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PmodJSTK2™ Reference Manual

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This manual applies to the PmodJSTK2 rev. C

Overview

The Digilent PmodJSTK2 (Revision C) is a versatile user input device that can be easily incorporated into a wide variety of projects. With a two-axis joystick on a center button, a trigger button, and a programmable RGB LED capable of 24-bit color.

The PmodJSTK2.

Features include:

- Factory Calibrated Two Axis Resistive Joystick
- Center Joystick Button
- Trigger Style Push Button
- 24-bit RGB LED
- 6-pin Pmod connector with SPI interface
- Library and example code available in resource center

1 Functional Descriptions

The PmodJSTK2 utilizes two potentiometers oriented orthogonally to one another and are manipulated by moving the joystick in the X and Y directions. As the joystick moves, the voltage output at the sweep pin of each potentiometer changes and is measured by the 10-bit ADC present on the embedded PIC16F1618 microcontroller. The raw measured data is stored at a rate of 100 Hz as a 16-bit right-justified variable in RAM with the upper 6 bits masked with zeros.

Additionally, each successive measurement also produces two 8-bit values representative of the joysticks physical location with respect to each axis. Note that if inversion of either of the 8-bit position axis are set, the values will not change until the data has been re-collected by the PIC16 at the 100 Hz rate.

2 Specifications

Parameter	Min	Typical[1]	Max	Units
Recommended Operating Voltage	3.1	3.3	3.5	V
Maximum Supply Voltage	-	-	5.5	V
Power Supply Current[2]	-	4.85	-	mA
Power Supply Current[3]	-	17.6	-	mA
Parameter	**Value**			**Units**
Maximum Joystick Angle	25			Degrees
Communication Protocol	SPI			

Note[1]: Data in the Typical Column uses V_{cc} at 3.3V unless otherwise noted

Note[2]: Normal operation with the RGB LED Off and no buttons pressed

Note[3]: Normal operation with the RGB LED set to white and both buttons pressed

3 Interfacing with the Pmod

The PmodJSTK2 communicates with the host board via the SPI protocol. With the PmodJSTK2, there are two types of data packet protocols: the standard data packet of 5 bytes and an extended data packet with 6 or 7 bytes in total. With the standard 5 byte protocol, users may use the old code from the PmodJSTK without any syntax errors. The 5 byte packet structure is provided in the image below:

	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
MOSI	COMMAND / 0	PARAM1 / DUMMY	PARAM2 / DUMMY	PARAM3 / DUMMY	PARAM4 / DUMMY
MISO	smpX (Low Byte)	smpX (High Byte)	smpY (Low Byte)	smpY (High Byte)	fsButtons

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
fsButtons	EXTPKT	0	0	0	0	0	TRIGGER	JOYSTICK

EXTPKT: Extended Packet Status Bit
1 = additional data corresponding to the command byte is available and may be retrieved after this byte
0 = standard response packet, no additional data follows this byte

TRIGGER: Trigger Button Status Bit
1 = trigger button is currently pressed
0 = trigger button is not being pressed

JOYSTICK: Joystick Center Button Status Bit
1 = joystick center button is currently pressed
0 = joystick center button is not being pressed

As noted in the standard data packet structure, users may either send a zero and a series of 4 dummy bytes to receive the standard 5 bytes of data or they may send a single command byte with up to 4 parameters in the four following bytes to set the internal values such as the joystick calibration or on-board RGB LED.

The extended data protocol allows for additional data to be obtained from the device during a communication session after the standard 5 bytes of information such as normalized 8-bit positional data for each axis. Users may also obtain the current calibration values and the status of the module through this method.

	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
MOSI	cmdGetStatus	DUMMY	DUMMY	DUMMY	DUMMY	DUMMY
MISO	smpX (Low Byte)	smpX (High Byte)	smpY (Low Byte)	smpY (High Byte)	fsButtons	fsStatus

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
fs Status	CALIBRATING	LASTCAL	LASTFWS	LASTFRS	-	-	INVX	INVY
Initial Value	0	0	0	1	0	0	0	0

Bit 7 **CALIBRATING:** Calibration Status Bit(1)
1 = calibration procedure is currently executing
0 = calibration is not taking place

Bit 6 **LASTCAL:** Calibration Success Bit(2)
1 = last calibration procedure was successful
0 = last calibration procedure failed

Bit 5 **LASTFWS:** Flash Write Success Bit(3)
1 = last flash write was successful
0 = last flash write failed

Bit 4 **LASTFRS:** Flash Read Success Bit(4)
1 = last flash read was successful
0 = last flash read failed

Bit 3 **Unimplemented:** Read as '0'

Bit 2 **Unimplemented:** Read as '0'

Bit 1 **INVX:** Joystick X-Axis Position Inversion Enable Bit
1 = joystick x-axis position inversion is enabled
0 = joystick x-axis position inversion is disabled

Bit 0 **INVY:** Joystick Y-Axis Position Inversion Enable Bit
1 = joystick y-axis position inversion is enabled
0 = joystick y-axis position inversion is disabled

Note

1: This bit is set immediately after receiving a Calibrate command. It will remain set until the calibration procedure completes.

2: This bit is set or cleared immediately after a calibration procedure completes.

3: This bit is set or cleared immediately after a flash write attempt is performed. It will always be cleared at initial power on.

4: This bit is set or cleared immediately after a flash read attempt is performed. This bit will be set at initial power on, provided that the calibration constants were successfully read from the high endurance flash.

3.1 SPI Timing Requirements

The embedded PIC16F1618 requires certain SPI timing requirements in order for successful communication to occur. When the Chip Select line is brought low, users must wait at least 15 µS before sending the first byte of data. An interbyte delay of at least 10 µS is required when transferring multiple bytes. When the Chip Select line is brought high after the last byte has been transferred, at least 25 µS is required before users may bring the Chip Select line low again to initiate another communication session.

3.2 Calibrating the Module

The PmodJSTK2 has a set of factory loaded calibration values that are used to calculate the 8-bit position values for each axis. Users may enter calibration mode to recalculate all of those values by rotating the joystick around so the embedded PIC16 can record all of the maximum and minimum samples for the two axes. The on-board blue LED will be flashing to indicate that the calibration sequence is taking place. When the embedded microcontroller detects that the joystick has not changed for an entire second, allowing the microcontroller to presume that the most recent set of measurements correspond to the joystick's center position, the blue LED will stop flashing and the green LED will flash twice to indicate that the calibration procedure was successful. However, if 10 seconds pass without the PIC16 detecting the center position, the blue LED will stop flashing and the red LED will flash twice indicating that the calibration procedure was not successful.

Once the Chip Select pin goes high after the calibration command has been processed, the PmodJSTK2 will not accept any new commands during the calibration procedure. Users may still poll the status register to determine the current status of the device during this time.

3.3 Using the High-endurance Flash

The PmodJSTK2 has a set of factory loaded calibration values that are used to calculate the 8-bit position values for each axis. Users may enter calibration mode to recalculate all of those values by rotating the joystick around so the embedded PIC16 can record all of the maximum and minimum samples for the two axes. The on-board blue LED will be flashing to indicate that the calibration sequence is taking place. When the embedded microcontroller detects that the joystick has not changed for an entire second, allowing the microcontroller to presume that the most recent set of measurements correspond to the joystick's center position, the blue LED will stop flashing and the green LED will flash twice to indicate that the calibration procedure was successful. However, if 10 seconds pass without the PIC16 detecting the center position, the blue LED will stop flashing and the red LED will flash twice indicating that the calibration procedure was not successful.

Once the Chip Select pin goes high after the calibration command has been processed, the PmodJSTK2 will not accept any new commands during the calibration procedure. Users may still poll the status register to determine the current status of the device during this time.

3.4 Command Summary

3.4.1 Get Commands

		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
cmdGetPosition	**(0xC0)**	1	1	0	0	0	0	0	0

Parameters

None

Get the 8-bit position variables corresponding to the location of the Joystick's X and Y axis. The X position is transferred to the master following the byte containing the button state. The Y position is transferred to the master immediately following the X position.

		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
cmdGetStatus	**(0xF0)**	1	1	1	1	0	0	0	0

Parameters

None

Get a copy of the device's status register. The 8-bit status register is transferred to the master following the byte containing the button state.

		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
cmdGetFirmwareVer	**(0xF1)**	1	1	1	1	0	0	0	1

Parameters

None

Get a copy of the device's firmware version. The low byte of the firmware version is transferred to the master following the byte containing the button state. The high byte is transferred to the master immediately following the low byte.

		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
cmdGetCalXMin	**(0xE0)**	1	1	1	0	0	0	0	0

Parameters

None

Get a copy of the smpXMin calibration constant. The low byte of the calibration constant is transferred to the master following the byte containing the button state. The high byte is transferred to the master immediately following the low byte.

		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
cmdGetCalXMax	**(0xE1)**	1	1	1	0	0	0	0	1

Parameters

None

Get a copy of the smpXMax calibration constant. The low byte of the calibration constant is transferred to the master following the byte containing the button state. The high byte is transferred to the master immediately following the low byte.

3.4.2 Set Commands

cmdSetLed **(0x80)**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	0	0	0	0	IGNORED	LEDST

Parameters

None

LEDST: Green LED ON/OFF State
1 = turn LED on
0 = turn LED off

IGNORED: the state of this bit has ignored

Turn the Green LED on or off. The Red and Green LEDs are both set to the off state.

cmdSetLedRGB **(0x84)**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	0	0	0	1	0	0

Parameters

PARAM1 – Red LED duty cycle
PARAM2 – Green LED duty cycle
PARAM3 – Blue LED duty cycle
PARAM4 – ignored

Set the duty cycles for the Red, Green, and Blue LEDs.

cmdSetInversion **(0x88)**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	0	0	1	0	INVX	INVY

Parameters

None

INVX: Joystick X-Axis Position Inversion Enable Bit
1 = enable joystick x-axis position inversion
0 = disable joystick x-axis position inversion

INVY: Joystick Y-Axis Position Inversion Enable Bit
1 = enable joystick y-axis position inversion
0 = disable joystick y-axis position inversion

Enable inversion of the 8-bit position value corresponding to the X and/or Y axis of the Joystick.

cmdSetCalXMin **(0xA8)**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	1	0	1	0	0	0

Parameters

PARAM1 – smpXMin (Low Byte)
PARAM2 – smpXMin (High Byte)
PARAM3 – ignored
PARAM4 – ignored

Set the smpXMin calibration constant. Please note that the value specified for smpXMin must be less than smpXCenterMin. If the specified value fails to meet this requirement then smpXMin will not be updated.

cmdSetCalXMax **(0xA9)**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	1	0	1	0	0	1

Parameters

PARAM1 – smpXMax (Low Byte)
PARAM2 – smpXMax (High Byte)
PARAM3 – ignored
PARAM4 – ignored

Set the smpXMax calibration constant. Please note that the value specified for smpXMax must be greater than smpXCenterMax. If the specified value fails to meet this requirement then smpXMax will not be updated.

cmdSetCalYMin **(0xAA)**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	1	0	1	0	1	0

Parameters

PARAM1 – smpYMin (Low Byte)
PARAM2 – smpYMin (High Byte)
PARAM3 – ignored
PARAM4 – ignored

Set the smpYMin calibration constant. Please note that the value specified for smpYMin must be less than smpYCenterMin. If the specified value fails to meet this requirement then smpYMin will not be updated.

		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
cmdSetCalYMax	**(0xAB)**	1	0	1	0	1	0	1	1

Parameters

PARAM1 – smpYMax (Low Byte)
PARAM2 – smpYMax (High Byte)
PARAM3 – ignored
PARAM4 – ignored

Set the smpYMax calibration constant. Please note that the value specified for smpYMax must be greater than smpYCenterMax. If the specified value fails to meet this requirement then smpYMax will not be updated.

		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
cmdSetCalXCenMin	**(0xAC)**	1	0	1	0	1	1	0	0

Parameters

PARAM1 – smpXCenterMin (Low Byte)
PARAM2 – smpXCenterMin (High Byte)
PARAM3 – ignored
PARAM4 – ignored

Set the smpXCenterMin calibration constant. Please note that the value specified for smpXCenterMin must be greater than smpXMin and less than smpXCenterMax. If the specified value fails to meet these requirements then smpXCenterMin will not be updated.

		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
cmdSetCalXCenMax	**(0xAD)**	1	0	1	0	1	1	0	1

Parameters

PARAM1 – smpXCenterMax (Low Byte)
PARAM2 – smpXCenterMax (High Byte)
PARAM3 – ignored
PARAM4 – ignored

Set the smpXCenterMax calibration constant. Please note that the value specified for smpXCenterMax must be greater than smpXCenterMin and less than smpXMax. If the specified value fails to meet these requirements then smpXCenterMax will not be updated.

		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
cmdSetCalYCenMin	**(0xAE)**	1	0	1	0	1	1	1	0

Parameters

PARAM1 – smpYCenterMin (Low Byte)
PARAM2 – smpYCenterMin (High Byte)
PARAM3 – ignored
PARAM4 – ignored

Set the smpYCenterMin calibration constant. Please note that the value specified for smpYCenterMin must be greater than smpYMin and less than smpYCenterMax. If the specified value fails to meet these requirements then smpYCenterMin will not be updated.

		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
cmdSetCalYCenMax	**(0xAF)**	1	0	1	0	1	1	1	1

Parameters

PARAM1 – smpYCenterMax (Low Byte)
PARAM2 – smpYCenterMax (High Byte)
PARAM3 – ignored
PARAM4 – ignored

Set the smpYCenterMax calibration constant. Please note that the value specified for smpYCenterMax must be greater than smpYCenterMin and less than smpYMax. If the specified value fails to meet these requirements then smpYCenterMax will not be updated.

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
cmdSetCalXMinMax (0xB0)	1	0	1	1	0	0	0	0

Parameters

PARAM1 – smpXMin (Low Byte)
PARAM2 – smpXMin (High Byte)
PARAM3 – smpXMax (Low Byte)
PARAM4 – smpXMax (High Byte)

Set the smpXMin and smpXMax calibration constants. Please note that the value specified for smpXMin must be less than smpXCenterMin and the value specified for smpXMax must be greater than smpXCenterMax. If either of the specified values fail to meet the above requirements then smpXMin and smpXMax will not be updated.

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
cmdSetCalYMinMax (0xB1)	1	0	1	1	0	0	0	1

Parameters

PARAM1 – smpYMin (Low Byte)
PARAM2 – smpYMin (High Byte)
PARAM3 – smpYMax (Low Byte)
PARAM4 – smpYMax (High Byte)

Set the smpYMin and smpYMax calibration constants. Please note that the value specified for smpYMin must be less than smpYCenterMin and the value specified for smpYMax must be greater than smpYCenterMax. If either of the specified values fail to meet the above requirements then smpYMin and smpYMax will not be updated.

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
cmdSetCalXCenMinMax (0xB2)	1	0	1	1	0	0	1	0

Parameters

PARAM1 – smpXCenterMin (Low Byte)
PARAM2 – smpXCenterMin (High Byte)
PARAM3 – smpXCenterMax (Low Byte)
PARAM4 – smpXCenterMax (High Byte)

Set the smpXCenterMin and smpXCenterMax calibration constants. Please note that the value specified for smpXCenterMin must be greater than smpXMin and the value specified for smpXCenterMax must be less than smpXMax. Additionally, the value specified for smpXCenterMin must be less than the value specified for smpXCenterMax. If any of the specified values fail to meet the above requirements then smpXCenterMin and smpXCenterMax will not be updated.

3.4.3 Other Commands

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
cmdCalibrate (0xA4)	1	0	1	0	0	1	0	0

Parameters

None

Enter Joystick calibration mode.

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
cmdWriteFlash (0xB8)	1	0	1	1	1	0	0	0

Parameters

None

Write the calibration constants from RAM to High Endurance Flash.

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
cmdRldFromFlash (0xBC)	1	0	1	1	1	1	0	0

Parameters

None

Read the calibration constants from High Endurance Flash and load them into RAM.

4 Pinout Description Table

A pinout table of the PmodJSTK2 is provided below.

Pin	Signal	Description
1	CS	Chip Select
2	MOSI	Master-Out-Slave-In
3	MISO	Master-In-Slave-Out
4	SCK	Serial Clock
5	GND	Power Supply Ground
6	VCC	Power Supply (3.3V/5V)

Although users are welcome to create their own interface code for the PmodJSTK2 if they so desire, pre-constructed libraries that provide functions for initializing the module, reading in values, and adjusting calibration values exist. They are available on the PmodJSTK2 example code page.

Any external power applied to the PmodJSTK2 must be within 2.95V and 5.5V; however, it is recommended that Pmod is operated at 3.3V.

5 Physical Dimensions

The pins on the pin header are spaced 100 mil apart. The PCB is 1.875 inches long on the sides parallel to the pins on the pin header, 0.9375-inch-long on the sides perpendicular to the pin header, and 1.75 inches tall. With the 3-D printed housing the module is 1.875 inches long on the sides parallel to the pins on the pin header, 1.125 inches long on the sides perpendicular to the pin header, and 1.75 inches tall.