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## Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

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# DNT90

## Low Cost 900 MHz FHSS Transceiver Module with I/O

- 900 MHz Frequency Hopping Spread Spectrum Transceiver
- Point-to-point, Point-to-multipoint, Peer-to-peer and
  Store & Forward Capabilities
- Transmitter Power Configurable to 40 or 158 mW
- 100 kbps RF Data Rate
- Serial Port Data Rate up to 250 kbps, SPI Port Data Rate up to 500 kbps
- 128-Bit AES Encryption
- Separate Serial Port for Diagnostics
- Analog and Digital I/O for Sensor Applications
- FCC and Canadian IC Certified for Unlicensed Operation

The DNT90 FHSS transceiver module provides a low-cost, versatile solution for wireless data communications in the 900 MHz ISM band. The DNT90 RF output power can be set at 40 or 158 mW. The DNT90 receiver input is protected by low-loss SAW filter, providing an excellent combination of receiver sensitivity and out-of-band interference rejection. The DNT90 module includes analog, digital and serial I/O, providing the flexibility to serve applications ranging from cable replacements to sensor networks. The DNT90 transceiver module is easy to integrate and provides reliable wireless communications up to 5 miles in line-of-sight installations.

**DNT90 Absolute Maximum Ratings**

| Rating | Value | Units |
|---|---|---|
| Power Supply Input | -0.5 to +6.5 | V |
| All Input/Output Pins | -0.5 to +3.3 | V |
| Input Power to RFIO Port | 0 | dBm |
| Non-Operating Ambient Temperature Range | -40 to +85 | $^{\circ}$C |

**DNT90 Electrical Characteristics**

| Characteristic | Sym | Notes | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|---|
| Operating Frequency Range | | | 902.76 | | 927.24 | MHz |
| Hop Duration | | 1 | 8 | | 100 | ms |
| Number of RF Channels | | 1 | | 25, 26 or 52 | | |
| Modulation | | | | FSK | | |
| RF Data Transmission Rate | | | | 100 | | kbps |
| Receiver Sensitivity @ $10^{-5}$ BER | | | | -100 | | dBm |
| Transmitter RF Output Power | | 1 | | 40 or 158 mW | | mW |
| Optimum Antenna Impedance | | | | 50 | | $\Omega$ |
| RF Connection | | | | U.FL Coaxial Connector | | |
| System Topologies | | | | Point-to-Point, Point-to-Multipoint, Peer-to-Peer and Store & Forward | | |
| Access Scheme | | | | Ad Hoc TDMA | | |

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**DNT90 Electrical Characteristics**

| Characteristic | Sym | Notes | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|---|---|
| ADC Input Range | | | 0 | | 2.7 | V |
| ADC Input Resolution | | | | | 12 | bits |
| ADC Sample Rate | | | | 100 | | Hz |
| Signal Source Impedance for ADC Reading | | | | | 10 | KΩ |
| ADC External Reference Voltage Range | | | 1.0 | | 2.7 | V |
| DAC Output Range | | | 0 | | 3.3 | V |
| DAC Output Resolution | | | | | 12 | bits |
| Primary and Diagnostic Serial Port Baud Rates | | | 1.2, 2.4, 4.8, 9.6, 14.4, 19.2, 28.8, 38.4, 57.6, 115.2, 230.4, 250.0 | | | kbps |
| Serial Peripheral Interface Data Rate | | | 125 | | 500 | kbps |
| Digital I/O: | | | | | | |
|     Logic Low Input Level | | | -0.5 | | 0.8 | V |
|     Logic High Input Level | | | 2.45 | | 3.3 | V |
|     Logic Input Internal Pull-up Resistor | | | | 20 | | KΩ |
| Power Supply Voltage Range | $V_{CC}$ | | +3.3 | | +5.5 | Vdc |
| Power Supply Voltage Ripple | | | | | 10 | $mV_{P-P}$ |
| Peak Transmit Mode Current, 158 mW Output | | | | | 170 | mA |
| Average Operating Receive Current: | | | | | | |
|     Base, Continuous Data Stream | | | | 110 | | mA |
|     Remote, Linked, No Data Transmission | | | | 15 | | mA |
|     Remote, Continuous Data Stream | | | | 25 | | mA |
| Sleep Current | | 2 | | 3 | 6 | µA |
| DNT90C Mounting | | | Reflow Soldering | | | |
| DNT90P Mounting | | | Socket | | | |
| Operating Temperature Range | | | -40 | | 85 | °C |
| Operating Relative Humidity Range, Non-condensing | | | 10 | | 90 | % |

Notes:

1. The DNT90 achieves regulatory certification under FHSS rules.

2. Maximum sleep current occurs at +85 °C.

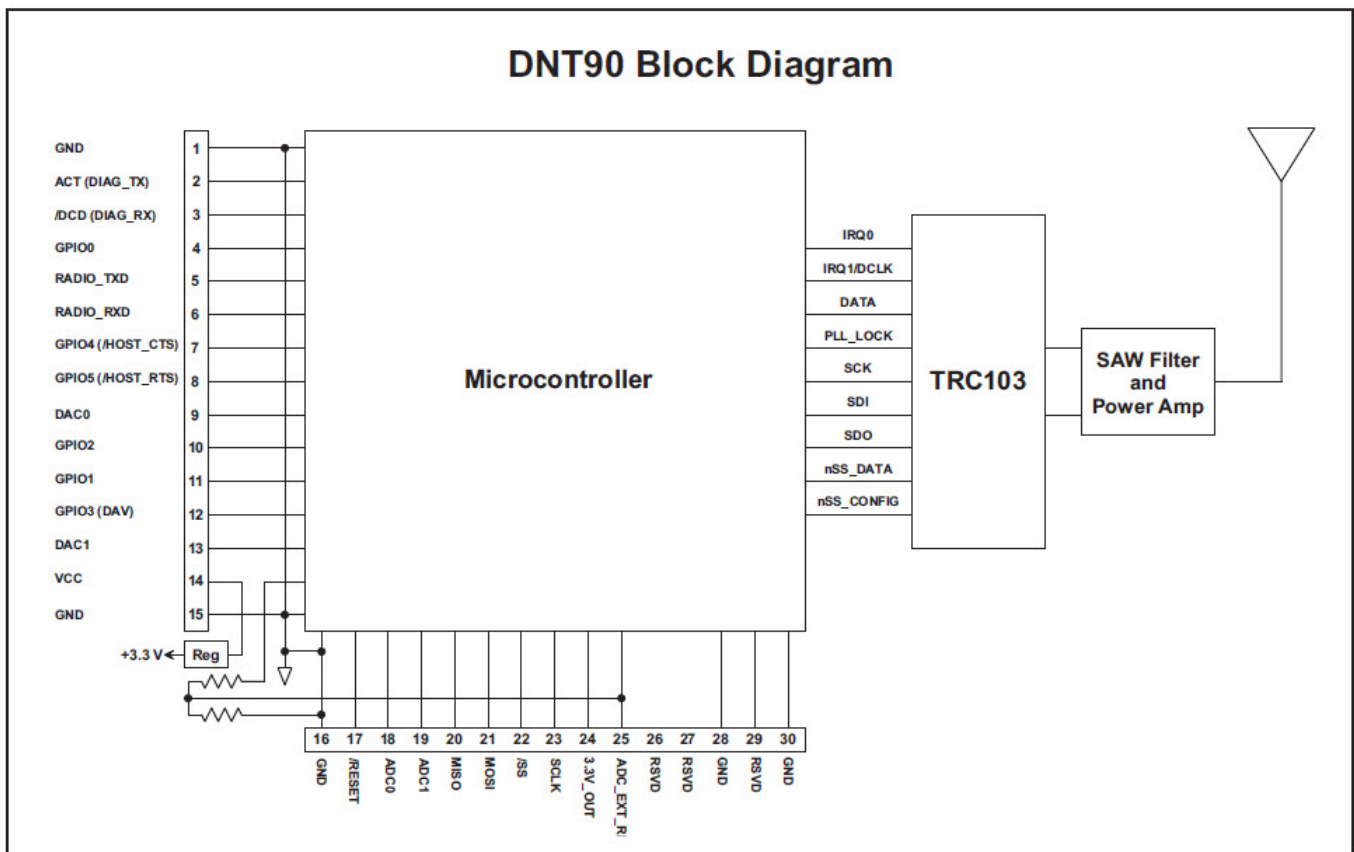**CAUTION: Electrostatic Sensitive Device. Observe precautions when handling.**

## DNT90 Block Diagram



**Figure 1**

## DNT90 Hardware

The major components of the DNT90 include a Murata TRC103 900 MHz FHSS transceiver, and a low current 8-bit microcontroller. The DNT90 operates in the 902 to 928 MHz ISM band. There are three selectable hopping patterns providing compatibility with frequency allocations in North America, South America and Australia. The DNT90 also has two selectable RF output power levels: +16 dBm (40 mW) and +22 dBm (158 mW).

The DNT90 receiver is protected by a low-loss SAW filter, providing an excellent blend of receiver sensitivity and out-of-band interference rejection that is especially important in outdoor applications.

The DNT90 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 most standard baud rates up to 250 kbps. The SPI port supports data rates up to 500 kbps. The DNT90 also includes three ADC inputs, two DAC outputs, and six general-purpose digital I/O ports. Four of the digital I/O ports support an optional interrupt-from-sleep mode when con-figured as inputs. The radio is available in two mounting configurations. The DNT90C is designed for solder reflow mounting. The DNT90P is designed for plug-in connector mounting.

## DNT90 Firmware

DNT90 firmware operates using hybrid Ad Hoc TDMA channel access optimized for periodic burst transmissions. DNT90 firmware operates "out of the box" using point-to-point transparent serial mode, with point-to-multipoint, peer-to-peer and store & forward system topologies also supported.

DNT90 firmware provides the user with a rich set of configuration options including a choice of hopping patterns, hopping dwell times, serial and/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.

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## DNT90 I/O Descriptions

| Pin | Name | I/O | Description |
|-----|------|-----|-------------|
| 1 | GND | - | Power supply and signal ground. Connect to the host circuit board ground. |
| 2 | ACT (DIAG_TX) | O (O) | This pin's default configuration is data activity output. On a base, this signal blinks when a valid packet is received. On a remote, this signal blinks when a packet is transmitted. On a router, this signal blinks when a valid upstream packet is received or a downstream packet is transmitted. Alternate pin function is the diagnostic serial port output. |
| 3 | /DCD (DIAG_RX) | O (I) | This pin's default configuration is data carrier detect output. On a base, this signal is asserted when any valid packet is received, and is cleared if no packets are heard for the configured router/remote registration time-out interval. On a router or remote, this signal is asserted when the radio obtains hopping pattern synchronization, and remains asserted until no beacons are heard for 50 hops. Alternate pin function is the diagnostic serial port input. |
| 4 | GPIO0 | I/O | Configurable digital I/O port 0. When configured as an input, an internal pull-up resistor can be selected and direct interrupt from sleep can be invoked. When configured as an output, the power-on state is configurable. In sleep mode the pin direction, input pull-up selection or output state are also separately configurable. |
| 5 | RADIO_TXD | O | Serial data output from the radio. |
| 6 | RADIO_RXD | I | Serial data input to the radio. |
| 7 | GPOI4 (/HOST_CTS) | I/O (O) | Default pin function is GPIO4 with the same configuration options as GPIO2. Alternate pin function is UART/SPI flow control output. The module sets this line low when it is ready to accept data from the host on the RADIO_RXD or MOSI input. When the line goes high, the host must stop sending data. |
| 8 | GPOI5 (/HOST_RTS) | I/O (I) | Default pin function is GPIO5 with the same configuration options as GPIO2. Alternate pin function is UART/SPI flow control input. The host sets this line low to allow data to flow from the module on the RADIO_TXD pin. When the host sets this line high, the module will stop sending data to the host. |
| 9 | DAC0 | O | 12-bit DAC 0 output. Full scale output can be referenced to the voltage at pin 25 or the 3.3 V regulated module bus voltage. |
| 10 | GPIO2 | I/O | Configurable digital I/O port 2. Same configuration options as GPIO0. |
| 11 | GPIO1 | I/O | Configurable digital I/O port 1. Same configuration options as GPIO0. |
| 12 | GPIO3 (DAV) | I/O (O) | Default pin function is GPIO3 with the same configuration options as GPIO0. When SPI slave mode operation is enabled, a logic high on this pin indicates when data is available to be clocked out by the SPI master. |
| 13 | DAC1 | O | 12-bit DAC 1 output. Same specifications and configuration options as DAC0. |
| 14 | VCC | I | Power supply input, +3.3 to +5.5 Vdc. |
| 15 | GND | - | Power supply and signal ground. Connect to the host circuit board ground. |
| 16 | GND | - | Power supply and signal ground. Connect to the host circuit board ground. |
| 17 | /RESET | I | Active low module hardware reset. |
| 18 | ADC0 | I | ADC input 0. This pin is a direct ADC input when the ADC is operating in single-ended mode, or the differential negative input for positive inputs applied to ADC1 or ADC2 when the ADC is operating in differential mode. Full-scale reading can be referenced to Pin 25 for ratiometric measurements. For absolute measurements, the ADC can use the regulated supply voltage divided by 1.6 (about 2.06 V), or an external voltage applied to Pin 25. In single-ended mode, ADC measurements are 11-bit unsigned values with full scale nominally 2.7 V when referenced to a 2.7 V input on Pin 27. In differential mode, ADC measurements are 12-bit signed values. |
| 19 | ADC1 | I | ADC input 1. Direct input when the ADC is operating in single-ended mode, positive differential input relative to ADC0 when the ADC is operating in differential mode. |
| 20 | MISO | I/O | This pin is the SPI master mode input or slave mode output. |
| 21 | MOSI | I/O | This pin is the SPI master mode output or slave mode input. |
| 22 | /SS | I/O | SPI active low slave select. This pin is an output when the module is operating as a master, and an input when it is operating as a slave. |

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| Pin | Name | I/O | Description |
|-----|------|-----|-------------|
| 23 | SCLK | I/O | SPI clock signal. This pin is an output when operating as a master, and an input when operating as a slave. |
| 24 | ADC2 | I | ADC input 2. Direct input when the ADC is operating in single-ended mode, positive differential input relative to ADC0 when the ADC is operating in differential mode. |
| 25 | ADC_EXT_REF | I/O | ADC external reference voltage pin. The voltage at this pin can be used by the ADCs as a reference for ratiometric measurements. With no external voltage or load applied, this pin presents a nominal 2.7 V output through a 2.126 K source resistance. A low impedance external reference voltage in the range of 1 to 2.7 V may be applied to this pin as an option. |
| 26 | RSVD | - | Reserved pin. Leave unconnected. |
| 27 | RSVD | - | Reserved pin. Leave unconnected. |
| 28 | GND | - | Connect to the host circuit board ground plane. |
| 29 | RSVD | - | Reserved pin. Leave unconnected. |
| 30 | GND | - | Connect to the host circuit board ground plane. |

## DNT90 Antenna Connector

A U.FL miniature coaxial connector is provided on both DNT90 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 DNT90 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 2, the width of this stripline depends on the thickness of the circuit board between the stripline and the groundplane. For FR-4 type circuit
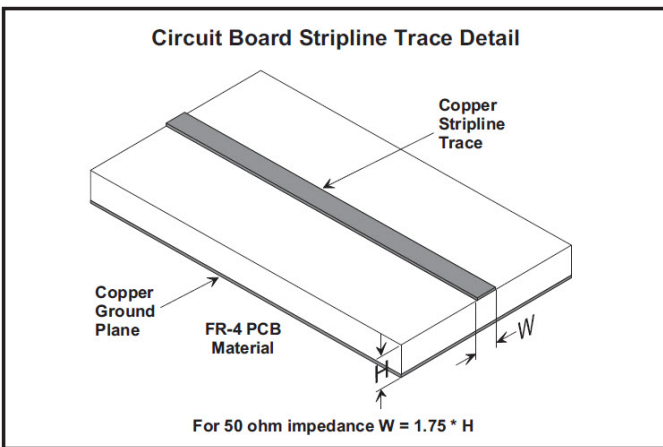


**Circuit Board Stripline Trace Detail**

For 50 ohm impedance W = 1.75 * H

**Figure 2**

| 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 3**

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 3. The stripline trace should be kept short to minimize its insertion loss.
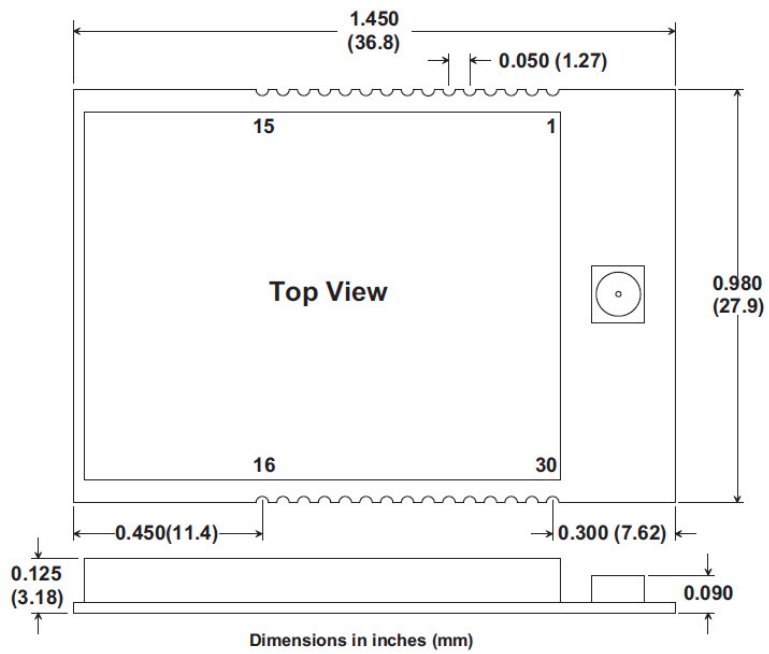
**Figure 4**



**Figure 5**

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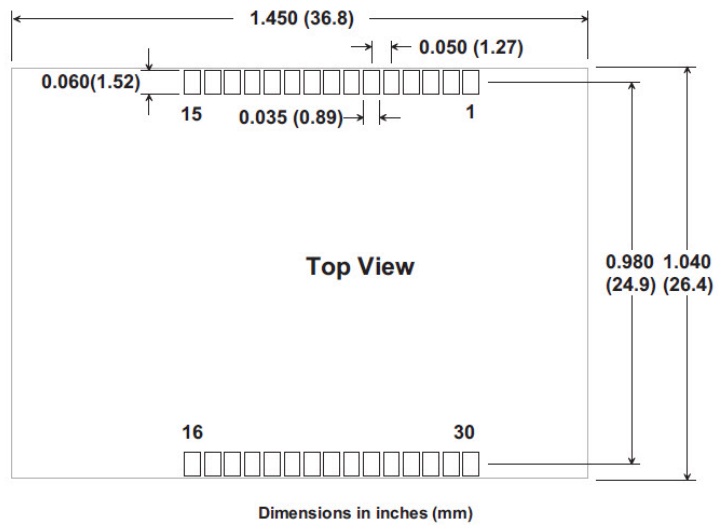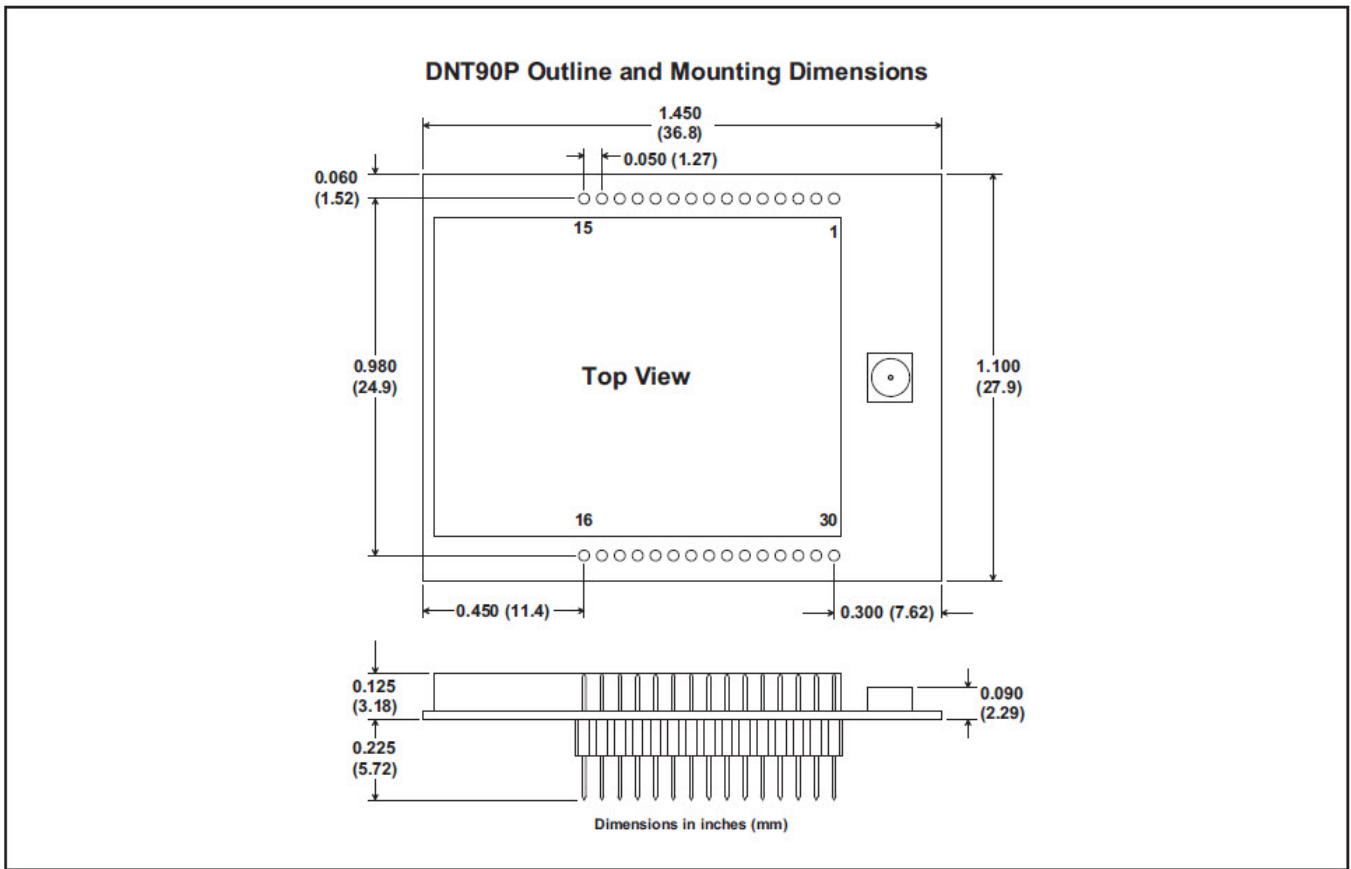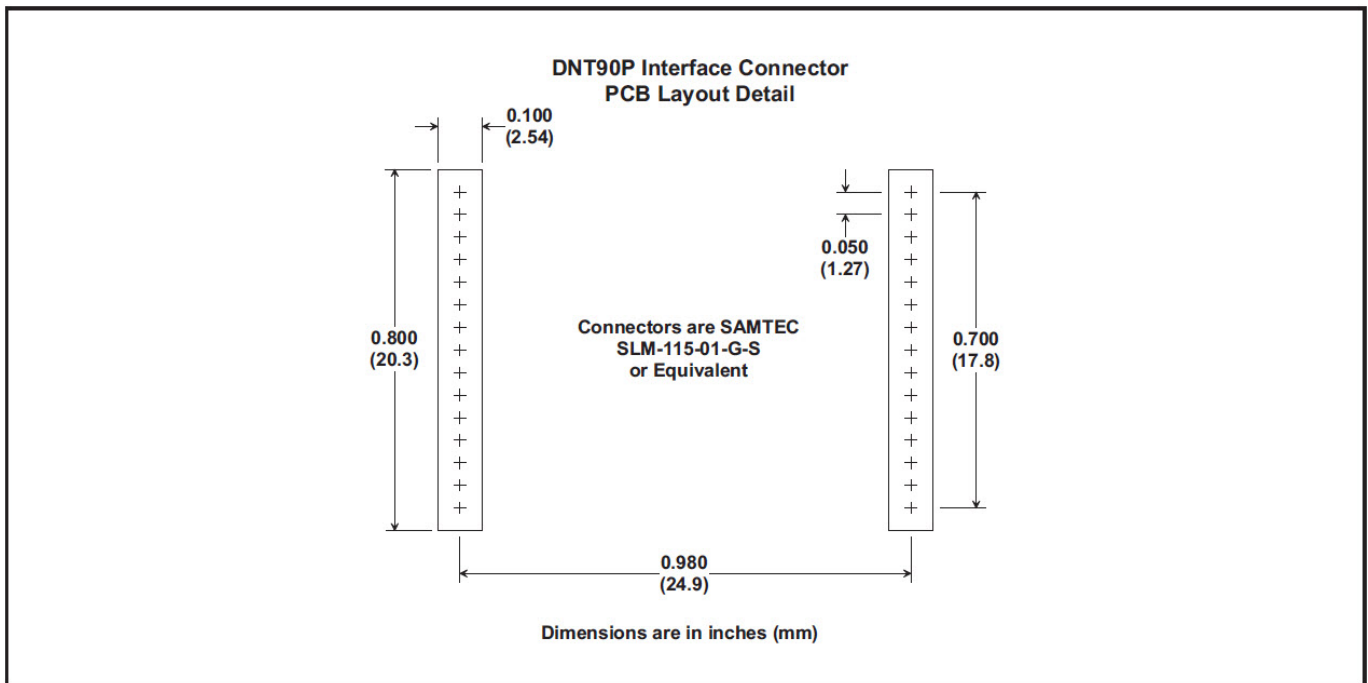
**Figure 6**



**Figure 7**

*Note: Specifications subject to change without notice.*

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