# Discontinued

**muRata**
INNOVATOR IN ELECTRONICS

## DNT2400

## Low Cost 2.4 GHz FHSS Transceiver Module with I/O

- *2.4 GHz Frequency Hopping Spread Spectrum Transceiver*
- *Point-to-point, Point-to-multipoint, Peer-to-peer and Tree-routing Networks*
- *Transmitter Power Configurable from 1 to 63 mW*
- *RF Data Rate Configurable from 38.4 to 500 kb/s*
- *Serial Port Rate up to 460.8 kb/s for Streaming Applications*
- *128-Bit AES Encryption*
- *Separate Serial Port for Diagnostics*
- *Analog and Digital I/O for Sensor Applications*
- *I/O Auto-reporting and Sleep Mode Functions*
- *Pin-for-Pin Compatible with DNT900*
- *FCC, Canadian IC and ETSI Certified for Unlicensed Operation*

The DNT2400 FHSS transceiver module is a low cost, high-power solution for robust wireless data communications in the 2.4 GHz ISM band. The DNT2400 RF output power can be set from 1 to 63 mW, and the RF data rate can be set from 38.4 to 500 kb/s. The DNT2400 module includes analog, digital and serial I/O, providing the flexibility and versatility to serve applications ranging from cable replacements to sensor networks. The DNT2400 transceiver module is easy to integrate and provides reliable wireless communications up to 10 miles in line-of-sight installations.

**DNT2400 Absolute Maximum Ratings**

| Rating | Value | Units |
|---|---|---|
| All Input/Output Pins | -0.5 to +3.3 | V |
| Non-Operating Ambient Temperature Range | -40 to +85 | $^o$C |

**DNT2400 Electrical Characteristics**

| Characteristic | Sym | Notes | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|---|
| Operating Frequency Range | | | 2409.3 | | 2467.1 | MHz |
| Hop Dwell Time | | | 5 | | 200 | ms |
| Number of Frequency Hopping Subbands | | | | | 9 | |
| Number of RF Channels in a Subband | | | 15 | | 37 | |
| Modulation | | | FSK/MSK | | | |
| RF Data Transmission Rates | | | 38.4, 115.2, 200 and 500 | | | kb/s |
| Receiver Sensitivity: | | | | | | |
|     $10^{-5}$ BER @ 38.4 kb/s | | | | -104 | | dBm |
|     $10^{-5}$ BER @ 200 kb/s | | | | -96 | | dBm |
|     $10^{-5}$ BER @ 500 kb/s | | | | -90 | | dBm |
| Transmitter RF Output Power Levels | | | 1, 10, 63 | | | mW |
| Optimum Antenna Impedance | | | | 50 | | $\Omega$ |
| RF Connection | | | U.FL Coaxial Connector | | | |
| Network Topologies | | | Point-to-Point, Point-to-Multipoint, Peer-to-Peer, Tree-Routing | | | |
| Access Schemes | | | CSMA and TDMA | | | |

**Discontinued**

**DNT2400 Electrical Characteristics**

| Characteristic | Sym | Notes | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|---|
| Number of Network Nodes: | | | | | | |
|     TDMA Mode | | | | | 16 | |
|     CSMA Mode | | | | | unlimited | |
| ADC Input Range | | | 0 | | 3.3 | V |
| ADC Input Resolution | | | | 10 | | bits |
| ADC Sample Rate | | | 10 | | | ms |
| Signal Source Impedance for ADC Reading | | | | | 10 | K$\Omega$ |
| PWM (DAC) Output Range | | | 0 | | 3.3 | V |
| PWM (DAC) Output Resolution | | 1 | | | 8 | bits |
| PWM Output Period | | | | 20 | | µs |
| Primary and Diagnostic Serial Port Baud Rates | | | 1.2, 2.4, 4.8, 9.6, 19.2, 28.8, 38.4, 57.6, 76.8, 115.2, 230.4, 460.8 | | | kb/s |
| Serial Peripheral Interface Data Rate | | | 6.35 | | 80.64 | kb/s |
| Digital I/O: | | | | | | |
|     Logic Low Input Level | | | -0.5 | | 0.8 | V |
|     Logic High Input Level | | | 2 | | 3.3 | V |
|     Logic Input Internal Pull-up Resistor | | | 50 | | 200 | K$\Omega$ |
| Power Supply Voltage Range | $V_{CC}$ | | +3.3 | | +5.5 | Vdc |
| Power Supply Voltage Ripple | | | | | 10 | mV$_{P-P}$ |
| Peak Transmit  Mode Current, 63 mW Output | | | | | 300 | mA |
| Average Operating Receive Current: | | | | | | |
|     Base | | | | 105 | | mA |
|     Remote, No Data Transmission | | | | 35 | | mA |
|     Remote, 9.6 kb/s Continuous Data Stream | | | | 40 | | mA |
|     Remote, 115.2 kb/s Continuous Data Stream | | | | 53 | | mA |
| Sleep Current | | 2 | | 50 | 225 | µA |
| DNT2400C Mounting | | | Reflow Soldering | | | |
| DNT2400P Mounting | | | Socket | | | |
| Operating Temperature Range | | | -40 | | 85 | $^{o}$C |
| Operating Relative Humidity Range, Non-condensing | | | 10 | | 90 | % |

Notes:

1.  PWM is set with an 8-bit value. DAC resolution is limited to 7 bits by residual ripple at output of low-pass filter.

2.  Maximum sleep current occurs at +85 $^{o}$C.

**CAUTION:  Electrostatic Sensitive Device. Observe precautions when handling.**
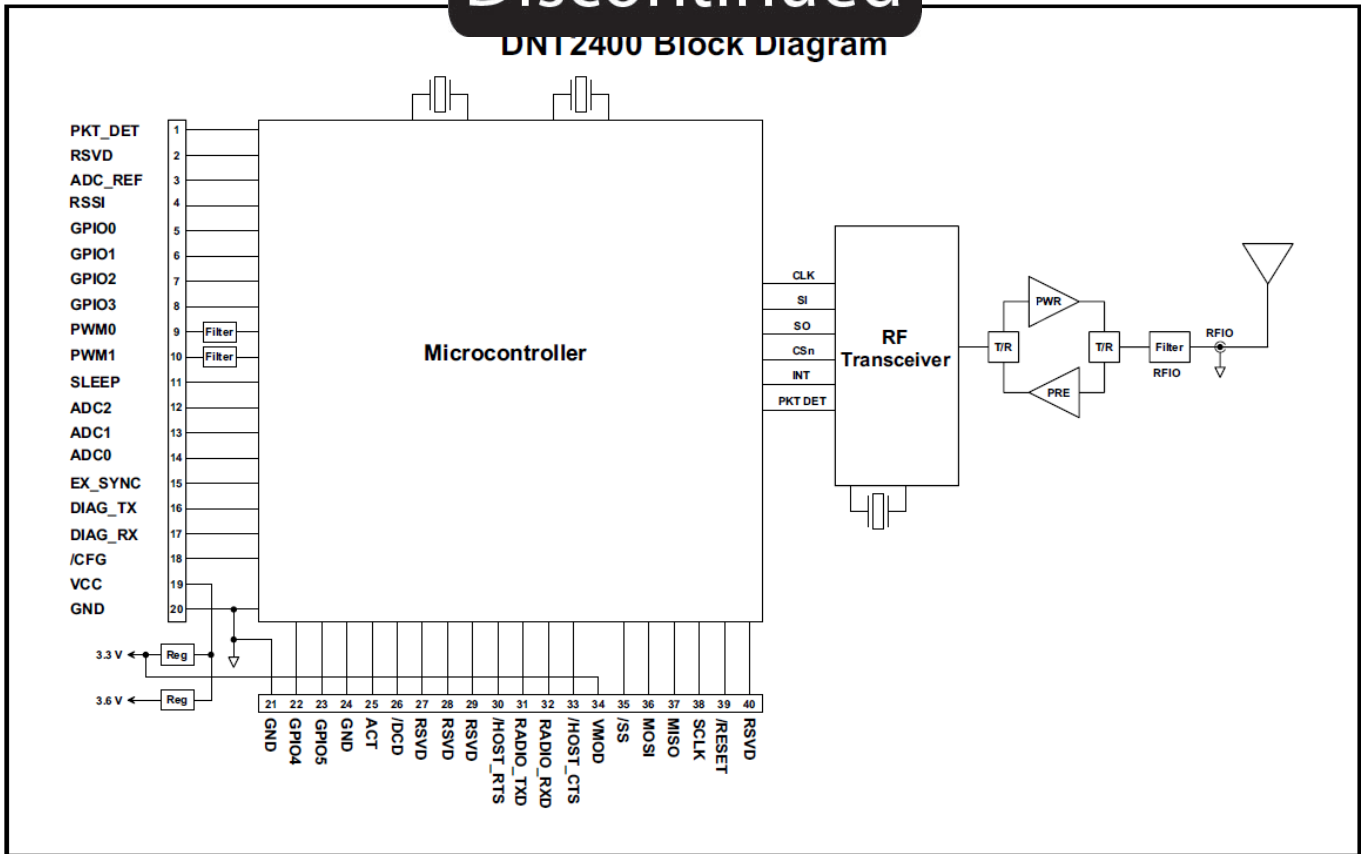
**DNT2400 Block Diagram**

PKT_DET 1
RSVD 2
ADC_REF 3
RSSI 4
GPIO0 5
GPIO1 6
GPIO2 7
GPIO3 8
PWM0 9 Filter
PWM1 10 Filter
SLEEP 11
ADC2 12
ADC1 13
ADC0 14
EX_SYNC 15
DIAG_TX 16
DIAG_RX 17
/CFG 18
VCC 19
GND 20

**Microcontroller**

3.3 V ← Reg
3.6 V ← Reg

21 GND
22 GPIO4
23 GPIO5
24 GND
25 ACT
26 /DCD
27 RSVD
28 RSVD
29 RSVD
30 /HOST_RTS
31 RADIO_TXD
32 RADIO_RXD
33 /HOST_CTS
34 VMOD
35 /SS
36 MOSI
37 MISO
38 SCLK
39 /RESET
40 RSVD

CLK
SI
SO
CSn
INT
PKT DET

**RF Transceiver**

PWR
PRE
T/R
T/R
Filter
RFIO
RFIO

**Figure 1**

## DNT2400 Hardware

The major components of the DNT2400 include a 2.4 GHz FHSS transceiver and a low current 32-bit microcontroller. The DNT2400 operates in the 2.4 GHz ISM band. The module includes nine frequency subbands and 37 total frequency channels to support the various 2.4 GHz frequency allocations used throughout the world. The DNT2400 has three selectable RF output power levels: 1, 10, and 63 mW. Also, there are four selectable RF transmission rates: 38.4, 115.2, 200 and 500 kb/s.

The DNT2400 includes a low-noise receiver preamplifier and a high efficiency transmitter amplifier, providing excellent range in outdoor applications.

The DNT2400 provides a variety of hardware interfaces. There are two serial ports plus one SPI port. Either the primary serial port or the SPI port can be selected for data communications. The second serial port is dedicated to diagnostics. The primary and diagnostic serial ports support standard rates from 1.2 to 460.8 kb/s. The SPI port supports data rates from 6.35 to 80.64 kb/s. Also included are three 10-bit ADC inputs, two 8-bit PWM outputs, and six general-purpose digital I/O ports. Four of the digital I/O ports support an optional interrupt-from-sleep mode when configured as inputs.

The radio is available in two mounting configurations. The DNT2400C is designed for solder reflow mounting, and the DNT2400P is designed for plug-in connector mounting.

## DNT2400 Firmware

The DNT2400 firmware can operate using either TDMA or CSMA channel access modes. TDMA supports up to 16 remotes with rapid, deterministic channel latency. CSMA provides carrier-sense managed channel access for an unlimited number of low-traffic remotes. DNT2400 firmware will operate "out of the box" using point-to-point transparent serial mode, with point-to-multipoint, peer-to-peer and tree-routing network topologies also supported.

DNT2400 firmware provides the user with a rich set of configuration options including a choice of hopping patterns, hopping dwell times, RF data rates, serial or SPI data port operation, serial and SPI data rate selection, RF output power selection, plus configurable analog and digital I/O lines. Data integrity is protected by 24-bit error detection, with optional ACK and automatic transmission retries or redundant transmissions. 128-bit AES encryption provides a high level of data security for sensitive applications. Sensor networks can take advantage of timer or event-based data reporting and remote node sleep cycling for extended battery life.

## DNT2400 I/O Descriptions

| Pin | Name | I/O | Description |
|-----|------|-----|-------------|
| 1 | PKT_DET | O | Packet detect output. Signal switches logic high at the end of the start-of-packet symbol and switches logic low at the end of the end-of-packet symbol on both received and transmitted packets. PKT_DET provides a timing reference for external use in network timing evaluations, etc. |
| 2 | RSVD | - | Reserved pin. Leave unconnected. |
| 3 | ADC_REF | I | ADC supply and external full scale reference voltage input. Voltage range is 2.4 to 3.3 Vdc. Connect pad 34 to this input to reference the ADC full scale reading to the module's 3.3 V regulated supply. |
| 4 | RSVD | - | Reserved pin. Leave unconnected. |
| 5 | GPIO0 | I/O | Configurable digital I/O port 0. When configured as an input, an internal pull-up resistor can be selected and interrupt from sleep can be invoked. When configured as an output, the power-on state is also configurable. |
| 6 | GPIO1 | I/O | Configurable digital I/O port 1. Same configuration options as GPIO0. |
| 7 | GPIO2 | I/O | Configurable digital I/O port 2. Same configuration options as GPIO0. |
| 8 | GPIO3 | I/O | Configurable digital I/O port 3. Same configuration options as GPIO0. |
| 9 | PWM0 | O | 8-bit pulse-width modulated output 0 with internal low-pass filter. Filter is first-order, with a 159 Hz 3 dB bandwidth. |
| 10 | PWM1 | O | 8-bit pulse-width modulated output 1 with internal low-pass filter. Filter is first-order, with a 159 Hz 3 dB bandwidth. |
| 11 | SLEEP/DTR | I | Active high module sleep input (active low DTR). When switched low after sleep, the module executes a power on-reset. Usually connected to host DTR. Connect to ground if SLEEP/DTR function not used. |
| 12 | ADC2 | I | 10-bit ADC input 0. Full scale reading is referenced to the ADC_REF input. |
| 13 | ADC1 | I | 10-bit ADC input 1. Full scale reading is referenced to the ADC_REF input. |
| 14 | ADC0 | I | 10-bit ADC input 2. Full scale reading is referenced to the ADC_REF input. |
| 15 | EX_SYNC | I | Rising-edge triggered input for synchronizing co-located base stations. Synchronization pulse interval must equal hop dwell time ±10 µs. Pulse width must be in the range of 50 µs to 2 ms. |
| 16 | DIAG_TX | O | Diagnostic UART transmitter output. |
| 17 | DIAG_RX | I | Diagnostic UART receiver input. |
| 18 | /CFG | I | Protocol selection input. Leave unconnected when using software commands to select transparent/protocol mode (default is transparent mode). Logic low selects protocol mode, logic high selects transparent mode. |
| 19 | VCC | I | Power supply input, +3.3 to +5.5 Vdc. |
| 20 | GND | - | Power supply and signal ground. Connect to the host circuit board ground. |
| 21 | GND | - | Power supply and signal ground. Connect to the host circuit board ground. |
| 22 | GPIO4 | I/O | Configurable digital I/O port 4. When configured as an input, an internal pull-up resistor can be selected. When configured as an output, the power-on state is configurable. |
| 23 | GPIO5 | I/O | Configurable digital I/O port 5. Same configuration options as GPIO4. |
| 24 | GND | - | Logic ground. |
| 25 | ACT | O | Data activity output, logic high when data is being transmitted or received. |
| 26 | /DCD | O | Default functionality is data carrier detect output, logic low on a remote when the module is locked to FHSS hopping pattern and logic low on a base station when at least one remote is connected to it. |
| 27 | RSVD | - | Reserved pin. Leave unconnected. |
| 28 | RSVD | - | Reserved pin. Leave unconnected. |
| 29 | RSVD | - | Reserved pin. Leave unconnected. |

| Pin | Name | I/O | Description |
|---|---|---|---|
| 30 | /HOST_RTS | I | UART flow control input. The host sets this line low to allow data to flow from the DNT2400 on the RADIO_TXD pin. When the host sets this line high, the DNT2400 will stop sending data to the host. |
| 31 | RADIO_TXD | O | UART transmitter output. The DNT2400 sends serial data to the host on this pin. |
| 32 | RADIO_RXD | I | UART receiver input. The DNT2400 receives serial data from the host on this pin. |
| 33 | /HOST_CTS | O | UART/SPI flow control output. The DNT2400 sets this line low when it is ready to accept data from the host on the RADIO_RXD or MOSI input. When the DNT2400 sets this line high, the host must stop sending data. |
| 34 | VMOD | O | +3.3 V regulated supply. Connect to pad 3 to support 3.3 V full scale and/or ratiometric ADC readings, etc. Current drain on this output should be no greater than 5 mA. |
| 35 | /SS | I/O | SPI active low slave select. This pin is an output when the DNT2400 operating as a master, and an input when it is operating as a slave. |
| 36 | MOSI | I/O | SPI master out, slave in function. This pin is an output when the DNT2400 is operating as a master, and is an input when the DNT2400 is operating as a slave. |
| 37 | MISO | I/O | SPI master in, slave out function. This pin is an input when the DNT2400 is operating as a master, and is an output when the DNT2400 is operating as a slave. |
| 38 | SCLK | I/O | SPI clock signal. This pin is an output when operating as a master, and an input when operating as a slave. |
| 39 | /RESET | I | Active low module hardware reset. |
| 40 | RSVD | - | Reserved pin. Leave unconnected. |



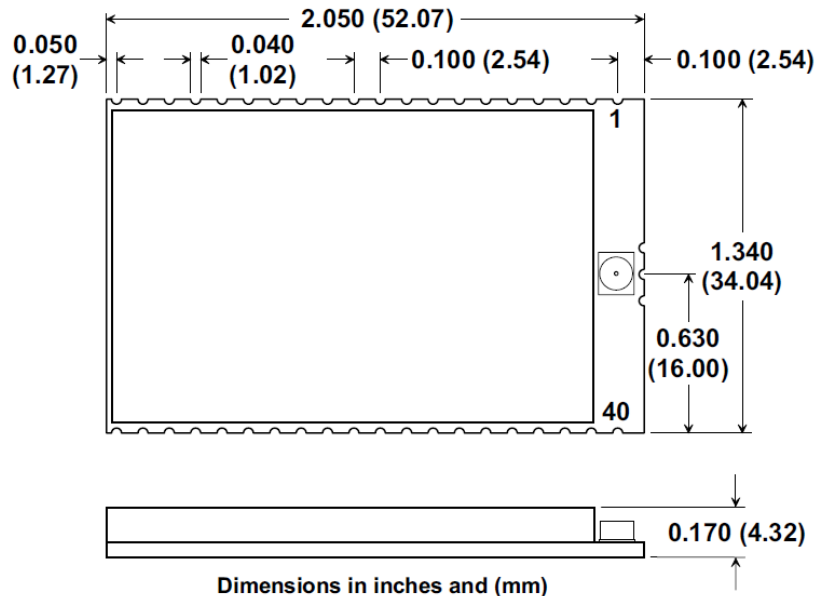**Figure 2**

## DNT2400C PCB Footprint



Dimensions in inches and (mm)

**Figure 3**

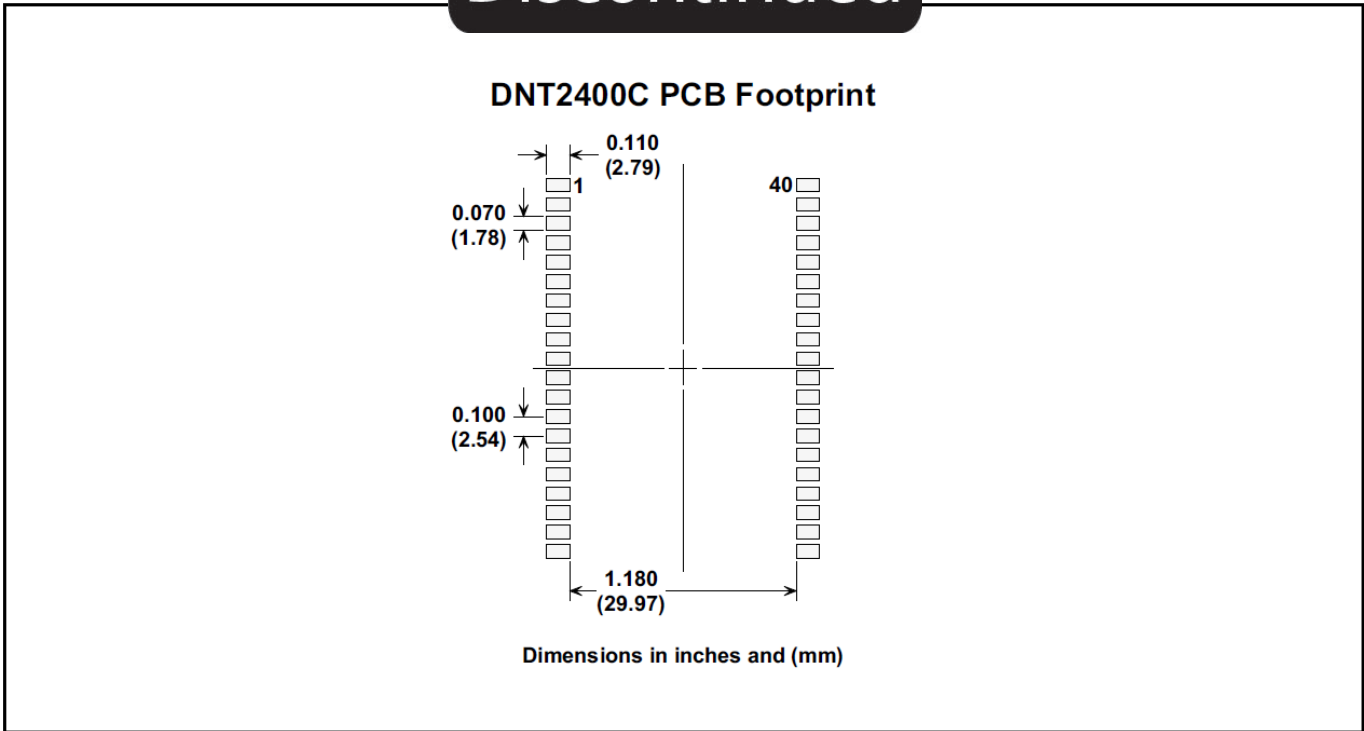### DNT2400 Antenna Connector

A U.FL miniature coaxial connector is provided on both DNT2400 configurations for connection to the RFIO port. A short U.FL coaxial cable can be used to connect the RFIO port directly to an antenna. In this case the antenna should be mounted firmly to avoid stressing the U.FL coaxial cable due to antenna mounting flexure. Alternately, a U.FL coaxial jumper cable can be used to connect the DNT2400 module to a U.FL connector on the host circuit board. The connection between the host circuit board U.FL connector and the antenna or antenna connector on the host circuit board should be implemented as a 50 ohm stripline. Referring to Figure 4, the width of this stripline depends on the thickness of the circuit board between the stripline and the groundplane. For FR-4 type circuit board materials (dielectric constant of 4.7), the width of the stripline is equal to 1.75 times the thickness of the circuit board. Note that other circuit board traces should be spaced away from the stripline to prevent signal coupling, as shown in Figure 5. The stripline trace should be kept short to minimize its insertion loss.
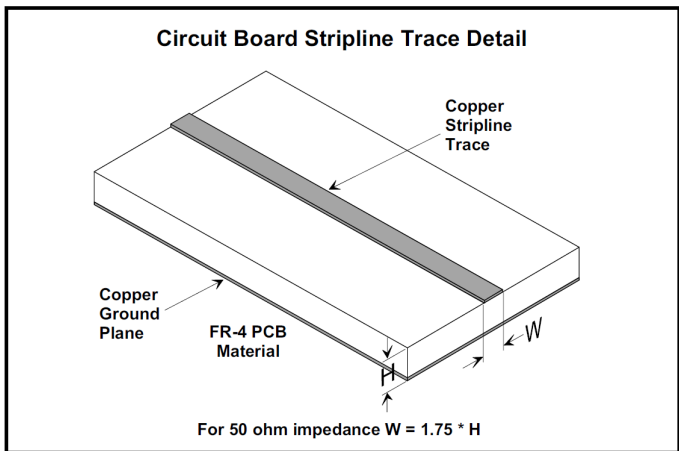


**Figure 4**

| Trace Separation from 50 ohm Microstrip | Length of Trace Run Parallel to Microstrip |
|---|---|
| 100 mil | 125 mil |
| 150 mil | 200 mil |
| 200 mil | 290 mil |
| 250 mil | 450 mil |
| 300 mil | 650 mil |

**Figure 5**

## DNT2400P Outline and Mounting Dimensions



Dimensions in inches and (mm)
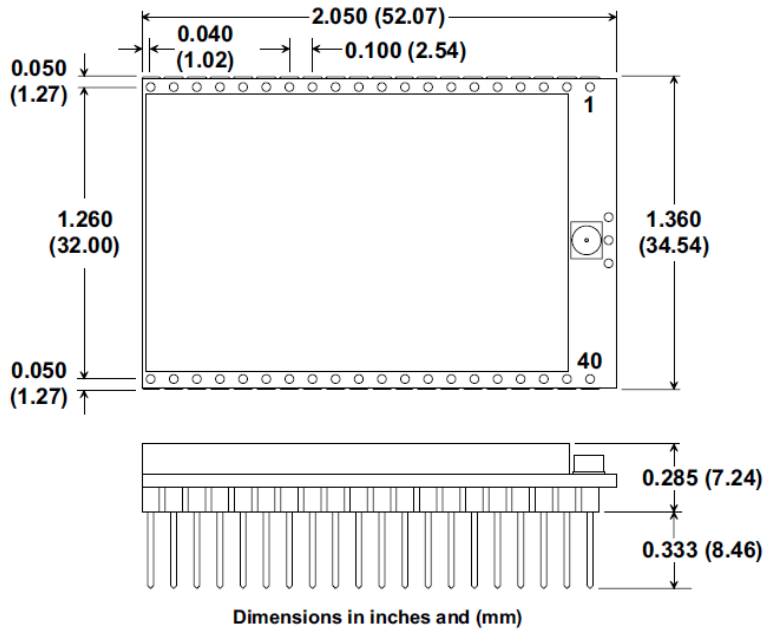
**Figure 6**

**DNT2400P Interface Connector
PCB Layout Detail**



Minimum plated PCB hole diameter 0.030 (0.76)

Connectors are FCI Electronics 75915-420LF or equivalent
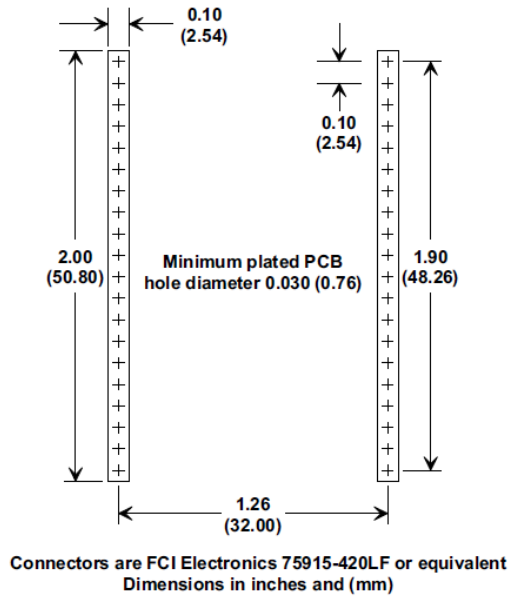Dimensions in inches and (mm)

**Figure 7**

*Note: Specifications subject to change without notice.*

Part # M-2400-3000, Rev C

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