to operate and to enable configuration using a base station and the appropriate toolkit software.
Power is supplied via the screw terminals and can be in the range of 9 to 36V DC.

SW-AO1I



SW-AO1i



Configuration

This section explains how to install software and connect the required devices together. Please note that you will need the T24 Toolkit software and a SW-USBBSE base station to allow your computer to communicate with our telemetry devices.

Installation

T24 Toolkit

To configure the devices we must use the **T24 Toolkit** software application. This can be downloaded from our web site or may be shipped with your products.
Install this on a PC or laptop.
Run **setup.exe** and follow the prompts to install the software.

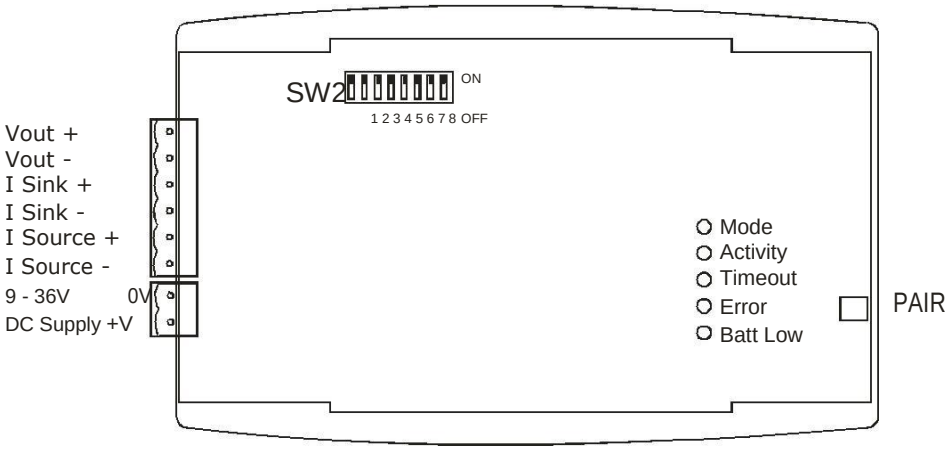
SW-USBBSE Base Station

If you have a USB version of the base station (SW-USBBSE) then you just need to plug this into a USB socket on your PC. If you are using an alternative base station then please refer to the appropriate manual.

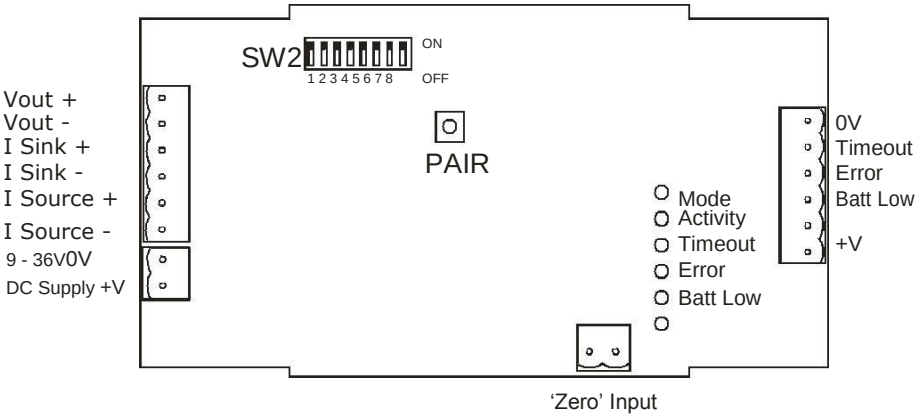
Connections and Indicators

Depending on the analog output device you have you will need to refer to one of the two following diagrams:

SW-AO1I



SW-AO1i



Output Range Setting

To configure the required output range the DIP switches (SW2) require setting as follows. To access the DIP switches you will need to remove the cover from the case.

	SW2 Switch Settings							
Range	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
0-10 V	ON	OFF	OFF	X	X	OFF	ON	OFF
+/-10 V	OFF	OFF	ON	X	X	OFF	ON	ON
0-5 V	ON	ON	OFF	X	X	OFF	OFF	OFF
+/-5 V	ON	OFF	ON	X	X	OFF	OFF	ON
0-20 mA Sink	X	X	X	OFF	ON	ON	OFF	OFF
0-20 mA Source	X	X	X	ON	OFF	ON	ON	OFF
4-20 mA Sink	X	X	X	OFF	ON	ON	OFF	ON
4-20 mA Source	X	X	X	ON	OFF	ON	ON	ON

Where X = Don't care

Operation

LED Indicators

LED	Description
Mode	Flashing at 2Hz indicates normal operation. Constantly on indicates currently attempting to pair. Flashing at 4Hz indicates a failed pair attempt.
Activity	LED lights for 20ms each time data arrives. When data arrives at a rate greater that 50Hz the LED will appear constantly illuminated.
Timeout	Lost communications with the remote device.
Error	Remote device is reporting an error.
Batt Low	Remote device is reporting a low battery.

Pairing

To associate the SW-AO1i with an acquisition device we just need to let the SW-AO1i know the Data Tag of the data to use.
This can be done manually using the T24 Toolkit (See the Advanced Settings page) or this can be achieved using the Pair button of the SW-AO1i.
When first configuring the SW-AO1i it really makes no difference which technique is used but if you were replacing a data acquisition device in the field the switch technique would negate the need for the Toolkit or a base station.
To perform a 'pair' first remove the power from the acquisition device. Next, press the Pair Switch on the SW-AO1i then within 10 seconds re- apply power to the acquisition device. The mode LED will indicate the success or failure of this operation (See above table).
Note: To access the Pair Switch on a SW-AO1i you need to remove the lid. The Pair Switch can be accessed through a hole in the end of the case on a SW-AO1I, a straightened paper clip could be used.

An advantage of using the Pair Switch is that you can pair to any acquisition device regardless of its radio channel or encryption key settings. When you pair the acquisition device settings will be changed to match those of the SW-AO1i. If you manually enter the Data Tag using the T24-Toolkit you will need to ensure that both the acquisition module and the SW-AO1I are on the same radio channel and are using the same encryption key.

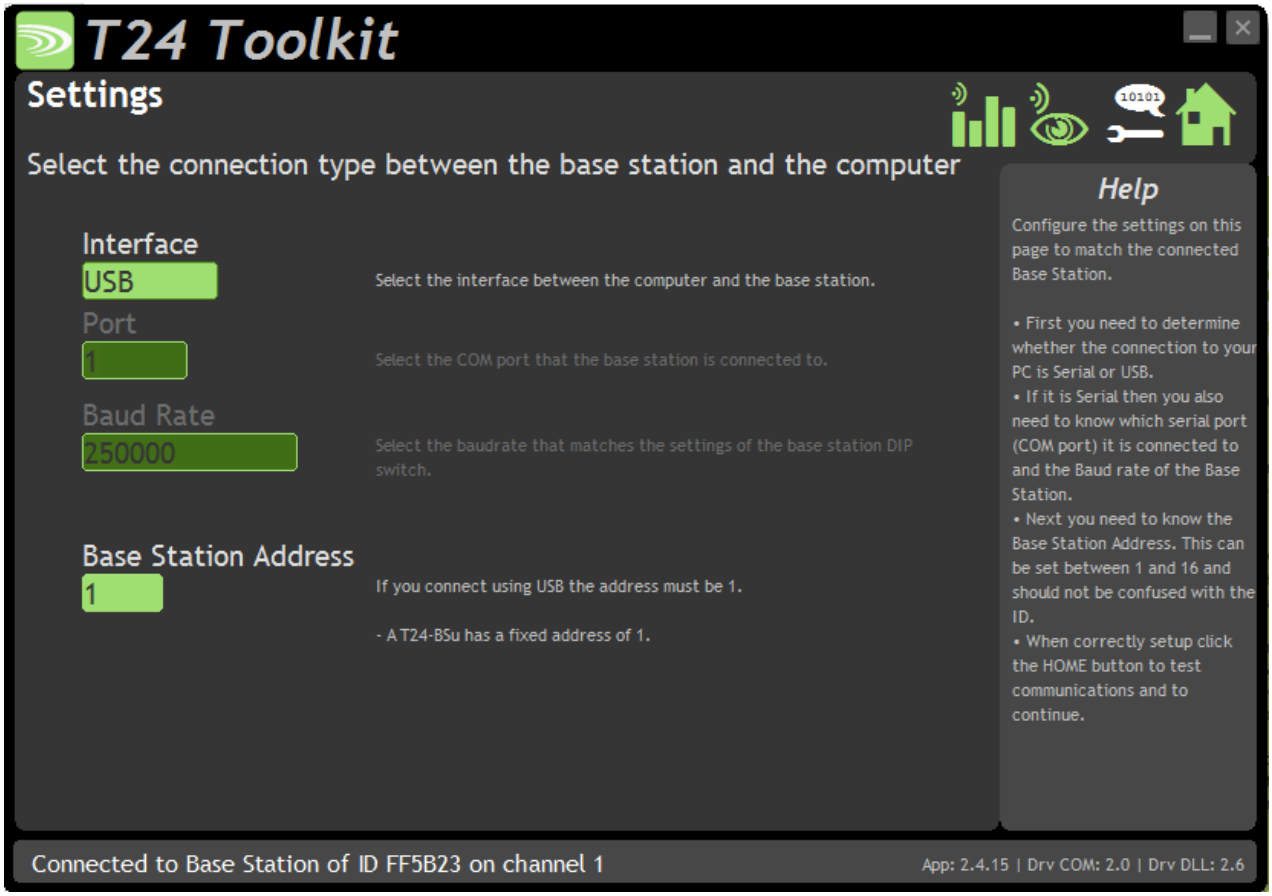
T24 Toolkit

The T24 Toolkit provides a means of simple configuration of the SW-AO1i and associated acquisition module along with useful tools to aid integration. Calibration of the acquisition modules is also provided.

Run the T24 Toolkit software application.

General Pages

Setup Base Station Communications

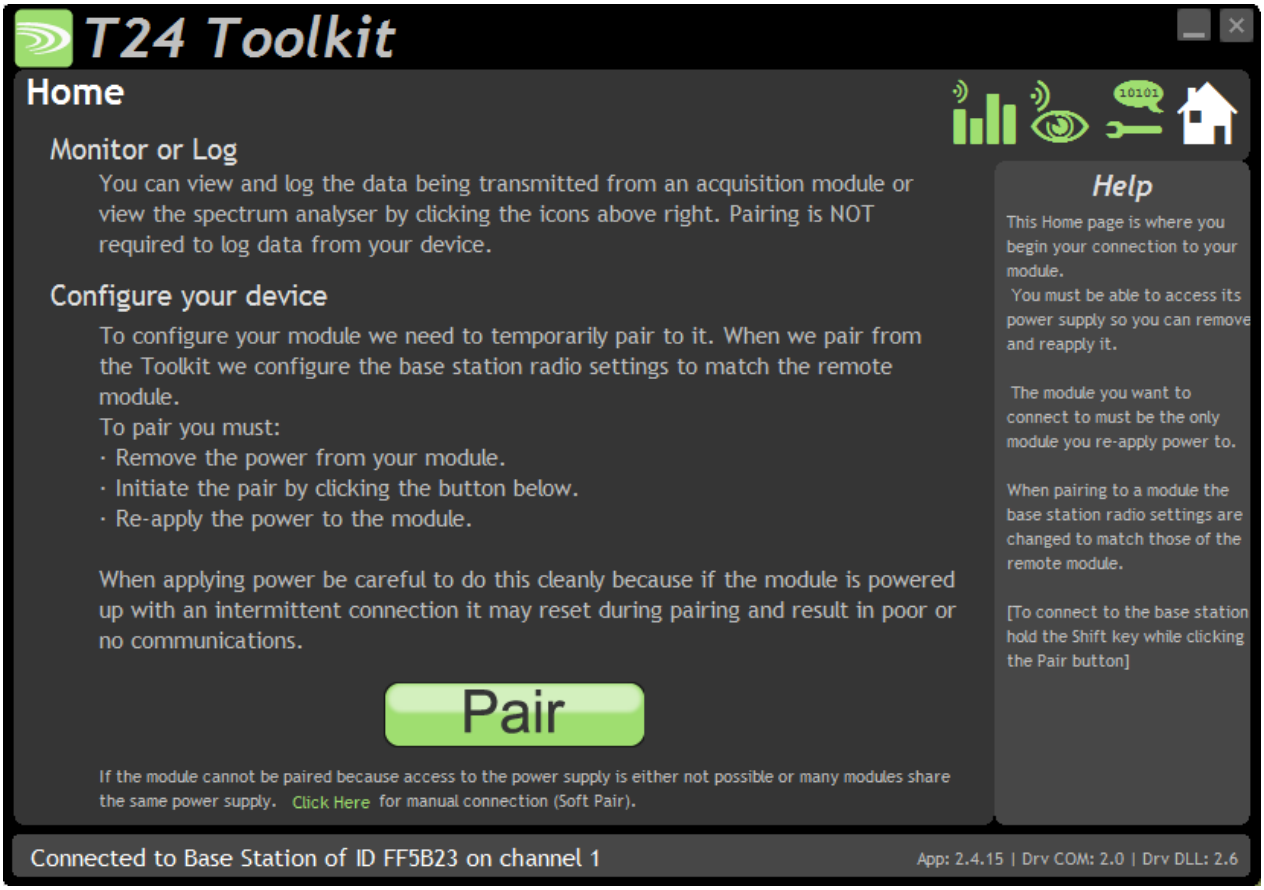


Select **USB** as the interface and select 1 as the Base Station Address.
In the toolkit all items that can be changed by the user are coloured orange.

To change a value just click on the relevant orange item. You will then be presented with a new dialog window allowing you to change the value.
This may use a slider, text box or list to allow your new value to be entered.

Click the Home button to attempt communications with the base station.
If no communications can be established the toolkit will remain on this page. You will need to check that the base station is powered and that it is connected to the computer correctly.

Home



We now have successful communications with the base station so we can now pair with our device or we can select the Spectrum Analyser mode or Data Provider Monitor mode.

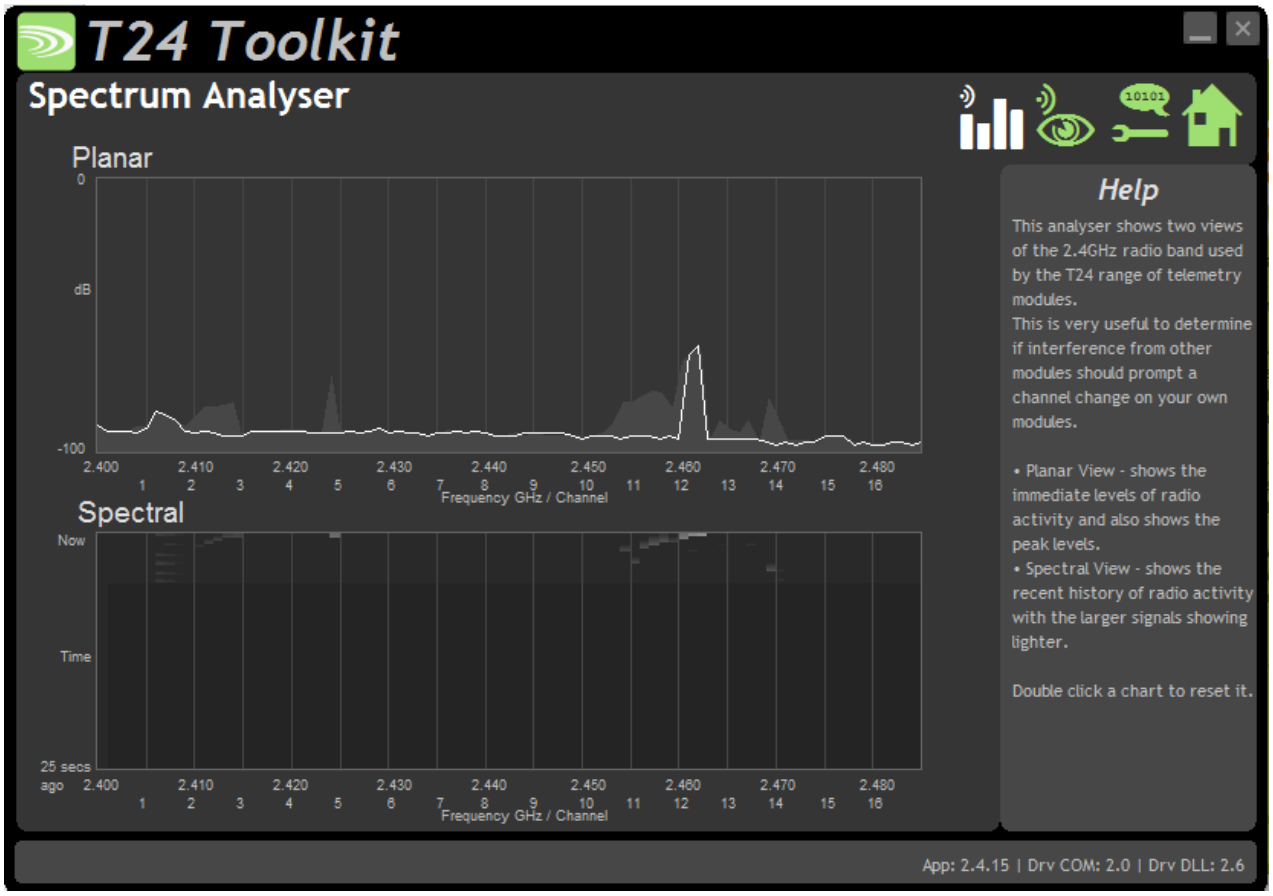
Pairing Procedure

- Remove power from the SW-AO1i module.
- Click the Pair button on the toolkit.
- You now have 10 seconds to re-apply power to the SW-AO1i module.

If you connect successfully the toolkit will change to the Information page.
If the pairing fails try again.

NOTE: The act of Pairing with the toolkit will **not** change the radio configuration settings of the connected device. The settings will only change if you change them yourself within the toolkit.

Analyser



The analyser page is provided as a tool and will not normally be needed unless you plan to change channels and want to find the best channel to select, or to diagnose poor communications issues.

This page shows the radio signal levels detected across all the channels available to the SW series of devices. Using this tool may help in detecting noisy areas and allow you to decide on which channels you may want to use.

The above charts show the traffic from a Wi-Fi network and it can be seen to be operating over channels 6 to 9 and it would be best (though not essential) to avoid using these channels.

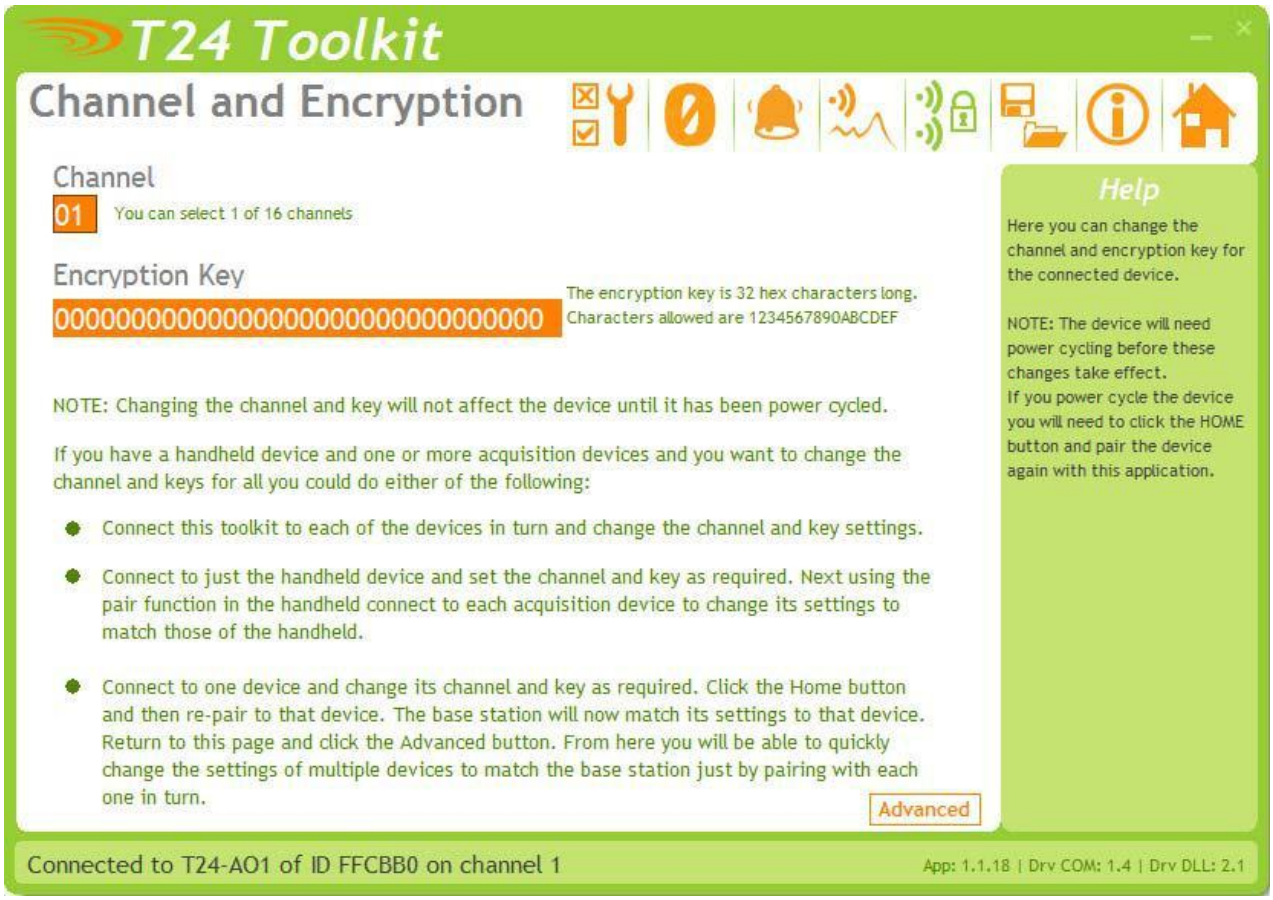
Information

This page shows you information about the connected device.

Items you can change:

Name — You can enter a short descriptive name (11 characters) which may help you recognise this device in the future.

Channel and Encryption



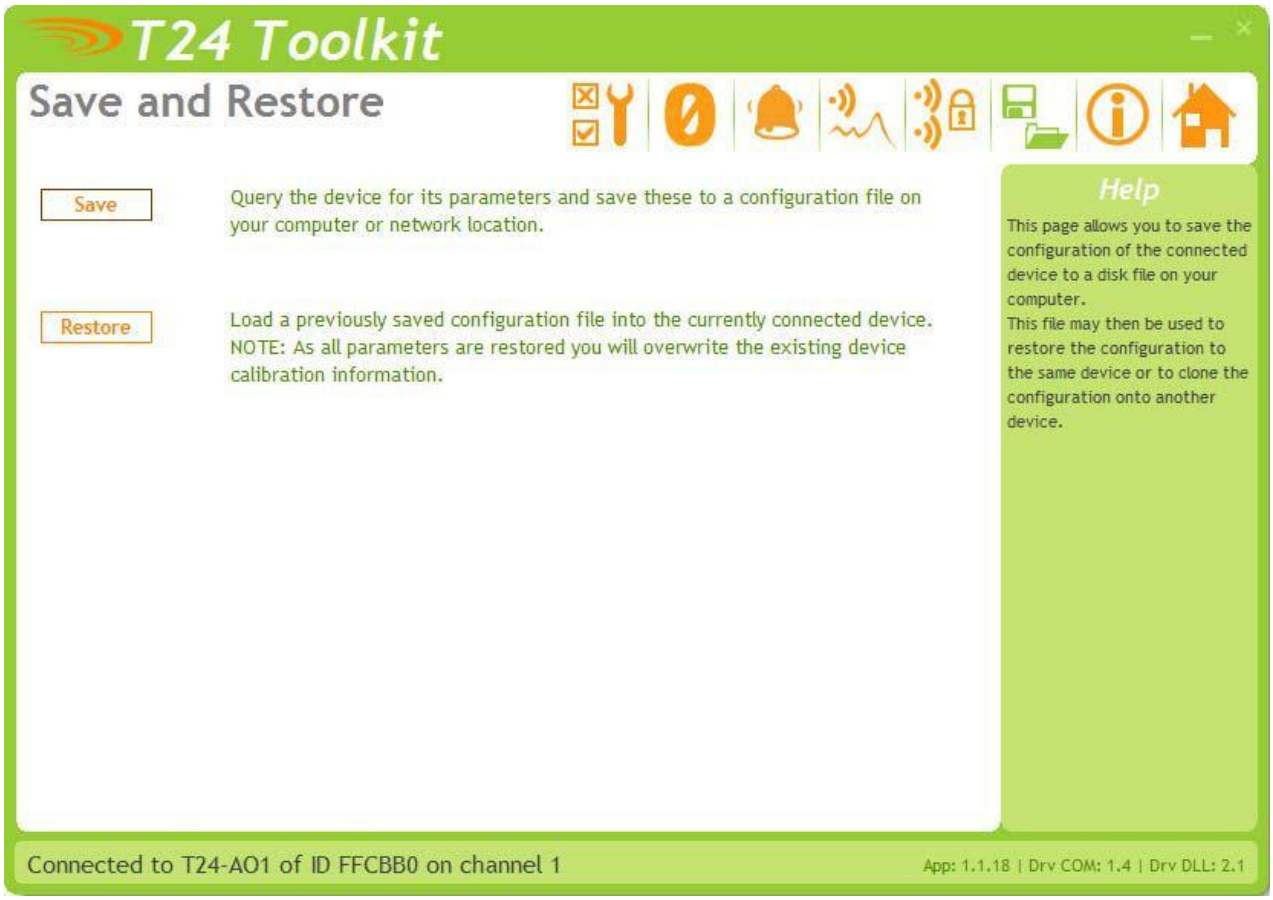
Here you can change the channel and encryption key for the module.

NOTE: Early T24 modules do not yet utilise the encryption keys so these should be left at all zeros.

Items you can change:

Channel	Select a channel between 1 and 16. The default is channel 1. You can use the Spectrum Analyser mode to determine a good clean channel to use. NOTE: Channel 16 is used to negotiate pairing so avoid this channel if possible.
Encryption Key	Only devices with identical encryption keys can communicate. You can isolate groups of devices on the same channel or just use the key to ensure the data cannot be read by somebody else.

Save and Restore

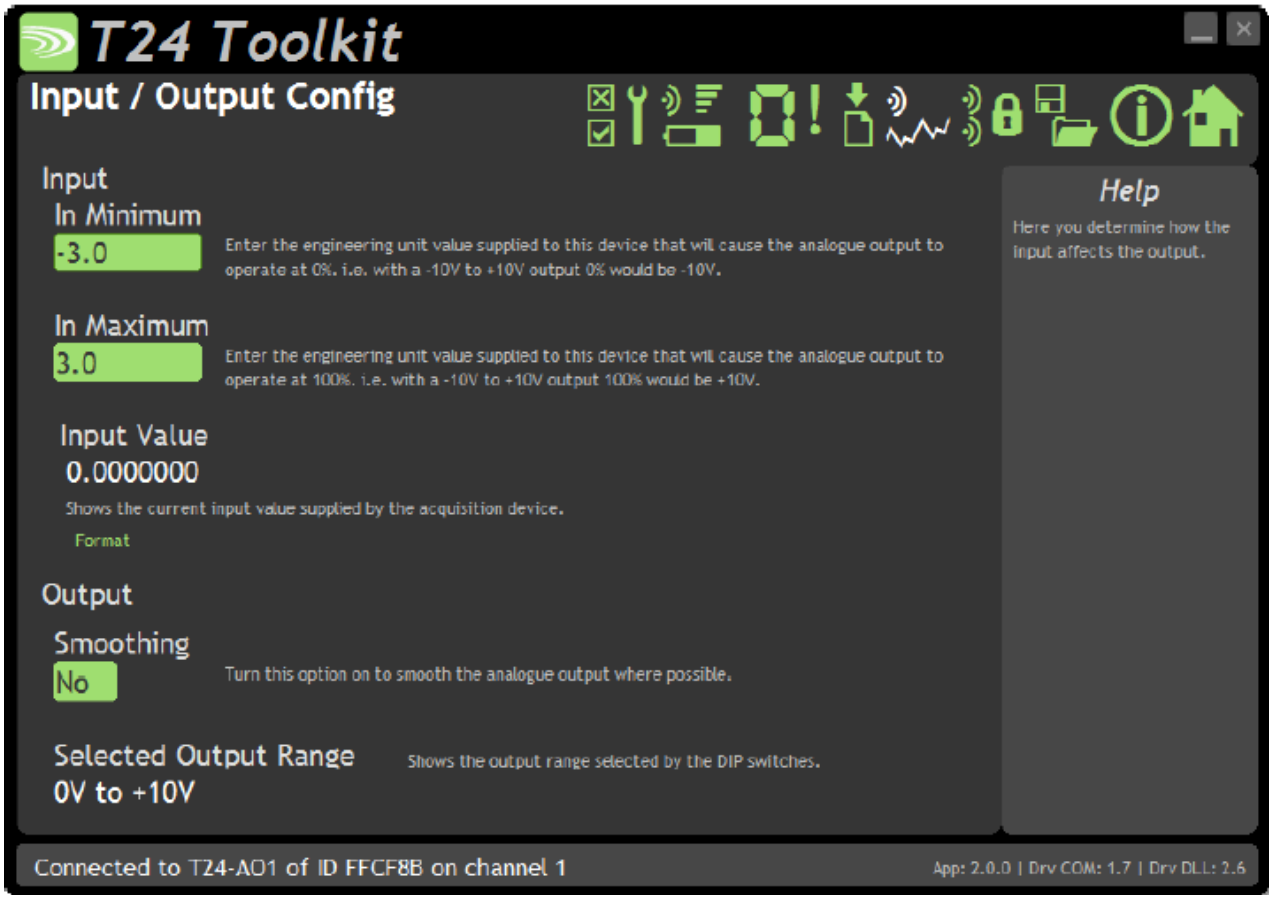


Here you can save the device settings to a file on your PC so that they can be later loaded back into the same or different device.

Items you can change:

Save	Click this button to open a file dialog window to allow you to select a filename and location to save the configuration file to. All configuration information including calibration data will be saved to the file. The file extension is tcf.
Restore	Click this button to open a file dialog window to allow you to select a filename and location of a previously saved file to load into the connected device. All configuration information **including** calibration data will be overwritten. The file extension is tcf.
Advanced Settings	Click this button to enter the Advanced Settings Page. Here are settings which do not normally require changing.

Input / Output Config



Here you set the properties that determine the input and output relationship.

Items you can change:

Input

In Minimum — Enter the input value that should result in the minimum output. The minimum output depends on the Current Selected Output which is determined by the SW2 DIP switch settings.

Range	Minimum Output
0-10 V	0 V
+/-10 V	-10 V
0-5 V	0 V
+/-5 V	-5 V
0-20 mA Sink	0 mA
0-20 mA Source	0 mA
4-20 mA Sink	4 mA
4-20 mA Source	4 mA

In maximum

Enter the input value that should result in the maximum output. The maximum output depends on the Current Selected Output which is determined by the SW2 DIP switch settings.

Range	Minimum Output
0-10 V	10 V
+/-10 V	10 V
0-5 V	5 V
+/-5 V	5 V
0-20 mA Sink	20 mA
0-20 mA Source	20 mA
4-20 mA Sink	20 mA
4-20 mA Source	20 mA

Input value

This shows the currently supplied value to the SW-AO1i. An active acquisition module must be in place to view this value.

Click Format to select a display format.

Output

Smoothing

Click here to select whether to apply smoothing to the output.
The analog output is updated at a rate of 2KHz.
When no smoothing is applied the output changes as soon as new data arrives from the acquisition module.
When smoothing is active the output is ramped between the last input value and the current input value at a rate of 2KHz. This has the effect of delaying the output (latency) by the interval between values being delivered to the input. i.e. The SW-AO1i must receive an input value then start to ramp up to it from the previous input value.

Example: with an acquisition module delivering data at 3Hz the SW-AO1i output would have a latency of 333ms when smoothing is active.

Current Selected Output

This shows the currently selected output range as set by the SW2 DIP switches. NOTE: Some of the DIP switches are used to indicate to the device the selected range and others are used to route circuitry so although this display may indicate the selected range that does not mean that all switches are in the correct position for the range to work correctly. Always check the SW2 DIP switch table for the correct settings.

Alarm Settings

Here you can set the action to take when certain errors occur.
The actions are applied when the errors occur and if more than one error is present the actions are applied with the following priorities:
Timeout Action, Remote Error Action, Remote Batt Action

When errors are removed the analog output resumes reflecting the current input.

Items you can change:

Timeout	Enter the timeout in milliseconds for the input to timeout. If a new Data Provider packet does not arrive within this time the **Timeout Action** will trigger. Generally this timeout should be set to at least three times the acquisition module transmission rate.
Timeout Action	Select the action to take place when a timeout occurs. i.e. when communications (for more than the duration of the Timeout value) is lost with the acquisition module. See the **Output Actions** section for the available actions and the effect of these choices on the different output ranges.
Remote Error Action	Acquisition modules can report errors. You will need to refer to the module manual for information regarding what constitutes an error. See the **Output Actions** section for the available actions and the effect of these choices on the different output ranges.
Remote Batt Action	When the acquisition module reports a low battery this action will occur. See the **Output Actions** section for the available actions and the effect of these choices on the different output ranges.

Output Actions

The following actions can be selected.

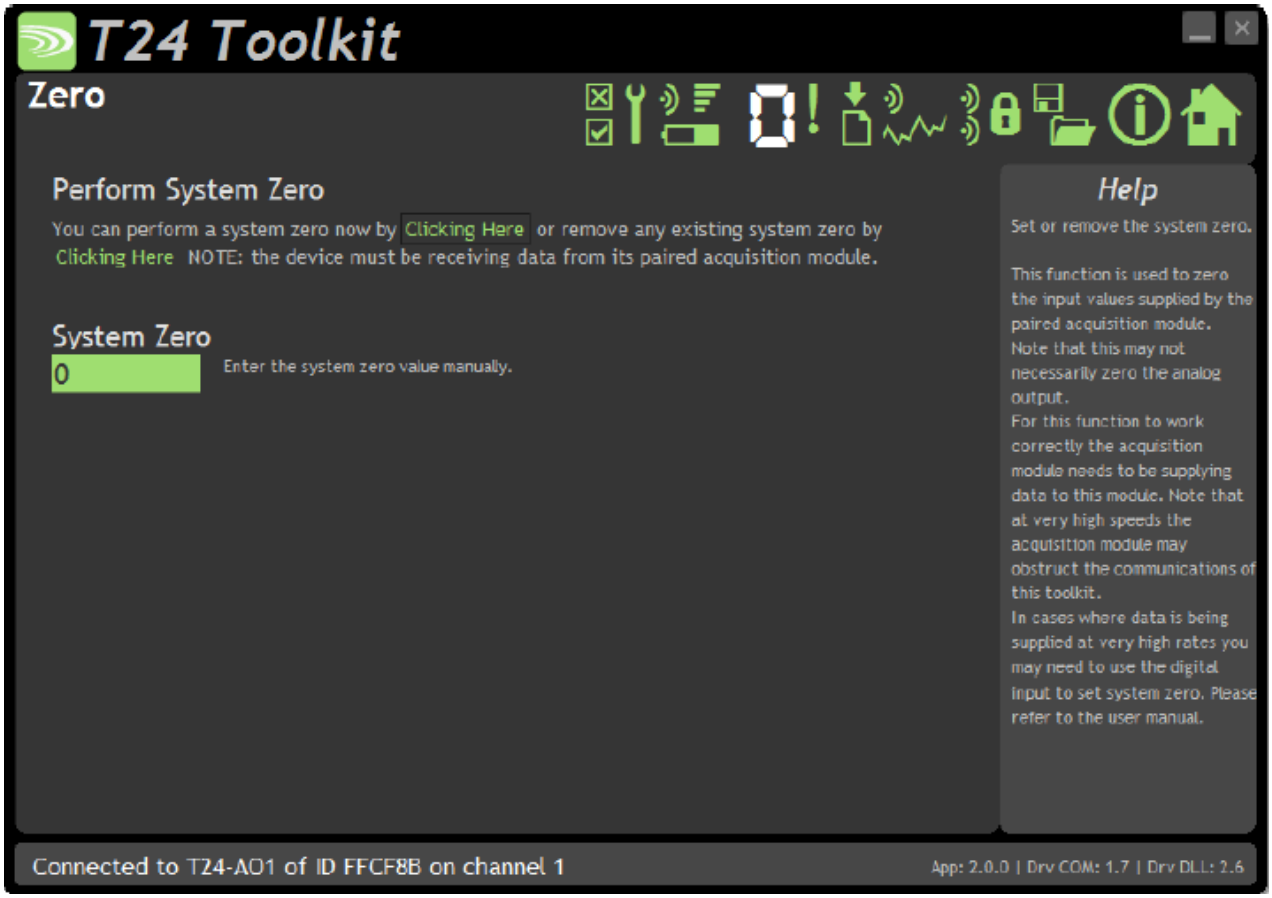
None	Do nothing
Minimum Full Scale	Set analog output to the minimum full scale value
Maximum Full Scale	Set analog output to the maximum full scale value
Minimum Output	Set analog output to the minimum possible value
Maximum Output	Set analog output to the maximum possible scale value
Half Full Scale	Set analog output to halfway between minimum and maximum full scale value
Hold Last Output	Hold the last output. (Does the same as None for the **Timeout Action**)

The following table shows the output that can be expected for each range.

	Output Range					
	0-10 V	+/-10 V	0-5 V	+/-5 V	0-20 mA	4-20 mA
Action						
None	-	-	-	-	-	-
Minimum Full Scale	0	-10	0	-5	0	4
Maximum Full Scale	10	10	5	5	20	20
Minimum Output *	-0.5	-11	-0.3	-5.5	0	0
Maximum Output *	11	12	5.4	6	22.4	22.4
Half Full Scale	5	0	2.5	0	10	12
Hold Last Output	-	-	-	-	-	-

* The values shown here are approximate. Each device will vary depending on tolerances of electronic components.

Zero Settings



System zero allows you to zero the input. The system zero value is subtracted from the input value before it is used to determine the analog output to apply.

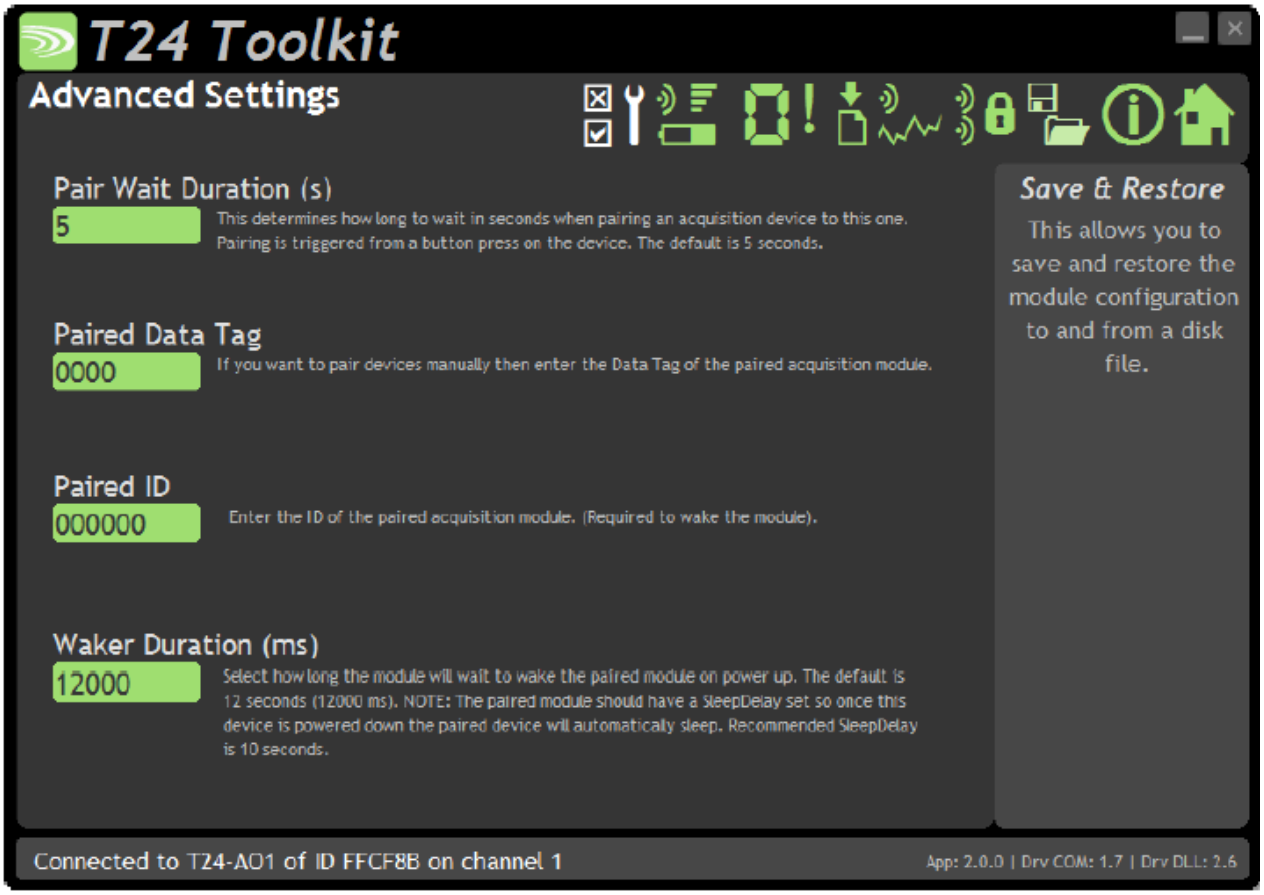
NOTE: Performing a System Zero does not necessarily zero the output!

This page allows either manual entry or to zero the current input value.

Items you can change:

Perform System Zero	Click to use the current input value as the new system zero.
Remove System Zero	Remove the system zero so that the input value is directly used to determine the analog output.
System Zero	Enter the required system zero value.

Advanced Settings



This page allows effective conversion between units. i.e. Although all devices supplying data are configured in Kg you can get a printed output in Lbs.

Items you can change:

Pair Wait Duration	Here you can set the duration that the SW-AO1I will wait to achieve successful pairing after the Pair Switch is pressed. The default is 5 seconds.
Paired Data Tag	This shows the currently paired Data Tag. You can click this to manually enter a Data Tag.
Paired ID	Version 1.1 onwards. This shows the ID of the paired module. This is required if the analog output device is to wake the acquisition module when it is first powered on.
Waker Duration (ms)	Version 1.1 onwards. To wake the paired acquisition module on powerup and to keep it awake you need to enter a time to try waking the module in milliseconds. The default is 12000 ms (12 seconds). Enter zero to disable the automatic waking of modules. NOTE: The paired acquisition module should have its SleepDelay parameter set so that once the analog output device is turned off the remote module will go back to sleep on its own. The recommended time for the sleep delay is 10 seconds or 10000 ms.

Specifications

General Radio

	Min	Typical	Max	Units
License		License Exempt		
Modulation method		MS (QPSK)		
Radio type		Transceiver (2 way)		
Data rate		250		k bits/sec
Radio Frequency	2.4000		2.4835	GHz
Power		1		mw
Range SW-AO1I			100 (325)	Metres (feet) *
Range SW-AO1i (External antenna)			200 (650)	Metres (feet) *
Channels (DSSS)		16		

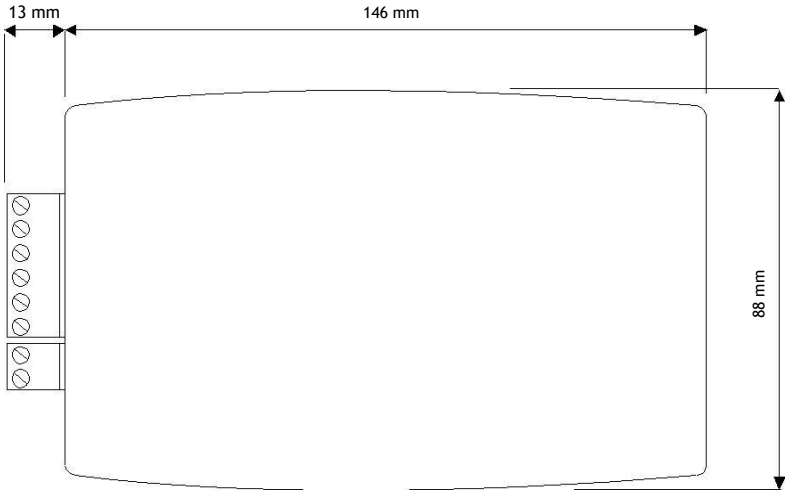
* Maximum range achieved in open field site with T24-SAx at a height of 3 metres (9.8 feet) above ground.

SW-AO1i

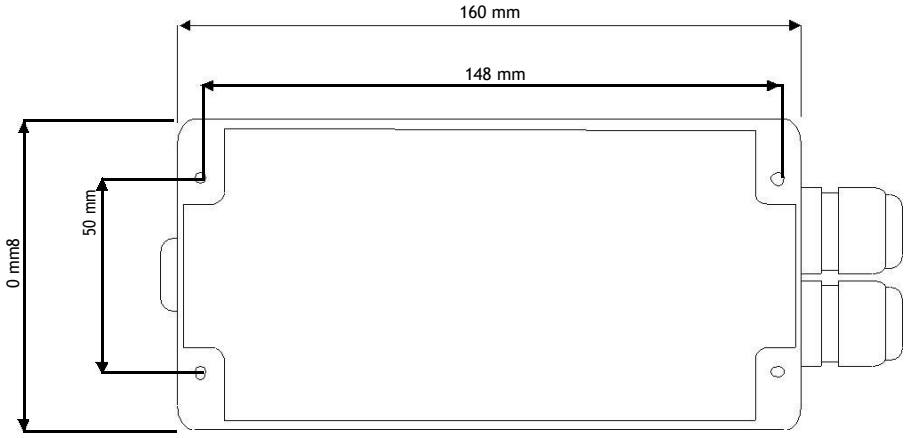
Parameter	Minimum	Typical	Maximum	Units	Notes
External Supply voltage Range	9	12	36	Volts	
Operational Current	-	85	150	mA	
Operating Temperature Range	-40	-	85	Deg C	
Storage Temperature Range	-40	-	85	Deg C	
Reverse polarity Protection	-	-	-36	Volts	Maximum Supply level
Digital output Drive voltage			30	Volts	
Digital output Drive Current			20	mA	
Source Impedance driving Digital Input (volt-free contact)			200	Ohms	
Voltage output					
Resolution		16		Bits	
output gain stability	-	0.008	0.015	± % FS/°C	
output zero stability	-	0.005	0.015	± % FS/°C	
Short term stability (1 hr)	-	0.003	0.01	± % FS	
Long term stability (10k hrs)	-	0.03	0.1	± % FS	
Residual ripple		40		mV p-p	
Minimum load impedance	5000			Ohms	
Linearity	-	0.007	0.01	± % FS	
Current output					
Resolution		16		Bits	
4-20mA output gain stability	-	0.006	0.03	± % FS/°C	
4-20mA output zero stability	-	0.003	0.02	± % FS/°C	
Short term stability (1 hr)	-	0.006	0.03	± % FS	
Long term stability (10k hrs)	-	0.06	0.2	± % FS	
Residual ripple		0.032		mA p-p	
Settling time to ±0.5uA (thermal effects)	-	5	-	secs	
Maximum load impedance			500	Ohms	
Linearity	-	0.01	0.02	± % FS	
Physical Dimensions					
SW-AO1I	166 X 87 X 26 mm				
SW-AO1i	190 X 80 X 55 mm				

Physical Dimensions

SW-AO1I



SW-AO1i



Installation

Overview

Radio performance at microwave wavelengths is very dependent upon the operating environment; any structure within the operating region of the radios will give rise to three effects:

Obscuration. Obscuration will result in reduced range and occurs when an obstruction masks the line-of-sight between radios.

Aberrations to the horizontal and vertical space patterns. Distortion of these patterns may occur if structures or objects are placed in the near or intermediate field of the antenna. The effect will be to distort the coverage patterns, adversely affecting range and link quality.

Reflection. Any object placed in line-of-sight of the transmit antenna will result in signals arriving at the receiver by an indirect path. Degradation of performance due to reflection (multipath effects) appears as reduced range or poor link quality.

Any of the above will cause poor RSSI figures, an increase in the packet loss rate and in extreme cases complete loss of signal. Fortunately, if consideration is given to these effects at the integration stage then a good quality link will be obtained.

Guidelines for product design:
When selecting materials for product enclosures, preference should be given to fibreglass, light coloured ABS or Polypropylene; at the wavelength of 2.4GHz radio other materials will adversely affect the signal by attenuation, refraction or change in polarisation.

If the application demands that the radio is fitted inside a metal enclosure then ensure that the specified clearances are maintained around the antenna and design in a fibreglass RF window at least as large as the clearance dimensions but ideally as large as possible.

RAD24i radios fitted inside a product should be oriented so that the chip antenna will be vertical when the product is in its normal operating position.

Guidelines for installation:
When planning installations ensure that line-of –sight between nodes is maintained and that objects or structures are kept at least one metre away from antennae wherever possible.

To avoid poor link quality between a RAD24i radio and a handheld device ensure that the RAD24i is mounted so that the chip antenna is vertical. Improvement may also be obtained by altering the height above ground of the RAD24i; a small increase or reduction in antenna elevation will often improve reception.

Range underwater is only a decimetre or so depending on packet rate. Best performance underwater is obtained by using low packet rates and immersing water-proofed antennae rather than water-tight enclosures containing the antennae.