

Data Sheet

PulsON[®] 410

TIME DOMAIN[®]

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1 Overview

The hardware used in Time Domain's PulsON 410 Ranging and Communications Module (P410 RCM) and the P410 Monostatic Radar Module (P410 MRM) is physically identical. Given that there are no differences in the device hardware, this document will refer to the platform as a P410 when describing hardware characteristics and as a P410 RCM or P410 MRM when describing applications.

The P410 is an Ultra Wideband (UWB) radio transceiver and/or radar sensor that provides the following functions:

- It accurately and reliably measures the distance between two P410s and provides these measurements at a high update rate.
- It supports two different range measurement techniques (Two-Way Time-of-Flight and Coarse Range Estimation).
- It communicates data between two or more P410s.
- It is interoperable with Time Domain's earlier generation P400s.
- It allows operation as a monostatic radar.
- It is also possible to operate the P410 as hybrid device that is both a ranging radio and a radar sensor.

The user controls and monitors the P410 through an Application Programming Interface (API) over USB or Serial connections. USB driver support is provided for Vista 32, Vista 64, Win7 32 and Win7 64 operating systems. The API provides all the commands and capabilities required by a user to design a network tailored for operating multiple P410s as ranging radios or as individual or systems of radars.

The API has been segregated by application. For details, see the following documents:

- *Ranging and Communications API Specification, PulsON 400 RCM*
- *Monostatic Radar Module API Specification, PulsON 400 MRM*

For details on the USB and serial interfaces, refer to:

- *Using the USB and Serial Interfaces*

To assist the user in demonstrating the performance of the P410 either as a ranging radio or as a radar sensor, Time Domain also provides two PC-based Graphical User Interfaces (GUIs). These GUIs exercise all of the API commands and offers the following capabilities:

- They provide programmers with a visual example of a host application which interfaces to the P410 through the API.
- They allow users to evaluate ranging and communications performance.
- They allow users to evaluate the radar performance through use of a sample Motion Filter, sample Detection Processor, and a graphic display of raw and processed radar scans.
- They allow system analysts to visualize, collect, and log raw ranging and radar data such that it is possible to develop algorithms/strategies tailored to a given application

Time Domain also provides sample C and MATLAB code for demonstrating the interface and performance of the hardware.

For details on these GUIs see the following documents:

- *Ranging and Communications Module Reconfiguration and Evaluation Tool (RCM RET) User Guide*
- *Monostatic Radar Module Reconfiguration and Evaluation Tool (MRM RET) User Guide*

This document focuses on describing the P410 hardware. This discussion is subdivided into the following subsections.

Section 2 describes operation as a ranging radio

Section 3 describes operation as a radar sensor

Section 4 provides and describes the P410 block diagram

Section 5 discusses the physical interfaces

Section 6 provides mechanical details

Section 7 describes performance

Section 8 discusses regulations and export compliance

Section 9 describes various optional accessories available with the P410

Additional information including all of the documents referenced in this section can be found on the web at www.timedomain.com. This includes: the API, software manuals, application notes, white papers, examples, published papers, sample C code, sample MATLAB code, and more.

Finally, it is Time Domain's intention to offer the following additional capabilities in the near future:

- Bistatic radar
- Multistatic radar
- Ranging/communications network

2 Using a P410 as a Ranging Radio

The P410, shown in **Figure 1**, is a small, low power and affordable device which provides accurate, high rate range measurements and superior operational performance when compared to conventional RFID/RTLS devices. The device is intended for use as an OEM module. When used as a ranging radio, it is typically referred to as a P410 RCM.

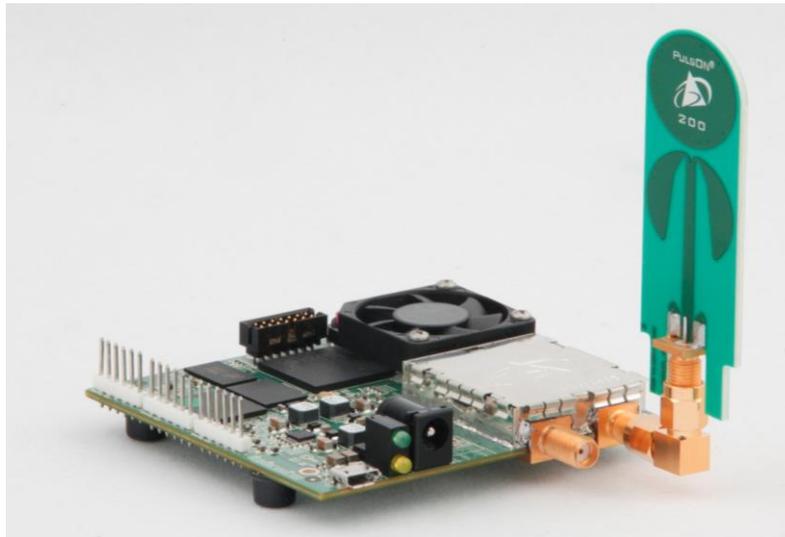


Fig. 1: P410 RCM with Broadspec antenna

Time Domain does not provide a standard network as part of the API. Instead, Time Domain is focused on providing a robust platform and a full featured, flexible interface. This focus includes all aspects of the physical and link layers as well as a few additional mechanisms to support implementation of a wide variety of network architectures. A block diagram showing operation of a ranging system is provided in **Figure 2**.

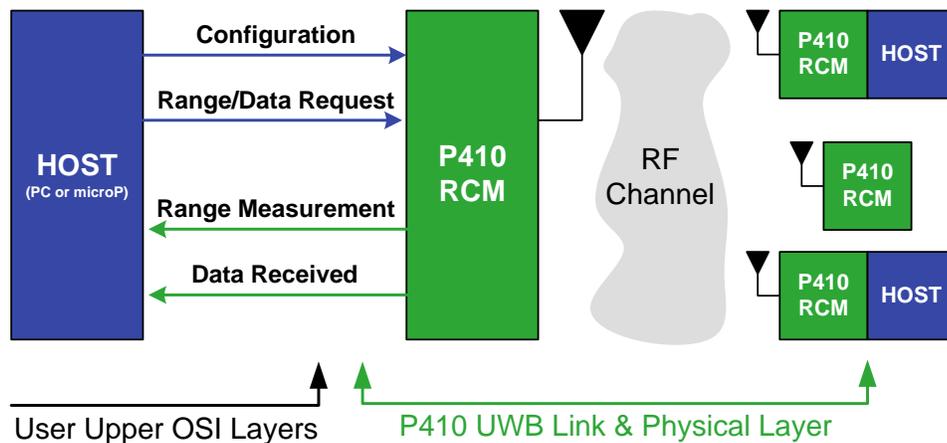


Fig. 2: Illustration of the interface with a system of P410 RCMs

Key Features of the P410 RCM

- Excellent performance in high multipath and high clutter environments
- Coherent signal processing extends operating range
- Direct sequential pulse sampling allows measurement of received waveform (resultant waveform is available to the user for ranging optimization)
- Two-Way Time-of-Flight (TW-TOF) ranging technique provides highly precise range measurements with industry-leading update rate
- Coarse Range Estimation (CRE) technique estimates the range from a transmitting unit by using the received leading edge signal strength and periodically recalibrating the estimate based on infrequent TW-TOF range measurements
- UWB chipset enables low cost, small size, and low power operation
- UWB waveform and pseudo random encoding ensures noise-like transmissions with a very small RF footprint
- RF transmissions from 3.1 GHz to 5.3 GHz, with center at 4.3 GHz
- Two user-configurable antenna ports for single or dual antenna operation
- RF emissions compliant with FCC limits
- Each unit is a full transceiver
- Single 3" x 3.15" (7.6 x 8.0 x 1.6 cm) board
- USB or Serial interface
- Several sleep modes allow user to reduce power consumption
- Interoperates with P400s

Typical Applications of the P410 RCM

- Peer-to-peer ranging with moderate-rate wireless communications
- GPS augmentation for multipath resistance
- Inertial augmentation for drift removal
- Robotics navigation and tracking, precision formation
- Autonomous vehicle convoys
- First responder tracking and man-down locator
- Asset tracking, especially in applications that preclude the use of fixed infrastructure or involving moving frames of reference
- Distributed sensor automatic survey and dynamic mapping with fused data communications
- Wireless channel impulse response (CIR) measurements
- Wireless noise-like / covert data communications

3 Using P410 as a Monostatic Radar System

The P410, shown in **Figure 3**, is a small, low-power and affordable monostatic radar platform that provides more than one gigahertz (GHz) of radio frequency (RF) bandwidth at a center frequency of approximately 4 GHz. The device is intended for use as an OEM module. When used as a radar sensor, it is typically referred to as a P410 MRM.

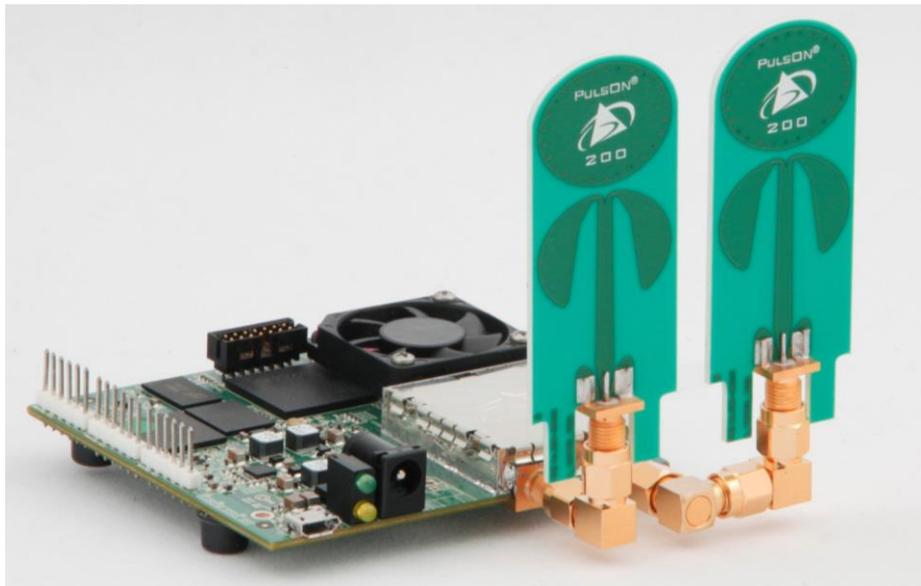


Fig. 3: P410 MRM with pair of Broadspec antennas

Time Domain does not provide standard radar signal processing tools as part of the API. Instead, Time Domain is focused on providing a robust, high-performance radar front-end, with a full-featured, flexible interface that provides coherently integrated radar scan information.

As part of the radar-specific GUI (MRM RET) previously mentioned, Time Domain also provides a Windows service called the MRM Service. This service is installed on the host computer during the initial MRM RET software installation. The service runs when the PC is booted. If the user desires, the MRM Service can be remotely operated such that it runs on a different computer than the host. If the service is selected, then the raw scans produced by the P410 MRM are post-processed and provided to MRM RET. Based on operator instruction, the MRM Service will band-pass filter, motion filter, and perform Constant False Alarm Rate (CFAR) target detection processing on the raw scan data. The processed data is provided to MRM RET for display and logging. The user has the option of applying several different types of filters. For a more detailed description, consult the *MRM RET User Guide*.

A system block diagram is provided in **Figure 4**.

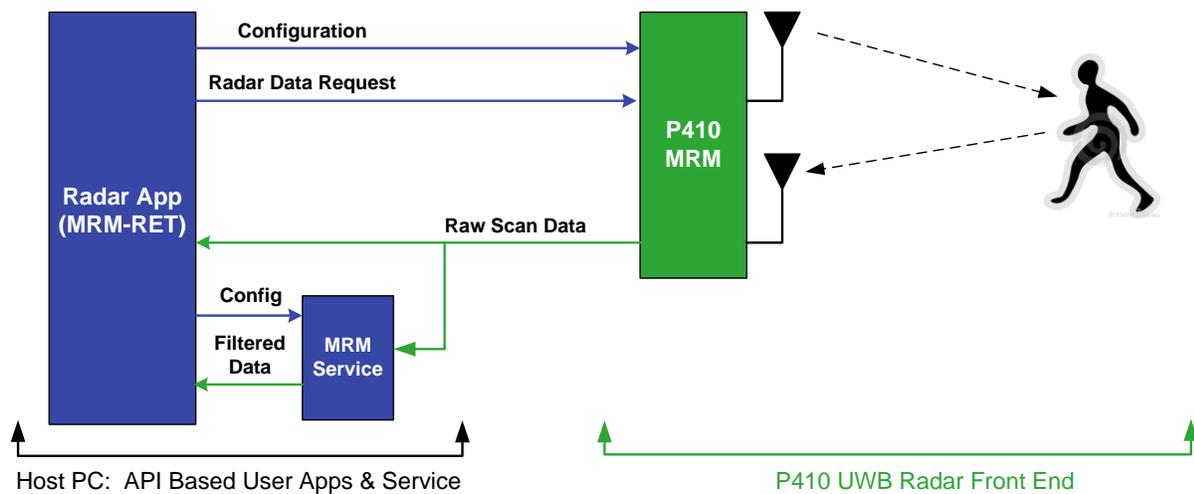


Fig. 4: Illustration of the interface to a P410 MRM

MRM RET will receive the raw data either directly from the MRM (if the MRM Service is not connected) or from the MRM Service (if the MRM Service is connected).

Key Features of the P410 MRM

- Excellent performance in high multipath and high clutter environments
- Coherent signal processing extends operating range at very low signal power levels
- P410 MRM provides raw scans for post processing
- UWB chipset enables low cost, small size, and low power operation
- UWB waveform and pseudo random encoding ensures noise-like transmissions with a very small RF footprint
- Seven separate channels provided, more are possible
- RF transmissions from 3.1 GHz to 5.3 GHz, with center at 4.3 GHz
- Two user-configurable antenna ports for dual antenna operation
- RF emissions compliant with FCC limits
- Single 3"x 3.15" (7.6 x 8.0 x 1.6 cm) board
- USB or Serial interface
- Several sleep modes allow user to reduce power consumption
- Interoperates with P400s

In the very near future it is anticipated that the MRM will also support the following enhancements:

- Different integration rates for different distances (segment control)
- Operation with a single antenna

Typical Applications of the P410 MRM

- Robotics
- Tagless tracking
- Proximity detection

- Collision avoidance
- Security applications
- Presence/intrusion detection
- Unattended ground sensors
- Surveillance
- Through-wall sensing

It should also be noted that since the P410 MRM and P410 RCM share the same hardware, it is also possible to construct hybrid systems that combine capabilities to address applications that would benefit from monostatic radar, UWB communications, and UWB ranging.

4 Hardware Block Diagram

This section provides and discusses at a high level the P410 functional hardware block diagram, as shown in **Figure 5**. Additional detail on the various interfaces is provided in Section 5.

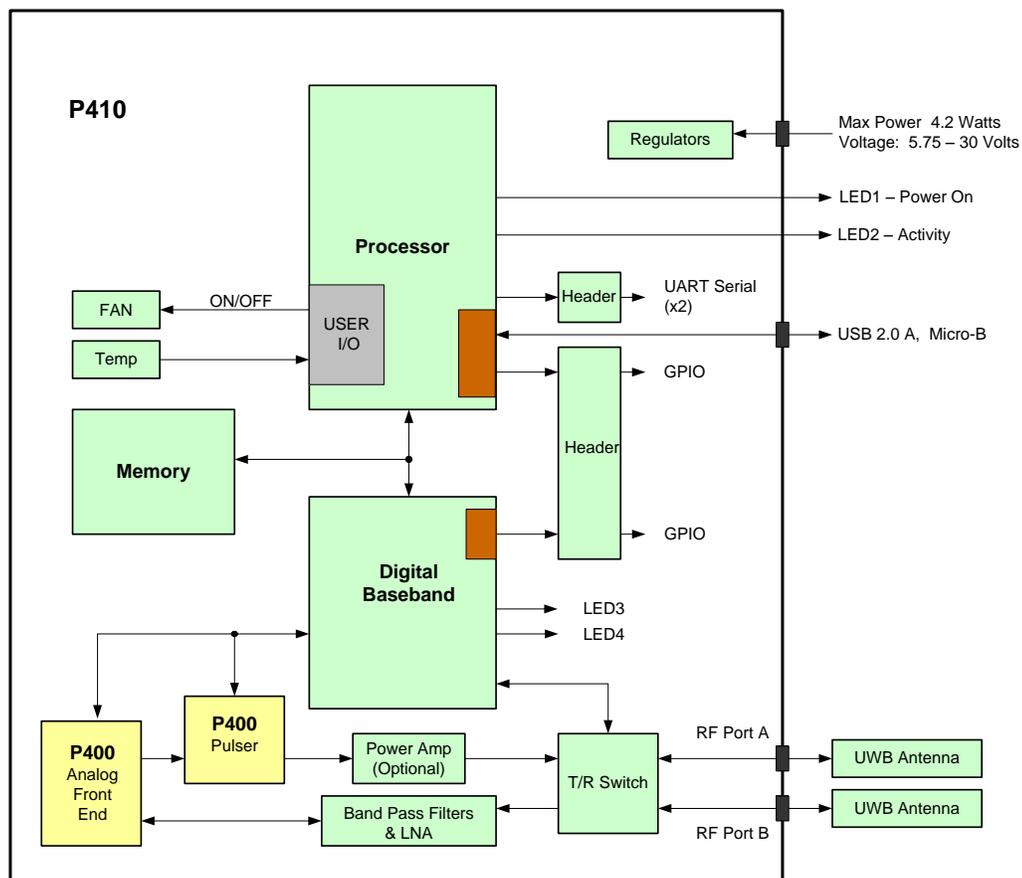


Fig. 5: P410 hardware functional block diagram

To power the board, the user must supply a maximum of 4.2 Watts at any voltage between 5.75-30V. This can be accomplished either with the provided power supply or from a battery. Indicating lights provide operating status information.

The user can interface to the P410 through either USB (standard USB Micro-B connector) or a Serial connection (header). In addition, the user can request the P410 to report the board temperature and can command the fan to turn on or off.

The processor controls the UWB front end through a Digital Baseband FPGA interface. More specifically, the FPGA configures the Time Domain P410 Pulser chip (UWB transmitter) and P410 Analog Front End (AFE) chip (UWB receiver), provides timing signals and outgoing data, receives incoming data, and controls the position of the transmit/receive (T/R) switch.

There are three RF sections:

- Power amplifiers are provided to boost the output of the Pulser. Amplification is adjustable from -32 to -12dBm. A high power option is available which provides -14.5 to 0.7 dBm.
- Receive chain consists of gain stages and band pass filter.
- T/R switch supports 5 configurations: Transmit/Receive on Port A, Transmit/Receive on Port B, Transmit on A, Receive on B, and Transmit on B, Receive on A and A/B Toggle. The T/R switch supports a configurable default receive position with an optional override when transmitting.

5 Interfaces

This section provides a detailed description of the various P410 interfaces. The overall board image in **Figure 6** is referenced throughout this section.

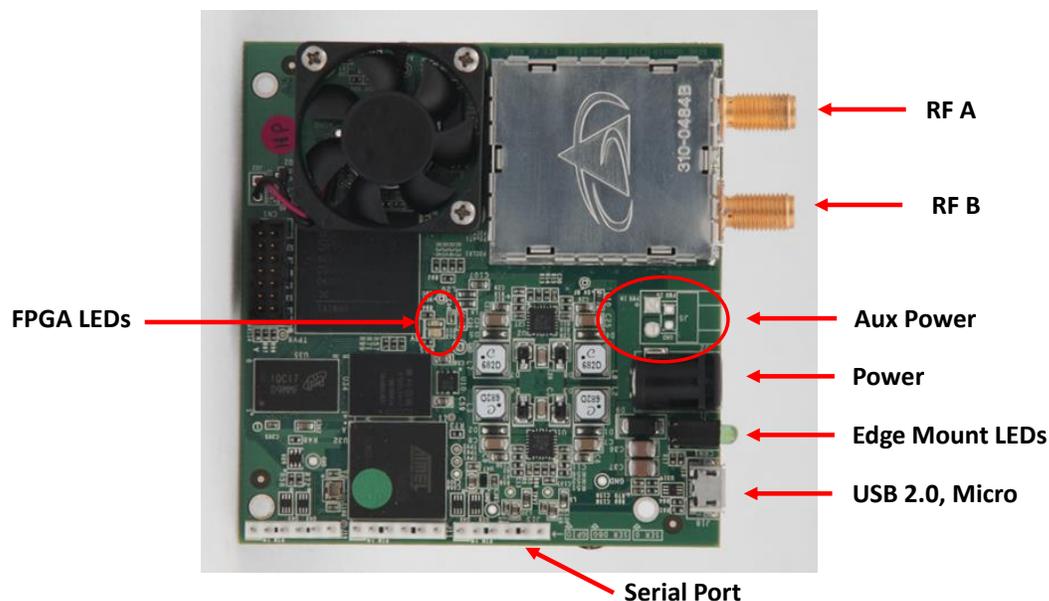


Fig. 6: Photo of the P410 highlighting key interfaces

5.1 Power

The P410 is normally powered by a modular power supply (optionally provided by Time Domain) that plugs directly to the P410 barrel connector power jack. Alternatively, the user can install alternate SIP connectors using either of two pairs of mounting holes shown in **Figure 7**. The pair of holes on the right is intended for a two position, 0.1 inch pitch header (Digi-Key part number WM8072-ND). The pair of holes on the left is intended for a locking, two position, 3.96 mm square connector (Digi-Key part number 455-1648-ND). The round hole is connected to ground. The square hole is for the supply voltage. The input power is specified in **Table 1**.

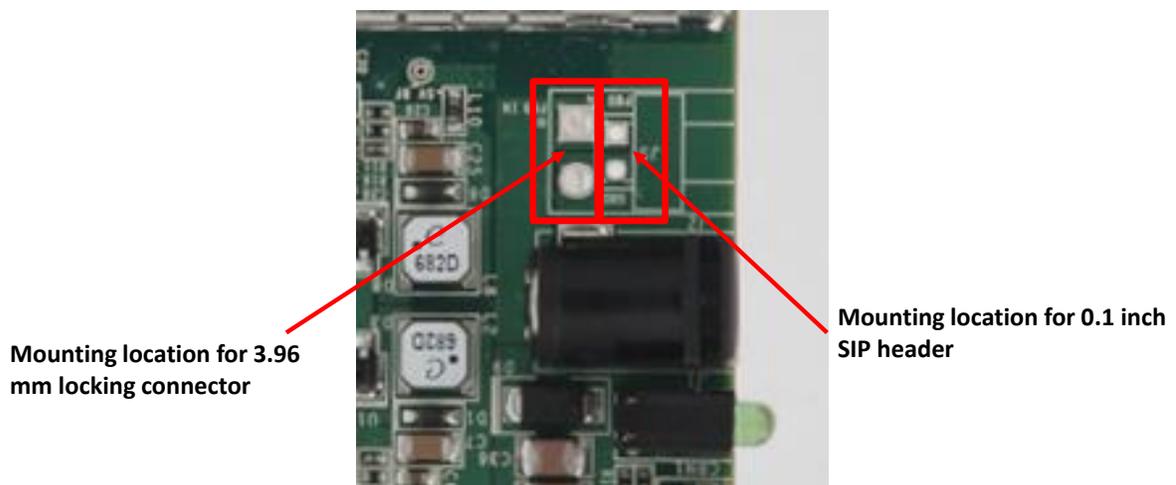


Fig. 7: Alternate Power Connections

Parameter	Description	Min	Max	Unit
V_{IN}	Input voltage to P410	5.75	30.0	Volts
I_{IN}	Input current to P410	0.037 @ 30 Vin	0.73 @ 5.75 Vin	Amps
W_{in}	Power to P410	1.1W (sleep)	4.2W (Max)	Watts

Table 1: Input voltage and current requirements

5.2 Indicator Lights

The P410 is provided with four indicator LEDs. Two are mounted on the edge of the board and two are mounted adjacent to the Digital Baseband FPGA. See **Figure 6** for exact locations.

Edge Mount LEDs - The amber LED indicates that power to the board is on. The green LED is off until the P410 has booted and is running. Once running, the LED will turn on solid. After that, it will toggle every time a packet is transmitted.

FPGA LEDs - The amber LED toggles at 1Hz to indicate that the FPGA has passed Built-In Test (BIT). If the FPGA fails BIT, then the amber LED will blink at approximately 10 Hz. The green LED is initially off indicating that the FPGA has not been loaded. It blinks rapidly to indicate that the FPGA has been loaded and is getting a clock. After that, a steady on or off indicates a failure.

5.3 USB and Serial Interfaces

The P410 offers two different interfaces that allow users to control the module according to their specific application needs. The standard interfaces currently supported by the system are: USB 2.0 through a Micro-B USB connector, and a 3.3V TTL-level serial interface through a six pin 0.1" SIP header. (Serial to USB cables compatible with this interface are available from FTDI (TTL-232R-3V3) or through Digi-Key (768-1015-ND)).

Note the USB connection does not provide enough power to support the RCM.

The protocol used to communicate with the P410 is fully defined in the RCM or MRM *API Specification*.

The P410 board has a 3.3V serial universal asynchronous receiver transmitter (UART) port which customers can also use to communicate with the P410. Both the Serial and USB interfaces are documented in Time Domain application note *Using the USB and Serial Interfaces*.

USB is recommended for PC/Laptop hosts, while Serial is intended primarily for embedded hosts. The P410 also has a number of currently unassigned GPIO pins. One processor GPIO (3.3V) and two FPGA GPIO (2.5V) pins are available for general use. Logic and drivers for these pins can be developed based on specific customer requests.

5.4 Antennas

The P410 has two antenna ports, designated Port A and Port B. The connector used on each port is a standard polarity female SMA connector (Digi-Key part number J801-ND). The two ports enable single and dual antenna modes of operation.

An RF transfer switch on the P410 controls how the RF electronics are connected to the SMA connector. The switch supports 5 configurations: Transmit/Receive on Port A, Transmit/Receive on Port B, Transmit on A/Receive on B, Transmit on B/Receive on A, and Toggle A-B. This fifth state is used only when a P410 RCM receives a series of range requests. When this occurs, the unit will automatically toggle between the two receive antennas. The user specifies the desired antenna configuration through the API. When operating as P410 MRM, the user's antenna choices are limited to Transmit on A/Receive on B and Receive on A/Transmit on B.

While Time Domain provides its standard BroadSpec UWB antenna with the Development Kit, the SMA ports are standard and any third party UWB antenna can be used depending on gain and directionality requirements. Please be aware that using alternate UWB antennas will likely change the RF time-of-flight electrical distance between the antenna port and the phase center of the antenna.

Failure to account for such changes will result in an offset or bias error in range measurements. See the RCM *API Specification* for details on how the electrical distance is defined and calibrated.

5.5 Fan

A small fan (2.5CFM) has been provided on the RCM. This fan is located between and above the FPGA and P400 AFE chip. Although these chips are manufactured to operate at high temperatures, the fan is used to provide a modest amount of heat removal required for optimal operation across all specified temperature and performance ranges. The fan can be turned off (through the API) or removed at the factory, but some degradation in maximum distance or accuracy may be encountered at high temperatures.

6 Mechanical

Board outlines and mounting hole locations are indicated in **Figure 8**. There are 4 mounting holes. Three are indicated in the drawing, and the fourth is located underneath the RF shield. The board profile is shown in **Figure 9**. The board comes with 4 rubber feet, which are removable. All units are English.

Contact Time Domain for 3D CAD files in support of integration or enclosure design.

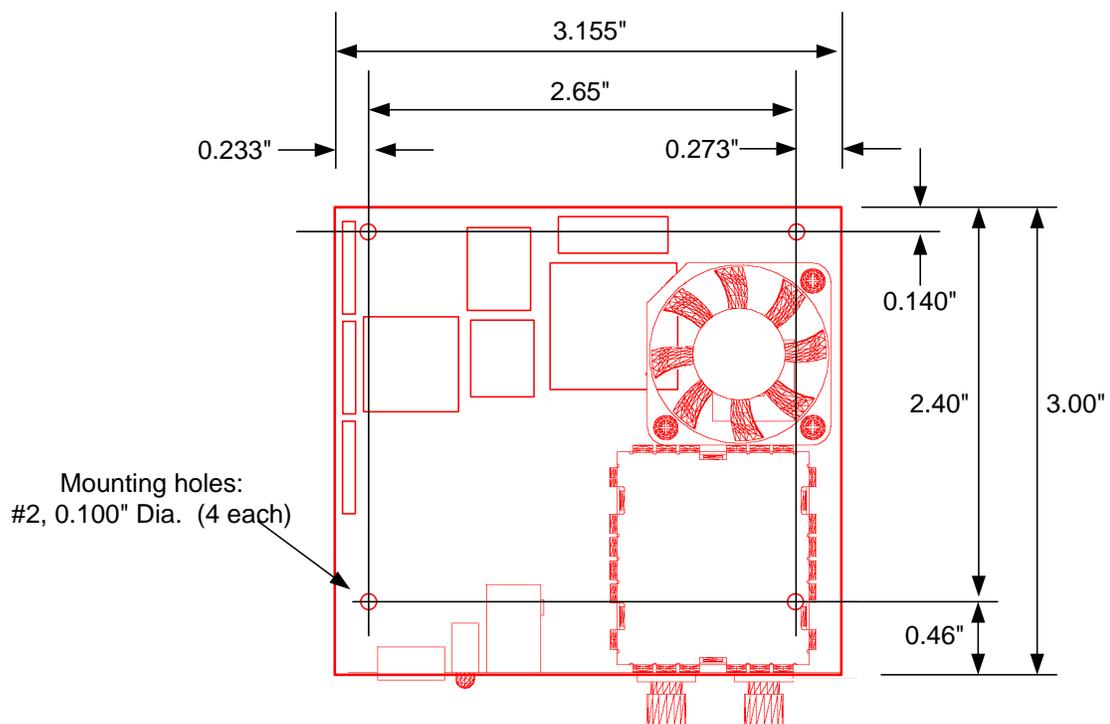


Fig. 8: P410 top view

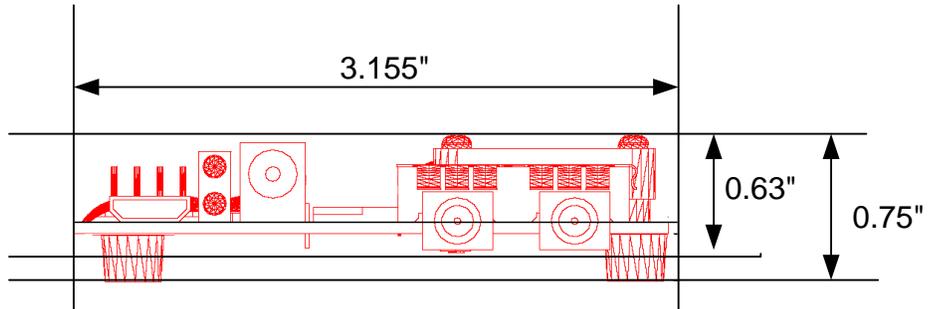


Fig. 9: P410 front view

7 Performance

Table 2 summarizes the P410 specifications and key performance parameters.

P410 Specs	Value
Physical Parameters	
Dimensions (with mounting feet):	3''x 3.155'' x 0.75'' (76 x 80 x 19 mm)
Dimensions (without feet):	3''x 3.155'' x 0.63'' (76 x 80 x 16 mm)
Weight	58 grams
Storage Temperature:	-40°C to 85°C
Operating Temperature range	0°C to 70°C
Max allowable board temperature:	70°C (as reported by on board temp sensor)
Humidity:	Up to 95%, non-condensing
Input Power Range:	5.75V to 30V DC
Input Power Ripple:	100 mV pk-pk
Power/Temp operating as a Ranging Radio	
Maximum Power Consumption:	4.2 Watts
Typical Power Consumption and Transition times (power function of communications interface):	
- Active (requesting)	3.90 Watts
- Active (receiving)	3.88 Watts
- IDLE	2.60 Watts (Enter: 1.2 ms, Exit: 1.2 ms)
- Standby_E	1.10 Watts (Enter: 1.2 ms, Exit: 2.9 ms)
- Standby_S	1.10 Watts (Enter: 1.3 ms, Exit: 2.9 ms)
Operating Temperature range: (on lab bench, with no enclosure)	-10°C to 60° C
Operating Temperature range: (in optional Time Domain enclosure)	-10°C to 54° C
Power/Temp operating as a Radar	
Maximum Power Consumption:	3.9 Watts
Typical Power Consumption and Transition times (power function of communications interface):	
- Active and scanning	3.65 Watts
- Active but not scanning	3.30 Watts
- IDLE	3.30 Watts (Enter: 1.2 ms, Exit: 1.2 ms)
- Standby_E	1.11 Watts (Enter: 1.2 ms, Exit: 2.9 ms)
- Standby_S	1.14 Watts (Enter: 1.3 ms, Exit: 2.9 ms)
Operating Temperature Range: (on lab bench, with no enclosure)	-10°C to 60°C
Operating Temperature Range: (in optional Time Domain enclosure)	-10°C to 54°C

User Interfaces/Devices	
Standard PC/Laptop Interface:	USB 2.0A Client – Micro-B connector
Standard embedded host interface:	3.3V TTL Serial UART 115.2kbps, 8, n, 1
Hardware Interfaces available but not currently supported:	<ul style="list-style-type: none"> • 1 Processor GPIO pin (3.3V) • 2 FPGA GPIO pins (2.5V)
On Board Temperature Sensor	-40°C to 125°C, +/- 2.0 °C
RF Characteristics	
Operating Band:	3.1 GHz to 5.3 GHz
Center Freq:	4.3 GHz
Transmit power (Adjustability range) (-14.5dBm is FCC Part 15):	Standard: (-31.6 to -12.64 dBm) High power: (-14.5 to 0.7 dBm) For adjustment control see Note 4.
Antenna Ports A&B:	Standard 50 Ohm SMA coaxial connector
Antennas Supported	Compatible with Time Domain Broadspec™ Toroidal Dipole Antenna (0 dB) as well as a wide variety of 3 rd party antennas.
Antenna Control:	User cross-bar configured as either Tx/Rx on either, or Transmit on one, Receive on the other.
Noise Figure:	4.8 dB
Dynamic Range:	
Integration: 1 (instantaneous)	30 dB
Integration: 16:1 (PII=4)	42 dB (Min Ranging Integration)
Integration: 64:1 (PII=6)	48 dB (Min Radar Integration)
Integration: 1024:1 (PII=10)	60 dB (Max Ranging Integration)
Integration: 32768:1 (PII=15)	75 dB (Max Radar Integration)
Transmit Pulse Repetition Rate	10.1 MHz (default - others available)
RF Communications	
Channelization:	7 user selectable pseudo-random pulse interval channels. Others available for special applications.
Raw Data (Symbol) rates:	See Table 3
Max Range (FCC Part 15, standard Broadspec Antennas, free space)	See Table 3
Comms type:	Packet transmission
Max user bytes/packet:	1024
Pulse integration rates (PII):	4 (16:1), 5 (32:1), 6 (64:1), 7 (128:1) 8 (256:1), 9 (512:1), 10(1024:1)
Ranging Performance	
Ranging techniques:	Pulsed Two-Way Time-of-Flight (TW-TOF), Coarse Range Estimation (CRE)
Two-Way Time-of-Flight	
Line of Sight Range Performance	See Note 1
Precision (Standard Deviation)	2.3 cm
Accuracy (Bias error):	2.1 cm
Range Update Rate	See Table 3
Non-Line of Sight Performance	See Note 2
Coarse Range Estimation (LOS only)	See Note 3

Range update rate	See Table 3
Radar Performance	
Approximate Detection Range (high power transmission)	Person Walking: 80m Person Crawling: 40m Vehicle: 80m See Note 5

Table 2: P410 performance characteristics

Note 1: Precision and Accuracy in LOS conditions. The Line of Sight (LOS) Precision and Accuracy specification is based on a measurement campaign that included 20,000 range measurements taken in an open field, over an operating range that varied from 2 ft. to 300 ft., for PII's 4 through 8 inclusive, at minimum and maximum transmit gain, when the received signal was linear and also when it was in compression. The quoted values are the results of the composite of all of the measurements. This includes combinations of settings that may not be reasonable (e.g., operation at minimum range and maximum transmit power). It is believed to be a conservative estimate of the system's ranging Precision and Accuracy. When averaging many range measurements, users have reported precisions on the order of a few millimeters.

Note 2: Precision and Accuracy in NLOS conditions. Time Domain does not have a specification for accuracy in Non-Line of Sight (NLOS) environments. This is because of the wide variety of conditions that can be encountered. For example, if one is measuring range inside a building that is constructed of wood frame and drywall (aka sheetrock or gypsum board), then one will experience a level of performance that is less than but close to LOS conditions. This is because wood and drywall do not significantly attenuate or disperse RF signals at the P410's operating frequency. At the opposite end of the propagation spectrum would be operation inside a metal ship. Because metal blocks radio frequencies, the operating range would be limited to the size of the room. Operation in NLOS must be determined empirically. Having said that, we routinely measure range from one side of our office space to the other (a distance of 30 meters through an environment that is not only NLOS but is also occluded by large amounts of metal) with an accuracy of better than +/- 1 meter.

PII	Max Range (meters)	Data rate: (bps)	Precision Range Measurement (time, rate)
4	35	632k	8.0 ms, 125.0 Hz
5	60	316k	9.7 ms, 103.1 Hz
6	88	158k	13.7 ms, 73.0 Hz
7	125	79k	21.3 ms, 46.9 Hz
8	177	39.5k	36.7 ms, 27.2Hz
9	250	19.7k	68.0 ms, 14.7 Hz
10	354	9.86k	132.5 ms, 7.5 Hz

Table 3: Data and ranging performance characteristics @ -14.5 dBm transmit power

Note 3: Precision and Accuracy of CRE: There are three main factors that affect the Precision and Accuracy of a CRE measurement: stability of the RF channel, signal strength, and changes in antenna pattern. If RF channel characteristics are stable, then the accuracy of the CRE measurement should be close to that of the reference precision range measurement (PRM). However, if the RCM is physically moving, with associated antenna pattern changes, then the RF channel will change with time. Therefore, the recalibrating PRMs should be taken frequently enough such that the rate of change (“drift”) of the RF channel will be small. This rate of change will vary with node speed and change in orientation and must be determined empirically. Random effects, along with sampling variability, can cause a static node’s signal strength measurement to vary as much as 10%. The CRE error is also a function of distance/SNR as a smaller/farther signal contains a higher proportion of noise elements. This translates into a CRE standard deviation error of approximately 10% at short distances growing up to 30% at very long distances.

Note 4: Setting the transmit power level: The user can adjust the transmit power level through the API “Set Configuration” command. Alternatively, this adjustment can be made through the RCM RET or MRM RET by modifying the “Transmit Gain” setting on the Configuration Tab. **Figure 10** shows the relationship between the value selected for Transmit Gain and the radiated power when using a standard P410. **Figure 11** shows the relationship when using a P410 with optional high power amp. This power levels shown assume a 0dBi antenna. Antennas with additional gain will have additional EIRP.

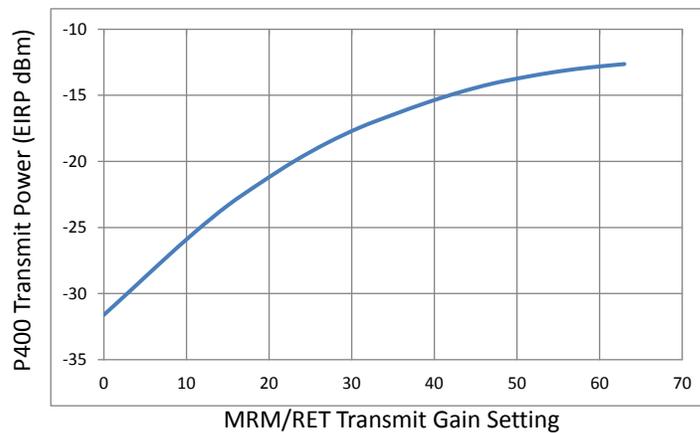


Fig. 10: Transmit power as a function of Transmit Gain setting (Setting 44= FCC -14.5 dBm)

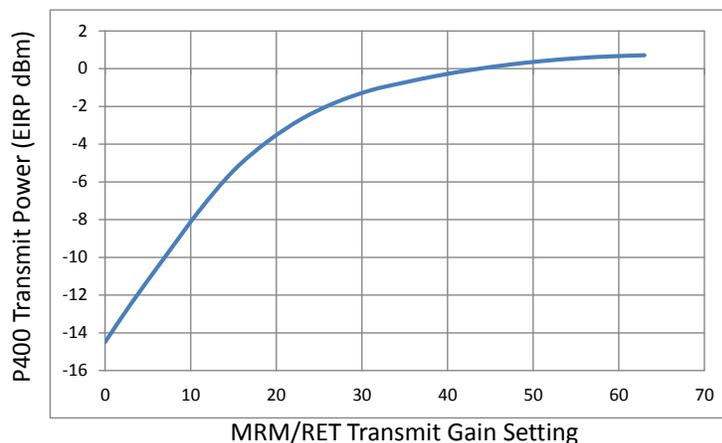


Fig. 11: Transmit power as a function of Transmit Gain setting (Setting 0= FCC -14.5 dBm)

Also note that this shows the typical relationship. The user can expect unit to unit variation of approximately 2 dB.

Note 5: Detection ranges: The detection range is a strong function of the antennas used, the ambient environment, clutter, target size and movement characteristics. The quoted detection ranges have been achieved and represent close to the maximum detection range achievable without using heroic measures. For additional insight into this subject, a validated Radar Range Equation for the P400 and P410s is provided on the time domain website.

8 Regulations and Export

The P410 has been designed to be in compliance with the Federal Communications Commission (FCC) regulations governing both UWB hand-held systems (Part 15.519) also known as “battery powered devices” and UWB Surveillance Systems (Part 15.511). This means that the device can be incorporated in a wide variety of products including mobile tracking systems, mobile locators, radar-based locators, guidance and position systems, radar fences and communication devices.

Please note that while the P410 is designed for unlicensed operation, it has not been certified by the FCC. Certification must be done once the P410 is integrated into the final mechanical design or housing, as well as with the intended antenna for product rollout or fielding. Both the housing and the antenna can impact unintentional and intentional emissions respectively. Time Domain is available to assist you with the certification process.

Based on requirements from a number of government and site-license customers, the P410 is capable of transmitting at power levels in excess of the FCC limits for enhanced performance. In order to use these higher powers, please consult and seek authorization from the appropriate regulatory agencies. Time Domain has expertise in working with regulatory agencies and can help as needed.

Additionally, the FCC regulations do not apply to government or military applications. Proper governmental use is described in “Government Regulations for Non-Licensed UWB Systems - Annex K”. Developers interested in building a device for a particular government agency should discuss their application and Annex K with that agency’s Spectrum Manager.

Related to export, the Department of Commerce’s Bureau of Industry and Security has assigned the Export Commodity Control Number (ECCN) of 5A001b.4 to the P410. Products falling under ECCN 5A001b.4 are controlled for export purposes pursuant to the Commerce Control List for National Security and Antiterrorism. For the latest information from the Commerce Department on Export, please go to: <http://www.bis.doc.gov/licensing/exportingbasics.htm>.

9 Configuration Options and Separate Accessories

The P410 is provided with one standard option. It can be ordered either with standard transmit power or with additional power amplification. A description of this option is provided in Section 7.

The following accessories are optionally available for use with the P410.

- Broadspec Antenna
- Power supply
- Enclosure
- Battery
- Charger

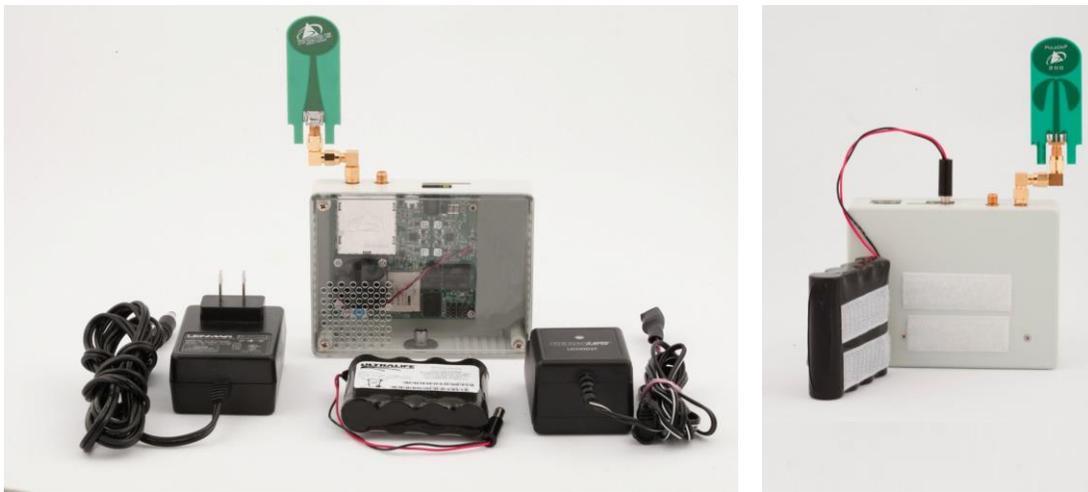


Fig. 12: P410 with all accessories (L), rear view of P410 showing battery attachment (R)

A short description of these accessories follows:

9.1 Broadspec Antenna PN: 100ANR1

This Ultra Wideband Antenna (~3dBi) provides an omni-directional transmit/receive pattern supporting a frequency range of 3.1 - 5.3 GHz. Standard SMA male connector. SMA standard right angle (male/male) connector included. Antenna measures 1" x 2.5" x 0.125". Specifications are available on the web at:

http://www.timedomain.com/datasheets/TD_Broadspec_Antenna.pdf



Fig. 13: Broadspec Antenna with right angle connector

9.2 P400 Power Supply PN: 300PS01

Unit accepts 100-240 VAC, 50-60Hz and provides 7.5 VDC at up to 2 Amps for the P400/P410. DC power barrel output. USA 3-prong AC power cord included. Compatible with P400 and P410s.

9.3 P410 Enclosure PN: 310EN01

Enclosure for P410 OEM module. Housing is made of damage resistant ABS plastic with clear polycarbonate cover. Provides protection from improper handling and is suitable for most outdoor work. Standard camera mount allows easy connection to tripods. Additional 90-degree RF connector for vertical tripod mounting included. Enclosure intended to protect the unit during development or evaluation. Not labeled for resale.



Fig. 14: Enclosure cover (left), Enclosure (right)

9.4 P400 Rechargeable Battery PN: 300RB01

Lithium ion battery for either P400 or P410. 34.6 Watt hours capacity provides between 4 and 9 hours of continuous operation. Battery mounts to P410 Enclosure with Velcro (included). Connector keyed to prevent improper connection to P400/P410 electronics. Weight: 191 grams.

9.5 P400 Battery Charger PN: 300BC01

Wall socket single unit charger for P400 Rechargeable Battery. Safety circuit prevents charging shorted battery packs. LED status indicator. Custom cable and barrel connector keyed to prevent improper connection with P400/P410 electronics. 100-240VAC 50/60Hz. Standard 3 prong USA plug.