MCP2221

USB 2.0 to I²C™/UART Protocol Converter with GPIO

Features:

Universal Serial Bus (USB)

- Supports Full-Speed USB (12 Mb/s)
- Implements USB Protocol Composite Device:
  - Communication Device Class (CDC) for USB-to-UART Conversion
  - Human Interface Device (HID) for I²C™ Device Control and Configuration
- 128-byte Buffer to Handle Data Throughput at Any Supported UART Baud Rate:
  - 64-Byte Transmit
  - 64-Byte Receive
- Human Interface Device (HID) for Both I²C Communication and Control:
  - 64-byte Buffer to Handle Data Throughput at Any I²C Baud Rate
- Fully-Configurable VID and PID Assignments and String Descriptors
- Bus-powered or Self-powered
- USB 2.0-Compliant: TID# 40001594

USB Driver and Software Support

- Enumerates as a Composite USB Device (CDC and HID) Using Standard Drivers for Virtual Com Port (VCP) on the Following Windows® Operating Systems: XP® (SP3), Vista®, 7, 8 and 8.1
- Configuration Utility for Establishing a Custom Boot-up Configuration
- I²C/SMBus Terminal
- Windows DLL

CDC and Universal Asynchronous Receiver/Transmitter (UART) Options

- Communications Device Class (CDC) for the USB-to-UART Option
- Responds to `SET LINE CODING` Commands to Dynamically Change Baud Rates
- Supports Baud Rates: 300-115200
- UART Tx and Rx Pins Only
- Serial Number Used During the CDC Enumeration Can Be Enabled By Using the Microchip-provided Configuration Utility or By Calling the Proper API From the Support Libraries for this Device

I²C/SMBus

- The Device Runs as an I²C Master. The Data to Write/Read On the I²C Bus is Conveyed By the USB Interface.
- I²C Master
  - Up to 400 kHz Clock Rate
  - Supports 7- or 10-bit Addressable Devices; 10-bit Addressable Devices are Supported Through the PC Host Library
  - Supports Block Reads/Writes of Up to 65,535 Bytes Long
- SMBus Master
  - Supports All of the SMBus Transfers
  - SMBus Functionality is Achieved Through a Combination of Chip and Support Library Processing
  - Up to 400 kHz Clock Rate

General-Purpose Input/Output (GPIO) Pins

- Four General-Purpose Input/Output Pins
- All GP Pins Can Be Assigned to Other Functionalities

Other Functionalities

- UART Activity LED Outputs (UTx and URx)
- SSPND Output Pin
- USBCFG Output Pin (Indicates When the Enumeration Has Completed)
- Three ADC Inputs
- One DAC with Two Possible Output Options
- Clock Reference Output: 12 MHz or Other Configurable Values
- External Interrupt Edge Detection

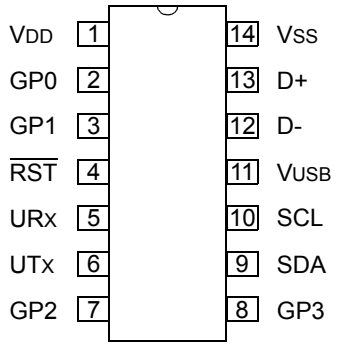
Other

- Operating Voltage: 3.0 to 5.5V
- Electrostatic Discharge (ESD) Protection: > 4 kV Human Body Model (HBM)
- Industrial (I) Operating Temperature: -40°C to +85°C

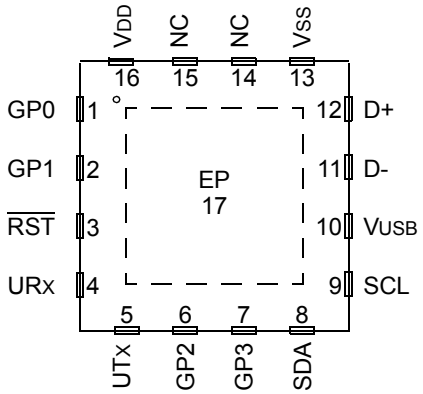
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Package Types

MCP2221
PDIP/SOIC/TSSOP

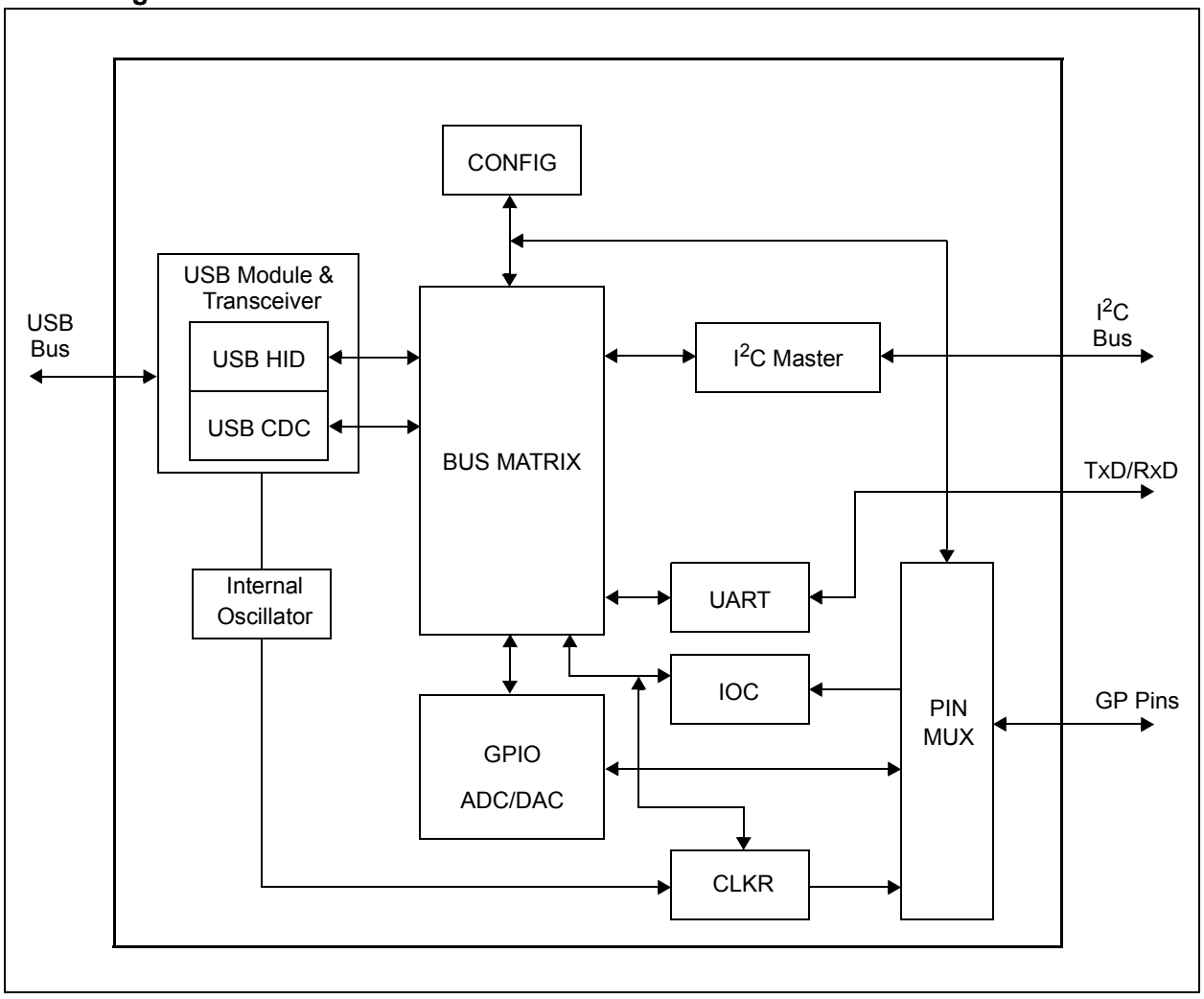


MCP2221
4 x 4 QFN*



* Includes Exposed Thermal Pad (EP); see Table 1-1.

Block Diagram



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1.0 FUNCTIONAL DESCRIPTION

The MCP2221 is a USB-to-UART serial converter that enables USB connectivity in applications that have UART and/or I^2C interfaces. The device reduces external components by integrating the USB termination resistors and the oscillator needed for USB operation.

The MCP2221 has four GP pins for miscellaneous functionalities (including GPIO, USBCFG, SSPND, Clock Output, ADC, DAC and interrupt detector).

See Table 1-1 and **Section 1.7 "Pin Mux Module"** for details about the pin functions.

TABLE 1-1: PINOUT DESCRIPTION

Pin Name	PDIP, SOIC, SSOP	QFN	Pin Type	Standard Function	Alternate Functions	
GP0	2	1	I/O	General-purpose I/O or alternate function pin	SSPND (OUT) LED_URX (OUT)	Signals when the host has entered Suspend mode UART RX LED activity output (factory default)
GP1	3	2	I/O	General-purpose I/O or alternate function pin	CLKR (OUT) ADC1 (IN) LED_UTX (OUT) IOC (IN)	Clock Reference Output ADC Channel 1 UART TX Led activity output (factory default) External interrupt edge detector
$\overline{RST}$	4	3	I	Reset input (with internal pull-up)	N/A	
URX	5	4	I	UART RX pin (input)	N/A	
UTX	6	5	O	UART TX pin (output)	N/A	
GP2	7	6	I/O	General-purpose I/O or alternate function pin	USBCFG (OUT) ADC2 (IN) DAC1 (OUT)	USB device configured status (factory default) ADC Channel 2 DAC Output 1
GP3	8	7	I/O	General-purpose I/O or alternate function pin	LED_I2C (OUT) ADC3 (IN) DAC2 (OUT)	USB-I^2C traffic indicator (factory default) ADC Channel 3 DAC Output 2
SDA	9	8	I/O	I^2C Data line	N/A	
SCL	10	9	I/O	I^2C Clock line	N/A	
VUSB	11	10	USB	USB Power pin (internally connected to 3.3V) Should be locally bypassed with a high-quality ceramic capacitor		
D-	12	11	USB	USB D-		
D+	13	12	USB	USB D+		
VSS	14	13	P	Ground		
NC	—	14 15	—	Not Connected		
VDD	1	16	P	Power		
EP	—	17	—	Exposed Thermal Pad (EP) Do not electrically connect.		

1.1 Supported Operating Systems

The following operating systems are supported:

- Windows – XP (SP3), Vista, 7, 8 and 8.1
- Linux® – any distribution with support for CDC and HID classes
- Mac OS® – all versions – beginning with 10.7

1.1.1 ENUMERATION

The MCP2221 enumerates as a composite USB device after POR. The device enumerates as both a Human Interface Device (HID) for I²C, GPIO control, and as CDC for the USB-to-UART converter.

1.1.1.1 USB HID

The MCP2221 enumerates as an HID, so the device can be configured, while the I²C and GPIO can be controlled. A DLL package, with example applications and tools, is supplied by Microchip on the device web page, on the Microchip web site www.microchip.com.

1.1.1.2 USB CDC

The CDC enumeration implements the USB-to-UART data translation.

1.2 Bus-Matrix Module

The Bus-Matrix module is the heart of the MCP2221. All other modules are tied together and controlled via the Bus-Matrix module. This module manages the data transfers between the USB and the UART, the I²C Master module, as well as the command requests generated by the USB host controller and commands for controlling the function of the UART, GPIO, ADC, DAC and Clock Output.

1.2.1 UART

The control module interfaces to the UART and USB modules.

1.2.2 ACCESSING THE DEVICE

The MCP2221 can be accessed for reading and writing via USB host commands. The device cannot be accessed or controlled via the UART interface.

1.3 UART Interface

The MCP2221 UART interface consists of the Tx and Rx data signals.

The UART is configurable for several baud rates. The available baud rates are listed in Table 1-2.

1.3.1 GET/SET LINE CODING

The `GET_LINE_CODING` and `SET_LINE_CODING` commands are used to read and set the UART parameters while in operation. For example, terminal applications (e.g., Putty, RealTerm, Hyperterminal, etc.) send the `SET_LINE_COMMAND` when connecting to the port. The MCP2221 responds by setting the baud rate only.

The other parameters (Data Bits, Parity, Stop Bits) remain unchanged.

Note: MCP2221 supports only eight Data bits, no Parity, and one Stop bit.

1.3.1.1 Rounding Errors

Primary baud rate settings (with associated rounding errors) are shown in Table 1-2.

If baud rates other than the ones shown in the table are used, the error percentage can be calculated using Equation 1-1 to find the actual baud rate.

TABLE 1-2: UART PRIMARY BAUD RATES

Desired Rate	Actual rate	% Error
300	300	0.00%
1200	1200	0.00%
2400	2400	0.00%
4800	4800	0.00%
9600	9600	0.00%
19200	19200	0.00%
38400	38339	0.16%
57600	57692	0.16%
115200	115385	0.16%

EQUATION 1-1: SOLVING FOR ACTUAL BAUD RATE

$$ActualRate = \frac{12MHz}{int(x)}$$

Where:

$$x = \frac{12MHz}{DesiredBaud}$$

1.3.2 CUSTOM BAUD RATES

Custom baud rates are configured by sending the `SET_LINE_CODING` USB command. See **Section 2.0 "USB Enumeration Process"** for more information.

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1.4 Device Configuration

The MCP2221 keeps all the essential device configuration settings stored in Flash memory.

Device configuration settings affect the way the MCP2221 behaves at run time.

The settings are stored into the Flash memory on the device. Some of the settings are also copied into SRAM at Power-Up/Reset.

These device configuration settings reside in the following two distinct areas of Flash memory:

- **Chip Settings**

  The Chip Settings area stores the key MCP2221 parameters – USB parameters, ADC/DAC reference voltage choice, start-up DAC value, Clock Reference output (CLKR) frequency and duty cycle values.

- **GP Settings**

  The GP Settings area stores the GP designation settings. For GP settings that are assigned to GPIO output operation, output values (logic 1 or 0) are also specified.

Even though the MCP2221 places a partial copy of the Chip Settings in SRAM, the following Chip Settings always reside in Flash:

- USB Manufacturer/Product and Serial Number descriptors
- USB VID and PID pair
- USB options (e.g., the requested amount of current that is presented to the USB host during the USB enumeration process)

1.4.1 POWER-UP/RESET DEVICE CONFIGURATION BEHAVIOR

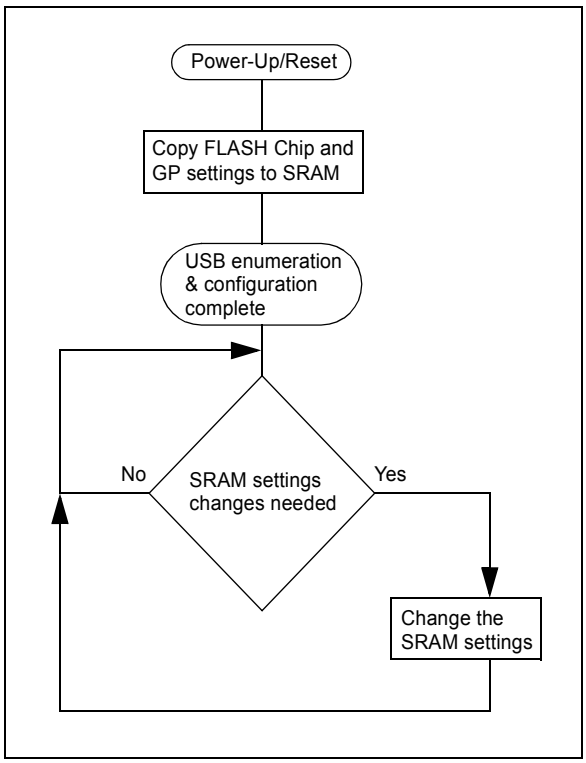
At Power-Up/Reset, the MCP2221 configures the device options (GP designation, special function pins parameters and USB enumeration options) according to the Flash settings. Then, the Flash Chip Settings and GP Settings are loaded into SRAM to allow for their temporary modification at run time.

Chip Settings of the Device Configuration Flash is copied partially into SRAM. Only the run-time-modifiable parameters are copied into SRAM.

GP Settings of the Device Configuration Flash (GP settings area) are copied entirely into the SRAM. By copying the GP settings completely into SRAM, the user is allowed to completely change the GP designation at run time.

The SRAM copy of the settings can be altered at run time in order to change certain device behavior, e.g., GP designation (the GPs can be re-assigned for a different type of operation than the one assigned at Power-Up) and special parameters (DAC value, ADC/DAC voltage references, Clock output value).

FIGURE 1-1: CHIP SETTINGS RUN TIME MANAGEMENT



The SRAM settings (GP and partial Chip Settings) can be modified through USB HID commands and they will have an effect on the following device features:

- GP pin designation (switch between GPIO, dedicated or special functions modes)
- GPIO direction and output value (only for GPIO outputs) – for the GPs assigned to work in GPIO mode
- Clock Output duty cycle and value – if GP1 is assigned for CLKR mode (Clock Reference output mode), by modifying the SRAM settings, the clock frequency and duty cycle can be changed at run time
- DAC value and voltage reference used – the DAC value setting as well as the voltage reference used for it are stored in SRAM settings and they can be changed at run time. Through this mechanism, at run time the user can change the DAC value, as well as the voltage reference.
- ADC voltage reference value – the voltage reference used for ADC conversions can be changed by altering its corresponding SRAM setting
- Interrupt-On-Change (IOC) detector settings – if GP1 is assigned for IOC mode, the SRAM settings are used for setting up the triggers used for external interrupt detection (positive, negative edge detection or both)

1.4.2 CHIP SETTINGS MAP

The Chip Settings area resides in Flash memory and is copied into SRAM at run time. Not all of the device's settings can be altered at run time. All the fields in the Flash settings can be altered by the user.

TABLE 1-3: CHIP SETTINGS MAP

Byte Index	Register Name	Comments
0	CHIPSETTING0	Controls the USB CDC serial number enumeration, default state for the GP LED designation, default state for GP dedicated-function pins and chip settings protection level
1	CHIPSETTING1	Default clock output divider and duty cycle
2	CHIPSETTING2	DAC reference options and default DAC value
3	CHIPSETTING3	ADC reference and interrupt detection settings
4	USBVIDL	USB VID lower byte
5	USBVIDH	USB VID higher byte
6	USBPIDL	USB PID lower value
7	USBPIDH	USB PID higher byte
8	USBPWRATTR	USB power attributes
9	USBREQCRT	USB required current
10	PASS0	Password byte 0
11	PASS1	Password byte 1
12	PASS2	Password byte 2
13	PASS3	Password byte 3
14	PASS4	Password byte 4
15	PASS5	Password byte 5
16	PASS6	Password byte 6
17	PASS7	Password byte 7

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REGISTER 1-1: CHIPSETTING0 REGISTER

R/W-0	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-0	R/W-0
CDCSNEN	LEDURXINST	LEDUTXINST	LEDI2CINST	SSPNDINST	USBCFGINST	CHIPPROT1	CHIPPROT0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 7 **CDCSNEN:** USB CDC Serial Number Enable
- 1 = USB CDC Serial Number is enumerated
- 0 = No USB CDC Serial Number enumeration (factory default)

bit 6 **LEDURXINST:** LED UART Rx Inactive State
- 1 = LED UART Rx is inactive high and active low (factory default)
- 0 = LED UART Rx is inactive low and active high

bit 5 **LEDUTXINST:** LED UART Tx Inactive State
- 1 = LED UART Tx is inactive high and active low (factory default)
- 0 = LED UART Tx is inactive low and active high

bit 4 **LEDI2CINST:** LED I^2C Inactive State
- 1 = LED I^2C is inactive high and active low (factory default)
- 0 = LED I^2C is inactive low and active high

bit 3 **SSPNDINST:** SSPND Inactive State
- 1 = SSPND is inactive high and active low (factory default)
- 0 = SSPND is inactive low and active high

bit 2 **USBCFGINST:** USBCFG Inactive State
- 1 = USBCFG is inactive high and active low (factory default)
- 0 = USBCFG is inactive low and active high

bit 1-0 **CHIPPROT<1:0>:** Chip Settings Protection Level
- 11 = Reserved
- 10 = Permanently locked
- 01 = Password protection
- 00 = Chip settings unprotected (factory default)

REGISTER 1-2: CHIPSETTING1 REGISTER

R/W-0	R/W-0	R/W-0	R/W-1	R/W-0	R/W-0	R/W-1	R/W-0
—	—	—	CLKDC1	CLKDC0	CLKDIV2	CLKDIV1	CLKDIV0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 7-5 **Reserved:** Set to '0'

bit 4-3 **CLKDC<1:0>:** Clock-Out Duty-Cycle

11 = Duty cycle 75% (75% of 1 clock period is logic '1' and 25% of 1 clock period is logic '0')
10 = Duty cycle 50% (50% of 1 clock period is logic '1' and 50% of 1 clock period is logic '0') (factory default)
01 = Duty cycle 25% (25% of 1 clock period is logic '1' and 75% of 1 clock period is logic '0')
00 = Duty cycle 0% (100% of 1 clock period is logic '0')

bit 2-0 **CLKDIV<2:0>:** Clock-Out Divider Output

111 = 375 kHz clock output
110 = 750 kHz clock output
101 = 1.5 MHz clock output
100 = 3 MHz clock output
011 = 6 MHz clock output
010 = 12 MHz clock output (factory default)
001 = 24 MHz clock output
000 = Reserved

REGISTER 1-3: CHIPSETTING2 REGISTER

R/W-1	R/W-0	R/W-0	R/W-0	R/W-1	R/W-0	R/W-0	R/W-0
DACVRM1	DACVRM0	DACREF	DACVAL4	DACVAL3	DACVAL2	DACVAL1	DACVAL0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 7-6 **DACVRM<1:0>:** DAC Internal Voltage Reference (DAC VRM) Selection

11 = VRM voltage is 4.096V (only if V_{DD} is above this voltage)
10 = VRM voltage is 2.048V (factory default)
01 = VRM voltage is 1.024V
00 = VRM is off

bit 5 **DACREF:** DAC Reference Output Selection

1 = DAC reference output is DAC VRM voltage selection
0 = DAC reference output is V_{DD} (factory default)

bit 4-0 **DACVAL<4:0>:** Initial DAC Output Value

5-bit value for the DAC output (factory default is 8 decimal)

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REGISTER 1-4: CHIPSETTING3 REGISTER

R/W-0	R/W-1	R/W-1	R/W-0	R/W-1	R/W-1	R/W-0	R/W-0
—	INTDETFEEN	INTDETREEN	ADCVRM1	ADCVRM0	ADCREF	—	—
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 7 **Reserved:** Set to '0'

bit 6 **INTDETFEEN:** Interrupt Falling Edge Detect Enable
1 = Interrupt detector will trigger when a falling edge is detected (factory default)
0 = Falling edges will not trigger the detector

bit 5 **INTDETREEN:** Interrupt Rising Edge Detect Enable
1 = Interrupt detector will trigger when a rising edge is detected (factory default)
0 = Rising edges will not trigger the detector

bit 4-3 **ADCVRM<1:0>:** ADC Internal Voltage Reference (ADC VRM) Selection
11 = VRM voltage is 4.096V (only if V_{DD} is above this voltage)
10 = VRM voltage is 2.048V
01 = VRM voltage is 1.024V (factory default)
00 = VRM is off

bit 2 **ADCREF:** ADC Reference Output Selection
1 = ADC reference output is ADC VRM voltage selection (factory default)
0 = ADC reference output is V_{DD}

bit 1-0 **Reserved:** Set to '0'

REGISTER 1-5: USBVIDL REGISTER

R/W-1	R/W-1	R/W-0	R/W-1	R/W-1	R/W-0	R/W-0	R/W-0
USBVIDL7	USBVIDL6	USBVIDL5	USBVIDL4	USBVIDL3	USBVIDL2	USBVIDL1	USBVIDL0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 7-0 **USBVIDL<7:0>:** USB VID Lower Byte (factory default: 0xD8(hex))

REGISTER 1-6: USBVIDH REGISTER

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-1	R/W-0	R/W-0
USBVIDH7	USBVIDH6	USBVIDH5	USBVIDH4	USBVIDH3	USBVIDH2	USBVIDH1	USBVIDH0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 7-0 **USBVIDH<7:0>:** USB VID Higher Byte (factory default: 0x04(hex))

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REGISTER 1-7: USBPIDL REGISTER

R/W-1	R/W-1	R/W-0	R/W-1	R/W-1	R/W-1	R/W-0	R/W-1
USBPIDL7	USBPIDL6	USBPIDL5	USBPIDL4	USBPIDL3	USBPIDL2	USBPIDL1	USBPIDL0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 7-0 **USBPIDL<7:0>:** USB PID Lower Byte (factory default: 0xDD(hex))

REGISTER 1-8: USBPIDH REGISTER

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
USBPIDH7	USBPIDH6	USBPIDH5	USBPIDH4	USBPIDH3	USBPIDH2	USBPIDH1	USBPIDH0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 7-0 **USBPIDH<7:0>:** USB PID Higher Byte (factory default: 0x00(hex))

REGISTER 1-9: USBPWRATTR REGISTER

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	SELFPWR	REMWKUP	—	—	—	—	—
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 7 **Reserved:** Reserved – set to '1' (factory default)

bit 6 **SELFPWR:** USB Self-Powered Attribute
- 1 = Chip will enumerate on the USB bus as being self-powered
- 0 = Chip will enumerate on the USB bus as being USB-bus powered (factory default)

bit 5 **REMWKUP:** USB Remote Wake-Up Capability
- 1 = Chip will enumerate on the USB bus as being able to wake up the USB host
- 0 = Chip will enumerate as not being capable of remote wake-up of the USB host (factory default)

bit 4-0 **Reserved:** Set all bits to '0' (factory default)

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REGISTER 1-10: USBREQCRT REGISTER

R/W-0	R/W-0	R/W-1	R/W-1	R/W-0	R/W-0	R/W-1	R/W-0
USBREQCRT7	USBREQCRT6	USBREQCRT5	USBREQCRT4	USBREQCRT3	USBREQCRT2	USBREQCRT1	USBREQCRT0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 7-0 **USBREQCRT<7:0>:** USB Bus-Powered Required Current Amount (in units of 2 mA)
Factory default is 50 (decimal); the USB enumeration interprets this value as a current requirement of 100 mA.

REGISTER 1-11: PASS0 – PASS7 REGISTER

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
PASSx7	PASSx6	PASSx5	PASSx4	PASSx3	PASSx2	PASSx1	PASSx0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 7-0 **PASSx<7:0>:** Password Byte X Value (factory default is 0)

1.4.3 GP SETTINGS MAP

The GP Settings area resides in Flash memory and is copied into SRAM at run time. The user can alter both the Flash and the SRAM GP settings. Any modification in the SRAM copy of the GP settings will have an immediate effect. The GP pins designation changes according to the new content of the SRAM settings. The Flash variant of the settings will affect the Power-Up behavior of the GP pins.

TABLE 1-4: GP SETTINGS MAP

Byte Index	Register Name	Comments
0	GPSETTING0	GP0 pin designation and GPIO default output value, when GP is set for GPIO output operation
1	GPSETTING1	GP1 pin designation and GPIO default output value, when GP is set for GPIO output operation
2	GPSETTING2	GP2 pin designation and GPIO default output value, when GP is set for GPIO output operation
3	GPSETTING3	GP3 pin designation and GPIO default output value, when GP is set for GPIO output operation

REGISTER 1-12: GPSETTING0 REGISTER

R/W-0	R/W-0	R/W-0	R/W-1	R/W-0	R/W-0	R/W-1	R/W-0
—	—	—	GPIOOUTVAL	GPIODIR	GPDES2	GPDES1	GPDES0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as ‘0’	
-n = Value at POR	‘1’ = Bit is set	‘0’ = Bit is cleared	x = Bit is unknown

bit 7-5 **Reserved:** Set to ‘0’

bit 4 **GPIOOUTVAL:** GPIO Output Value (valid only when GP0 is set for GPIO output operation)
1 = Default output value is logic ‘1’ (factory default)
0 = Default output value is logic ‘0’

bit 3 **GPIODIR:** GPIO Direction (input or output; valid only when GP0 is set for GPIO operation)
1 = GPIO Input
0 = GPIO Output (factory default)

bit 2-0 **GPDES<2:0>:** GP0 Designation
111 = Reserved
110 = Reserved
101 = Reserved
100 = Reserved
011 = Reserved
010 = Alternate function 0 (LED UART Rx – LEDURX) (factory default)
001 = Dedicated function operation (SSPND)
000 = GPIO operation (GPIO0)

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REGISTER 1-13: GPSETTING1 REGISTER

R/W-0	R/W-0	R/W-0	R/W-1	R/W-0	R/W-0	R/W-1	R/W-1
—	—	—	GPIOOUTVAL	GPIODIR	GPDES2	GPDES1	GPDES0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 7-5 **Reserved:** Set to '0'

bit 4 **GPIOOUTVAL:** GPIO Output Value (valid only when GP1 is set for GPIO output operation)
1 = Default output value is logic '1' (factory default)
0 = Default output value is logic '0'

bit 3 **GPIODIR:** GPIO Direction (input or output; valid only when GP1 is set for GPIO operation)
1 = GPIO Input
0 = GPIO Output (factory default)

bit 2-0 **GPDES<2:0>:** GP1 Designation
111 = Reserved
110 = Reserved
101 = Reserved
100 = Alternate function 2 (Interrupt detector)
011 = Alternate function 1 (LED UART Tx – LEDUTX) (factory default)
010 = Alternate function 0 (ADC1)
001 = Dedicated function operation (Clock Output)
000 = GPIO operation (GPIO1)

REGISTER 1-14: GPSETTING2 REGISTER

R/W-0	R/W-0	R/W-0	R/W-1	R/W-0	R/W-0	R/W-0	R/W-1
—	—	—	GPIOOUTVAL	GPIODIR	GPDES2	GPDES1	GPDES0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 7-5 **Reserved:** Set to '0'

bit 4 **GPIOOUTVAL:** GPIO Output Value (valid only when GP2 is set for GPIO output operation)
1 = Default output value is logic '1' (factory default)
0 = Default output value is logic '0'

bit 3 **GPIODIR:** GPIO Direction (input or output; valid only when GP2 is set for GPIO operation)
1 = GPIO Input
0 = GPIO Output (factory default)

bit 2-0 **GPDES<2:0>:** GP2 Designation
111 = Reserved
110 = Reserved
101 = Reserved
100 = Reserved
011 = Alternate function 1 (DAC1)
010 = Alternate function 0 (ADC2)
001 = Dedicated function operation (USBCFG) (factory default)
000 = GPIO operation (GPIO2)

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REGISTER 1-15: GPSETTING3 REGISTER

R/W-0	R/W-0	R/W-0	R/W-1	R/W-0	R/W-0	R/W-0	R/W-1
—	—	—	GPIOOUTVAL	GPIODIR	GPDES2	GPDES1	GPDES0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 7-5 **Reserved:** Set to '0'

bit 4 **GPIOOUTVAL:** GPIO Output Value (valid only when GP3 is set for GPIO output operation)
1 = Default output value is logic '1' (factory default)
0 = Default output value is logic '0'

bit 3 **GPIODIR:** GPIO Direction (input or output; valid only when GP3 is set for GPIO operation)
1 = GPIO Input
0 = GPIO Output (factory default)

bit 2-0 **GPDES<2:0>:** GP3 Designation
111 = Reserved
110 = Reserved
101 = Reserved
100 = Reserved
011 = Alternate function 1 (DAC2)
010 = Alternate function 0 (ADC3)
001 = Dedicated function operation (LEDI2C) (factory default)
000 = GPIO operation (GPIO3)

1.5 USB Module (HID, CDC and Transceiver Modules)

The USB HID and CDC modules in the MCP2221 are full-speed USB 2.0-compliant.

- Composite device (CDC + HID):
  - CDC: USB-to-UART Communications
  - HID: I^2C Transactions, GPIO Control, Configuration and Miscellaneous Operations (ADC, DAC, Clock Output)
- 128-byte buffer to handle data throughput at any UART Baud Rate:
  - 64-Byte Transmit
  - 64-Byte Receive
- Fully Configurable VID and PID Assignments and Descriptors (stored on-chip)
- Bus-Powered or Self-Powered

1.5.1 DESCRIPTORS

During configuration, the supplied PC interface stores the descriptors in the MCP2221.

1.5.2 SUSPEND AND RESUME

The USB Suspend and Resume signals are supported for power management of the MCP2221. The device enters Suspend mode when “Suspend Signaling” is detected on the bus.

The MCP2221 exits Suspend mode when any of the following events occur:

- “Resume Signaling” is detected or generated
- A USB “Reset” signal is detected
- A device Reset occurs

1.6 USB Transceiver

The MCP2221 has a built-in USB 2.0 full-speed transceiver internally connected to the USB module.

The USB transceiver obtains power from the VUSB pin, which is internally connected to the 3.3V regulator. The best electrical signal quality is obtained when VUSB is locally bypassed with a high-quality ceramic capacitor.

1.6.1 INTERNAL PULL-UP RESISTORS

The MCP2221 devices have built-in pull-up resistors designed to meet the requirements for full-speed USB.

1.6.2 MCP2221 POWER OPTIONS

The following are the main power options for the MCP2221:

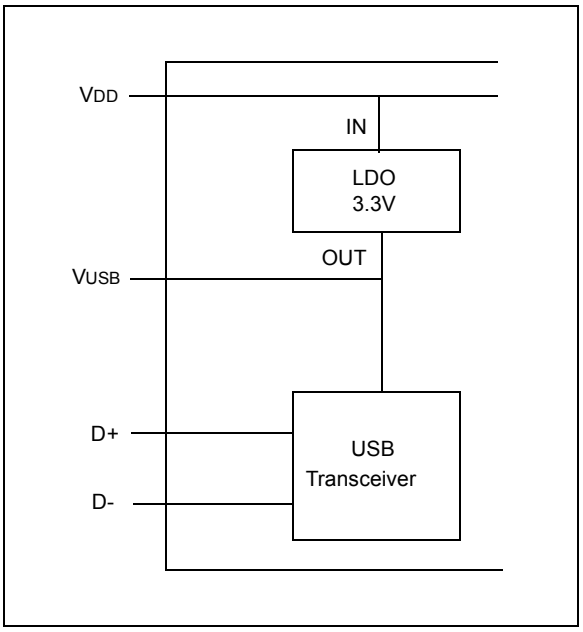
- USB Bus-Powered (5V)
- 3.3V Self-Powered

1.6.2.1 Internal Power Supply Details

MCP2221 offers various options for power supply. To meet the required USB signaling levels, the MCP2221 incorporates an internal LDO that is used solely by the USB transceiver to present the correct D+/D- voltage levels.

Figure 1-2 shows the internal connections of the USB transceiver LDO in relation to the VDD power supply rail. The output of the USB transceiver LDO is tied to the VUSB line. A capacitor connected to the VUSB pin is required if the USB transceiver LDO provides the 3.3V supply to the transceiver.

FIGURE 1-2: MCP2221 INTERNAL POWER SUPPLY DETAILS



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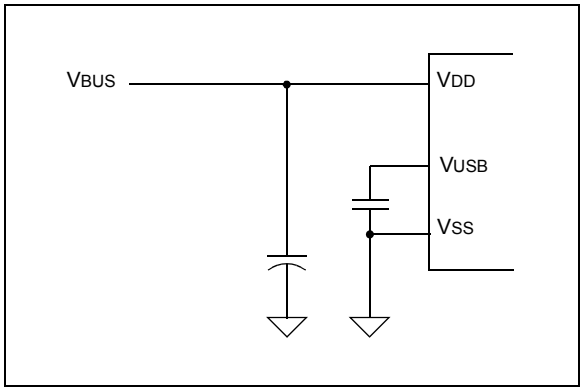
The provided VDD voltage has a direct influence on the voltage levels present on the GPIO and UART TX/RX pins. When VDD is 5V, all of these pins will have a logical '1' around 5V with the variations specified in **Section 4.1 "DC Characteristics"**.

For applications that require a 3.3V logical '1' level, VDD must be connected to a power supply providing the 3.3V voltage. In this case, the internal USB transceiver LDO cannot provide the required 3.3V power. It is necessary to also connect the VUSB pin of the MCP2221 to the 3.3V power supply rail. This way, the USB transceiver is powered up directly from the 3.3V power supply.

1.6.2.2 USB Bus-Powered (5V)

In Bus Power Only mode, all power for the application is drawn from the USB (Figure 1-3). This is effectively the simplest power method for the device.

FIGURE 1-3: BUS POWER ONLY



In order to meet the inrush current requirements of the USB 2.0 specifications, the total effective capacitance appearing across VBUS and ground must be no more than 10 µF. If it is more than 10 µF, some kind of inrush limiting is required. For more details on Inrush Current Limiting, search for that subject in the latest "*Universal Serial Bus Specification*".

According to the USB 2.0 specification, all USB devices must also support a Low-Power Suspend mode. In the USB Suspend mode, devices must consume no more than 500 µA (or 2.5 mA for high-powered devices that are remote wake-up capable) from the 5V VBUS line of the USB cable.

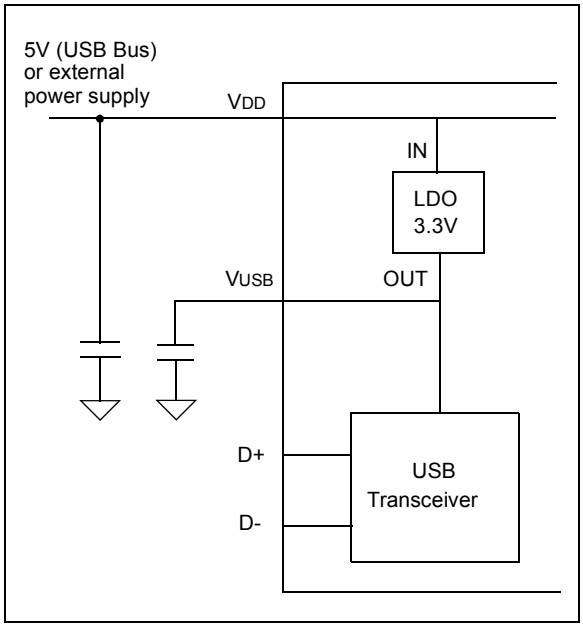
The host signals the USB device to enter Suspend mode by stopping all USB traffic to that device for more than 3 ms.

The USB bus provides a 5V voltage. However, the USB transceiver requires 3.3V for the signaling (on D+ and D- lines).

During USB Suspend mode, the D+ or D- pull-up resistor must remain active, which will consume some of the allowed suspend current budget (500 µA/2.5 mA). The VUSB pin requires an external bypass capacitor with a value between 0.22 and 0.47 µF (ceramic cap).

Figure 1-4 shows a circuit where MCP2221's internal LDO is used to provide 3.3V to the USB transceiver. The voltage on the VDD affects the voltage levels onto the UART and GPIO pins. With VDD at 5V, these pins will have a logic '1' of 5V with the variations specified in **Section 4.1 "DC Characteristics"**.

FIGURE 1-4: TYPICAL POWER SUPPLY OPTION USING THE 5V PROVIDED BY THE USB



1.6.2.3 3.3V Self-Powered

Typically, many embedded applications are using 3.3V power supplies. When such option is available in the target system, MCP2221 can be powered up from the existing 3.3V power supply rail. The typical connections for MCP2221 are shown in Figure 1-5.

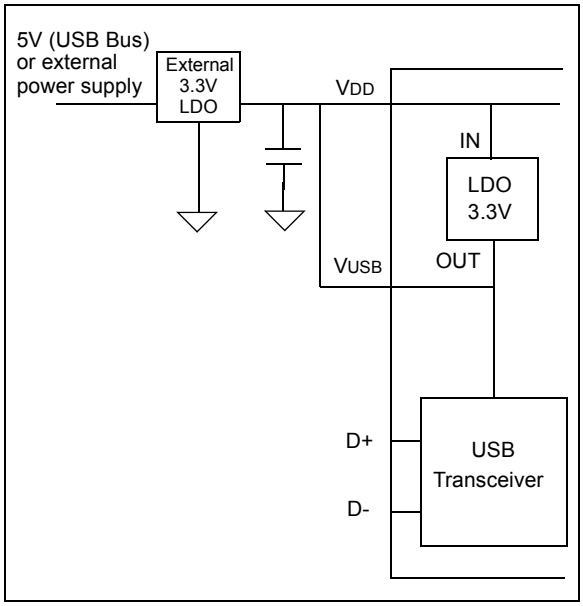
In this example, MCP2221 has both VDD and VUSB lines tied to the 3.3V rail. These tied connections disable the internal USB transceiver LDO of the MCP2221 to regulate the power supply on the VUSB pin. Another consequence is that the '1' logical level on the GPIO pins will be at the 3.3V level, in accordance with the variations specified in **Section 4.1 "DC Characteristics"**.

1.6.2.4 Remote Wake-Up Capability

The MCP2221 offers a mechanism for triggering a remote wake-up event for the USB host. The remote wake-up trigger works only with the external interrupt detector.

In order to use this capability, GP1 must be designated for interrupt detection operation. Before the USB host goes into Sleep/Standby, the interrupt detector must be set up for detecting positive edges, negative edges or both; also, the detector flag must be cleared. After these conditions are met, the USB host can go into Sleep/Standby mode and it will be awakened whenever an external signal on GP1 triggers the interrupt detector.

FIGURE 1-5: USING AN EXTERNALLY PROVIDED 3.3V POWER SUPPLY



1.7 Pin Mux Module

The Pin Mux module offers multiple functionalities for the GP pins.

1.7.1 CONFIGURABLE PIN FUNCTIONS

The pins can be configured as:

- GPIO – individually configurable general-purpose input or output
- SSPND – USB Suspend state
- USBCFG – indicates USB configuration status
- LED_URX – indicates UART receive traffic (when seen from the MCP2221)
- LED_UTX – indicates UART transmit traffic (when seen from the MCP2221)
- LED_I2C – indicates I^2C traffic
- ADC1/2/3 – analog inputs connected to the internal 10-bit ADC
- DAC1/2 – analog outputs connected to the same 5-bit DAC
- CLKR – digital clock output (the nominal value is 12 MHz, but other values are possible)
- IOC – external interrupt detector

1.7.1.1 GPIO Pin Function

When the GPIO pin function is enabled for a given GP(n) pin, it will operate as a digital input or an output pin. When configured as a digital output, its value is controlled through the USB HID commands. When configured as a digital input, its logic value is read using USB HID commands.

1.7.1.2 SSPND Pin Function

The SSPND pin (if enabled) reflects the USB state (Suspend/Resume). The pin is active low (factory-default setting; see the CHIPSETTING0 register for more details) when the Suspend state has been issued by the USB host. Likewise, the pin drives high after the Resume state is achieved.

This pin allows the application to go into Low Power mode when USB communication is suspended and switches to a full active state when USB activity is resumed.

1.7.1.3 USBCFG Pin Function

The USBCFG pin (if enabled) starts out low (factory default setting; see the CHIPSETTING0 register for more details) during Power-Up or after Reset and goes high after the device successfully configures to the USB. The pin will go low when in Suspend mode and high when the USB resumes.

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1.7.1.4 LED_URX

The “RX” in this pin name refers to the UART of the MCP2221. The LED_URX pin is an indicator of UART RX characters being received.

This pin will pulse low or high (depending on the chip configuration settings; see the CHIPSETTING0 register for more details) for a period of time (a few milliseconds). This allows the application to provide a visual indication of the UART RX traffic.

1.7.1.5 LED_UTX

The “TX” in this pin name refers to the UART of the MCP2221. The LED_UTX pin is an indicator of UART TX characters being transmitted.

This pin will pulse low or high (depending on the chip configuration settings; see the CHIPSETTING0 register for more details) for a period of time (a few milliseconds). This allows the application to provide a visual indication of the UART TX traffic.

1.7.1.6 LED_I2C

The “I2C” in this pin name refers to the I^2C module in the MCP2221. The LED_I2C pin is an indicator of I^2C activity.

This pin will pulse low or high (depending on the chip configuration settings; see the CHIPSETTING0 register for details) for a period of time (a few milliseconds). This allows the application to provide a visual indication of the I^2C traffic.

1.7.1.7 ADC1/2/3

When GP1/2/3 are configured for ADC operation, they will work as analog input pins and they are tied to the first three channels of the 10-bit ADC in the MCP2221.

1.7.1.8 DAC1/2

When GP2/3 are configured for DAC operation, they will work as analog output pins and they are tied to the output of the MCP2221’s 5-bit DAC.

TABLE 1-5: GP DESIGNATION TABLE

GP Designation Bits <2:0>	Assignment	GP0	GP1	GP2	GP3
000	GPIO	GPIO	GPIO	GPIO	GPIO
001	DEDICATED_FUNC	SSPND	CLK OUT	USBCFG	LED_I2C
010	ALT_FUNC_0	LED_URX	ADC1	ADC2	ADC3
011	ALT_FUNC_1	—	LED_UTX	DAC1	DAC2
100	ALT_FUNC_2	—	IOC	—	—

1.8 GPIO/ADC/DAC Module

This module communicates with the USB HID sub-module through the Bus Matrix module. It allows the manipulation of GPIOs, retrieving the ADC data and setting the DAC value.

1.8.1 GPIO

When the GPs are configured for GPIO operation, those configured GPs can be used as digital inputs or outputs.

When working as outputs, the GPs output logic levels (logic `0` or `1`).

1.8.1.1 VRM

The ADC and DAC sub-modules each have a voltage reference module (VRM). Each VRM can be configured (at Power-Up and run time) to output one of the four voltage choices available.

The VRM can provide the following voltages as a reference:

- VDD – the VRM output is exactly the voltage present at the VDD pin of the MCP2221. It can take any value from 3.3 to 5V.
- 1.024V – the VRM output of 1.024V is obtained from an internal voltage reference
- 2.048V – the VRM output of 2.048V is obtained from an internal voltage reference
- 4.096V – the VRM output of 4.096V is obtained from an internal voltage reference. If the VDD is lower than 4.096V, the VRM output will have the value of VDD.

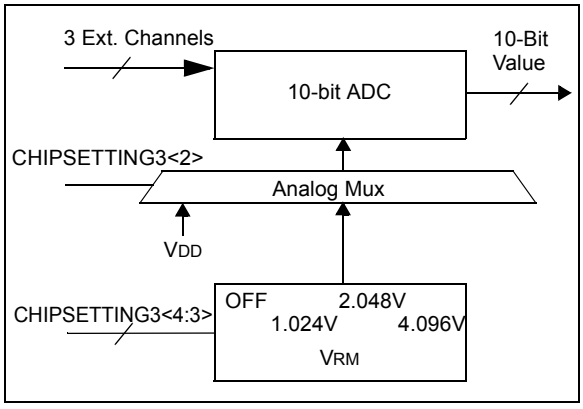
1.8.2 ADC CONVERTER

The ADC converter is producing 10-bit values and it uses its own VRM module.

It features three external channels (connected to GP1/2/3 if configured for ADC operation).

The sampling rate of the ADC is around 1000 sps.

FIGURE 1-6: ADC SUB-MODULE DETAILS



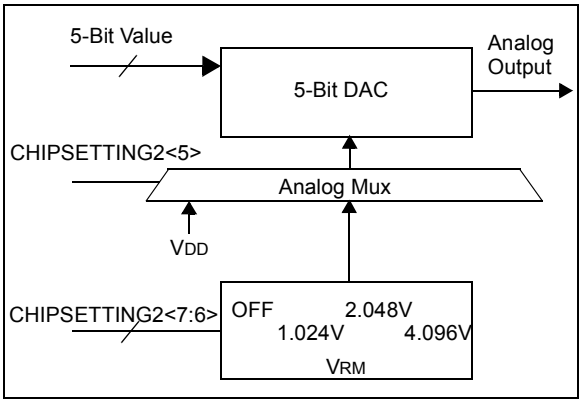
1.8.3 DAC CONVERTER

The DAC is 5-bit wide, has a single analog output and it uses its own VRM module.

The DAC output voltage can be routed to GP2/3 (if GP2/3 are configured for DAC operation).

If the GP2 and GP3 are configured for DAC operation, they will present the same analog voltage value because they are connected to the same DAC output.

FIGURE 1-7: DAC SUB-MODULE DETAILS



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1.9 CLKR

When GP1 is configured for clock output operation, the GP1 pin will act as a digital output, providing a clock signal derived from the device's internal clock. The clock's nominal frequency is 12 MHz ± 0.25%. Other clock values and duty cycles are possible by setting different values that are associated with this mode of operation.

1.10 IOC

When GP1 is configured for Interrupt-on-Change (IOC) operation, GP1 acts as a digital input that is sensitive to positive and negative edges. Depending on the settings associated with this mode of operation, the GP1 can detect positive, negative or both edges.

1.11 RESET/POR

1.11.1 RESET PIN

The $\overline{RST}$ pin provides a method for triggering an external Reset of the device. A Reset is generated by holding the pin low. These devices have a noise filter in the Reset path, which detects and ignores small pulses.

1.11.2 POR

A POR pulse is generated on-chip whenever V_{DD} rises above a certain threshold. This allows the device to start in the initialized state when V_{DD} is adequate for operation.

To take advantage of the POR circuitry, tie the $\overline{RST}$ pin to V_{DD} through a resistor (1 – 10 kΩ). This will eliminate external RC components usually needed to create a POR delay.

When the device starts normal operation (i.e., exits the Reset condition), device operating parameters (voltage, frequency, temperature, etc.) must be met to ensure operation. If these conditions are not achieved, the device must be held in Reset until the operating conditions are met.

1.12 Internal Oscillator

The MCP2221 features an internal oscillator that provides a 12 MHz clock, which is needed for the USB modules (HID and CDC).

Full-speed USB is nominally 12 Mb/s. The clock signal's accuracy is over temp (2,500 ppm maximum).

The internal clock of the MCP2221 is fed into the CLKR module to provide a clock signal outside of the device.

GP1 can be configured as a clock output pin providing a 12 MHz clock to the rest of the system. Other clock and duty-cycle values are possible by using different settings for this module.

1.13 I²C™ Master Module

The I²C Master module is responsible for the I²C traffic generation. The module is controlled through the USB HID, through the Bus Matrix module.

The I²C module only implements the functionality of an I²C/SMBus Master.

1.13.1 I²C/SMBUS MASTER

The I²C Master initiates all the I²C/SMBus transactions (being read or write operations) on the bus.

The I²C/SMBus Master module has the following capabilities:

- sending/receiving data at a multitude of bit rates, up to 400 kbps
- 7-bit Addressing mode
- single data transfers of up to 65,535 bytes
- clock-stretching (it allows the slower I²C Slaves to communicate)

All the user data to be sent/transmitted over the I²C bus is conveyed to the USB host only through the USB HID interface.

1.14 Bus Matrix Module

The Bus Matrix module manages the communication between various functional modules, such as: USB (HID and CDC), I²C, UART, GPIO/ADC/DAC, Config, IOC, CLKR, Pin Mux.

1.15 Config Module

The Config module is in charge of the storage of the device settings and also of their management (loading/modifying/access protection). The module uses non-volatile memory for storing the Power-Up device settings.

At Power-Up, the module loads the settings from the non-volatile storage area into an SRAM location (volatile settings). These settings represent the device's configuration, along with other key parameters (e.g., string descriptors, VID/PID, etc.). After the settings are loaded in SRAM (volatile settings), they can be changed through the USB HID interface.

The user can read/modify/change either settings (nonvolatile or volatile) through the same interface (USB HID).

The Config module contains the relevant Power-Up settings that are used by the MCP2221. A few examples of settings are: USB descriptors, GP settings, ADC, DAC, CLKR.

2.0 USB ENUMERATION PROCESS

The MCP2221 implements the CDC class to support the USB-to-UART protocol converter functionality. Using USB-to-UART (CDC class) adapters with personal computers running the Windows operating system (OS) requires some consideration because of the way the Windows OS responds to their connection.

When a USB-to-UART (CDC class) adapter is connected to the USB port of the PC, Windows searches for a driver. After a suitable driver is found, the system creates an entry in the registry. The entry stores relevant information about the USB-to-UART adapter, its driver and the associated COM port.

The COM port and its number are legacy-type adapters, which are still supported by Windows OS. Historically, the COM ports in a computer are part of the computer's motherboard and are assigned a different index number. With the advent of USB-to-UART adapters, the Windows OS kept the COM port concept and extended it to support the USB adapters.

Whenever a USB-to-UART adapter is first connected to a PC, the system searches the registry for an entry that is suitable for the connected adapter. If one is not found, the system asks for a suitable driver. If this step is completed, it creates a registry entry, and assigns a COM port number as well. Then, whenever the USB-to-UART adapter is connected to that PC, the system checks the registry entry, loads the specified driver and assigns the given COM port number (as found in the registry entry).

During the enumeration process, the device can specify a serial number. If it does, this number is stored in the registry entry and it is used to assign the same COM port number to the adapter in question, no matter which USB port the adapter is connected to.

USB-to-UART adapters have the option to not present a serial number during USB enumeration. In this case, the operating system would not be able to differentiate between two identical devices, if neither is providing its serial number. Each time one of these two devices (with no serial number provided during enumeration) is connected to the same USB port, they will have the same COM port number assigned.

Both functionalities (with or without serial numbers) are very useful for different applications.

When the serial number is provided, an adapter using the MCP2221 solution receives the same COM port number from a Windows machine, no matter which USB port they are connected to.

The case with no serial number is useful for test/validation of products using the MCP2221. The fact that all the tested boards are not supplying a serial number will force Windows to assign them the same COM port number (but only if connected to the same USB port).

The MCP2221 is factory-set to not use a serial number. Later in the process, if a customer wants the benefits provided by using a serial number, the Configuration Utility from Microchip can be used to enable the MCP2221 to enumerate its serial number as well.

The MCP2221 comes with a uniquely-provided serial number to be used during the USB enumeration process; however, this can be changed by the user in the Configuration Utility.

The serial number enumeration enable/disable can be changed, as well, using the Configuration Utility.

All the USB-related settings mentioned above are part of the Device Configuration (Chip Settings area) and they reside only in Flash. When the Chip Settings area (1st area) is being copied into the SRAM (at Power-Up), the USB settings are skipped (not copied into SRAM).

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3.0 USB HID COMMUNICATION

Except for the USB CDC and UART modules, all the other modules in the MCP2221 use USB HID protocol for communication.

The USB HID protocol uses 64-byte reports.

A typical command exchange starts with a 64-byte packet that is written by the USB Host (i.e., the PC). Afterward, the USB Host reads the response from the device as a 64-byte packet.

3.1 USB HID Commands/Responses

3.1.1 STATUS/SET PARAMETERS

This command offers many options for this device. It is used to poll for the status of the device. It is also used to establish certain I^2C bus parameters/conditions.

TABLE 3-1: COMMAND STRUCTURE

Byte Index	Function Description	Value	Effect
0		0x10	Status/Set Parameters – command code
1	Don't care	Any value	
2	Cancel current I^2C/SMBus transfer (sub-command)	0x10	When this value is put in this field, the device will cancel the current I^2C/SMBus transfer and will attempt to free the I^2C bus. This command is very useful since it can cancel a transfer and free the bus. An example would be when trying to communicate with a device using a wrong address. This will cause a timeout to occur. This timeout situation can be read using the "Status/Set Parameter" and the cancellation of the I^2C/SMBus transfer can be achieved by this sub-command.
		Any other value	No effect.
3	Set I^2C/SMBus communication speed (sub-command)	0x20	When this value is put in this field, the device will take the next command field and interpret it as the system clock divider that will give the I^2C/SMBus communication clock.
		Any other value	No effect.
4	The I^2C/SMBus system clock divider that will be used to establish the communication speed		The value in this field is being taken into consideration only when the Byte Index 3 contains the code for establishing a new communication speed. In all the other cases, this field's value won't matter.
5-63	Don't care	Any value	

3.1.1.1 Responses

TABLE 3-2: RESPONSE 1 STRUCTURE

Byte Index	Function Description	Value	Effect
0		0x10	Status/Set Parameters – command code echo
1		0x00	Command completed successfully
2	Cancel transfer	0x00	No special operation (i.e., Cancel current I^2C/SMBus transfer)
		0x10	The current I^2C/SMBus transfer was marked for cancellation. The actual I^2C/SMBus transfer cancellation and bus release will need some time (a few hundreds of microseconds, depending on the communication speed initially chosen for the canceled transfer)
		0x11	The I^2C engine (inside MCP2221) was already in Idle mode. The cancellation command had no effect.
3		0x00	No Set I^2C/SMBus communication speed was issued.
		0x20	The new I^2C/SMBus communication speed is now considered.
		0x21	The I^2C/SMBus communication speed was not set (e.g., I^2C transfer in progress).
4		The divider value given at the same index in the command field	Only in the case when the code for establishing a new communication speed is given at Byte Index 3.
		0x00	When the communication speed is not being set.
5-7	Don’t care	Any value	
8	Internal I^2C state machine state value		
9	Lower byte (16-bit value) of the requested I^2C transfer length		
10	Higher byte (16-bit value) of the requested I^2C transfer length		
11	Lower byte (16-bit value) of the already transferred (through I^2C) number of bytes		
12	Higher byte (16-bit value) of the already transferred (through I^2C) number of bytes		
13	Internal I^2C data buffer counter		
14	Current I^2C communication speed divider value		
15	Current I^2C timeout value		
16	Lower byte (16-bit value) of the I^2C address being used		
17	Higher byte (16-bit value) of the I^2C address being used		
18-21	Don’t care	Any value	
22	SCL line value – as read from the pin		

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TABLE 3-2: RESPONSE 1 STRUCTURE (CONTINUED)

Byte Index	Function Description	Value	Effect
23	SDA line value – as read from the pin		
24	Interrupt edge detector state	0 or 1	
25	I^2C Read pending value	0, 1 or 2	This field is used by the USB host to know if the MCP2221 still has to read from a slave device.
26-45	Don't care	Any value	
46	MCP2221 Hardware Revision Major ('A')		
47	MCP2221 Hardware Revision Minor ('6')		
48	MCP2221 Firmware Revision Major ('1')		
49	MCP2221 Firmware Revision Minor ('1')		
50-55	ADC Data (16-bit) values.		3 x (16-bit) little-endian ADC channel values (CH0 LSB, CH0 MSB, CH1 LSB, CH1 MSB, CH2 LSB, CH2 MSB).
56-63	Don't care	Any value	

3.1.2 READ FLASH DATA

This command is used to read various important data structures and strings that are stored in Flash memory on the MCP2221.

TABLE 3-3: COMMAND STRUCTURE

Byte Index	Function Description	Value	Effect
0		0xB0	Read Flash Data – command code
1	Read Flash Data Sub-code. The value in this field will instruct the MCP2221 on what Flash data to be read.	0x00	Read Chip Settings – it will read the MCP2221 flash settings
		0x01	Read GP Settings – it will read the MCP2221 flash GP settings
		0x02	Read USB Manufacturer Descriptor String – reads the USB Manufacturer String Descriptor used during the USB enumeration
		0x03	Read USB Product Descriptor String – reads the USB Product String Descriptor used during the USB enumeration
		0x04	Read USB Serial Number Descriptor String – reads the USB Serial Number String Descriptor that is used during USB enumeration. This serial number can be changed by the user through a specific USB HID command.
		0x05	Read Chip Factory Serial Number – reads the factory-set serial number. This serial number cannot be changed.
		Any other value	No meaning. The device will reply with a code for an unsupported command at Byte Index 1 in the Response report.
2-63	Reserved	0x00	

3.1.2.1 Responses

TABLE 3-4: RESPONSE STRUCTURE

Byte Index	Function Description	Value	Effect
0		0xB0	Read Flash Data – command code
1		0x00	Command completed successfully
		0x01	Command not supported
2	Data structure length or Don't care		
3-63	Data or Don't care		Depends on the issued sub-command or the returned code at Byte Index 1

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TABLE 3-5: RESPONSE STRUCTURE – READ CHIP SETTINGS SUB-COMMAND

Byte Index	Function Description	Value	Effect
0		0xB0	Read Flash Data – command code echo
1		0x00	Command completed successfully
2	Structure length		
3	Don't care		
4	Bit 7: CDC Serial Number Enumeration Enable	1	The USB serial number will be used during the USB enumeration of the CDC interface.
		0	No serial number descriptor will be presented during the USB enumeration.
	Bit 6: Initial value for LEDUARTRX pin option		This value represents the logic level signaled when no UART RX activity takes places. When the UART RX (of the MCP2221) is receiving data, the LEDUARTRX pin will take the negated value of this bit.
	Bit 5: Initial value for LEDUARTTX pin option		This value represents the logic level signaled when no UART TX transmission takes place. When the UART TX (of the MCP2221) is sending data, the LEDUARTTX pin will take the negated value of this bit.
	Bit 4: Initial value for LEDI2C pin option		This value represents the logic level signaled when no I^2C traffic occurs. When the I^2C traffic is active, the LEDI2C pin (if enabled) will take the negated value of this bit.
	Bit 3: Initial value for SSPND pin option		This value represents the logic level signaled when the device is not in Suspend mode. Upon entering Suspend mode, the SSPND pin (if enabled) will take the negated value of this bit.
	Bit 2: Initial value for USBCFG pin option		This value represents the logic level signaled when the device is not USB configured. When the device will be USB configured, the USBCFG pin (if enabled) will take the negated value of this bit.
	Bits 1-0: Chip configuration security option	11-10	Permanently locked
		01	Password-protected
		00	Unsecured
5	Bits 7-5	Don't care	
	Bits 4-0: Clock Output divider value		If the GP pin (exposing the clock output) is enabled for clock output operation, the divider value will be used on the 48 MHz USB internal clock and its divided output will be sent to this pin.
6	Bits 7-6: DAC Reference voltage option	11	Reference voltage is 4.096V (only if VDD is above this voltage)
		10	Reference voltage is 2.048V
		01	Reference voltage is 1.024V
		00	Reference voltage is off (this is useful for the case in which the DAC uses other reference than VRM DAC; e.g., VDD)
	Bit 5: DAC reference option	1	DAC reference is VRM DAC voltage
		0	DAC reference is VDD
	Bits 4-0: Power-Up DAC value		

TABLE 3-5: RESPONSE STRUCTURE – READ CHIP SETTINGS SUB-COMMAND (CONTINUED)

Byte Index	Function Description	Value	Effect
7	Bit 7	Don't care	
	Bit 6: Interrupt detection – negative edge		If set, the interrupt detection flag will be set when a negative edge occurs.
	Bit 5: Interrupt detection – positive edge		If set, the interrupt detection flag will be set when a positive edge occurs.
	Bit 4-3: ADC Reference Voltage	11	Reference voltage is 4.096V (only if VDD is above this voltage)
		10	Reference voltage is 2.048V
		01	Reference voltage is 1.024V
		00	Reference voltage is off (this is useful for the case in which the ADC uses other reference than VRM ADC; e.g., VDD)
	Bit 2	1	DAC reference is VDD DAC voltage
		0	DAC reference is VRM
	Bit 1	Don't care	
	Bit 0	Don't care	
8	Lower byte of the 16-bit USB VID value		
9	Higher byte of the 16-bit USB VID value		
10	Lower byte of the 16-bit USB PID value		
11	Higher byte of the 16-bit USB PID value		
12	USB power attributes(1)		This value will be used by the MCP2221's USB Configuration Descriptor (power attributes value) during the USB enumeration.
13	USB requested number of mA(s)(1)		The requested mA value during the USB enumeration will represent the value at this index multiplied by 2.
14-63	Don't care		

Note 1: Please consult the USB 2.0 specification for details on the correct values for power and attributes

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TABLE 3-6: RESPONSE STRUCTURE – READ GP SETTINGS SUB-COMMAND

Byte Index	Function Description	Value	Effect
0		0xB0	Read Flash Data – command code echo
1		0x00	Command completed successfully
2			Structure length
3		Don't care	
4	**GP0 Power-Up Settings**		
	Bit 7-5:	Don't care	
	Bit 4: GPIO Output value		When GP0 is set as an output GPIO, this value will be present at the GP0 pin at Power-Up/Reset.
	Bit 3: GPIO Direction (Input/Output) – Works only when GP0 is set for GPIO operation	1	GPIO Input mode
		0	GPIO Output mode
	Bit 2-0: GP0 Designation	111-011	Don't care
		010	Alternate function 0 (LED UART RX)
		001	Dedicated function operation (SSPND)
		000	GPIO operation
5	**GP1 Power-Up Settings**		
	Bits7-5:	Don't care	
	Bit 4: GPIO Output value		When GP1 is set as an output GPIO, this value will be present at the GP1 pin at Power-Up/Reset.
	Bit 3: GPIO Direction (Input/Output) – Works only when GP0 is set for GPIO operation	1	GPIO Input mode
		0	GPIO Output mode
	Bit 2-0: GP1 Designation	111-101	Don't care
		001	Dedicated function operation (Clock Output)
		100	Alternate function 2 (Interrupt Detection)
		011	Alternate function 1 (LED UART TX)
		010	Alternate function 0 (ADC1)
		000	GPIO operation
6	**GP2 Power-Up Settings**		
	Bits7-5:	Don't care	
	Bit 4: GPIO Output value		When GP2 is set as an output GPIO, this value will be present at the GP2 pin at Power-Up/Reset.
	Bit 3: GPIO Direction (Input/Output) – Works only when GP2 is set for GPIO operation	1	GPIO Input mode
		0	GPIO Output mode
	Bit 2-0: GP1 Designation	111-100	Don't care
		011	Alternate function 1 (DAC1)
		010	Alternate function 0 (ADC2)
		001	Dedicated function operation (USB)
		000	GPIO operation

TABLE 3-6: RESPONSE STRUCTURE – READ GP SETTINGS SUB-COMMAND (CONTINUED)

Byte Index	Function Description	Value	Effect
7	**GP3 Power-Up Settings**		
	Bits7-5:	Don't care	
	Bit 4: GPIO Output value		When GP3 is set as an output GPIO, this value will be present at the GP3 pin at Power-Up/Reset.
	Bit 3: GPIO Direction (Input/Output) – Works only when GP3 is set for GPIO operation	1	GPIO Input mode
		0	GPIO Output mode
	Bit 2-0: GP1 Designation	111-100	Don't care
		011	Alternate function 1 (DAC2)
		010	Alternate function 0 (ADC3)
		001	Dedicated function operation (LED I2C)
		000	GPIO operation
8-63		Don't care	

TABLE 3-7: RESPONSE STRUCTURE – READ USB MANUFACTURER DESCRIPTOR STRING SUB-COMMAND

Byte Index	Value	Effect
0	0xB0	Read Flash Data – command code echo
1	0x00	Command completed successfully
2	(2)	Number of bytes + 2 in the provided USB Manufacturer Descriptor String. The actual String starts at Byte Index 4.
3	0x03	The value at this index must always be 0x03.
4 + 2 x Unicode_char_number + 0(1)		Lower byte of the 16-bit Unicode character.
4 + 2 x Unicode_char_number + 1(1)		Higher byte of the 16-bit Unicode character.
(4 + 2 x Unicode_char_number + 2) - 63(1)		Don't care. Only if the USB string descriptor is less than 60-bytes long in total.

Note 1: "Unicode_char_number" value starts from 0 to a maximum of 30 (included).
2: The value at Byte Index 2 must be 2 + 2 x (number of Unicode characters in the string).

TABLE 3-8: RESPONSE STRUCTURE – READ USB PRODUCT DESCRIPTOR STRING SUB-COMMAND

Byte Index	Value	Effect
0	0xB0	Read Flash Data – command code echo
1	0x00	Command completed successfully
2	(2)	Number of bytes + 2 in the provided USB Product Descriptor String. The actual String starts at Byte Index 4.
3	0x03	The value at this index must always be 0x03
4 + 2 x Unicode_char_number + 0(1)		Lower byte of the 16-bit Unicode character.
4 + 2 x Unicode_char_number + 1(1)		Higher byte of the 16-bit Unicode character.
(4 + 2 x Unicode_char_number + 2) - 63(1)		Don't care. Only if the USB string descriptor is less than 60-bytes long (in total).

Note 1: "Unicode_char_number" value starts from 0 to a maximum of 30 (included).
2: The value at Byte Index 2 must be 2 + 2 x (number of Unicode characters in the string).

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TABLE 3-9: RESPONSE STRUCTURE – READ USB SERIAL NUMBER DESCRIPTOR STRING SUB-COMMAND

Byte Index	Value	Effect
0	0xB0	Read Flash Data – command code echo
1	0x00	Command completed successfully
2	(2)	The number of bytes + 2 in the provided USB Serial Number Descriptor String. The actual String starts at Byte Index 4
3	0x03	The value at this index must always be 0x03
4 + 2 x Unicode_char_number + 0(1)		Lower byte of the 16-bit Unicode character
4 + 2 x Unicode_char_number + 1(1)		Higher byte of the 16-bit Unicode character
(4 + 2 x Unicode_char_number + 2) - 63(1)		Don't care. Only if the USB string descriptor is less than 60-bytes long in total.

Note 1: "Unicode_char_number" value starts from 0 to a maximum of 30 (included).

2: The value at Byte Index 2 must be 2 + 2 x (number of Unicode characters in the string).

TABLE 3-10: RESPONSE STRUCTURE – READ CHIP FACTORY SERIAL NUMBER SUB-COMMAND(1)

Byte Index	Value	Effect
0	0xB0	Read Flash Data – command code echo
1	0x00	Command completed successfully
2		Structure length
3	Don't care	
4 - (4 + Structure length - 1)		Structure data – Factory Serial Number String
(4 + Structure length) - 63	Don't care	

Note 1: The Chip Serial Number is typically 8 bytes in length.

3.1.3 WRITE FLASH DATA

This command is used to write various important data structures and strings into the Flash memory of the device.

TABLE 3-11: COMMAND STRUCTURE

Byte Index	Function Description	Value	Effect
0		0xB1	Write Flash Data – command code
1	Write Flash Data Sub-code. The value in this field will instruct the MCP2221 about the particular Flash settings to be altered.	0x00	Write Chip Settings – it will write the MCP2221 flash settings
		0x01	Write GP Settings – it will write the MCP2221 flash GP settings
		0x02	Write USB Manufacturer Descriptor String – writes the USB Manufacturer String Descriptor used during the USB enumeration
		0x03	Write USB Product Descriptor String – writes the USB Product String Descriptor used during the USB enumeration
		0x04	Write USB Serial Number Descriptor String – writes the USB Serial Number String Descriptor used during the USB enumeration
		Any other value	No meaning. The device will reply with a code for an unsupported command at Byte Index 1 in the response report.
2-63	Data to be written		Data format depends on the Write Flash Data Sub-code (at Byte Index 1).

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TABLE 3-12: SUB-COMMAND STRUCTURE – WRITE CHIP SETTINGS SUB-COMMAND

Byte Index	Function Description	Value	Effect
0		0xB1	Write Flash Data – command code
1		0x00	Write Chip Settings – it will write the MCP2221 flash device settings
2	Bit 7: CDC Serial Number Enumeration Enable.	1	The USB serial number will be used during the USB enumeration of the CDC interface.
		0	No serial number descriptor will be presented during the USB enumeration.
	Bit 6: Initial value for LEDUARTRX pin option		This value represents the logic level signaled when no UART RX activity takes places. When the UART RX (of the MCP2221) is receiving data, the LEDUARTRX pin will take the negated value of this bit.
	Bit 5: Initial value for LEDUARTTX pin option		This value represents the logic level signaled when no UART TX transmission takes place. When the UART TX (of the MCP2221) is sending data, the LEDUARTTX pin will take the negated value of this bit.
	Bit 4: Initial value for LEDI2C pin option		This value represents the logic level signaled when no I^2C traffic occurs. When I^2C traffic is active, the LEDI2C pin (if enabled) will take the negated value of this bit.
	Bit 3: Initial value for SSPND pin option		This value represents the logic level signaled when the device is not in Suspend mode. Upon entering Suspend mode, the SSPND pin (if enabled) will take the negated value of this bit.
	Bit 2: Initial value for USBCFG pin option		This value represents the logic level signaled when the device is not USB configured. When the device will be USB-configured, the USBCFG pin (if enabled) will take the negated value of this bit.
	Bit 1-0: Chip Configuration Security Option	11-10	Permanently locked
		01	Password-protected
		00	Unsecured
3	Bit 7-5	Don't care	
	Bit 4-0: Clock Output divider value		If the GP pin (exposing the clock output) is enabled for clock output operation, the divider value will be used on the 48 MHz USB internal clock and its divided output will be sent to this pin.
4	Bit 7-6: DAC Reference voltage option	11	Reference voltage is 4.096V (only if V_{DD} is above this voltage)
		10	Reference voltage is 2.048V
		01	Reference voltage is 1.024V
		00	Reference voltage is off (this is useful for the case in which the DAC uses other reference than V_{RM} DAC, i.e., V_{DD})
	Bit 5: DAC reference option	1	DAC reference is V_{DD}
		0	DAC reference is V_{RM} DAC voltage
	Bit 4-0: Power-Up DAC value		

TABLE 3-12: SUB-COMMAND STRUCTURE – WRITE CHIP SETTINGS SUB-COMMAND

Byte Index	Function Description	Value	Effect
5	Bit 7	Don't care	
	Bit 6: Interrupt detection – negative edge		If set, the interrupt detection flag will be set when a negative edge occurs.
	Bit 5: Interrupt detection – positive edge		If set, the interrupt detection flag will be set when a positive edge occurs.
	Bit 4-3: ADC Reference Voltage	11	Reference voltage is 4.096V (only if V_{DD} is above this voltage).
		10	Reference voltage is 2.048V
		01	Reference voltage is 1.024V
		00	Reference voltage is off (this is useful for the case in which the ADC uses other reference than V_{RM} ADC; e.g., V_{DD})
	Bit 2: ADC Reference Option	1	ADC reference voltage is V_{RM} ADC
		0	ADC reference voltage is V_{DD}
	Bit 1	Don't care	
	Bit 0	Don't care	
6	Lower byte of the 16-bit USB VID value.		
7	Higher byte of the 16-bit USB VID value.		
8	Lower byte of the 16-bit USB PID value.		
9	Higher byte of the 16-bit USB PID value.		
10	USB power attributes		This value will be used by the MCP2221's USB Configuration Descriptor (power attributes value) during the USB enumeration.
11	USB requested number of mA(s)		The requested mA value during the USB enumeration will represent the value at this index multiplied by 2.
12-19	8-bytes password (for Flash modifications protection)		
20-63		Don't care	

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TABLE 3-13: SUB-COMMAND STRUCTURE – WRITE GP SETTINGS SUB-COMMAND

Byte Index	Function Description	Value	Effect
0		0xB1	Write Flash Data – command code
1		0x01	Write GP Settings – it will write the MCP2221 flash GP settings
2	**GP0 Power-Up Settings**		
	Bit 7-5:	Don't care	
	Bit 4: GPIO Output value		When GP0 is set as an output GPIO, this value will be present at the GP0 pin at Power-Up/Reset.
	Bit 3: GPIO Direction (Input/Output) – Works only when GP0 is set for GPIO operation.	1	GPIO Input mode
		0	GPIO Output mode
	Bit 2-0: GP0 Designation	111-011	Don't care
		010	Dedicated function operation (SSPND)
		001	Alternate function 0 (LED UART RX)
		000	GPIO operation
3	**GP1 Power-Up Settings**		
	Bit 7-5:	Don't care	
	Bit 4: GPIO Output value		When GP1 is set as an output GPIO, this value will be present at the GP1 pin at Power-Up/Reset.
	Bit 3: GPIO Direction (Input/Output) – Works only when GP1 is set for GPIO operation.	1	GPIO Input mode
		0	GPIO Output mode
	Bit 2-0: GP1 Designation	111-101	Don't care
		100	Alternate function 2 (Interrupt Detection)
		011	Alternate function1 (LED UART TX)
		010	Alternate function 0 (ADC1)
		001	Dedicated function operation (Clock Output)
		000	GPIO operation
4	**GP2 Power-Up Settings**		
	Bit 7-5:	Don't care	
	Bit 4: GPIO Output value		When GP2 is set as an output GPIO, this value will be present at the GP2 pin at Power-Up/Reset.
	Bit 3: GPIO Direction (Input/Output) – Works only when GP2 is set for GPIO operation.	1	GPIO Input mode
		0	GPIO Output mode
	Bit 2-0: GP2 Designation	111-100	Don't care
		011	Alternate function1 (DAC1)
		010	Alternate function 0 (ADC2)
		001	Dedicated function operation (Clock Output)
		000	GPIO operation

TABLE 3-13: SUB-COMMAND STRUCTURE – WRITE GP SETTINGS SUB-COMMAND (CONTINUED)

Byte Index	Function Description	Value	Effect
5	**GP3 Power-Up Settings**		
	Bit 7-5:	Don't care	
	Bit 4: GPIO Output value		When GP3 is set as an output GPIO, this value will be present at the GP2 pin at Power-Up/Reset.
	Bit 3: GPIO Direction (Input/Output) – Works only when GP3 is set for GPIO operation.	1	GPIO Input mode
		0	GPIO Output mode
	Bit 2-0: GP3 Designation	111-100	Don't care
		011	Alternate function 1 (DAC2)
		010	Alternate function 0 (ADC3)
		001	Dedicated function operation (LED I2C)
		000	GPIO operation
6-63		Don't care	

TABLE 3-14: SUB-COMMAND STRUCTURE – WRITE USB MANUFACTURER DESCRIPTOR STRING SUB-COMMAND

Byte Index	Value	Effect
0	0xB1	Write Flash Data – command code
1	0x02	Write USB Manufacturer Descriptor String – writes the USB Manufacturer String Descriptor used during the USB enumeration
2	(2)	Number of bytes + 2 in the provided USB Serial Number Descriptor String
3	0x03	The value at this index must always be 0x03.
4 + 2 x Unicode_char_number + 0(1)		Lower byte of the 16-bit Unicode character.
4 + 2 x Unicode_char_number + 1(1)		Higher byte of the 16-bit Unicode character.

Note 1: "Unicode_char_number" value starts from 0 to a maximum of 30 (included).
2: The value at Byte Index 2 must be 2 + 2 x (number of Unicode characters in the string).

TABLE 3-15: SUB-COMMAND STRUCTURE – WRITE USB PRODUCT DESCRIPTOR STRING SUB-COMMAND

Byte Index	Value	Effect
0	0xB1	Write Flash Data – command code
1	0x03	Write USB Product Descriptor String – writes the USB Product String Descriptor used during the USB enumeration
2	(2)	Number of bytes + 2 in the provided USB Serial Number Descriptor String. The actual String starts at Byte Index 4.
3	0x03	The value at this index must always be 0x03.
4 + 2 x Unicode_char_number + 0(1)		Lower byte of the 16-bit Unicode character
4 + 2 x Unicode_char_number + 1(1)		Higher byte of the 16-bit Unicode character

Note 1: "Unicode_char_number" value starts from 0 to a maximum of 30 (included).
2: The value at Byte Index 2 must be 2 + 2 x (number of Unicode characters in the string).

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TABLE 3-16: SUB-COMMAND STRUCTURE – WRITE USB SERIAL NUMBER DESCRIPTOR STRING SUB-COMMAND

Byte Index	Value	Effect
0	0xB1	Write Flash Data – command code
1	0x04	Write USB Serial Number Descriptor String – writes the USB Serial Number String Descriptor used during the USB enumeration
2	(2)	Number of bytes + 2 in the provided USB Serial Number Descriptor String. The actual String starts at Byte Index 4
3	0x03	The value at this index must always be 0x03.
4 + 2 x Unicode_char_number + 0(1)		Lower byte of the 16-bit Unicode character
4 + 2 x Unicode_char_number + 1(1)		Higher byte of the 16-bit Unicode character

Note 1: "Unicode_char_number" value starts from 0 to a maximum of 30 (included).
2: The value at Byte Index 2 must be 2 + 2 x (number of Unicode characters in the string).

3.1.3.1 Responses

TABLE 3-17: RESPONSE STRUCTURE – READ CHIP FACTORY SERIAL NUMBER SUB-COMMAND

Byte Index	Value	Effect
0	0xB1	Write Flash Data – command code
1	0x00	Command completed successfully
	0x02	Command not supported
	0x03	Command not allowed
2-63	Don't care	

3.1.4 SEND FLASH ACCESS PASSWORD

This command is used to send a user-supplied password that will be compared to the one stored in the device's Flash when Flash updates (Chip/GP configuration, USB strings) are required and the Flash data is password-protected.

In the case where no protection mechanism is in place or the Flash data has been permanently locked, this command has no meaning.

TABLE 3-18: COMMAND STRUCTURE

Byte Index	Value	Effect
0	0xB2	Send Flash Access Password – command code
1	Don't care	
2		Password byte 1
3		Password byte 2
4		Password byte 3
5		Password byte 4
6		Password byte 5
7		Password byte 6
8		Password byte 7
9		Password byte 8
10-63		Don't care

3.1.4.1 Responses

TABLE 3-19: RESPONSE 1 STRUCTURE

Byte Index	Value	Effect
0	0xB2	Send Flash Access Password – command code echo
1	0x00	Command completed successfully
	0x03	Command not allowed (when the number of failed Flash updates has been reached, no password will be accepted)
2-63	Don't care	

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3.1.5 I²C™ WRITE DATA

This command is used to write user-given data to the I²C Slave device (the speed is specified by the STATUS/SET Parameters command).

The command will have the following effects:

- The I²C engine will send the “START” condition.
- The selected I²C slave address is sent next and the I²C engine will wait for the slave to send an acknowledge bit.
- The user data follows next and the I²C engine awaits for the acknowledge bit from the slave.
- If the requested length is more than 60 bytes, subsequent user bytes will be sent on the bus.
- When the user data length (being sent on the bus) reaches the requested length, the I²C engine will send the “STOP” condition on the bus.

TABLE 3-20: COMMAND STRUCTURE(1)

Byte Index	Value	Effect
0	0x90	I²C Write Data – command code
1	Low Byte	Requested I²C transfer length – 16-bit value – low byte
2	High Byte	Requested I²C transfer length – 16-bit value – high byte
3	I²C Slave Address	8-bit value representing the I²C slave address to communicate with (even – address to write, odd – address to read) (Note 2)
4-63		User data to be sent to the selected I²C slave device

Note 1: When the requested transfer length is more than 60 bytes, subsequent “I²C Write Data” commands will transport the reminder of the user data (till the requested length).

2: The I²C slave address is represented on 8 bits, with even values for writes and odd for reads. To get the 8-bit address value out of a 7-bit address, the 7-bit value needs to be shifted left by 1 position. For write operations use the shifted value, while for reads add 1 to the shifted value.

3.1.5.1 Responses

TABLE 3-21: RESPONSE 1 STRUCTURE

Byte Index	Value	Effect
0	0x90	I²C Write Data – command code echo
1	0x00	Command completed successfully
	0x01	I²C Engine is busy (command not completed)
2		Internal I²C Engine state (at the moment the command was issued) – useful for monitoring the status of the I²C Engine
3-63	Don’t care	

3.1.6 I²C™ WRITE DATA REPEATED-START

This command is used to write user-given data to the I²C Slave device (the speed is specified by the STATUS/SET Parameters command).

The command will have the following effects:

- The I²C engine will send the “Repeated-START” condition.
- The selected I²C slave address is sent next and the I²C engine will wait for the slave to send an acknowledge bit.
- The user data follows next and the I²C engine waits for the acknowledge bit from the slave.
- If the requested length is more than 60 bytes, subsequent user bytes will be sent on the bus.
- When the user data length (being sent on the bus) reaches the requested length, the I²C engine will send the “STOP” condition on the bus.

TABLE 3-22: COMMAND STRUCTURE (1)

Byte Index	Value	Effect
0	0x92	I²C Write Data Repeated-START – command code (cI2C_CMD_RSTART_WRDATA7)
1	Low Byte	Requested I²C transfer length – 16-bit value – low byte
2	High Byte	Requested I²C transfer length – 16-bit value – high byte
3	I²C Slave Address	8-bit value representing the I²C slave address to communicate with (even – address to write, odd – address to read) (Note 2)
4-63		User data to be sent to the selected I²C slave device

Note 1: When the requested transfer length is more than 60 bytes, subsequent “I²C Write Data Repeated-START” commands will transport the reminder of the user data (till the requested length).

2: The I²C slave address is represented on 8 bits, with even values for writes and odd for reads. To get the 8-bit address value out of a 7-bit address, the 7-bit value needs to be shifted left by 1 position. For write operations use the shifted value, while for reads add 1 to the shifted value.

3.1.6.1 Responses

TABLE 3-23: RESPONSE 1 STRUCTURE

Byte Index	Value	Effect
0	0x92	I²C Write Data Repeated-START – command code echo (cI2C_CMD_RSTART_WRDATA7)
1	0x00	Command completed successfully
	0x01	I²C Engine is busy (command not completed)
2		Internal I²C Engine state (at the moment the command was issued) – useful for monitoring the status of the I²C Engine
3-63	Don’t care	

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3.1.7 I²C™ WRITE DATA NO STOP

This command is used to write user-given data to the I²C Slave device (the speed is specified by the STATUS/SET Parameters command).

The command will have the following effects:

- The I²C engine will send the “START” condition.
- The selected I²C slave address is sent next and the I²C engine will wait for the slave to send an acknowledge bit.
- The user data follows next and the I²C engine waits for the acknowledge bit from the slave.
- If the requested length is more than 60 bytes, subsequent user bytes will be sent on the bus.
- When the user data length (being sent on the bus) reaches the requested length, the I²C engine will **not** send the “STOP” condition on the bus.

TABLE 3-24: COMMAND STRUCTURE (1)

Byte Index	Value	Effect
0	0x94	I²C Write Data No STOP – command code
1	Low Byte	Requested I²C transfer length – 16-bit value – low byte
2	High Byte	Requested I²C transfer length – 16-bit value – high byte
3	I²C Slave Address	8-bit value representing the I²C slave address to communicate with (even – address to write, odd – address to read) (Note 2)
4-63		User data to be sent to the selected I²C slave device

Note 1: When the requested transfer length is more than 60 bytes, subsequent “I²C Write Data No STOP” commands will transport the reminder of the user data (till the requested length).

2: The I²C slave address is represented on 8 bits, with even values for writes and odd for reads. To get the 8-bit address value out of a 7-bit address, the 7-bit value needs to be shifted left by 1 position. For write operations use the shifted value, while for reads add 1 to the shifted value.

3.1.7.1 Responses

TABLE 3-25: RESPONSE 1 STRUCTURE

Byte Index	Value	Effect
0	0x94	I²C Write Data No STOP – command code echo
1	0x00	Command completed successfully
	0x01	I²C Engine is busy (command not completed)
2		Internal I²C Engine state (at the moment the command was issued) – useful for monitoring the status of the I²C Engine
3-63	Don’t care	

3.1.8 I²C™ READ DATA

This command is used to read user-given data to the I²C Slave device (the speed is specified by the STATUS/SET Parameters command).

The command will have the following effects:

- The I²C engine will send the “START” condition.
- The selected I²C slave address is sent next and the I²C engine will wait for the slave to send an acknowledge bit.
- The user data is read next and the I²C engine sends the acknowledge bit to the slave.
- If the requested length is more than 60 bytes, subsequent user bytes will be read from the I²C slave on the bus.
- When the user data length (being sent on the bus) reaches the requested length, the I²C engine will send the “STOP” condition on the bus.

TABLE 3-26: COMMAND STRUCTURE

Byte Index	Value	Effect
0	0x91	I²C Read Data – command code
1	Low Byte	Requested I²C transfer length – 16-bit value – low byte
2	High Byte	Requested I²C transfer length – 16-bit value – high byte
3	I²C Slave Address	8-bit value representing the I²C slave address to communicate with (even – address to write, odd – address to read) (Note 1)
4-63	Don’t care	

Note 1: The I²C slave address is represented on 8 bits, with even values for writes and odd for reads. To get the 8-bit address value out of a 7-bit address, the 7-bit value needs to be shifted left by 1 position. For write operations use the shifted value, while for reads add 1 to the shifted value.

3.1.8.1 Responses

TABLE 3-27: RESPONSE 1 STRUCTURE

Byte Index	Value	Effect
0	0x91	I²C Read Data – command code echo
1	0x00	Command completed successfully
	0x01	I²C Engine is busy (command not completed)
2		Internal I²C Engine state (at the moment the command was issued) – useful for monitoring the I²C Engine’s status
3-63	Don’t care	

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3.1.9 I²C™ READ DATA REPEATED-START

This command is used to read user-given data to the I²C Slave device (the speed is specified by the STATUS/SET Parameters command).

The command will have the following effect:

- The I²C engine will send the “Repeated-START” condition.
- The selected I²C slave address is sent next and the I²C engine will wait for the slave to send an acknowledge bit.
- The user data is read next and the I²C engine sends the acknowledge bit to the slave.
- If the requested length is more than 60 bytes, subsequent user bytes will be read from the I²C slave on the bus.
- When the user data length (being sent on the bus) reaches the requested length, the I²C engine will send the “STOP” condition on the bus.

TABLE 3-28: COMMAND STRUCTURE

Byte Index	Value	Effect
0	0x93	I²C Read Data Repeated-START – command code
1	Low Byte	Requested I²C transfer length – 16-bit value – low byte
2	High Byte	Requested I²C transfer length – 16-bit value – high byte
3	I²C Slave Address	8-bit value representing the I²C slave address to communicate with (even – address to write, odd – address to read) (Note 1)
4-63	Don’t care	

Note 1: The I²C slave address is represented on 8 bits, with even values for writes and odd for reads. To get the 8-bit address value out of a 7-bit address, the 7-bit value needs to be shifted left by 1 position. For write operations use the shifted value, while for reads add 1 to the shifted value.

3.1.9.1 Responses

TABLE 3-29: RESPONSE 1 STRUCTURE

Byte Index	Value	Effect
0	0x93	I²C Read Data Repeated-START – command code echo
1	0x00	Command completed successfully
	0x01	I²C Engine is busy (command not completed)
2		Internal I²C Engine state (at the moment the command was issued) – useful for monitoring the status of the I²C Engine
3-63	Don’t care	

3.1.10 I²C READ DATA – GET I²C DATA

This command is used to read back the data from the I²C Slave device.

TABLE 3-30: COMMAND STRUCTURE

Byte Index	Value	Effect
0	0x40	I²C Read Data – Get I²C Data – command code
1-63	Don't care	

3.1.10.1 Responses

TABLE 3-31: RESPONSE 1 STRUCTURE

Byte Index	Value	Effect
0	0x40	I²C Read Data – Get I²C Data – command code echo
1	0x00	Command completed successfully
	0x41	Error reading the I²C slave data from the I²C engine
2		Internal I²C Engine state (at the moment the command was issued) – useful for monitoring the I²C Engine's status
3	0-60	The number of read-back data bytes to follow in this packet: from 0 to a maximum of 60 bytes of read-back bytes
	127	This value is signaled when an error has occurred and the following data should not be taken into account
4-63		User Data or Don't care

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3.1.11 SET GPIO OUTPUT VALUES

This command is used to change the GPIO output value for those GP pins assigned for GPIO operation (GPIO outputs).

TABLE 3-32: COMMAND STRUCTURE

Byte Index	Function Description	Value	Effect
0		0x50	Set GPIO Output Values – command code
1		Don't care	
2	Alter GP0 output (enable/disable)	0x00	Do not modify GP0 output (if GP0 is set as GPIO output)
		Any other value	The next byte (index 3) will be the value used to set GP0 output (only if GP0 is set for GPIO output)
3	GP0 output value	0x00	GP0 (if set up for GPIO output operation) will take a logical value of '0'
		Any other value	GP0 (if set up for GPIO output operation) will take a logical value of '1'
4	Alter GP0 pin direction (enable/disable)	0x00	Leave the GP0 GPIO designation as is (input or output)
		Any other value	The next byte (index 5) will be the value used to set GP0's pin direction (only if GP0 is set for GPIO operation)
5	GP0 pin direction (input or output)	0x00	Set GP0 GPIO as output
		Any other value	GP0 (if set up for GPIO operation) will be set as a digital input
6	Alter GP1 output (enable/disable)	0x00	Do not modify GP1 output (if GP1 is set as GPIO output)
		Any other value	The next byte (index 7) will be the value used to set GP1 output (only if GP1 is set for GPIO output)
7	GP1 output value	0x00	GP1 (if set up for GPIO output operation) will take a logical value of '0'
		Any other value	GP1 (if set up for GPIO output operation) will take a logical value of '1'
8	Alter GP1 pin direction (enable/disable)	0x00	Leave the GP1 GPIO designation as is (input or output)
		Any other value	The next byte (index 9) will be the value used to set GP1's pin direction (only if GP1 is set for GPIO operation)
9	GP1 pin direction (input or output)	0x00	Set GP1 GPIO as output
		Any other value	GP1 (if set up for GPIO operation) will be set as a digital input
10	Alter GP2 output (enable/disable)	0x00	Do not modify GP2 output (if GP2 is set as GPIO output)
		Any other value	The next byte (index 11) will be the value used to set GP2 output (only if GP2 is set for GPIO output)
11	GP2 output value	0x00	The GP2 (if GP2 is set up for GPIO output operation) will take a logical value of '0'
		Any other value	GP2 (if GP2 is set up for GPIO output operation) will take a logical value of '1'
12	Alter GP2 pin direction (enable/disable)	0x00	Leave the GP2 GPIO designation as is (input or output)
		Any other value	The next byte (index 13) will be the value used to set GP2's pin direction (only if GP2 is set for GPIO operation)
13	GP2 pin direction (input or output)	0x00	Set GP2 GPIO as output
		Any other value	GP2 (if set up for GPIO operation) will be set as a digital input
14	Alter GP3 output (enable/disable)	0x00	Do not modify GP3 output (if GP3 is set as GPIO output)
		Any other value	The next byte (index 11) will be the value used to set GP3 output (only if GP3 is set for GPIO output)

TABLE 3-32: COMMAND STRUCTURE (CONTINUED)

Byte Index	Function Description	Value	Effect
15	GP3 output value	0x00	GP3 (if set up for GPIO output operation) will take a logical value of '0'.
		Any other value	GP3 (if set up for GPIO output operation) will take a logical value of '1'
16	Alter GP3 pin direction (enable/disable)	0x00	Leave the GP3 GPIO designation as is (input or output)
		Any other value	The next byte (index 17) will be the value used to set GP3's pin direction (only if GP3 is set for GPIO operation)
17	GP3 pin direction (input or output)	0x00	Set GP3 GPIO as output
		Any other value	GP3 (if set up for GPIO operation) will be set as a digital input
18-63	Reserved	0x00	

3.1.11.1 Responses

TABLE 3-33: RESPONSE 1 STRUCTURE

Byte Index	Function Description	Value	Effect
0		0x50	Set GPIO Output Values – command code
1		0x00	Command completed successfully
2	Alter GP0 output (enable/disable) status	0xEE	If GP0 is not set for GPIO operation
		Any other value	If GP0 is already set for GPIO operation, the value will be copied from the same byte index in the command structure
3	GP0 output value status	0xEE	If GP0 is not set for GPIO operation
		Any other value	If GP0 is already set for GPIO operation, the value will be copied from the same byte index in the command structure
4	Alter GP0 pin direction (enable/disable)	0xEE	If GP0 is not set for GPIO operation
		Any other value	If GP0 is already set for GPIO operation, the value will be copied from the same byte index in the command structure
5	GP1 pin direction (input or output)	0xEE	If GP1 is not set for GPIO operation
		Any other value	If GP1 is already set for GPIO operation, the value will be copied from the same byte index in the command structure
6	Alter GP1 output (enable/disable) status	0xEE	If GP1 is not set for GPIO operation
		Any other value	If GP1 is already set for GPIO operation, the value will be copied from the same byte index in the command structure
7	GP1 output value status	0xEE	If GP1 is not set for GPIO operation
		Any other value	If GP1 is already set for GPIO operation, the value will be copied from the same byte index in the command structure
8	Alter GP1 pin direction (enable/disable)	0xEE	If GP1 is not set for GPIO operation
		Any other value	If the GP1 is already set for GPIO operation, the value will be copied from the same byte index in the command structure
9	GP1 pin direction (input or output)	0xEE	If GP1 is not set for GPIO operation
		Any other value	If GP1 is already set for GPIO operation, the value will be copied from the same byte index in the command structure
10	Alter GP2 output (enable/disable) status	0xEE	If GP2 is not set for GPIO operation
		Any other value	If GP2 is already set for GPIO operation, the value will be copied from the same byte index in the command structure

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TABLE 3-33: RESPONSE 1 STRUCTURE (CONTINUED)

Byte Index	Function Description	Value	Effect
11	GP2 output value status	0xEE	If GP2 is not set for GPIO operation
		Any other value	If GP2 is already set for GPIO operation, the value will be copied from the same byte index in the command structure
12	Alter GP2 pin direction (enable/disable)	0xEE	If GP2 is not set for GPIO operation
		Any other value	If GP2 is already set for GPIO operation, the value will be copied from the same byte index in the command structure
13	GP2 pin direction (input or output)	0xEE	If GP2 is not set for GPIO operation
		Any other value	If GP2 is already set for GPIO operation, the value will be copied from the same byte index in the command structure
14	Alter GP3 output (enable/disable) status	0xEE	If GP3 is not set for GPIO operation
		Any other value	If GP3 is already set for GPIO operation, the value will be copied from the same byte index in the command structure
15	GP3 output value status	0xEE	If GP3 is not set for GPIO operation
		Any other value	If GP3 is already set for GPIO operation, the value will be copied from the same byte index in the command structure
16	Alter GP3 pin direction (enable/disable)	0xEE	If GP3 is not set for GPIO operation
		Any other value	If GP3 is already set for GPIO operation, the value will be copied from the same byte index in the command structure
17	GP3 pin direction (input or output)	0xEE	If GP3 is not set for GPIO operation
		Any other value	If GP3 is already set for GPIO operation, the value will be copied from the same byte index in the command structure
18-63		Don’t care	

3.1.12 GET GPIO VALUES

This command is used to retrieve the GPIO direction and pin value for those GP pins assigned for GPIO operation (GPIO inputs or outputs).

TABLE 3-34: COMMAND STRUCTURE

Byte Index	Value	Effect
0	0x51	Get GPIO Values – command code
1-63	Don't care	

3.1.12.1 Responses

TABLE 3-35: RESPONSE 1 STRUCTURE

Byte Index	Function Description	Value	Effect
0		0x51	Get GPIO Values – command code
1		0x00	Command completed successfully
2	GP0 pin value	0xEE	If GP0 is not set for GPIO operation
		Other values (0x00 or 0x01)	If GP0 is already set for GPIO operation, the value represents the GP0 logic pin value
3	GP0 direction value	0xEF	If GP0 is not set for GPIO operation
		Other values (0x00 or 0x01)	If GP0 is already set for GPIO operation, the value represents the GP0 pin designation (0x00 for output and 0x01 for input)
4	GP1 pin value	0xEE	If GP1 is not set for GPIO operation
		Other values (0x00 or 0x01)	If GP1 is already set for GPIO operation, the value represents the GP1 logic pin value
5	GP1 direction value	0xEF	If GP1 is not set for GPIO operation
		Other values (0x00 or 0x01)	If GP1 is already set for GPIO operation, the value represents the GP1 pin designation (0x00 for output and 0x01 for input)
6	GP2 pin value	0xEE	If GP2 is not set for GPIO operation
		Other values (0x00 or 0x01)	If GP2 is already set for GPIO operation, the value represents the GP2 logic pin value
7	GP2 direction value	0xEF	If GP2 is not set for GPIO operation
		Other values (0x00 or 0x01)	If GP2 is already set for GPIO operation, the value represents the GP2 pin designation (0x00 for output and 0x01 for input)
8	GP3 pin value	0xEE	If GP3 is not set for GPIO operation
		Other values (0x00 or 0x01)	If GP3 is already set for GPIO operation, the value represents the GP3 logic pin value
9	GP3 direction value	0xEF	If GP3 is not set for GPIO operation
		Other values (0x00 or 0x01)	If GP3 is already set for GPIO operation, the value represents the GP3 pin designation (0x00 for output and 0x01 for input)
10-63		Don't care	

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3.1.13 SET SRAM SETTINGS

This command is used to alter various run time chip-settings. The altered settings reside in SRAM memory and they won't affect the chip's Power-Up/Reset default settings. These altered settings will be active till the next chip Power-Up/Reset.

TABLE 3-36: COMMAND STRUCTURE

Byte Index	Function Description	Value	Effect
0		0x60	Set SRAM settings – command code
1		Don't care	
2	**Clock Output Divider value** – this allows the user to modify the clock output value on the fly, at run-time		
	Bit 7: Enable loading of a new clock divider	1	The 4-0 bits will be loaded into the clock divider
		0	Clock divider value won't be altered
	Bit 6-5	Don't care	
	Bit 4-3: Duty cycle	00	0% duty cycle
		01	25% duty cycle
		10	50% duty cycle
		11	75% duty cycle
	Bit 2-0: Clock divider value		
3	**DAC Voltage Reference** – this allows the user to modify the DAC reference voltage		
	Bit 7: Enable loading of a new DAC reference	1	Bits 2-0 will be used for DAC reference voltage selection
		0	DAC reference will remain unaltered
	Bit 6-3	Don't care	
	Bit 2-1: DAC V_{RM} voltage selection. These bits are used to change the DAC V_{RM} voltage	11	V_{RM} voltage is 4.096V (only if V_{DD} is higher than this value)
		10	V_{RM} voltage is 2.048V
		01	V_{RM} voltage is 1.024V
		00	V_{RM} voltage is off
	Bit 0: This bit is used to change the DAC reference voltage	1	DAC voltage reference is the internal DAC voltage reference module (DAC V_{RM})
		0	DAC voltage reference is V_{DD}
4	**Set DAC output value**		
	Bit 7: Enable loading of a new DAC value	1	Bits 4-0 will be used for DAC reference voltage selection
		0	The current DAC value will remain unaltered
	Bit 6-5	Don't care	
	Bit 4-0: The new DAC value		

TABLE 3-36: COMMAND STRUCTURE (CONTINUED)

Byte Index	Function Description	Value	Effect
5	**ADC Voltage Reference** – this allows the user to modify the ADC reference voltage		
	Bit 7: Enable loading of a new ADC reference	1	Bits 2-0 will be used for ADC reference voltage selection
		0	ADC reference will remain unaltered
	Bit 6-3	Don't care	
	Bit 2-1: These bits are used to change the DAC VRM voltage	11	VRM voltage is 4.096V (only if VDD is higher than this value)
		10	VRM voltage is 2.048V
		01	VRM voltage is 1.024V
		00	VRM voltage is off
	Bit 0: This bit is used to change the DAC reference voltage	1	VDD ADC voltage reference is the internal ADC voltage reference module (ADC VRM)
		0	ADC voltage reference is V_{DD}
6	**Setup the interrupt detection mechanism and clear the detection flag** – useful for preparing the interrupt detection module to detect a new interrupt condition		
	Bit 7: Enable the modification of the interrupt detection conditions	1	The interrupt detection settings and flag will change
		0	The interrupt detection settings and flag will remain unchanged
	Bit 6-5	Don't care	
	Bit 4		Enable the modification of the positive edge detection
	Bit 3: The new value for the positive edge detector	1	Interrupt detection will trigger on positive edges
		0	Interrupt detection will not trigger on positive edges
	Bit 2		Enable the modification of the negative edge detection
	Bit 1: The new value for the negative edge detector	1	Interrupt detection will trigger on negative edges
		0	Interrupt detection will not trigger on negative edges
	Bit 0: Clear the interrupt detection flag	1	Clear the interrupt detection flag
		0	Leave the interrupt detection flag as is
7	Alter GPIO configuration: alters the current GP designation	1	Alter the GP designation. The values from Byte Index 8 will be used to load a new set of values into the SRAM GP settings.
		0	Do not alter the current GP designation
8	**GP0 settings**		
	Bit 7-5	Don't care	
	Bit 4: GPIO Output value		When GP0 is set as an output GPIO, this value will be present at the GP0 pin
	Bit 3: GPIO Direction (Input/Output) – Works only when GP0 is set for GPIO operation	1	GPIO Input mode
		0	GPIO Output mode
	Bit 2-0: GP0 Designation	111-011	Don't care
		010	Alternate function 0 (LED UART RX)
		001	Dedicated function operation (SSPND)
		000	GPIO operation

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TABLE 3-36: COMMAND STRUCTURE (CONTINUED)

Byte Index	Function Description	Value	Effect
9	**GP1 settings**		
	Bit 7-5	Don't care	
	Bit 4: GPIO Output value		When GP1 is set as an output GPIO, this value will be present at the GP1 pin
	Bit 3: GPIO Direction (Input/Output) – Works only when GP1 is set for GPIO operation	1	GPIO Input mode
		0	GPIO Output mode
	Bit 2-0: GP0 Designation	111-101	Don't care
		100	Alternate function 2 (Interrupt Detection)
		011	Alternate function 1 (LED UART TX)
		010	Alternate function 0 (ADC1)
		001	Dedicated function operation (Clock Output)
		000	GPIO operation
10	**GP2 settings**		
	Bit 7-5	Don't care	
	Bit 4: GPIO Output value		When GP2 is set as an output GPIO, this value will be present at the GP2 pin
	Bit 3: GPIO Direction (Input/Output) – Works only when GP2 is set for GPIO operation	1	GPIO Input mode
		0	GPIO Output mode
	Bit 2-0: GP2 Designation	111-100	Don't care
		011	Alternate function 1 (DAC1)
		010	Alternate function 0 (ADC2)
		001	Dedicated function operation (USBCFG)
		000	GPIO operation
11	**GP3 settings**		
	Bit 7-5	Don't care	
	Bit 4: GPIO Output value		When GP3 is set as an output GPIO, this value will be present at the GP3 pin
	Bit 3: GPIO Direction (Input/Output) – Works only when GP3 is set for GPIO operation	1	GPIO Input mode
		0	GPIO Output mode
	Bit 2-0: GP3 Designation	111-100	Don't care
		011	Alternate function 1 (DAC2)
		010	Alternate function 0 (ADC3)
		001	Dedicated function operation (LED I2C)
		000	GPIO operation
12-63	Reserved	0x00	

3.1.13.1 Responses

TABLE 3-37: RESPONSE 1 STRUCTURE

Byte Index	Value	Effect
0	0x60	Set SRAM Settings – command code echo
1	0x00	Command completed successfully
2-63	Don't care	

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3.1.14 GET SRAM SETTINGS

This command is used to retrieve the run time Chip and GP settings.

TABLE 3-38: COMMAND STRUCTURE

Byte Index	Value	Effect
0	0x61	Get SRAM Settings – command code echo
1-63	0x00	Command completed successfully

3.1.14.1 Responses

TABLE 3-39: RESPONSE 1 STRUCTURE

Byte Index	Function Description	Value	Effect
0		0x61	Get SRAM Settings – command code echo
1		0x00	Command completed successfully
2	Length in bytes of the SRAM Chip-settings area.		
3	Length in bytes of the SRAM GP settings area.		
4	Bit 7: CDC Serial Number Enumeration Enable	1	The USB serial number will be used during the USB enumeration of the CDC interface
		0	No serial number descriptor will be presented during the USB enumeration
	Bit 6: Initial value for LEDUARTRX pin option		This value represents the logic level signaled when no UART RX activity takes places. When the UART RX (of the MCP2221) is receiving data, the LEDUARTRX pin will take the negated value of this bit.
	Bit 5: Initial value for LEDUARTTX pin option.		This value represents the logic level signaled when no UART TX transmission takes place. When the UART TX (of the MCP2221) is sending data, the LEDUARTTX pin will take the negated value of this bit.
	Bit 4: Initial value for LEDI2C pin option		This value represents the logic level signaled when no I^2C traffic occurs. When I^2C traffic is active, the LEDI2C pin (if enabled) will take the negated value of this bit.
	Bit 3: Initial value for SSPND pin option		This value represents the logic level signaled when the device is not in Suspend mode. Upon entering Suspend mode, the SSPND pin (if enabled) will take the negated value of this bit.
	Bit 2: Initial value for USBCFG pin option		This value represents the logic level signaled when the device is not USB configured. When the device will be USB-configured, the USBCFG pin (if enabled) will take the negated value of this bit.
	Bit 1-0: Chip configuration security option	10	Permanently locked
		01	Password-protected
		00	Unsecured

TABLE 3-39: RESPONSE 1 STRUCTURE (CONTINUED)

Byte Index	Function Description	Value	Effect
5	Bit 7-5	Don't care	
	Bit 4-0: Clock Output divider value		If the GP pin (exposing the clock output) is enabled for clock output operation, the divider value will be used on the 48 MHz USB internal clock and its divided output will be sent to this pin. (Bits 4-3 for duty cycle and bits 2-0 for the clock divider.)
6	Bit 7-6: DAC Reference voltage option	11	Reference voltage is 4.096V
		10	Reference voltage is 2.048V
		01	Reference voltage is 1.024V
		00	Reference voltage is off (this is useful for the case in which the DAC uses other reference than VRM DAC; e.g., VDD)
	Bit 5: DAC reference option	1	DAC reference is VRM DAC voltage
		0	DAC reference is VDD
	Bit 4-0: Power-Up DAC value		
7	Bit 7	Don't care	
	Bit 6: Interrupt detection – negative edge		If set, the interrupt detection flag will be set when a negative edge occurs
	Bit 5: Interrupt detection – positive edge		If set, the interrupt detection flag will be set when a positive edge occurs
	Bit 4-3: ADC Reference Voltage	11	Reference voltage is 4.096V (only if VDD is above this voltage)
		10	Reference voltage is 2.048V
		01	Reference voltage is 1.024V
		00	Reference voltage is off (this is useful for the case in which the ADC uses other reference than VRM DAC; e.g., VDD)
	Bit 2: ADC Reference Option	1	ADC reference is VRM ADC
		0	ADC reference is VDD
	Bit 1	Don't care	
	Bit 2	Don't care	
8	Lower byte of the 16-bit USB VID value		
9	Higher byte of the 16-bit USB VID value		
10	Lower byte of the 16-bit USB PID value		
11	Higher byte of the 16-bit USB PID value		
12	USB power attributes		This value will be used by the MCP2221's USB Configuration Descriptor (power attributes value) during the USB enumeration
13	USB requested number of mA(s)		The requested mA value during the USB enumeration will represent the value at this index multiplied by 2
14	Current supplied-password byte 1		
15	Current supplied-password byte 2		
16	Current supplied-password byte 3		

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TABLE 3-39: RESPONSE 1 STRUCTURE (CONTINUED)

Byte Index	Function Description	Value	Effect
17	Current supplied-password byte 4		
18	Current supplied-password byte 5		
19	Current supplied-password byte 6		
20	Current supplied-password byte 7		
21	Current supplied-password byte 8		
22	**GP0 settings**		
	Bit 7-5	Don't care	
	Bit 4: GPIO Output value		When the GP0 is set as an output GPIO, this value will be present at the GP0 pin
	Bit 3: GPIO Direction (Input/Output) – Works only when GP0 is set for GPIO operation	1	GPIO Input mode
		0	GPIO Output mode
	Bit 2-0: GP0 Designation	111-011	Don't care
		010	Alternate function 0 (LED UART RX)
		001	Dedicated function operation (SSPND)
		000	GPIO operation
23	**GP1 settings**		
	Bit 7-5	Don't care	
	Bit 4: GPIO Output value		When the GP1 is set as an output GPIO, this value will be present at the GP1 pin
	Bit 3: GPIO Direction (Input/Output) – Works only when GP1 is set for GPIO operation	1	GPIO Input mode
		0	GPIO Output mode
	Bit 2-0: GP1 Designation	111-101	Don't care
		100	Alternate function 2 (Interrupt Detection)
		011	Alternate function 1 (LED UART TX)
		010	Alternate function 0 (ADC1)
		001	Dedicated function operation (Clock Output)
		000	GPIO operation
24	**GP2 settings**		
	Bit 7-5	Don't care	
	Bit 4: GPIO Output value		When the GP2 is set as an output GPIO, this value will be present at the GP2 pin
	Bit 3: GPIO Direction (Input/Output) – Works only when GP2 is set for GPIO operation	1	GPIO Input mode
		0	GPIO Output mode
	Bit 2-0: GP2 Designation	111-100	Don't care
		011	Alternate function 1 (DAC1)
		010	Alternate function 0 (ADC2)
		001	Dedicated function operation (USBCFG)
		000	GPIO operation

TABLE 3-39: RESPONSE 1 STRUCTURE (CONTINUED)

Byte Index	Function Description	Value	Effect
25	**GP3 settings**		
	Bit 7-5	Don't care	
	Bit 4: GPIO Output value		When the GP3 is set as an output GPIO, this value will be present at the GP3 pin
	Bit 3: GPIO Direction (Input/Output) – Works only when GP3 is set for GPIO operation	1	GPIO Input mode
		0	GPIO Output mode
	Bit 2-0: GP3 Designation	111-100	Don't care
		011	Alternate function 1 (DAC2)
		010	Alternate function 0 (ADC3)
		001	Dedicated function operation (LED I2C)
		000	GPIO operation
26-63		Don't care	

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3.1.15 RESET CHIP

This command is used to force a Reset of the MCP2221 device. This command is useful when the Flash memory is updated with new data. The MCP2221 would need to be re-enumerated to see the new data.

Note:	This command is the only command that does not expect a response.

TABLE 3-40: COMMAND STRUCTURE

Byte Index	Value	Effect
0	0x70	Reset Chip – command code
1	0xAB	
2	0xCD	
3	0xEF	
4-63	0x00	Reserved

NOTES:

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4.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings (†)(1)

Ambient temperature under bias ..... -40°C to +85°C
Storage temperature ..... -65°C to +150°C
Voltage on V_{DD} with respect to V_{SS} ..... -0.3V to +6.0V
Voltage on $\overline{RST}$ with respect to V_{SS} ..... -0.3V to +9.0V
Voltage on V_{USB} pin with respect to V_{SS} ..... -0.3V to +4.0V
Voltage on D+ and D- pins with respect to V_{SS} ..... -0.3V to (V_{USB} + 0.3V)
Voltage on all other pins with respect to V_{SS} ..... -0.3V to (V_{DD} + 0.3V)
Total power dissipation(2) ..... 800 mW
Maximum current out of V_{SS} pin ..... 95 mA
Maximum current into V_{DD} pin ..... 95 mA
Clamp current, I_K (V_{PIN} < 0 or V_{PIN} > V_{DD}) ..... ± 20 mA
Maximum output current sunk by any I/O pin ..... 25 mA
Maximum output current sourced by any I/O pin ..... 25 mA
Maximum current sunk by all ports ..... 90 mA
Maximum current sourced by all ports ..... 90 mA

† NOTICE: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure above maximum rating conditions for extended periods may affect device reliability.

Note 1: V_{USB} must always be ≤ V_{DD} + 0.3V.

2: Power dissipation is calculated as follows: $P_{DIS} = V_{DD} \times \{I_{DD} - \sum I_{OH}\} + \sum \{(V_{DD} - V_{OH}) \times I_{OH}\} + \sum(V_{OL} \times I_{OL})$.

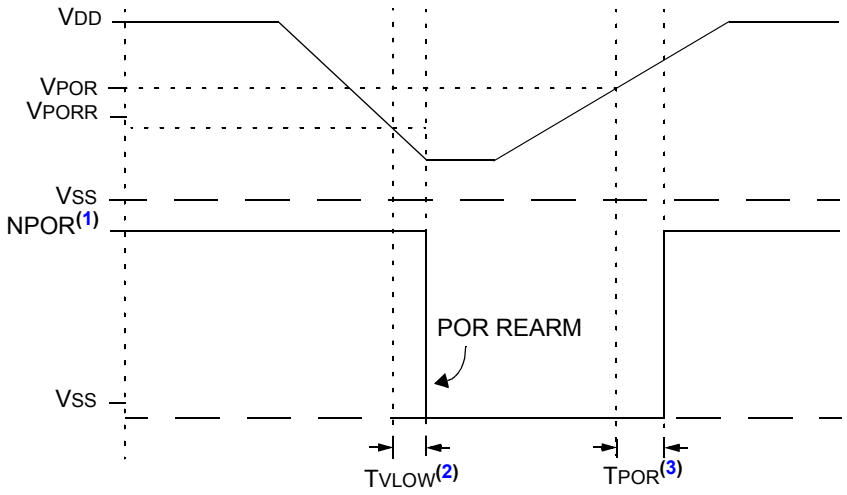
4.1 DC CHARACTERISTICS

DC Characteristics		Operating Conditions (unless otherwise indicated): 3.0V ≤ V_{DD} ≤ 5.5V at -40°C ≤ T_A ≤ +85°C (I-Temp)					
Param. No.	**Characteristic**	**Sym.**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
D001	Supply Voltage	V_{DD}	3.0	—	5.5	V	
	POR Release Voltage	V_{POR}		1.6		V	
	POR Rearm Voltage			0.8		V	
D003	V_{DD} Rise Rate to Ensure POR	SV_{DD}	0.05	—	—	V/ms	Design guidance only Not tested
D004	Supply Current	I_{DD}					
	V_{DD} = 3.0V		—	10	12	mA	F_{OSC} = 12 MHz, (330 nF on V_{USB})
	V_{DD} = 5.0V		—	13	15	mA	
D005	Standby Current	I_{DDS}	—	46	—	µA	
	Input Low-Voltage						
D031	Schmitt Trigger (URX)	V_{IL}	—	—	0.2 V_{DD}	V	3.0V ≤ V_{DD} ≤ 5.5V
	TTL (GP pins)		—	—	0.8		4.5V ≤ V_{DD} ≤ 5.5V
	Input High-Voltage						
D041	Schmitt Trigger (URX)	V_{IH}	0.8 V_{DD}	—	V_{DD}	V	3.0V ≤ V_{DD} ≤ 5.5V
	TTL (GP pins)		2.0	—	V_{DD}		4.5V ≤ V_{DD} ≤ 5.5V
	Input Leakage Current						
D060	GP, URX	I_{IL}	—	±50	±100	nA	V_{SS} ≤ V_{PIN} ≤ V_{DD}, pin at Hi-Z
	Output Low-Voltage						
D080	GP, UTX	V_{OL}	—	—	0.6	V	I_{OL} = 8.0 mA, V_{DD} = 5.0V
			—	—	0.6		I_{OL} = 6.0 mA, V_{DD} = 3.3V
	Output High-Voltage						
D090	GP, UTX	V_{OH}	V_{DD} – 0.7	—	—	V	I_{OH} = -3.5 mA, V_{DD} = 5.0V
			V_{DD} – 0.7	—	—		I_{OH} = -3.0 mA, V_{DD} = 3.3V
	Capacitive Loading Specs on Output Pins						
D102	GPIO	C_{IO}	—	—	50	pF	**Note 1**

Note 1: Characterized only, not 100% tested.

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FIGURE 4-1: POR AND POR REARM WITH SLOW RISING VDD



Note 1: When NPOR is low, the device is held in Reset.

2: TPOR 1 µs typical.

3: TVLOW 2.7 µs typical.

TABLE 4-1: USB MODULE SPECIFICATIONS

DC Characteristics		Operating Conditions (unless otherwise indicated): 3.0V ≤ VDD ≤ 5.5V at -40°C ≤ TA ≤ +85°C (I-Temp)					
Param. No.	**Characteristic**	**Sym.**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
D313	USB Voltage	VUSB	3.0	—	3.6	V	Voltage on the VUSB pin must be in this range for proper USB operation
D314	Input Leakage on Pin	IIL	—	—	±1	µA	VSS ≤ VPIN ≤ VDD pin at high impedance
D315	Input Low Voltage for USB Buffer	VILUSB	—	—	0.8	V	For VUSB range
D316	Input High Voltage for USB Buffer	VIHUSB	2.0	—	—	V	For VUSB range
D318	Differential Input Sensitivity	VDIFS	—	—	0.2	V	The difference between D+ and D- must exceed this value while VCM is met
D319	Differential Common Mode Range	VCM	0.8	—	2.5	V	
D320	Driver Output Impedance(1)	ZOUT	28	—	44	W	
D321	Voltage Output Low	VOL	0.0	—	0.3	V	1.5 kΩ load connected to 3.6V
D322	Voltage Output High	VOH	2.8	—	3.6	V	1.5 kΩ load connected to ground

Note 1: The D+ and D- signal lines have been built-in impedance matching resistors. No external resistors, capacitors or magnetic components are necessary on the D+/D- signal paths between the MCP2221 family device and the USB cable.

TABLE 4-2: THERMAL CONSIDERATIONS

Standard Operating Conditions (unless otherwise stated) Operating temperature: -40°C ≤ TA ≤ +85°C (I-Temp)					
Param. No.	**Sym.**	**Characteristic**	**Typ.**	**Units**	**Conditions**
TH01	θJA	Thermal Resistance Junction to Ambient	70	°C/W	14-pin PDIP package
			95.3	°C/W	14-pin SOIC package
			100	°C/W	14-pin TSSOP package
			45.7	°C/W	16-pin QFN 4 x 4 mm package
TH02	θJC	Thermal Resistance Junction to Case	32	°C/W	14-pin PDIP package
			31	°C/W	14-pin SOIC package
			24.4	°C/W	14-pin TSSOP package
			6.3	°C/W	16-pin QFN 4 x 4 mm package
TH03	TJMAX	Maximum Junction Temperature	+150	°C	
TH04	PD	Power Dissipation	—	W	PD = PINTERNAL + PI/O
TH05	PINTERNAL	Internal Power Dissipation	—	W	PINTERNAL = IDD x VDD(1)
TH06	PI/O	I/O Power Dissipation	—	W	PI/O = Σ(IOL x VOL) + Σ(IOH x (VDD – VOH))
TH07	PDER	Derated Power	—	W	PDER = PDMAX (TJ – TA)/θJA(2, 3)

Note 1: IDD is the current to run the device alone without driving any load on the output pins.

2: TA = Ambient Temperature.

3: TJ = Junction Temperature.

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4.2 AC Characteristics

4.2.1 TIMING PARAMETER SYMBOLOGY

The timing parameter symbols have been created in one of the following formats:

1. TppS2ppS

T	
F	Frequency
E	Error

2. TppS

T	Time

Lowercase letters (pp) and their meanings:

pp			
io	Input or Output pin	osc	Oscillator
rx	Receive	tx	Transmit
bitclk	RX/TX BITCLK	RST	Reset
drt	Device Reset Timer		

Uppercase letters and their meanings:

S			
F	Fall	P	Period
H	High	R	Rise
I	Invalid (high-impedance)	V	Valid
L	Low	Z	High-impedance

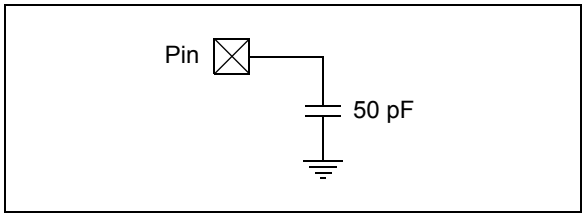
4.2.2 TIMING CONDITIONS

The operating temperature and voltage specified in Table 4-3 apply to all timing specifications, unless otherwise noted. Figure 4-2 specifies the load conditions for the timing specifications.

TABLE 4-3: TEMPERATURE AND VOLTAGE SPECIFICATIONS – AC

AC CHARACTERISTICS	**Standard Operating Conditions (unless otherwise stated)** Operating temperature -40°C ≤ T_A ≤ +85°C Operating voltage V_{DD} range as described in DC spec, **Section 4.1 "DC Characteristics"**.

FIGURE 4-2: LOAD CONDITIONS FOR DEVICE TIMING SPECIFICATIONS



4.2.3 TIMING DIAGRAMS AND SPECIFICATIONS

TABLE 4-4: RESET, OSCILLATOR START-UP TIMER AND POWER-UP TIMER PARAMETERS

Standard Operating Conditions (unless otherwise stated) Operating Temperature: -40°C ≤ TA ≤ +85°C							
Param No.	**Sym.**	**Characteristic**	**Min.**	**Typ.†**	**Max.**	**Units**	**Conditions**
30	TRST	$\overline{\text{RST}}$ Pulse Width (low)	2	—	—	µs	
31	TPWRT	Power-Up timer	40	65	140	ms	
32	TOST	Oscillator Start-Up Time	—	1024	—	TOST	

* These parameters are characterized but not tested.

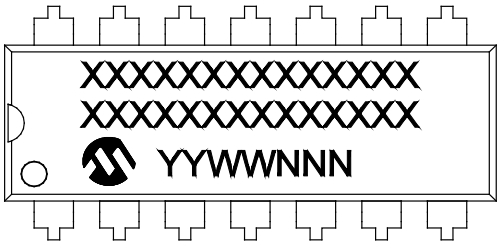
† Data in the “Typ.” column is at 5V, +25°C, unless otherwise stated. These parameters are for design guidance only and are not tested.

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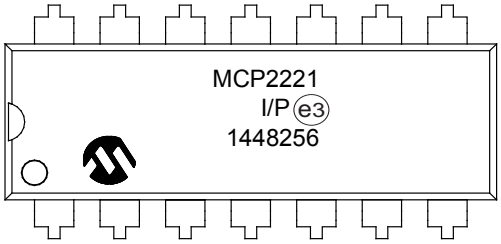
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

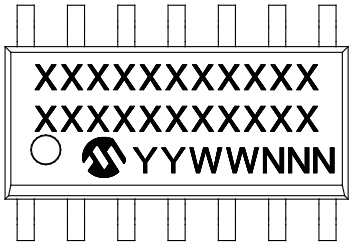
14-Lead PDIP (300 mil)



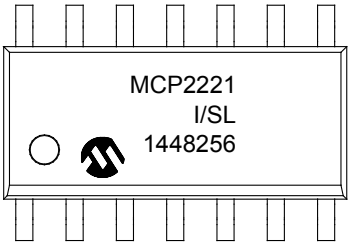
Example



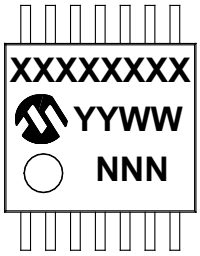
14-Lead SOIC (3.90 mm)



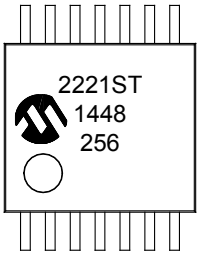
Example



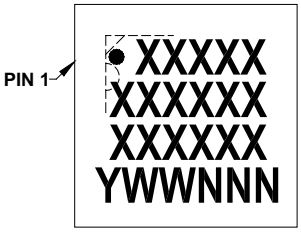
14-Lead TSSOP (4.4 mm)



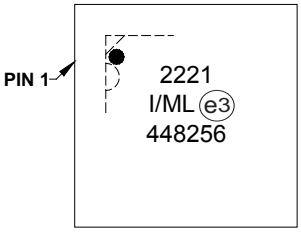
Example



16-Lead QFN (4x4x0.9 mm)



Example

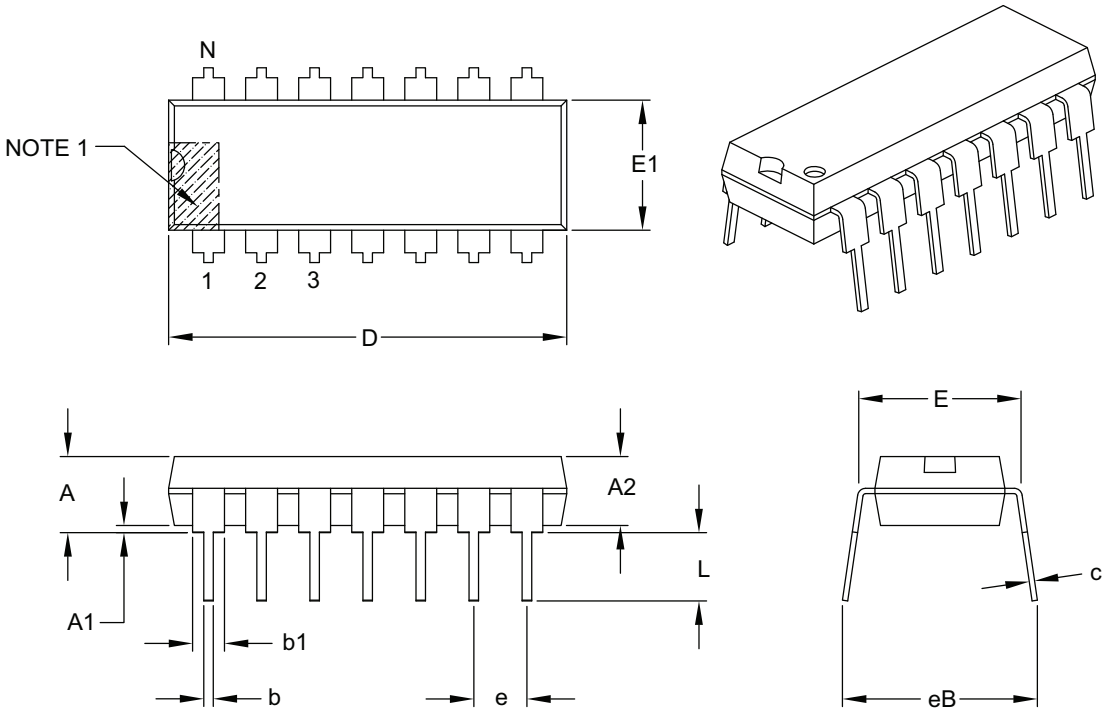


Legend:	XX...X	Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	e3	Pb-free JEDEC designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator (e3) can be found on the outer packaging for this package.

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.

14-Lead Plastic Dual In-Line (P) – 300 mil Body [PDIP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		INCHES		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		14	
Pitch	e		.100 BSC	
Top to Seating Plane	A	–	–	.210
Molded Package Thickness	A2	.115	.130	.195
Base to Seating Plane	A1	.015	–	–
Shoulder to Shoulder Width	E	.290	.310	.325
Molded Package Width	E1	.240	.250	.280
Overall Length	D	.735	.750	.775
Tip to Seating Plane	L	.115	.130	.150
Lead Thickness	c	.008	.010	.015
Upper Lead Width	b1	.045	.060	.070
Lower Lead Width	b	.014	.018	.022
Overall Row Spacing §	eB	–	–	.430

Notes:

1. Pin 1 visual index feature may vary, but must be located with the hatched area.
2. § Significant Characteristic.
3. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" per side.
4. Dimensioning and tolerancing per ASME Y14.5M.

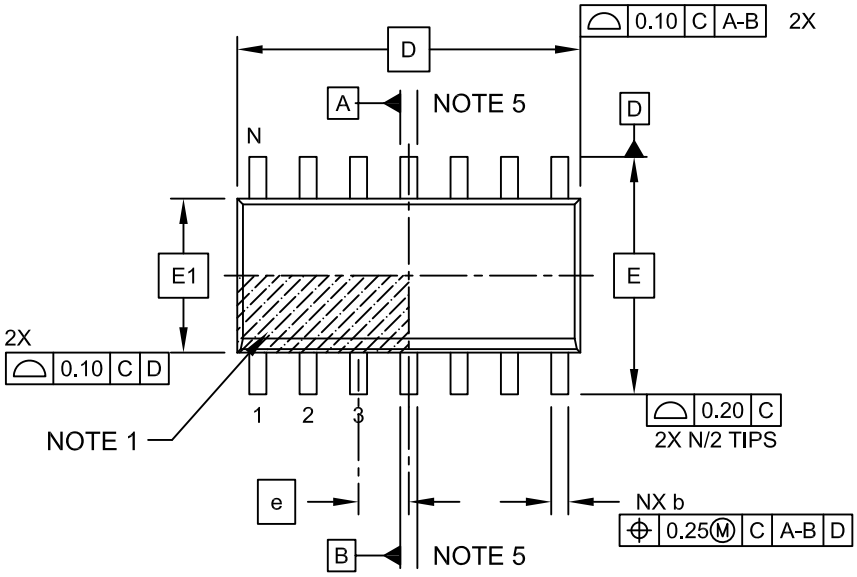
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-005B

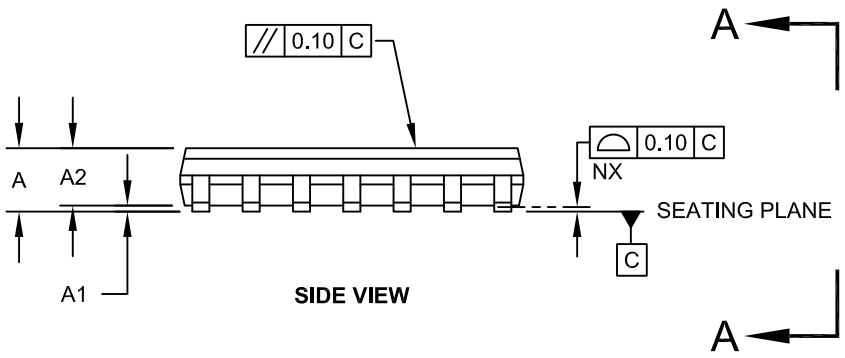
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14-Lead Plastic Small Outline (SL) - Narrow, 3.90 mm Body [SOIC]

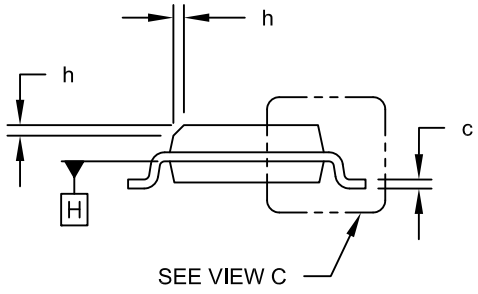
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



TOP VIEW



SIDE VIEW

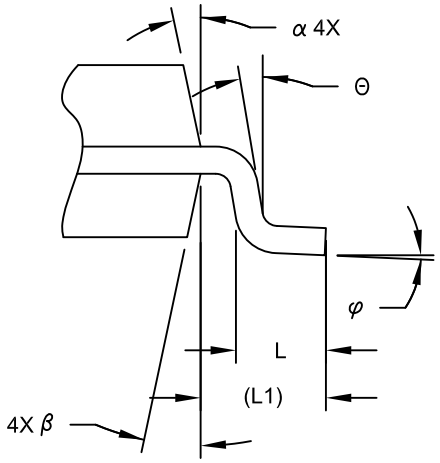


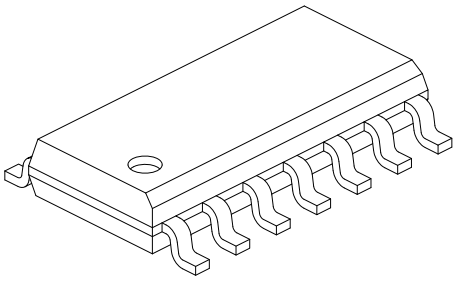
VIEW A-A

Microchip Technology Drawing No. C04-065C Sheet 1 of 2

14-Lead Plastic Small Outline (SL) - Narrow, 3.90 mm Body [SOIC]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging





VIEW C

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		14	
Pitch	e		1.27 BSC	
Overall Height	A	-	-	1.75
Molded Package Thickness	A2	1.25	-	-
Standoff §	A1	0.10	-	0.25
Overall Width	E		6.00 BSC	
Molded Package Width	E1		3.90 BSC	
Overall Length	D		8.65 BSC	
Chamfer (Optional)	h	0.25	-	0.50
Foot Length	L	0.40	-	1.27
Footprint	L1		1.04 REF	
Lead Angle	Θ	0°	-	-
Foot Angle	φ	0°	-	8°
Lead Thickness	c	0.10	-	0.25
Lead Width	b	0.31	-	0.51
Mold Draft Angle Top	α	5°	-	15°
Mold Draft Angle Bottom	β	5°	-	15°

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. § Significant Characteristic
3. Dimension D does not include mold flash, protrusions or gate burrs, which shall not exceed 0.15 mm per end. Dimension E1 does not include interlead flash or protrusion, which shall not exceed 0.25 mm per side.
4. Dimensioning and tolerancing per ASME Y14.5M

   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

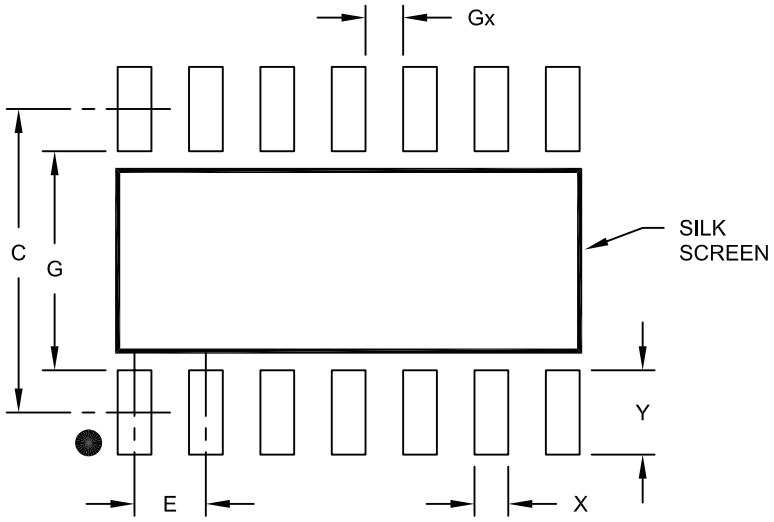
   REF: Reference Dimension, usually without tolerance, for information purposes only.
5. Datums A & B to be determined at Datum H.

Microchip Technology Drawing No. C04-065C Sheet 2 of 2

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14-Lead Plastic Small Outline (SL) - Narrow, 3.90 mm Body [SOIC]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E	1.27 BSC		
Contact Pad Spacing	C		5.40	
Contact Pad Width	X			0.60
Contact Pad Length	Y			1.50
Distance Between Pads	Gx	0.67		
Distance Between Pads	G	3.90		

Notes:

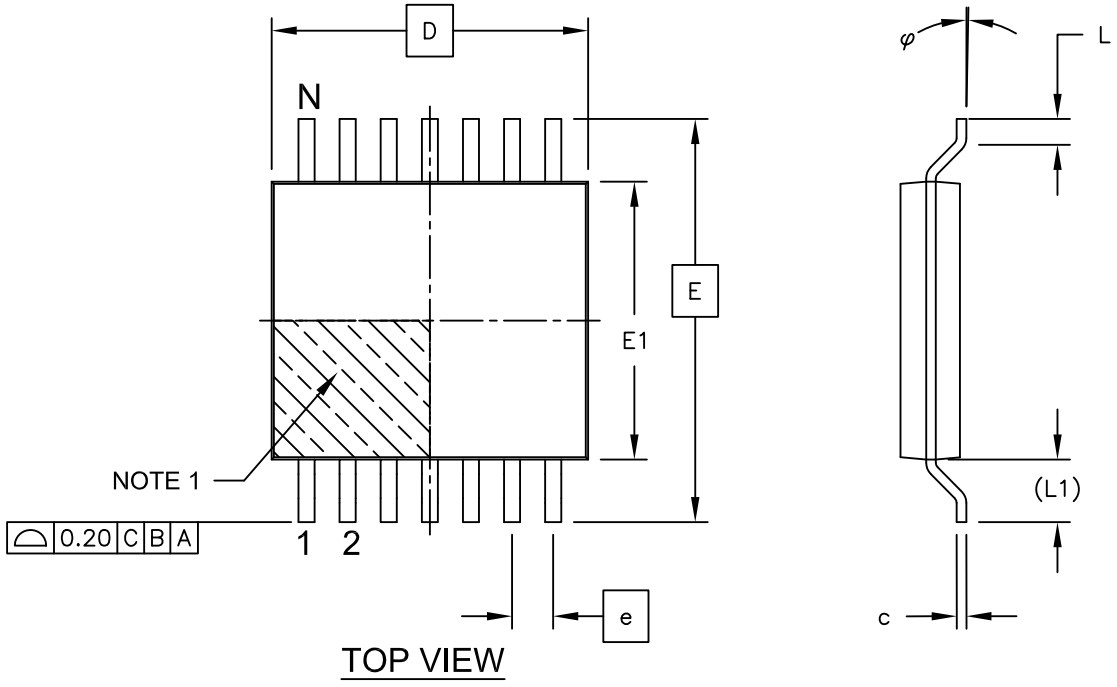
1. Dimensioning and tolerancing per ASME Y14.5M

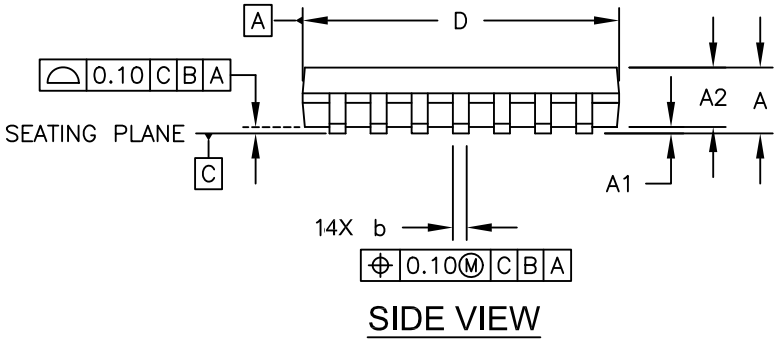
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2065A

14-Lead Plastic Thin Shrink Small Outline (ST) - 4.4 mm Body [TSSOP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



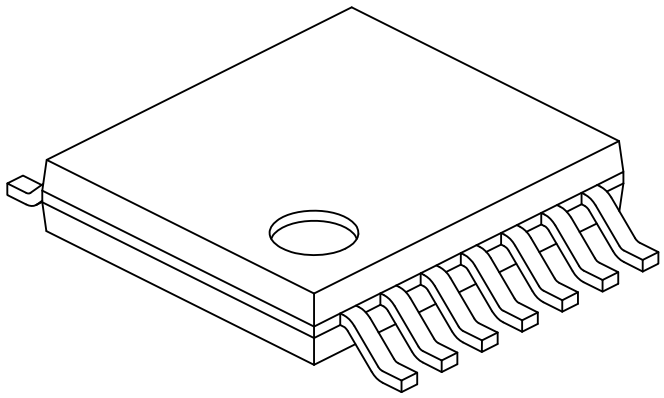


Microchip Technology Drawing C04-087C Sheet 1 of 2

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14-Lead Plastic Thin Shrink Small Outline (ST) - 4.4 mm Body [TSSOP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		14	
Pitch	e		0.65 BSC	
Overall Height	A	-	-	1.20
Molded Package Thickness	A2	0.80	1.00	1.05
Standoff	A1	0.05	-	0.15
Overall Width	E		6.40 BSC	
Molded Package Width	E1	4.30	4.40	4.50
Molded Package Length	D	4.90	5.00	5.10
Foot Length	L	0.45	0.60	0.75
Footprint	(L1)		1.00 REF	
Foot Angle	φ	0°	-	8°
Lead Thickness	c	0.09	-	0.20
Lead Width	b	0.19	-	0.30

Notes:

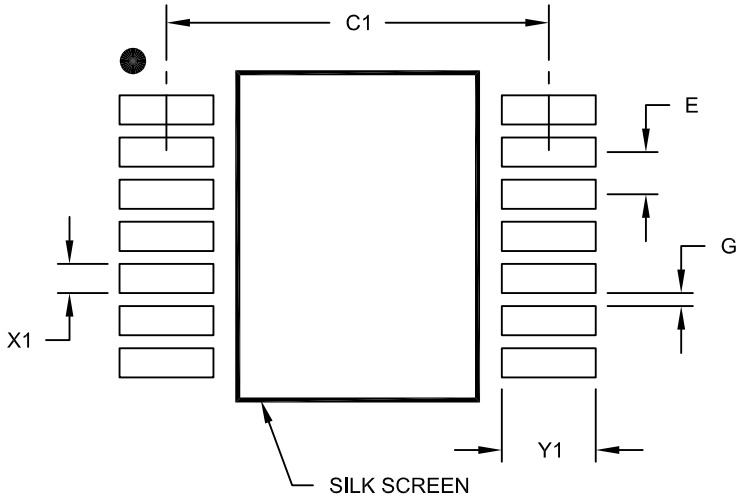
1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm per side.
3. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.
REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing No. C04-087C Sheet 2 of 2

14-Lead Plastic Thin Shrink Small Outline (ST) - 4.4 mm Body [TSSOP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		0.65 BSC	
Contact Pad Spacing	C1		5.90	
Contact Pad Width (X14)	X1			0.45
Contact Pad Length (X14)	Y1			1.45
Distance Between Pads	G	0.20		

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

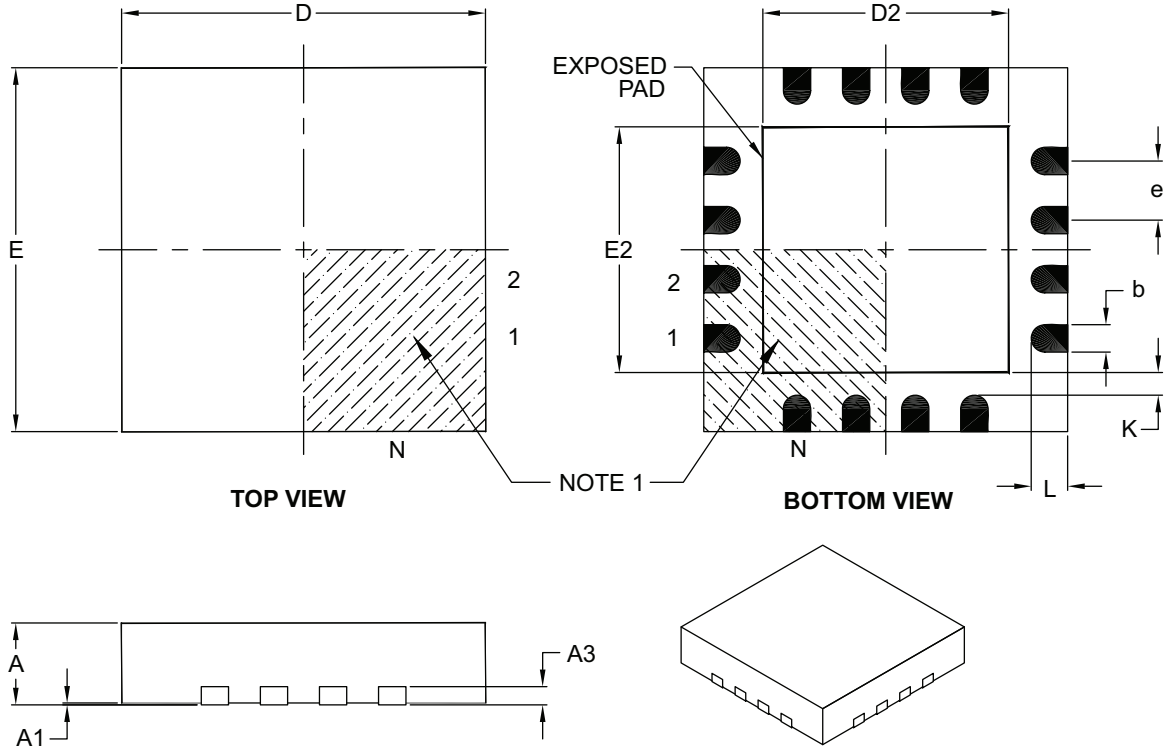
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2087A

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16-Lead Plastic Quad Flat, No Lead Package (ML) – 4x4x0.9 mm Body [QFN]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		16	
Pitch	e		0.65 BSC	
Overall Height	A	0.80	0.90	1.00
Standoff	A1	0.00	0.02	0.05
Contact Thickness	A3		0.20 REF	
Overall Width	E		4.00 BSC	
Exposed Pad Width	E2	2.50	2.65	2.80
Overall Length	D		4.00 BSC	
Exposed Pad Length	D2	2.50	2.65	2.80
Contact Width	b	0.25	0.30	0.35
Contact Length	L	0.30	0.40	0.50
Contact-to-Exposed Pad	K	0.20	–	–

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package is saw singulated.
3. Dimensioning and tolerancing per ASME Y14.5M.

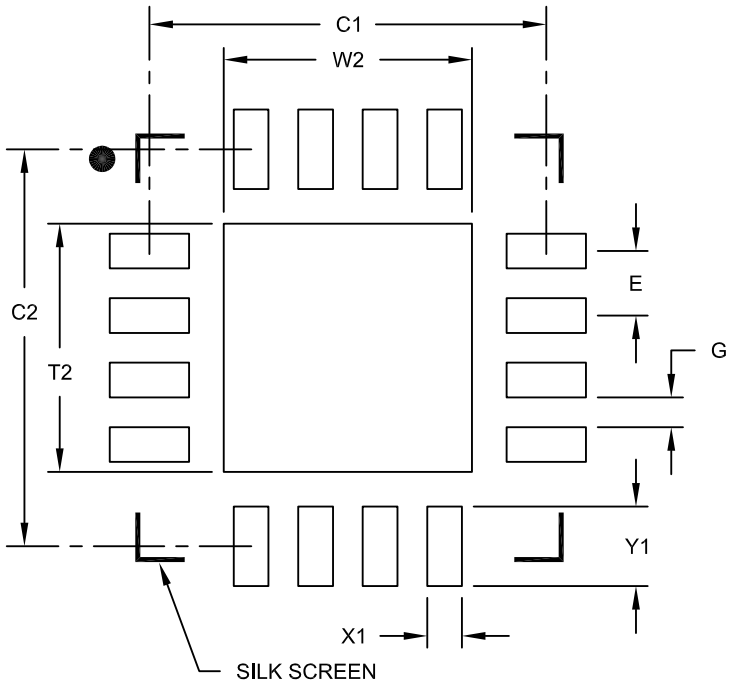
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-127B

16-Lead Plastic Quad Flat, No Lead Package (ML) - 4x4x0.9mm Body [QFN]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		0.65 BSC	
Optional Center Pad Width	W2			2.50
Optional Center Pad Length	T2			2.50
Contact Pad Spacing	C1		4.00	
Contact Pad Spacing	C2		4.00	
Contact Pad Width (X16)	X1			0.35
Contact Pad Length (X16)	Y1			0.80
Distance Between Pads	G	0.30		

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2127A

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APPENDIX A: REVISION HISTORY

Revision B (February 2015)

1. Updated bit settings in Registers 1-1 to 1-7, Register 1-10 and Registers 1-12, 1-13, 1-14, 1-15.

Revision A (May 2014)

Original Release of this Document.

NOTES:

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PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip sales office.

PART NO.	[X](1)	X	/XX
Device	Tape and Reel Option	Temperature Range	Package

Device:	MCP2221:	USB-to-I^{2}C/UART Protocol Converter
	MCP2221T:	USB-to-I^{2}C/UART Protocol Converter (Tape and Reel)
Temperature Range:	I =	-40°C to +85°C (Industrial)
Package:	ML =	Plastic Quad Flat, No Lead Package – 4x4x0.9 mm Body (QFN), 16-Lead
	P =	Plastic Dual In Line, 300 mil. Body (PDIP), 14-Lead
	SL =	Plastic Small Outline – Narrow, 3.90 mm Body (SOIC), 14-Lead
	ST =	Plastic Thin Shrink Small Outline – 4.4 mm Body (TSSOP), 14-Lead

Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

Examples:

a)	MCP2221- I/P:	Industrial temperature, 14LD PDIP Package
a)	MCP2221- I/SL:	Industrial temperature, 14LD SOIC Package
b)	MCP2221T- I/SL:	Tape and Reel, Industrial temperature, 14LD SOIC Package
a)	MCP2221- I/ST:	Industrial temperature, 14LD TSSOP Package
b)	MCP2221T- I/ST:	Tape and Reel, Industrial temperature, 14LD TSSOP Package
a)	MCP2221- I/ML:	Industrial temperature, 16LD 4x4 QFN Package
b)	MCP2221T- I/ML:	Tape and Reel, Industrial temperature, 16LD 4x4 QFN Package

NOTES:

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Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

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ISBN: 978-1-63277-016-5

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