

# Introduction

The following document details the installation, configuration, and operation for the Keynes Controls Ltd **TS103** range of low power tilt sensor signal conditioning units. The TS103 supports up to 2 liquid tilt sensor inputs and is supplied complete with an on-board temperature sensor. The on-board temperature sensor is used to make local temperature reading when thermal compensation is required for the tilt sensor readings.

The TS103 offers both cable free and local analogue output representation of the tilt levels allowing a single unit to operate both cable free and permanent connection to a data logger or

data acquisition system. Both the 434 and 869 MHz licence free bands are available for cable free operations.

Two operational modes are supported enabling a User to select between continuous high speed reading to low power slow speed measurements to maximise on battery life. In slow speed **Normal** mode operations 4 AA cell batteries will run the TS103 unit for up to 5 years before replacement.

Figure 1 shows the full schematic layout of the TS103 unit.

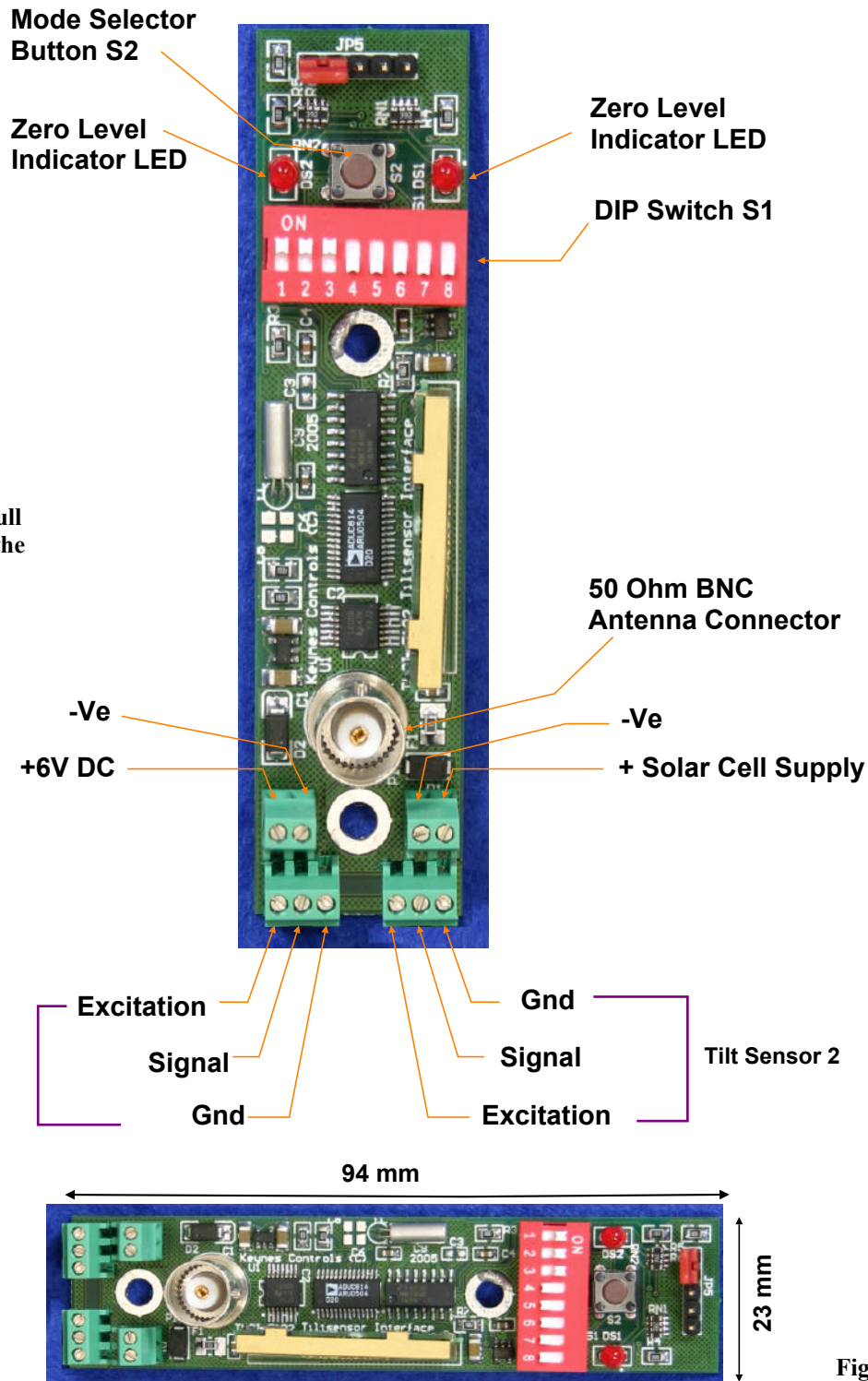


Figure 2

## Transmitter Module

The transmitter module is used for the cable free operations and can send data from each TS103 sensors. Options are available within the module setup to select which sensor data is broadcast.

## Power Requirements

A minimum of 3.5V is required to power the device. If alkaline batteries are being used they reduce in voltage throughout their life. The normal end life of a alkaline battery cell is 0.9V, so it is recommended that 4 cells (6V nominal level) be used. The voltage applied to the device must not in any circumstances exceed 9 Volts.

The average power consumption when the device is set in low power mode (see below) is typically 60 uA, and this is equivalent to 530mAH per year. The approximate battery capacity for various batteries are shown below:

### Capacity and running time for Alkaline (Zn/MnO<sub>2</sub>) batteries

Battery Size	Type	Capacity	Lifetime
AA cells (LR6)	MN1500	2700 mAH	5 Years
C cells (LR14)	MN1400	8700 mAH	16 Years
D cells (LR20)	MN1300	17400 mAH	32 Years

Table 1

### Information on the operating characteristics of Alkaline batteries is taken from

<http://www.duracell.com> (Duracell battery manufacturer)

## Connection Details

The tiltmeter module consists of two power connections P1 and P2, two sensor connections T1 and T2 and a single BNC antenna mount.

The sensor connections are as follows:

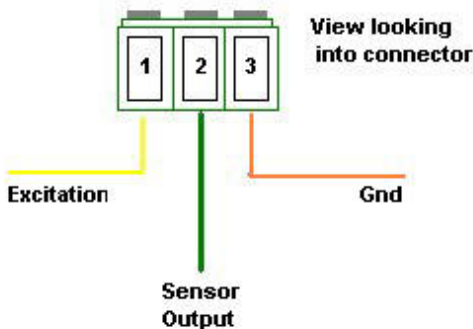


Figure 3

### Tilt Sensor Connection

Sensor connectors T1 & T2 are used for connecting the tilt sensors to the signal conditioning unit are identical in their signal input specification.

### Power Supply

All of the Keynes Controls tilt meter signal conditioning units required 6V for continuous operations. Under no circumstances should any input supply be greater than 9V.

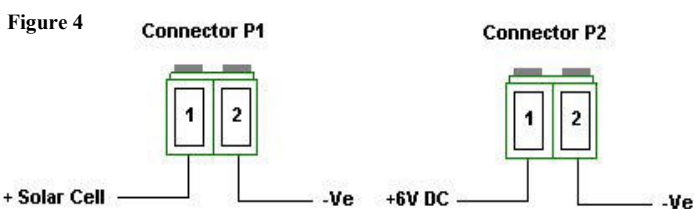
The table below shows the sensor connections and colour code for tilt sensors supplied by Soil Instruments Ltd and Slope Inc USA.

Table 2

Sensor Input	Colour	Pin-out
Excitation	Yellow	1
Sensor Output	Green	2
Gnd	Orange	3

## Solar Panel Specification and Installation

The power connectors P1 and P2 are identical in their input configurations. The Solar cell specification for continuous operations should be rated 6V @ 5 mA and the Solar cell input P1 includes a reverse polarity protection diode.



View looking into the connectors

## System Configuration

The main system configuration is undertaken using the DIP switch S1 and this switch is used to select the mode of operation of the tilt meter signal conditioning unit.

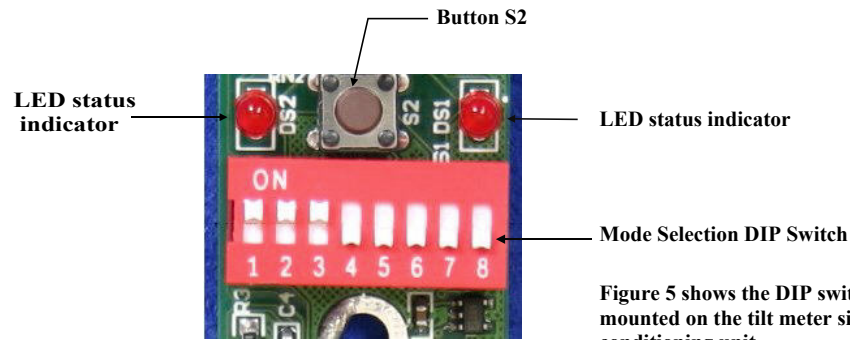


Figure 5 shows the DIP switch S1 mounted on the tilt meter signal conditioning unit.

## DIP Switch S1 Settings

DIP switches 1 to 7 on S1 is used in normal mode to select the device address.

Up to 128 different node addresses can be used on the same frequency band. The systems address is set in binary, for example:

Address	DIP1	DIP2	DIP3	DIP4	DIP5	DIP6	DIP7
0	Off	Off	Off	Off	Off	Off	Off
1	On	Off	Off	Off	Off	Off	Off
2	Off	On	Off	Off	Off	Off	Off
3	On	On	Off	Off	Off	Off	Off
4	Off	Off	On	Off	Off	Off	Off
5	On	Off	On	Off	Off	Off	Off

Table 3 - Channel Selection table

## Mode Selection

The TS103 has two operational modes identified as **Normal** and **Setup** and are selected by switch DIP8 on switch S1, see Fig 1.

**Normal Mode** of operation is when the module transmits level information for each sensor input every 60 seconds then goes into sleep mode between readings.

In **Setup Mode** data sensor readings are sampled and transmitted 5 times/Sec and the LED level indicators are illuminated and operational. The operator should zero the instrument in setup mode as the results are updated continuously making this operation simple to carry out.

Table 4 shows the DIP8 switch settings used to select the modes of operation. The exact time between signal transmissions depends upon the address selection and this is done automatically to prevent data collision between different units. The power consumption in this mode is approximately 60 uA.

## Level Indicator LED's

The level indicators operate when the TS103 is in Setup mode only. The indicators only work as specified when the tilt sensor is correctly orientated. Both of the LEDs will be illuminated when the tilt sensor is level. Adjust the tilt sensor towards the single illuminated LED when the sensor is angled away from zero datum position and continue until both level indicator LED's are illuminated to zero the unit.

Mode	DIP8	Update Rate	Level Indicators
Normal	Off	1 per minute	Off
Setup	On	5 per Second	On

Table 4 - DIP8 Mode Selection Switch

## Frequency Selection

The tilt meter signal conditioning units can be supplied to operate on 434, 869.9 and 914.65 MHz licence free bands. The working frequency for the modules has to be determined at time of order is factory set. For each dedicated channel on the specified frequency band Keynes Controls can support directly up to 127 instruments.

## Channel Selection

The transmitter with the tilt meter signal conditioning unit can transmit on 10 frequency bands within the 433 MHz band and 2 frequencies within the 870MHz licence free band. The channel selection for the transmitter is stored within non-volatile EEPROM and can be User set.

To set the channel to be used first set the DIP switches to indicate the desired channel. The channel selection is set by a binary number representing the channel to be used on DIP switches DIP1-DIP4. The switches should be set as follows:

Channel	Frequency	DIP1	DIP2	DIP3	DIP4	DIP5..7
0	433.23	Off	Off	Off	Off	Off
1	433.30	On	Off	Off	Off	Off
2	433.45	Off	On	Off	Off	Off
3	433.55	On	On	Off	Off	Off
4	433.68	Off	Off	On	Off	Off
5	433.83	On	Off	On	Off	Off
6	433.88	Off	On	On	Off	Off
7(std)	434.00	On	On	On	Off	Off
8	434.15	Off	Off	Off	On	Off
9	434.35	ON	Off	Off	On	Off

Table 5 - Channel Configuration 434 MHz Band

Channel	Frequency	DIP1	DIP2	DIP3	DIP4	DIP5..7
0	869.9	Off	Off	Off	Off	Off
1	914.65	On	Off	Off	Off	Off

Table 6 - Channel Configuration 870 MHz Band

Next press and hold button S2 for around 2 seconds until the level indicator LED's go out. After the LED's stop illuminating release the button immediately and the new channel will be set.

**Note.** Do not continue to hold the button after the LED's go out.

## Sensor Signal Selection

The module can be configured to transmit 1 or 2 tilt sensor channels with or without a temperature compensation signal. The temperature reading is the ratio of the built in thermistor to that of a reference resistor. The Beta value of the thermistor is indicated on the calibration sheet and is 3620 unless otherwise specified.

Sensor Channels	DIP1	DIP2	DIP3	DIP4	DIP5	DIP6	DIP7
Tilt 1	On	Off	Off	Off	On	Off	Off
Tilt 2	Off	On	Off	Off	On	Off	Off
Temperature	Off	Off	On	Off	On	Off	Off
Tilt 1 & Tilt 2	On	On	Off	Off	On	Off	Off
Tilt 1 & Temperature	On	Off	On	Off	On	Off	Off
Tilt 1 + Tilt 2 + Temperature	On	On	On	Off	On	Off	Off

Table 7 - Sensor Signal Selection Options

## Theory of Operation

The TS103 interfaces directly to liquid level tilt sensors that utilise is an electrolytic element to form a basic potentiometer. The sensor tilt angle is indicated by the potential difference across the sensor element when a voltage is applied to the ends of the potentiometer. As the tilt sensor element is an electrolytic sensor it requires an AC signal to be applied for excitation otherwise the sensor can become degraded by polarisation effects. The TS103 sensor excitation signal provide the AC signal by applying a square wave signal with amplitude of 3.3 Volts with duration of 600 microseconds positive and 600 microseconds negative. The output voltage is recorded at both positive and negative excitations. Signal processing is undertaken by the on-board microprocessor to determine the tilt angle.

## Example

Setup the TS103 to operate on 914.65 MHz in Normal Mode (1 Acquisition/min) with Tilt 1 and temperature sensor values transmitted to the receiver unit.

Note. When operating on the 869 MHz band only 2 individual frequencies are available. The choice of 434 or 869 MHz operation is made at the time of order and is factory set..

Figure 6



Figure 7



Figures 6 and 7 show the DIP switch settings for assigning the frequency of operation.



Figure 8

Figure 6 shows the DIP switch settings needed to setup the TS103.

1. Set DIP 1 to **On** and DIP 2 - 7 to **Off**

The DIP switches above set the Frequency of operation. In this example to 914.65 MHz.

2. Press button S2 and hold for approximately 2 seconds until. The LED's will flash as soon as the button S2 is selected and then go out. The frequency of operation is now set.
3. Set DIP 8 to **Off** - Normal Mode Selected.

The TS103 detects the mode of operation automatically. Adjusting the position of DIP 8 at any time will be detected and the mode selection activated. Figure 7 shows the DIP switch settings for the TS103 running in **Normal** mode.

New configuration parameters can be assigned at any time by simply adjusting the position of DIP 8.

4. To select the sensor data to be transmitted.

Set DIP 1 and DIP 3 to **On**, DIP 2,DIP 4-6 to **Off**.

Press button S2 and hold for approximately 2 seconds and hold until the LED's go out. The sensor data to be transmitted is now selected.

Figure 8 the DIP switch settings used to select Tilt 1 and temperature readings for data transmission.

## Mounting Instructions

Use 2.5 mm mounting screws to fasten the TS103 into the tilt meter bars.

Ensure that now stress due incorrectly installed mounting screws is applied to the TS103 PCB in order to ensure reliable operation.