Provided no two devices attempt to transmit simultaneously no further restrictions on data transmission need be made, as all transmit timing, valid data identification and datastream buffering is conducted by the unit. Synchronisation and framing words in the packet prevent the receiver outputting garbage in the absence of wanted RF signal or presence of interference. For multiple radio systems (polled networks) a TDH2 can be set to 1 of 8 unique addresses. As well as having unique addresses, the TDH2 allows operation on one of 5 pre-set frequencies in the 433MHz band. These frequencies are non-overlapping and simultaneous operation of TDH2s in the same area on different channels will be possible.

Features

- Conforms to Australian/New Zealand AS/NZS 4268:2003
- High quality, stable crystal reference; Low noise synthesiser / VCO
- SAW front-end filter and multi-stage ceramic IF filtering
- Single conversion superhet
- Serial modem baud rate at 9600bps (half-duplex)
- Addressable point-to-point
- Carries ASCII and RTU MODBUS messages
- 5 serial select wideband channels
- Available as TDH2T transmitter and TDH2R receiver for one way communication

Applications

- PDAs, organisers & laptops
- Handheld / portable terminals
- EPOS equipment, barcode scanners
- In-building environmental monitoring and control
- Remote data acquisition system, data logging
- Fleet management, vehicle data acquisition

Technical Summary

- Operating frequency: 433.925MHz (default)
- Modulation: 16kbps bi-phase FSK
- Supply: 5V at 50mA transmit, 22mA receive/idle
- Transmit power: +14dBm (25mW)
- Receiver sensitivity: -105dBm (for 1% BER)
- 32 byte data buffer
- Adjacent channel rejection: 60dB @ ±320kHz

Evaluation platforms: TDL2A Evaluation Kit
Figure 2: TDH2 block diagram
### Pin description

<table>
<thead>
<tr>
<th>Pin</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>17</td>
<td>Vcc</td>
<td>5V (regulated power supply)</td>
</tr>
<tr>
<td>16</td>
<td>ENABLE</td>
<td>Enable or DTR (5V CMOS logic level input)</td>
</tr>
<tr>
<td>15</td>
<td>SETUP</td>
<td>Test/Setup mode selection</td>
</tr>
<tr>
<td>14</td>
<td>TXD</td>
<td>Transmit Data (Inverted RS232 at 5V CMOS logic level)</td>
</tr>
<tr>
<td>13</td>
<td>NC</td>
<td>No Pin</td>
</tr>
<tr>
<td>12</td>
<td>RXD</td>
<td>Receive Data (Inverted RS232 at 5V CMOS logic level)</td>
</tr>
<tr>
<td>11</td>
<td>STATUS</td>
<td>Busy or CTS (5V CMOS logic level output)</td>
</tr>
<tr>
<td>10</td>
<td>GND</td>
<td>Ground</td>
</tr>
</tbody>
</table>

**RF GND**  
Pin 1 & 3  
RF Ground pin, internally connected to the module screen and pins 10 and 18 (0V). This pin should be connected to the RF return path (e.g. co-axial cable braid, main PCB ground plane, etc).

**RF**  
Pin 2  
50Ω RF input/output from the antenna, it is DC isolated internally. (see antenna section for details).

**GND**  
Pin 8, 9, 10 and 18  
Supply ground connection to ground plane and can.

**VCC**  
Pin 17  
5V voltage regulator should be used to have a clean 5V supply to the module. A 4V regulator is used inside for radio circuitry.

**ENABLE**  
Pin 16  
Active low Enable pin. It has a 47kΩ pull-ups to Vcc. It should be pulled Low to enable the module. This can also be connected to DTR pin (only if it is asserted by the host) of an RS232 serial port via a MAX232 or equivalent RS232-CMOS level converter.
**SETUP**

**pin 15**
Active low input to enter configuration or diagnostic test mode. It has a 47kΩ pull-ups to Vcc

**TXD**

**pin 14**
This is inverted RS232 data input at 5V CMOS logic level. It can be directly interfaced to data output of a UART in a microcontroller or to a TXD pin of an RS232 serial port via a MAX232 or equivalent RS232-CMOS level converter. TXD does not have an internal pull-up. If TDH2 is used in Receive only mode, TXD should be tied to Vcc.

**NC**

**pin 13**
There is no pin in this position.

**RXD**

**pin 12**
This is inverted RS232 data output at 5V CMOS logic level. It can be directly interfaced to data input of a UART in a microcontroller or to a RXD pin of an RS232 serial port via a MAX232 or equivalent RS232-CMOS level converter.

**STATUS**

**pin 11**
This pin goes high when valid data is present in the receive buffer. It can be used to trigger an interrupt in the host to download received data packet instead of waiting for it. It can also be used as a primitive CTS signal. It is inverted RS232 data output at 5V CMOS logic level. It can be directly interfaced to an input of a microcontroller as a Data Detect (DD) or to CTS, DSR, DCD pins of an RS232 serial port via a MAX232 or equivalent RS232-CMOS level converter. This is can only be used to prevent host from uploading any data before downloading already received data, because transmission is prioritised over reception and any data to be transmitted will erase received data which is in the common buffer.

**Serial interface – modem operation**

To connect to a true RS232 device, inverting RS232-CMOS level shifters must be used. Maxim MAX232 or equivalent are ideal, but simple NPN transistor switches with pull-ups often suffice. With typical microcontrollers and UARTs, direct connection is possible.

**The Radio / data stream interface**

A 32 byte software FIFO is implemented in both the transmit and receive sub-routine. At the transmitting end this is used to allow for the transmitter start up time (about 3mS), while on receiving end it buffers arriving packets to the constant output data rate. All timing and data formatting tasks are handled by the internal firmware. The user need not worry about keying the transmitter before sending data as the link is entirely transparent.

For transmission across the radio link data is formatted into packets, each comprising 3 bytes of data and a sync code. If less than 3 bytes are in the transmit end FIFO then a packet is still sent, but idle codes replaces the unused bytes. When the transmit end FIFO is completely emptied, then the transmitter is keyed off.

**Operation: Radio interface.**

Raw data is not fed to the radios. A coding operation in the transmit sub-routine, and decoding in the receiver, isolate the AC coupled, potentially noisy baseband radio environment from the datastream.

The radio link is fed a continuous tone by the modem. As in bi-phase codes, information is coded by varying the duration consecutive half-cycles of this tone. In our case half cycles of 62.5us and 31.25us are used. In idle (or ‘preamble’) state, a sequence of the longer cycles is sent (resembling an 8KHz tone).

A packet comprises the Synchronising (or address) part, followed by the Data part, made up of twelve Groups (of four half cycles duration). Each Group encodes 2 data bits, so one byte is encoded by 4 Groups.
The oscilloscope screen capture shows a single byte being transmitted by TDH2. A BiM2-433-64 transceiver is used to capture the transmitted data. The character appears on the serial data output (RXD) pin of the other TDH2 after about 12.5ms. Busy (STATUS) pin is momentarily set high to indicate the presence of a valid data in the receive buffer of the TDH2.

It can be clearly seen that unlike raw radio modules, TDH2 does not output any noise when there is not any transmission. Data fed into the TXD input of a TDH2 appears at the RXD output of another TDH2 within radio range in the original form it was fed.

Continuous serial data at 9600bps (above) is encoded as half-cycles of 8kHz (62.5s long bit) and 16kHz (31.25s short bit).
Programming the TDH2

In order to use all the functions embedded in the TDH2, the user must be aware of the setup/programming facility, which allow different addresses and frequency channels to be set up, and if necessary accesses diagnostic test modes.

The TDH2 is programmed through the same RS232 port that is used for sending/receiving data. An RS232 terminal emulator (such as Aterm or HyperTerminal) is an ideal tool.

To enter program mode, the SETUP pin must be pulled low. In this mode the radio link is disabled, but characters sent (at 9600 baud, as normal) to the unit are echoed back on the RXD pin.

The unit will only respond to certain command strings:

- **ADDR0** to **ADDR7** <CR>: These commands set up one of 8 unique addresses.
- **CHAN0** to **CHAN4** <CR>: These commands select one of 5 preset channels

A TDH2 will only communicate with a unit set to the same address and the same channel.

Address and channel numbers are stored in volatile memory. On power-up the TDH2 reverts to the default in EEPROM (as supplied this is always address 0 and Channel 0)

**SETPROGRAM** <CR>: Writes the current address and current channel into EEPROM as the new default.

A tilda character (~, ascii 126dec) sent by the unit indicates end of EEPROM write sequence

(please commands are normally only used for factory diagnostics)

- **NOTONE** <CR>: Transmit unmodulated carrier
- **LFTONE** <CR>: Transmit carrier modulated with 8KHz squarewave
- **HFTONE** <CR>: Transmit carrier modulated with 16KHz squarewave
- **#** <CR>: Transmitter off

A Carriage Return ‘<CR>’ (00Dhex) should be entered after each command sequence to execute it.

Releasing the SETUP pin to high state returns the TDH2 to normal operation.

Interfacing a microcontroller to TDH2

TDH2 can be directly interfaced to any microcontrollers. If the microcontroller has a built-in UART, it can concentrate on its main task and leave the packet formatting, bit balancing and error checking of serial data to TDH2.
Serial data should be in the following format:
1 start bit, 8 data bits, no parity, 1 or 2 stop bits
9600bps
0V=low, 5V=high

STATUS pin can be connected to one of the port pins which can generate an interrupt on low-to-high transition (e.g. RB0/INT pin in the PIC). This can be used to enter a receive sub-routine to download data received from remote TDH2. Therefore, the host does not need to wait in a loop for a packet.

Range test and site survey can be carried out by connecting an LED on the STATUS pin. Every time, TDH2 is within range to receive valid data, the LED will flicker.

Interfacing RS232 port to TDH2

STATUS pin in this can be connected to CTS, DSR and DCD pin to simulate a flow control signal.

TDH2 is capable of continuously streaming data at 9600bps. Therefore, STATUS pin is not asserted to stop the Host from sending data as in normal RTS/CTS flow control method, but merely to warn the host that there is already data in the receive buffer which need to be downloaded before sending any more data.

Some DTE hosts assert DTR signal when they are active and this can be used via RS232 line receiver to enable TDH2. Otherwise the ENABLE must be physically pulled-low to activate the TDH2.

**NOTE:**
An interface board (with MAX232 type buffer, 9 way D connector, 5V voltage regulator and SMA RF connector) is available. This board is 61mm x 33mm in size.
Condensed specifications

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
<td></td>
</tr>
<tr>
<td>433.925MHz – CHAN0 (default channel)</td>
<td></td>
</tr>
<tr>
<td>433.285MHz – CHAN1</td>
<td></td>
</tr>
<tr>
<td>433.605MHz – CHAN2</td>
<td></td>
</tr>
<tr>
<td>434.245MHz – CHAN3</td>
<td></td>
</tr>
<tr>
<td>434.565MHz – CHAN4</td>
<td></td>
</tr>
<tr>
<td><strong>Frequency stability</strong></td>
<td>±10kHz</td>
</tr>
<tr>
<td><strong>Channel width</strong></td>
<td>320kHz</td>
</tr>
<tr>
<td><strong>Number of channels</strong></td>
<td>1 of 5, user programmed</td>
</tr>
<tr>
<td><strong>Supply Voltage</strong></td>
<td>5V</td>
</tr>
<tr>
<td><strong>Current</strong></td>
<td>50mA transmit</td>
</tr>
<tr>
<td></td>
<td>22mA receive/idle</td>
</tr>
<tr>
<td><strong>Operating temperature</strong></td>
<td>-20 °C to +70 °C (Storage -30 °C to +80 °C)</td>
</tr>
<tr>
<td><strong>Regulation</strong></td>
<td>Compliant with Australian/New Zealand AS/NZS 4268:2003</td>
</tr>
<tr>
<td><strong>Interfaces User</strong></td>
<td>9pin 0.1” pitch molex</td>
</tr>
<tr>
<td><strong>RF</strong></td>
<td>3pin 0.1” pitch molex</td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>37 x 26 x 8mm</td>
</tr>
</tbody>
</table>

**Transmitter**

- **Output power**: +14dBm (25mW) ±1dB
- **TX on switching time**: <4ms
- **Modulation type**: 16kbps bi-phase FSK
- **FM peak deviation**: +/-22KHz
- **TX spurious**: <-40dBm

**Receiver**

- **Sensitivity**: -105dBm for 1% BER
- **image**: -40dB
- **spurious / adjacent channel**: -60dB
- **Blocking**: -80dB nominal
- **LO re-radiation**: <-60dBm

**Interface**

- **Data rate**: 9600baud, Half duplex
- **Format**: 1 start, 8 data, 1 stop, no parity
- **Levels**: 5V CMOS (inverted RS232. Mark = 5V = idle)
- **Buffers**: 32 byte FIFO

- **Flow control**: None (‘RX busy’ pin provided)
- **Addressing**: 1 of 8, user programmed

- **Data latency**: 14ms (first byte into TX, to first byte out of RX)
**Antenna requirements**

Three types of integral antenna are recommended and approved for use with the module:

A) **Whip**  
This is a wire, rod, PCB track or combination connected directly to RF pin of the module. Optimum total length is 16cm (1/4 wave @ 433MHz). Keep the open circuit (hot) end well away from metal components to prevent serious de-tuning. Whips are ground plane sensitive and will benefit from internal 1/4 wave earthed radial(s) if the product is small and plastic cased.

B) **Helical**  
Wire coil, connected directly to RF pin, open circuit at other end. This antenna is very efficient given it’s small size (20mm x 4mm dia.). The helical is a high Q antenna, trim the wire length or expand the coil for optimum results. The helical de-tunes badly with proximity to other conductive objects.

C) **Loop**  
A loop of PCB track tuned by a fixed or variable capacitor to ground at the 'hot' end and fed from RF pin at a point 20% from the ground end. Loops have high immunity to proximity de-tuning.

<table>
<thead>
<tr>
<th>Feature</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultimate performance</td>
<td>***</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>Easy of design set-up</td>
<td>***</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>Size</td>
<td>*</td>
<td>***</td>
<td>**</td>
</tr>
<tr>
<td>Immunity proximity effects</td>
<td>*</td>
<td>**</td>
<td>***</td>
</tr>
</tbody>
</table>

The antenna choice and position directly controls the system range. Keep it clear of other metal in the system, particularly the 'hot' end. The best position by far, is sticking out the top of the product. This is often not desirable for practical/ergonomic reasons thus a compromise may need to be reached. If an internal antenna must be used, try to keep it away from other metal components, particularly large ones like transformers, batteries and PCB tracks/earth plane. The space around the antenna is as important as the antenna itself.

**Figure 8: Antenna types**

- **A. Helical antenna**
  - RF
  - 0.5 mm enameled copper wire close wound on 3.2 mm diameter former
  - 433 MHz = 24 turns

- **B. Loop antenna**
  - RF-GND
  - Feed point 15% to 25% of total loop length
  - track width = 1mm
  - 4 to 10 cm² inside area

- **C. Whip antenna**
  - RF
  - 16.4 cm
  - wire, rod, PCB-track or a combination of these three
  - 433 MHz = 16.4 cm total from RF pin.
Ordering information

The TDH2 radio modem is manufactured in the following variants as standard:

For Australian general applications on 433MHz band

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>Frequency band</th>
<th>Maximum baud rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDH2-433-9</td>
<td>Half duplex modem</td>
<td>433.925 - 434.565 MHz</td>
<td>9.6kbps</td>
</tr>
<tr>
<td>TDH2T-433-9</td>
<td>Transmitter only</td>
<td>433.925 - 434.565 MHz</td>
<td>9.6kbps</td>
</tr>
<tr>
<td>TDH2R-433-9</td>
<td>Receiver only</td>
<td>433.925 - 434.565 MHz</td>
<td>9.6kbps</td>
</tr>
<tr>
<td>TDH2-433-4</td>
<td>Half duplex modem</td>
<td>433.925 - 434.565 MHz</td>
<td>4.8kbps</td>
</tr>
<tr>
<td>TDH2T-433-4</td>
<td>Transmitter only</td>
<td>433.925 - 434.565 MHz</td>
<td>4.8kbps</td>
</tr>
<tr>
<td>TDH2R-433-4</td>
<td>Receiver only</td>
<td>433.925 - 434.565 MHz</td>
<td>4.8kbps</td>
</tr>
</tbody>
</table>
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The Intrastat commodity code for all our modules is: 8542 6000

R&TTE Directive

After 7 April 2001 the manufacturer can only place finished product on the market under the provisions of the R&TTE Directive. Equipment within the scope of the R&TTE Directive may demonstrate compliance to the essential requirements specified in Article 3 of the Directive, as appropriate to the particular equipment.

Further details are available on The Office of Communications (Ofcom) web site:

http://www.ofcom.org.uk/

Information Requests

Ofcom
Riverside House
2a Southwark Bridge Road
London SE1 9HA
Tel: +44 (0)300 123 3333 or 020 7981 3040
Fax: +44 (0)20 7981 3333
information.requests@ofcom.org.uk

European Communications Office (ECO)
Pebblinghus
Nansensgade 19
DK 1366 Copenhagen
Tel. +45 33896300
Fax +45 33896330
ero@ero.dk
www.ero.dk