



# DNT2400

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

- 2.4 GHz Frequency Hopping Spread Spectrum Transceiver
- Point-to-Point and Point-to-Multipoint Network Topologies
- 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 point-to-point and point-to-multipoint wireless systems in the 2.4 GHz ISM band. The RF output power of the DNT2400 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 robust 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	°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 <sup>-5</sup> BER @ 38.4 kb/s				-104		dBm
10 <sup>-5</sup> BER @ 200 kb/s				-96		dBm
10 <sup>-5</sup> BER @ 500 kb/s				-90		dBm
Transmitter RF Output Power Levels			1, 10, 63			mW
Optimum Antenna Impedance				50		Ω
RF Connection			DNT2400P - U.FL Coaxial Connector DNT2400C - U.FL Connector or PCB Pad			
Network Topologies			Point-to-Point, Point-to-Multipoint			
Access Schemes			CSMA and TDMA			

## 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		$\mu$ s
Primary 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
Diagnostic Serial Port Baud Rate			38.4			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 $\Omega$
Logic Input Internal Pull-down Resistor			50		180	K $\Omega$
Power Supply Voltage Range	V <sub>CC</sub>		+3.3		+5.5	Vdc
Power Supply Voltage Ripple					10	mV <sub>P-P</sub>
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	$\mu$ A
DNT2400C Mounting			Reflow Soldering			
DNT2400P Mounting			Socket			
Operating Temperature Range			-40		85	$^{\circ}$ 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  $^{\circ}$ C.



**CAUTION: Electrostatic Sensitive Device. Observe precautions when handling.**

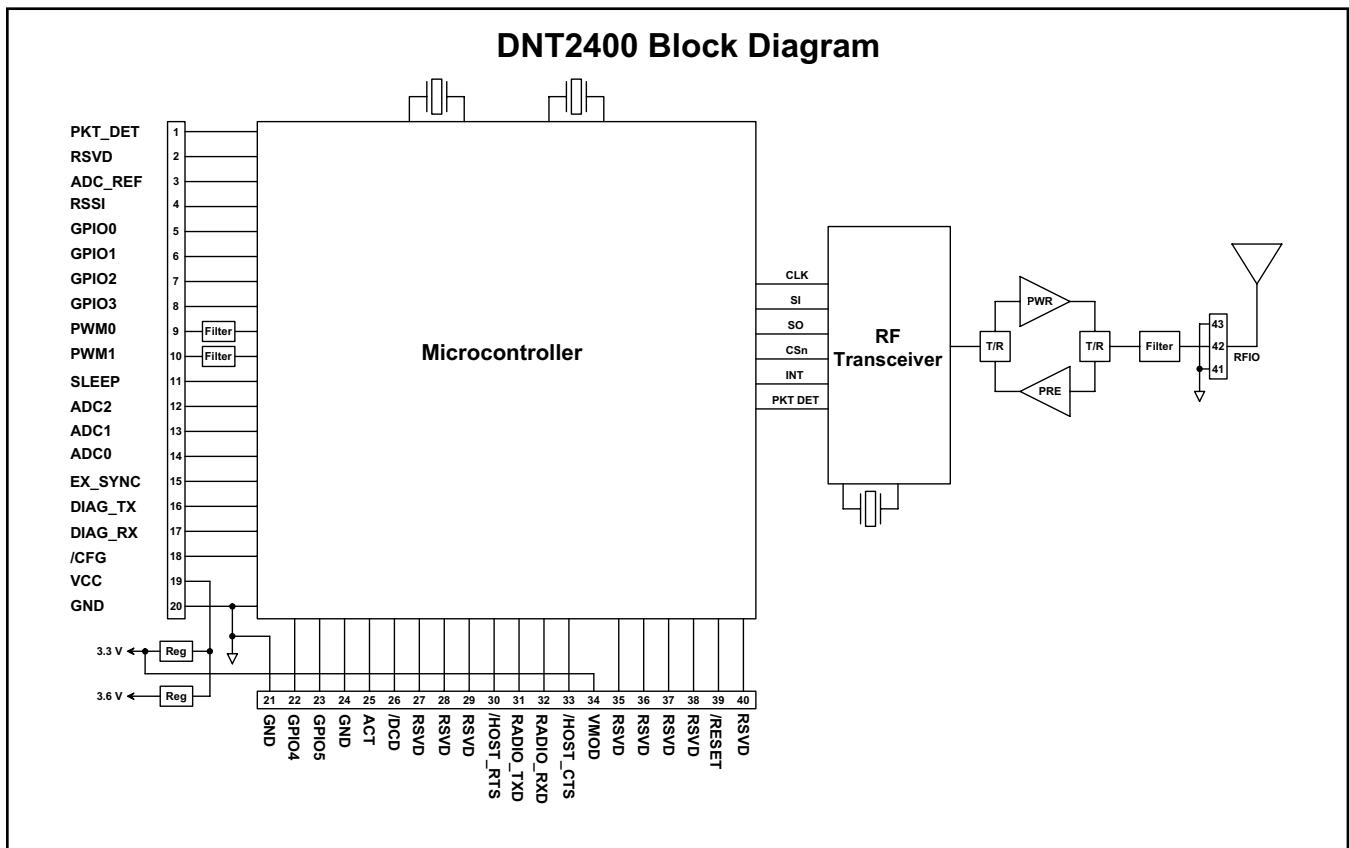


Figure 1

### 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 UART serial ports, one for data and a second for diagnostics. The data port supports standard baud rates from 1.2 to 460.8 kb/s, with the diagnostic port fixed at 38.4 kb/s. The module also includes 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.

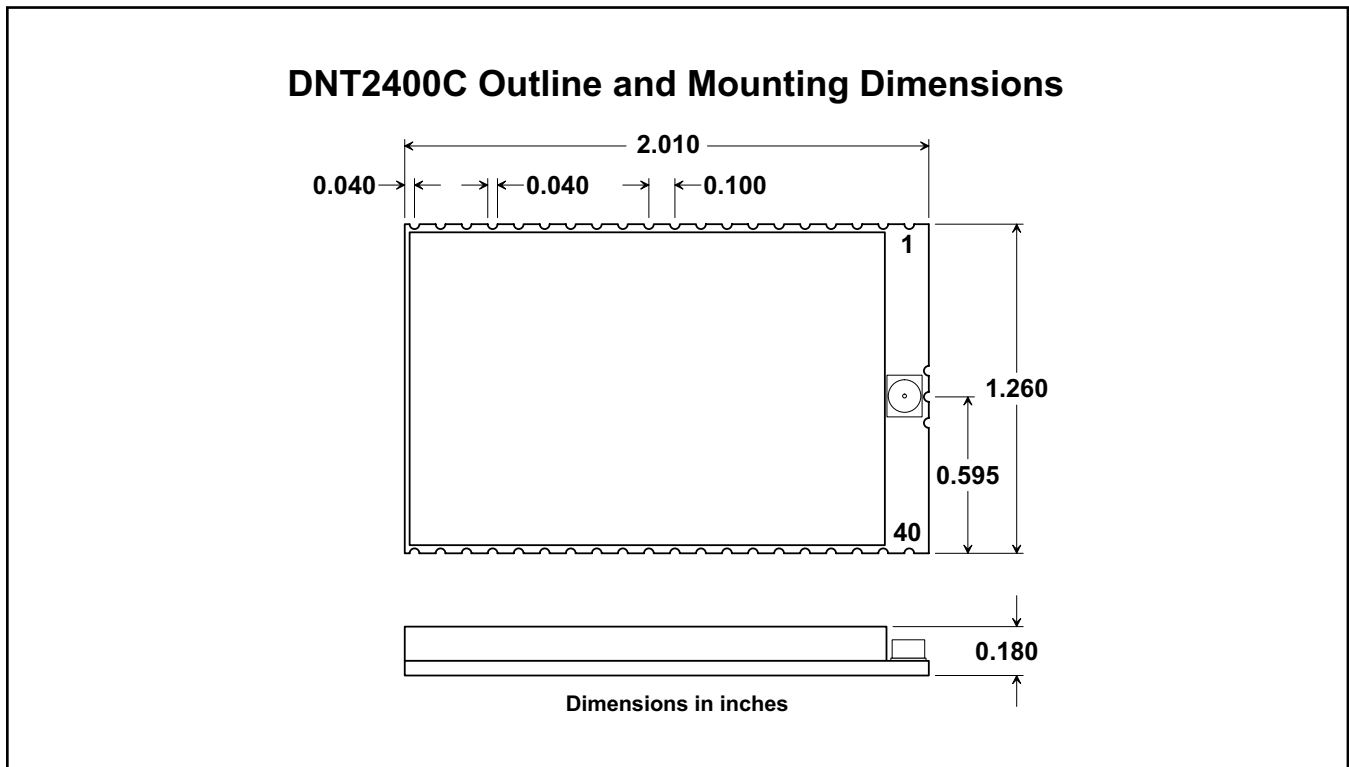
### DNT2400 Firmware

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 its point-to-point transparent serial mode, with point-to-multipoint supported by the firmware's protocol mode. DNT2400 firmware provides the user with a rich set of configuration options including a choice of hopping patterns, hopping dwell times, RF data transmission rates, serial port data rates and RF power levels, 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 $\pm 10 \mu\text{s}$ . Pulse width must be in the range of 50 $\mu\text{s}$ 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 flow control output. The DNT2400 sets this line low to indicate it is ready to accept data from the host on the RADIO_RXD input. When the DNT2400 sets this line high, the host must stop sending data.
34	VMOD	O	Module's +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	RSVD	-	Reserved pin. Leave unconnected.
36	RSVD	-	Reserved pin. Leave unconnected.
37	RSVD	-	Reserved pin. Leave unconnected.
38	RSVD	-	Reserved pin. Leave unconnected.
39	/RESET	I	Active low module hardware reset.
40	RSVD	-	Reserved pin. Leave unconnected.
41	GND	-	RF ground for the DNT2400C only. Connect to the host circuit board ground plane.
42	RFIO	I/O	Alternate RF port for the DNT2400C only. The antenna can be connected to this port with a 50 ohm stripline or coaxial cable. Leave unconnected when using the U.FL connector.
43	GND	-	RF ground for the DNT2400C only. Connect to the host circuit board ground plane.



**Figure 2**

### DNT2400C RFIO Stripline

The DNT2400C has a U.FL coaxial connector mounted near pad 42 for antenna connection (see Antenna Connector discussion below). It is also possible to connect an antenna using a stripline from pad 42. It is important

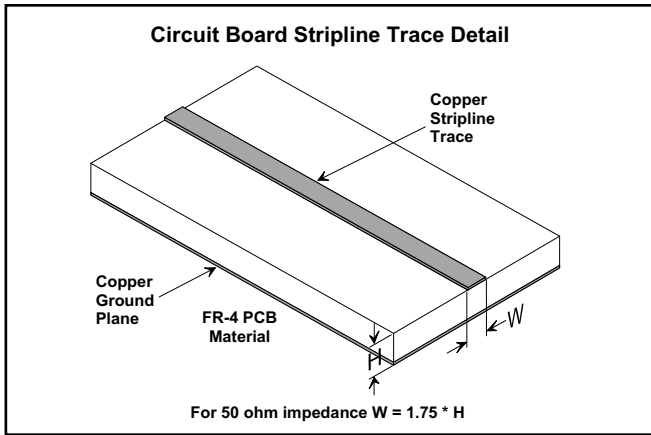


Figure 3

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 4

that this connection be implemented as a 50 ohm stripline. Referring to Figure 3, 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 4. The stripline trace should be kept short to minimize its insertion loss.

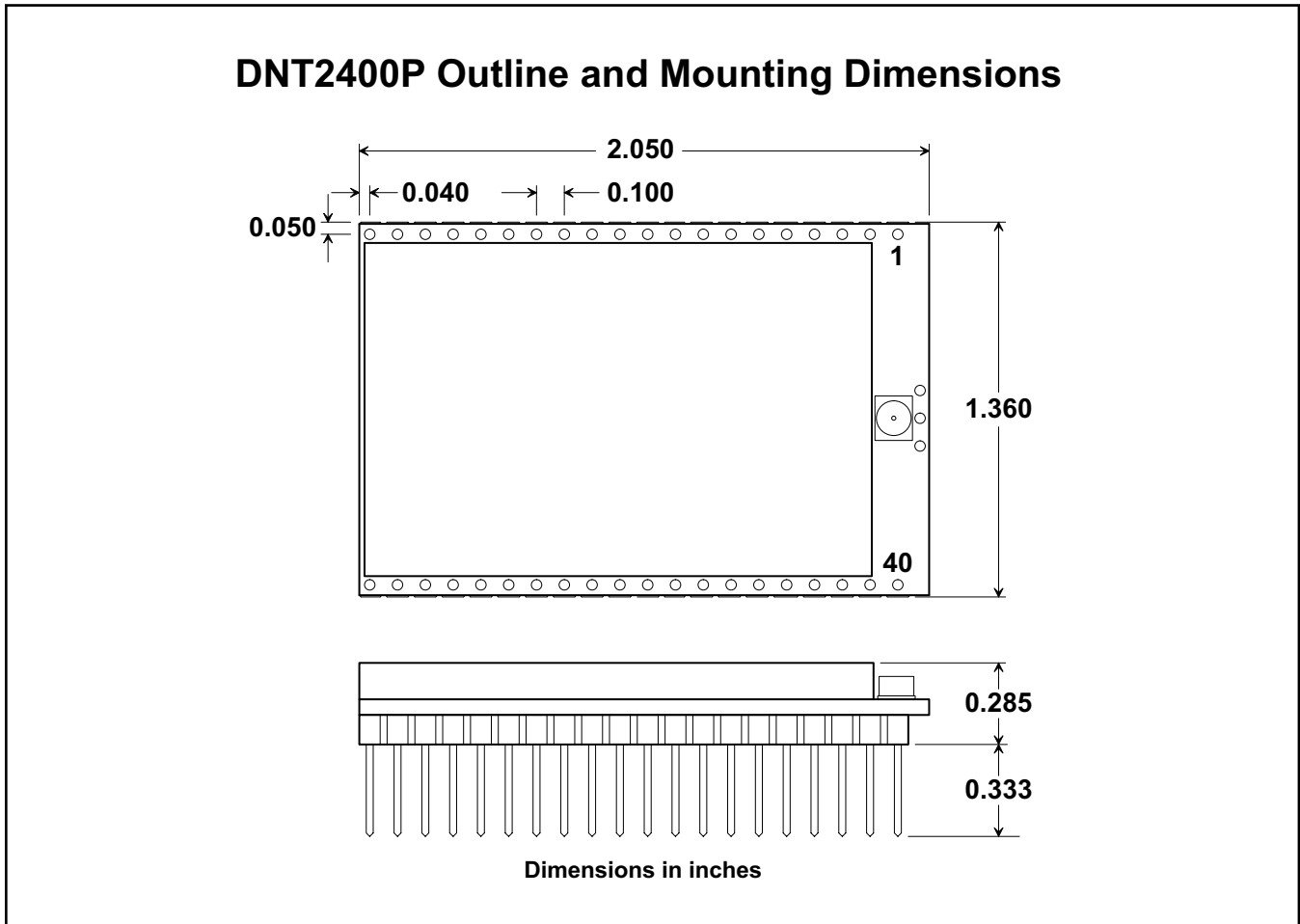
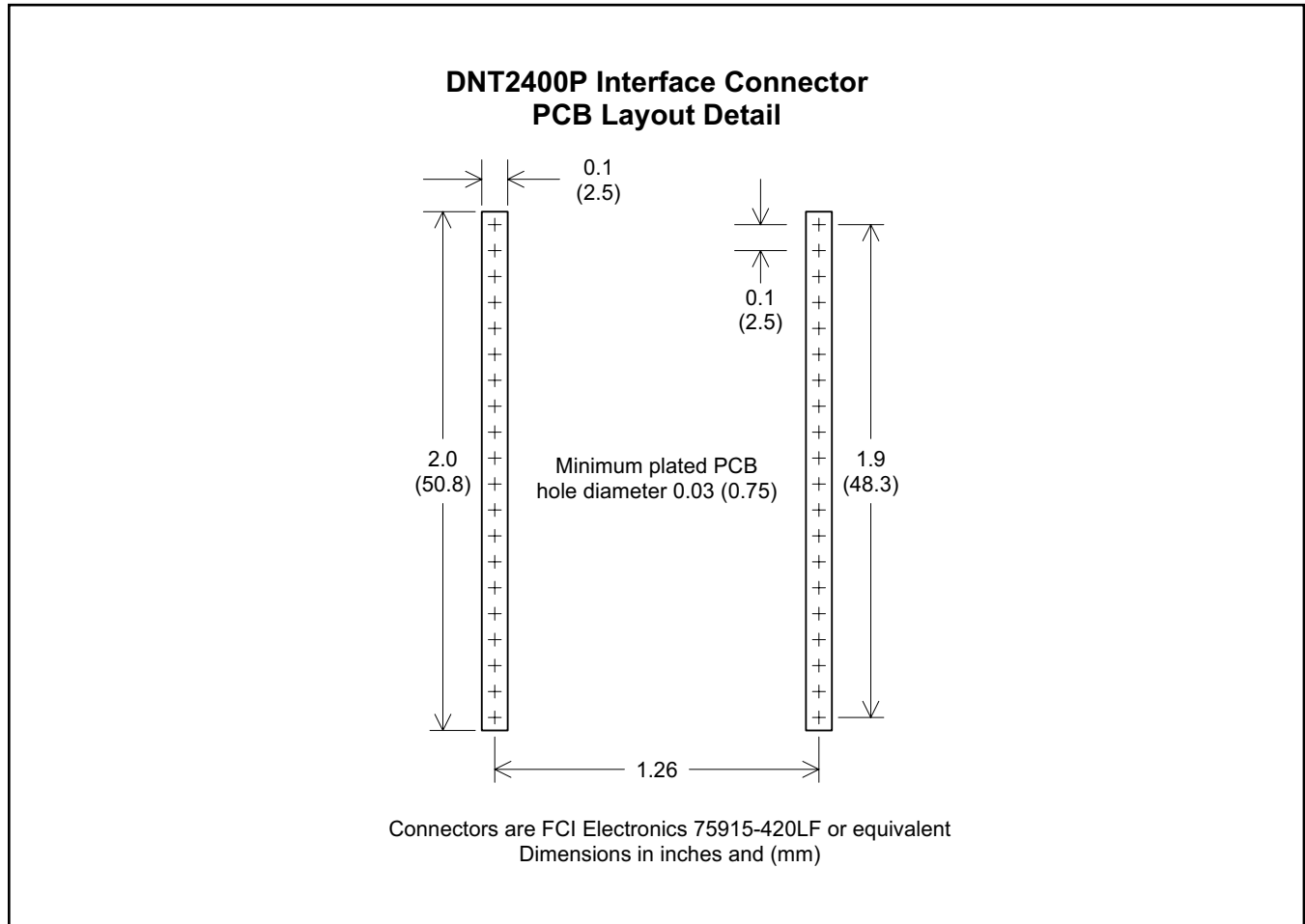


Figure 5

## 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 3, 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 4. The stripline trace should be kept short to minimize its insertion loss.



**Figure 6**

*Note: Specifications subject to change without notice.*

Part # M-2400-3000, Rev A