



Intel® Quark™ Microcontroller D2000 Development Platform

Hardware Manual

September 2016



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Revision History

| Date | Revision | Description |
|----------------|----------|--|
| September 2016 | 005 | Added note on internal oscillator trim codes and updates based on user feedback. |
| May 2016 | 004 | Updated sections 1 and 2. |
| March 2016 | 003 | Updated table 2 with booster pack pins. |
| February 2016 | 002 | Updated for development platform. |
| December 2015 | 001 | Initial release. |

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1.0 Introduction

This document describes the Intel® Quark™ microcontroller D2000 SoC based development board that is contained in the Intel® Quark™ microcontroller Developer Kit D2000 (MM 948988) and the Intel® Quark™ microcontroller Evaluation Kit D2000 (MM 951244).

1.1 Terminology

Table 1. Terminology

| Acronym | Definition |
|------------------|---|
| ADC | Analog-to-Digital Converter |
| AIN | Analog Input |
| AREF | Analog Reference Voltage Input |
| BGA | Ball Grid Array |
| BSP | Board Support Package – Refers to OS + Device Drivers |
| COMP | Comparator |
| CLK | Clock |
| CRB | Customer Reference Board |
| CTS | Clear To Send |
| DC | Direct Current |
| DDR | Double Data Rate |
| DIO | Digital Input / Output |
| DOUT | Digital OUT |
| EFI | Extensible Firmware Interface |
| ESD | Electrostatic Discharge |
| GND | Ground |
| GPIO | General-Purpose Input / Output |
| HW | Hardware |
| I ² C | Inter-Integrated Circuit |
| IA | Intel Architecture |
| ICSP | In-Circuit Serial Programming |
| IOREF | Input/Output Reference Voltage Input |
| JTAG | Joint Test Action Group |
| MCU | Micro Controller Unit |



| Acronym | Definition |
|---------|---|
| MISO | Master In Slave Out |
| MOSI | Master Out Slave In |
| NC | Not Connected |
| OTP | One-Time Programming |
| PCB | Printed Circuit Board |
| PWM | Pulse Width Modulation |
| RTC | Real Time Clock |
| RTS | Request To Sen |
| RXD | Receive Data |
| SCK | Serial Clock |
| SCS | Chip Select |
| SCLK | Serial Clock |
| SDA | Serial Data |
| SoC | System on Chip |
| SPI | Serial Peripheral Interface Bus |
| SS | Slave Select |
| SRAM | Static Random Access Memory |
| TCK | JTAG (Test) Clock |
| TDI | JTAG (Test) Chain In |
| TDO | JTAG (Test) Chain Data Out |
| TMS | JTAG (Test) Chain Mode Select |
| TRST | JTAG (Test) Chain Reset |
| TXD | Transmit Data |
| UART | Universal Asynchronous Receiver/Transmitter |
| USB | Universal Serial Bus |



2.0 Development Platform

2.1 Overview

The Intel® Quark™ Microcontroller D2000 Development Board is a versatile platform targeted towards Internet of Things developers.

Intel® Quark™ microcontroller D2000 features:

- Intel® Quark™ microcontroller D2000 SoC 32MHz
- 32KB flash memory (internal)
- 8KB OTP flash (internal)
- 4KB data flash (internal)
- 8KB SRAM (internal)
- 1x I²C (Master/Slave)
- 1x SPI master supports up to 4 devices
- 1x SPI slave
- 2x UART – supports 9-bit addressing mode
- 19 ADC/Comparator inputs
- 2x PWM signals
- 25 GPIOs
- Real-time clock
- Watchdog timer

Intel® Quark™ microcontroller D2000 development platform main expansion options:

- “Arduino Uno” like SIL sockets (3.3V IO only) (see section 2.1.2)
- Booster pack like SIL headers (3.3V IO only)

On-board components:

- 6-axis Accelerometer / Magnetometer with temperature sensor
- UART/JTAG to USB convert for USB debug port

Other connectors include:

- 1x USB 2.0 Device Port – micro Type B
- On-board coin cell battery holder (type CR2032)
- 5V input a screw terminal/header (external power or Li-ion)

Power sources for this platform:

- External (2.5V - 5V) DC input
- USB power (5V) – via debug port
- Coin cell battery (type CR2032 not supplied)



2.1.1 Arduino Shield Sockets Note

The Intel® Quark™ Microcontroller D2000 Development Platform supports the familiar open standard Arduino Uno Rev 3.0 physical interface and is mechanically compatible with Uno Rev 3.0.

- Each functional I/O can be configured to provide the same function that is supported on the Arduino Uno Rev 3.0 with the exception of the PWM capability which can only be supported on IO6 and IO9.
- The developer platform supports 3.3V IO operation only and is not 5V tolerant.
- VIN Pin is not supported.
- The 6 pin ICSP Header is not supported.

The purpose of supporting the Arduino Uno Rev3.0 form factor is to enable rapid hardware prototyping through leveraging the existing ecosystem of 3.3v Arduino Shields or the Arduino compatible prototyping shields. Software compatibility of any Arduino shield is not assumed and would be the responsibility of the developer to produce the appropriate code.

2.1.2 Internal Oscillator Trim Codes

Certain early build versions of the D2000 Development Platform used Intel® Quark™ Microcontroller D2000 devices that did not have the internal oscillator trim codes programmed into them. The effect of using an MCU with untrimmed silicon oscillators means the operating frequency of the oscillator is not precise. Effects can vary but are not limited to:

- System clock frequency may contain an offset.
- On Self clocked interfaces like UART, the issue can potentially cause unexpected characters on the terminal.
- On Interfaces with a clock the issue can potentially cause unexpected reduction or increase in bandwidth.

The D2000 Developer & Evaluation Kits affected by this issue have the following serial numbers:

Table 2 Kits Affected

| Description | MM# | Batch Code | Serial Number Range |
|----------------------|--------|-------------------------|-----------------------|
| D2000 Developer Kit | 948988 | CNHT605001 | 160500001 - 160501000 |
| D2000 Developer Kit | 948988 | CNHT615001 - CNHT615005 | 161501001 - 161505500 |
| D2000 Evaluation Kit | 951244 | CNHT615006 | 161505501 - 161506000 |



There are 3 options to resolve the issue of un-programmed trim codes:

1. If the solution design is not sensitive to the problem then there is nothing to do.
2. Use the external platform crystal on the development platform.
3. From Intel® QMSI version 1.1 onwards, trim codes are automatically set through a function in 'rom_startup.c'.

2.2 Handling the Development Board

Electrostatic Discharge (ESD) can damage electronic components. To prevent damage to any printed circuit boards (PCBs), it is important to handle them very carefully. To prevent the development board from bending, keep one hand under the centre of the board to support it when handling. The following measures are generally sufficient to protect your equipment from electric static discharge:

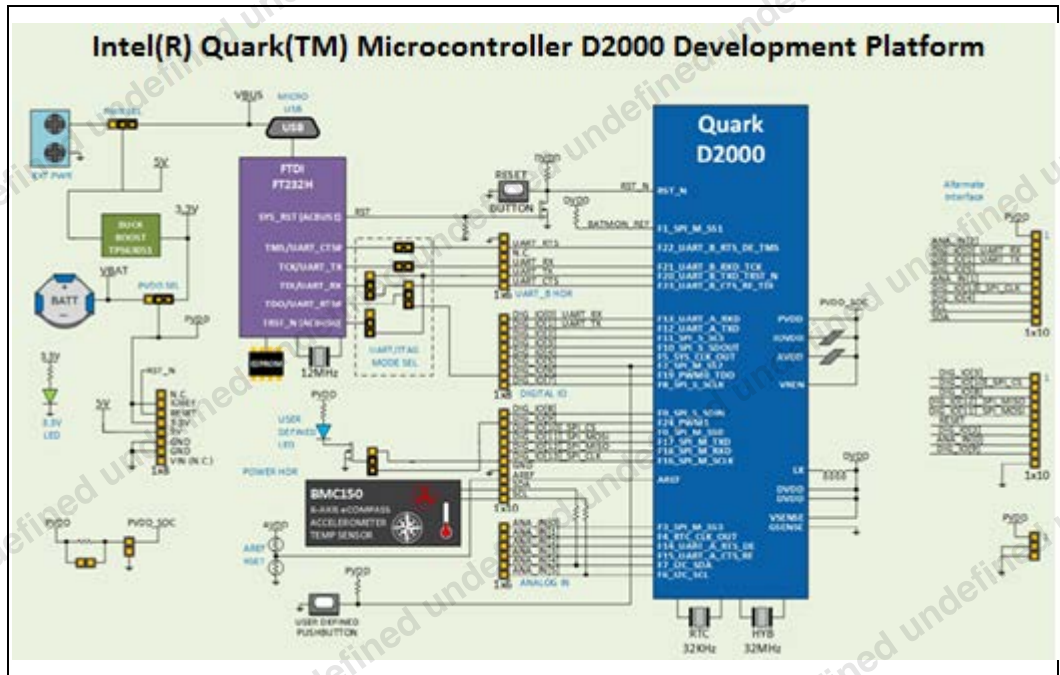
- Use a grounded wrist strap designed to prevent ESD.
- Touch a grounded metal object before removing boards from antistatic bags.
- Handle a board by its edges only; do not touch its components, peripheral chips, memory modules or gold contacts.
- When handling chips or modules, avoid touching their pins.
- Put the board, add-on cards and any peripherals back into their antistatic bags when not in use.

2.3 General Assumptions

This section covers the general Intel® Quark™ microcontroller D2000 module and development board system topology and interface connectivity assumptions.



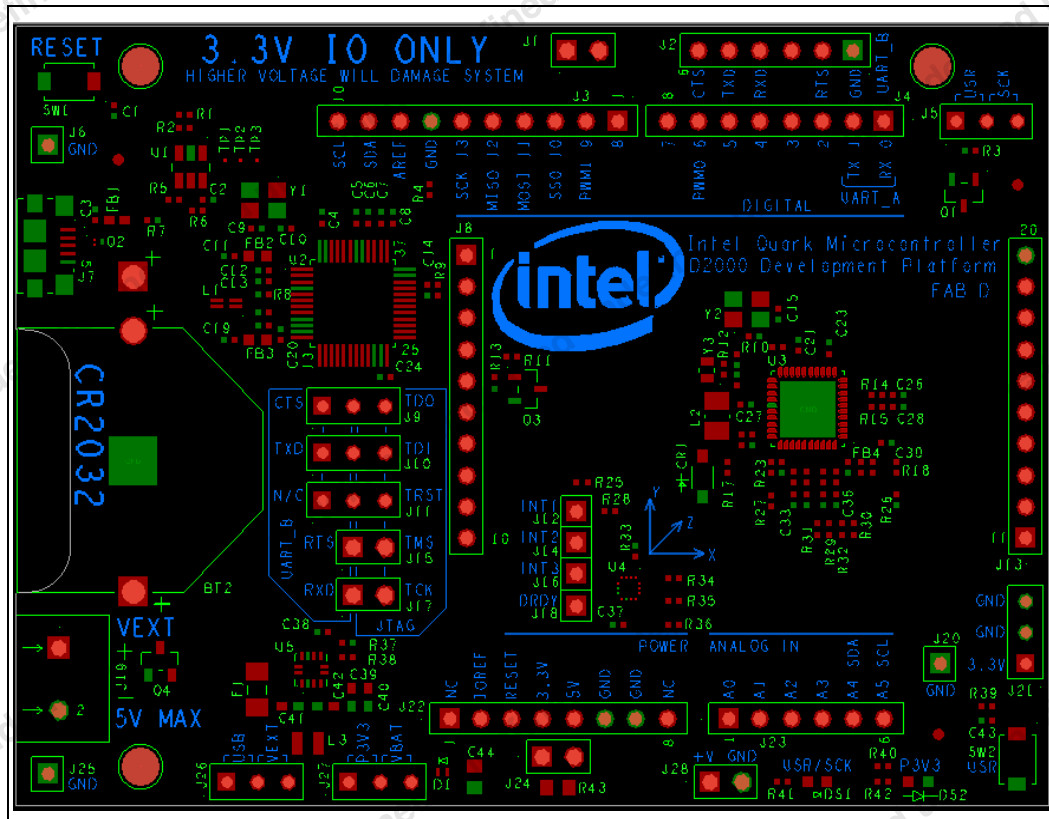
Figure 1. Block Diagram



2.4 Floor Plan

Figure 2 illustrates the development platform floor plan. The Development Platform PCB dimension is 3.3 x 2.25 inches.

Figure 2. PCB Floor Plan





2.5

Development Platform Pin Muxing

The Intel® Quark™ microcontroller D2000 provides flexibility for the platform design in configuring the functional I/Os to convey alternative functions or become GPIOs. The User Mode columns show the alternative microcontroller functions for each pin.

Table 3 presents the Intel® Quark™ Microcontroller D2000 Development Board PIN to Function mapping for this platform.

Table 3. Development Board Pin Mapping

| Arduino Pin No. | Arduino Pin Label | CRB Pin Usage | User Mode0 | User Mode1 | User Mode2 | Booster Pack Pin(s) |
|-----------------|-------------------|------------------------------|-------------|----------------|------------|----------------------------|
| J1_1 | | 3.3V | | | | |
| J1_2 | | Address Select Accel/Gyro | | | | |
| J2_1 | GND | GND | | | | J13_10, J21_2, J21_3 |
| J2_2 | RTS | USB port / Hdr | JTAG_TMS | GPIO_22 | UART_BRTS | |
| J2_3 | | NC | | | | |
| J2_4 | RXD | USB port / Hdr | JTAG_TCK | GPIO_21 | UART_BRXD | |
| J2_5 | TCD | USB port / Hdr | JTAG_TRST_N | GPIO_20 | UART_BTXD | |
| J2_6 | CTS | USB port / Hdr | JTAG_TDI | GPIO_23 | UART_BCTS | |
| J3_1 | 8 | DIO_8 | GPIO_9 | ADC / COMP9 | SPI_S_MOSI | J13_3 |
| J3_2 | 9 PWM1 | DIO_9 | GPIO_24 | LPD_SIG_OUTPUT | PWM1 | J13_9 |
| J3_3 | 10 SS0 | SPI_M_SS0 / DIO_10 | GPIO_0 | ADC / COMP0 | SPI_M_SS0 | J13_2 |
| J3_4 | 11 MOSI | SPI_M_MOSI / DIO_11 | GPIO_17 | ADC / COMP17 | SPI_M_MOSI | J13_5 |
| J3_5 | 12 MISO | SPI_M_MISO / DIO_12 | GPIO_18 | ADC / COMP18 | SPI_M_MISO | J13_4 |
| J3_6 | 13 SCK | SPI_M_SCLK / DIO_13 | GPIO_16 | ADC / COMP16 | SPI_M_SCLK | J8_7 |
| J3_7 | GND | GND | | | | |
| J3_8 | ARF | AREF | | | | |
| J3_9 | SDA | SDA / AIN_04 / DIO_18 | GPIO_7 | ADC / COMP7 | I2C_SDA | J8_10 |



| Arduino Pin No. | Arduino Pin Label | CRB Pin Usage | User Mode0 | User Mode1 | User Mode2 | Booster Pack Pin(s) |
|-----------------|-------------------|-----------------------|------------|--------------|------------------------|---------------------|
| J3_10 | SCL | SCL / AIN_05 / DIO_19 | GPIO_6 | ADC / COMP6 | I2C_SCL | J8_9 |
| J4_1 | 0 RX [UART_A] | UART_RXD / DIO_0 | GPIO_13 | ADC / COMP13 | UART_A_RXD | J8_3 |
| J4_2 | 1 TX [UART_A] | UART_TXD / DIO_1 | GPIO_12 | ADC / COMP12 | UART_A_TXD | J8_4 |
| J4_3 | 2 | DIO_2 | GPIO_11 | ADC / COMP11 | SPI_S_SCS | J13_7 |
| J4_4 | 3 | DIO_3 | GPIO_10 | ADC / COMP10 | SPI_S_MISO | J13_1 |
| J4_5 | 4 | DIO_4 | GPIO_5 | ADC / COMP5 | SYS_CLK_OUT | J8_8 |
| J4_6 | 5 | DIO_5 | GPIO_2 | ADC / COMP2 | SPI_M_SS2 | J8_5 |
| J4_7 | 6 PWM0 | USB port / DIO_6 | JTAG_TDO | GPIO_19 | PWM0 | |
| J4_8 | 7 | DIO_7 | GPIO_8 | ADC / COMP8 | SPI_S_SCLK | |
| J22_1 | NC | NC | | | | |
| J22_2 | IOREF | IOREF | | | | |
| J22_3 | RESET | RESET_N | RESET_N | | | J13_6 |
| J22_4 | 3.3V | 3.3V | | | | J8_1, J21_1 |
| J22_5 | 5V | 5V | | | | |
| J22_6 | GND | GND | | | | |
| J22_7 | GND | GND | | | | |
| J22_8 | NC | NC | | | | |
| J23_1 | A0 | AIN_0 | GPIO_3 | ADC / COMP3 | SPI_M_SS3 | J13_8 |
| J23_2 | A1 | AIN_1 | GPIO_4 | ADC / COMP4 | RTC_CLK_OUT | J8_6 |
| J23_3 | A2 | AIN_2 | GPIO_14 | ADC / COMP14 | UART_A_RTS / UART_A_DE | J8_2 |
| J23_4 | A3 | AIN_3 | GPIO_15 | ADC / COMP15 | UART_A_CTS / UART_A_RE | |
| J23_5 | A4 SDA | AIN_4 | | | | J8_9 |



| Arduino Pin No. | Arduino Pin Label | CRB Pin Usage | User Mode0 | User Mode1 | User Mode2 | Booster Pack Pin(s) |
|-----------------|-------------------|---------------|------------|------------|------------|---------------------|
| J23_6 | A5 SCL | AIN_5 | | | | J8_10 |



2.6 Development Platform Jumper Connections

This section describes the pin connection options for the various jumpers on the board.

2.6.1 J1 Jumper

Jumper J1 allows the I²C address to be modified; by default the jumper is not connected and the I²C address is 0x10 & 0x12. When the jumper is connected the I²C address is 0x11 & 0x13.

Table 4. J1 Jumper

| J1 | Pin 1 | Pin 2 | Description |
|---------------|-------|-------|---|
| Not connected | | | This is the default, I ² C address is 0x10 & 0x12. |
| Connected | ✓ | ✓ | I ² C address is 0x11 & 0x13. |

2.6.2 J5 Jumper

Jumper J5 allows the onboard LED to be controlled by either DIO_9 or DIO_13.

Table 5. J5 Jumper

| J5 | Pin 1 | Pin 2 | Pin 3 | Description |
|-----|-------|-------|-------|---|
| USR | ✓ | ✓ | | By selecting pins 1 & 2 on jumper J5, DIO_9 is used to control the LED. |
| SCK | | ✓ | ✓ | Selecting pins 2 & 3 on jumper J5 enables DIO_13 to control the LED. |

2.6.3 J24 Jumper

Jumper J24 is connected by default, and connects the SoC power supply. Removing this jumper connection allows external power supply to the SoC or access to measure the current being drawn by the SoC.

Table 6. J24 Jumper

| J24 | Pin 1 | Pin 2 | Description |
|---------------|-------|-------|--|
| Connected | ✓ | ✓ | SoC power supply connected, this is the default. |
| Not connected | | | SoC power supply disconnected. |



2.6.4 J26 Jumper

Jumper J26 allows the external power source to be set to either USB or external DC input.

Table 7. J26 Jumper

| J26 | Pin 1 | Pin 2 | Pin 3 | Description |
|-------|-------|-------|-------|--|
| USB | ✓ | ✓ | | External power taken from connected USB host device 5V, this is the default. |
| VSEXT | | ✓ | ✓ | External power from connected DC source 2.5V – 5V. |

2.6.5 J27 Jumper

Jumper J27 allows the internal regulator to be activated when an external power source is used (J26 jumper). The regulator will maintain a steady flow of 3.3V to the platform. If an external power source is being used then pins 1 and 2 on this jumper should be connected, if on board coin cell battery source is being used then pins 2 and 3 on this jumper should be connected.

Table 8. J27 Jumper

| J27 | Pin 1 | Pin 2 | Pin 3 | Description |
|-----|-------|-------|-------|--|
| 3V3 | ✓ | ✓ | | Internal regulator activated to maintain steady flow of power from external power source (USB or external DC input). |
| BAT | | ✓ | ✓ | Connected when power is provided via the on board coin cell battery. |