SEMTECH

PixiPoint™ Z UR7HCPXZ-P440
Advanced "Click-to-Select"
No-Drift™ PS/2 Force Stick Controller

HID & SYSTEM MANAGEMENT PRODUCTS, MOUSECODER™ FAMILY

DESCRIPTION

The PixiPoint™ Z mouse encoder is a cost-effective, high-functionality IC designed to interface the CTS 106, 108 and 109 sensors to the PS/2 port. Ideal for laptop/palmtop use, the low power PixiPoint™ Z offers an advanced algorithm for enhanced motion control. The IC also enables click, double-click, MouseWheel action and slow drag without the need for special drivers. The IC provides an extra port for hot-plug connection of an external pointing device, including those with built-in Mousewheel. Both the embedded sensor and the external device can be operated concurrently.

The PixiPoint™ Z utilizes a special signal conditioning circuit (US and International patent pending) which enables a low cost, simple and real estate-saving implementation. Just a few low tolerance external components are needed.

The IC implements typically consumes less than 3mA, making it suitable for use in battery-operated systems.

PS/2 communication is bidirectional at 10 kbps. The IC, a CMOS device operating at 4 MHz, is compatible with both the IBM and Microsoft two-button and the Logitech three-button mouse protocols. It implements all commands from and to the system, as defined in the IBM PS/2 Mouse Communication Protocol. Custom versions are also available to suit a range of applications.

FEATURES

- Accurate cursor control via Semtech's Advanced Motion Control algorithm
- Click (Select), Double-Click (Execute), MouseWheel and slow drag are implemented in the IC – no special driver support required
- Enables hot-plug connections of an external pointing device, including those with MouseWheel
- Offers concurrent operation of force stick and external pointing device
- Provides ideal interface for CTS Series 106, 108 and 109 sensors
- Low power consumption of typically less than 3mA makes it ideal for battery-operated systems
- 3-5V operation in extended temperature range
- Can utilize standard mouse drivers
- Inexpensive, simple and real estate-saving implementation with USAR's proprietary signal conditioning circuit
- Offers "Clean Stop" so cursor stops when you want it to
- Compatible with IBM/Microsoft two-button and Logitech three-button mouse
- Supports all commands from and to the system, as defined in the IBM PS/2 Mouse Communication Protocol
- Small 32-pin 7mm X 7mm LQFP package
- Customized versions available
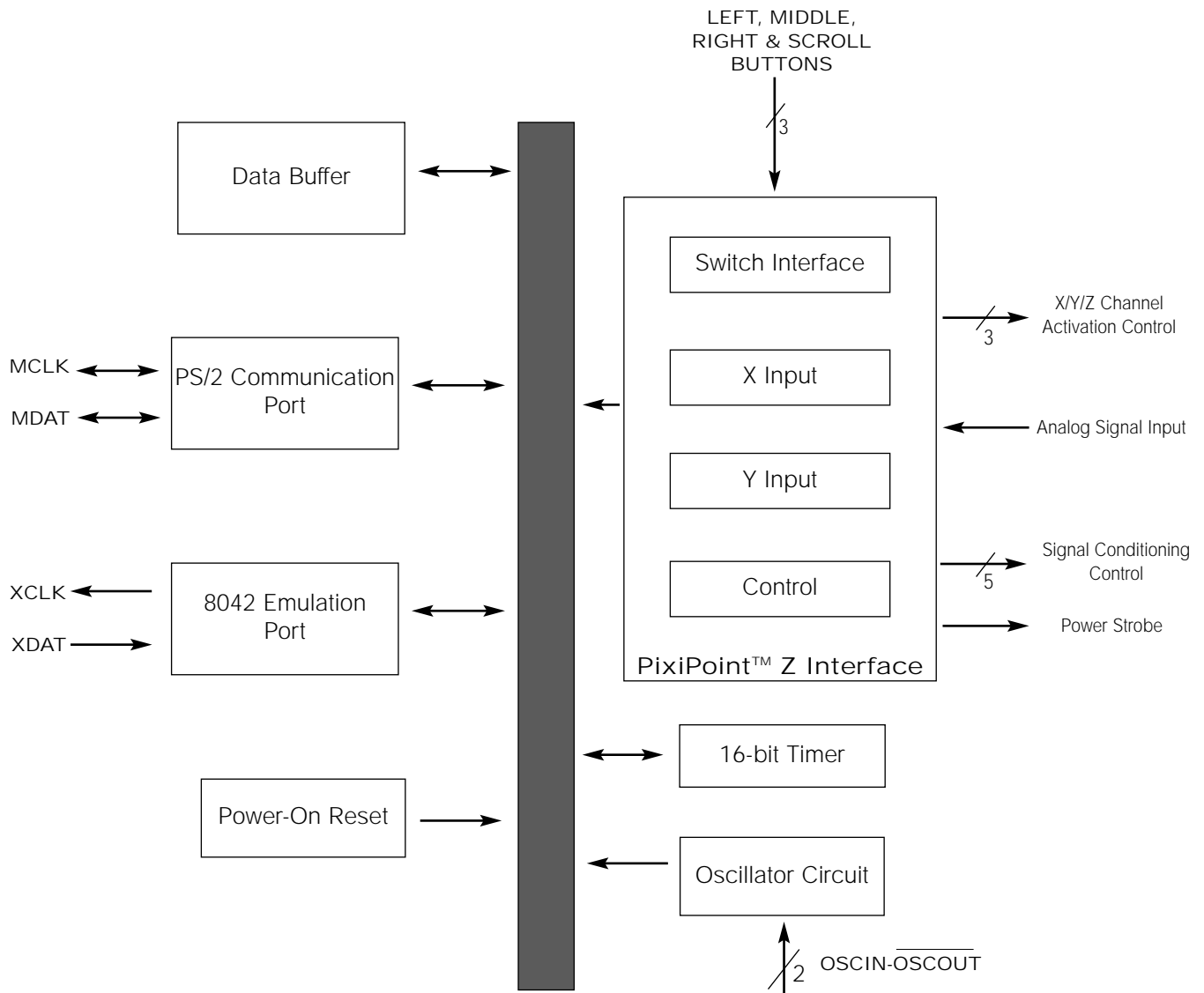- Royalty-free and cost-effective

APPLICATIONS

- Notebooks/laptops
- Handhelds
- Keyboards
- Instrumentation

PIN ASSIGNMENTS
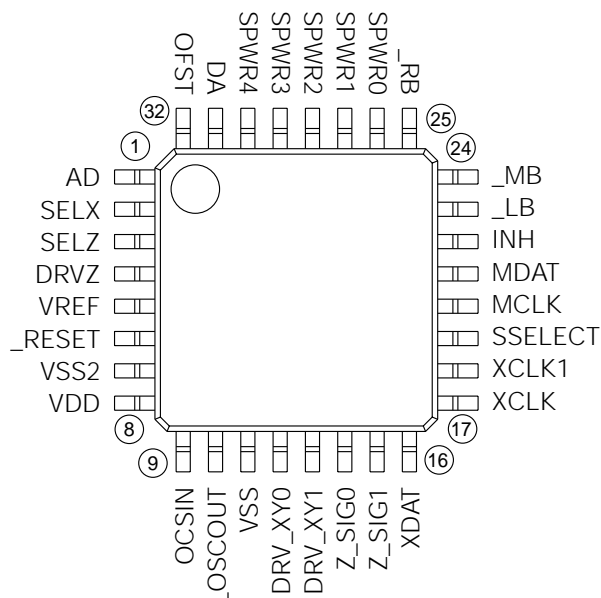
Package options	Pitch in mm's	TA = -20°C to +85°C
32-pin, Plastic LQFP	0.5	UR7HCPXZ-P440-FA

XX = Optional for customization codes

BLOCK DIAGRAM

www.semtech.com

FUNCTIONAL DESCRIPTION

The UR7HCPXZ-P440 consists functionally of five major sections (see Functional Diagram, previous page). These are the PixiPoint™ Z Interface, the 16-Bit Timer, the Oscillator Circuit, the PS/2 Communication Port and the 8042 Emulation Port. All sections communicate with each other and operate concurrently.

SIGNAL CONDITIONING CIRCUIT

The PixiPoint™ Z sensor is a flexible (but very firm) "beam" with four Strain Gages – one on each of the sides. If the force is applied precisely in the X direction, then it will produce a change of resistance of only the two X gages. Force in the Y direction will cause changes only in the Y gages. One of the pair of the gages will increase, while the other will concurrently decrease the resistance.

If the user presses on the sensor from the top (Z Axis), all of the strain gages will decrease the resistance.

When the test current is passed through the gages, these resistance changes are converted into the voltage changes. These signals are very small, typically under 1 mV Full Scale.

The Signal Conditioning Circuit (patent pending) balances and amplifies the incoming signals for digitizing by a built-in A/D converter.

PIN DEFINITIONS

Mnemonic	Pin #	Type	Name and Function
VDD	8	P	**Power Supply:** +5V
VSS	11	P	**Ground**
VSS2	7	P	**Ground**
OSCIN	9	I	**Oscillator Input:** external clock input or one side of the Ceramic Resonator with built-in Load Capacitors
_OSCOUT	10	O	**Oscillator Output:** open for external clock input or other side of the Ceramic Resonator with built-in Load Capacitors
_RESET	6	I	**Reset:** apply 0V to provide orderly start-up
MDAT	21	I/O (nd)	**Mouse Data:** connects to host's data line
MCLK	20	I/O (nd)	**Mouse Clock:** connects to host's clock line
XCLK	17	I	**External Mouse Clock:** PS/2 clock signal from external mouse
XCLK1	18	I/O (nd)	**External Mouse Clock 1:** connect to XCLK
XDAT	16	I/O (nd)	**External Mouse Data:** PS/2 data signal from external mouse
_LB	23	I/O (nd)	**Left Button:** active low, strobed sampling
_MB	24	I/O (nd)	**Middle Button:** active low, strobed sampling
_RB	25	I/O (nd)	**Right Button:** active low, strobed sampling
DRV_XY0	12	I/O	**Sensor's Excitation Driver**
DRV_XY1	13	I/O	**Sensor's Excitation Driver:** connect to DRV_XY0
Z_SIG0	14	I/O	**Sensor's Excitation Driver**
Z_SIG1	15	I/O	**Sensor's Excitation Driver:** connect to Z_SIG0
DRVZ	4	I/O	**Sensor's Excitation Driver**
SELX	2	O	**Select X:** control line for analog multiplexer
SELZ	3	O	**Select Z:** control line for analog multiplexer
INH	22	O	**Multiplexer Inhibit Signal:** active high
VREF	5	AI	**Reference Voltage** for built-in A/D
AD	1	AI	**Analog to Digital Converter Input**
DA	31	I/O	**Digital to Analog Converter Output**
OFST	32	I/O	**Offset:** resets the offset circuit during inactivity
SPWR0	26	I/O	**Switched Power Driver**
SPWR1	27	I/O	**Switched Power Driver:** connect to SPWR0
SPWR2	28	I/O	**Switched Power Driver:** connect to SPWR0
SPWR3	29	I/O	**Switched Power Driver:** connect to SPWR0
SPWR4	30	I/O	**Switched Power Driver:** connect to SPWR0
PWROFF	19	I/O	**Reserved:** power management control

Note: An underscore before a pin mnemonic denotes an active low signal.
Pin Types Legend: AI=Analog Input; I=Input; O=Output; I/O=Input or Output; I/O (nd)=Input or Output with N-chanel Open Drain driver

SIGNAL CONDITIONING CIRCUIT (CON'T)

Semtech's proprietary circuit can correct a significant imbalance between the gages in each X and Y pair (+/- 25%), allowing relaxed manufacturing tolerances for the sensors, interconnecting cabling, and temperature-shift induced errors (no performance degradation over the full operating temperature range and for large temperature gradients between the paired gages).

www.semtech.com

BUILT-IN FEATURES

The PixiPoint™ Z enables click, double-click, MouseWheel action and slow drag without the need for special drivers. A standard PS/2 mouse driver can be utilized.

PS/2 COMMUNICATION

At start-up or upon receiving a reset command, the PixiPoint™ Z will wait between 300 and 500 milliseconds before sending an AAh to the host followed by a device ID of 00h. Then the IC will set itself to its default values, i.e. Incremental Stream Mode with 1:1 scaling, and a report rate of 100 Hz. The device will then disable itself until a command is sent from the host. PixiPoint™ Z has responded or until 25 milliseconds have elapsed.

EXTERNAL PS/2 PORT

The UR7HCPXZ-P440 offers an external PS/2 mouse port. Data from this port is seamlessly merged with data from the internal pointing device. External devices, including those utilizing a MouseWheel, can be hot-plug connected.

ERROR HANDLING

For every correct command or parameter received from the host, the UR7HCPXZ-P440 sends an Acknowledge (FAh). If an invalid command or parameter is received, the UR7HCPXZ-P440 issues a Resend Request (FEh). If an invalid input is again received, the device transmits an Error Code (FCh) to the host. Both error and Resend request responses are sent by the device within 25 milliseconds. The host may not issue any new commands until either the PixiPoint™ Z has responded or until 25 milliseconds have elapsed.

www.semtech.com

SEMTECH

The following table shows the data report format. Each of the two position values (X and Y) is expressed as a 9-bit Two's Complement integer with the most significant bit (the sign bit) stored separately in Byte 1. Z value (wheel or scroll) is expressed as an 8-bit Two's complement integer.

If there is an overflow of the accumulator, the maximum positive or negative count is reported and the corresponding overflow bit is set.

DATA REPORT FORMAT TABLE

Byte 1

b0	Left Button status	1 = depressed
b1	Right Button Status	1 = depressed
b2	Middle Button Status	1 = depressed
b3	Reserved	Always = 1
b4	X8: MSB of X data, sign bit	1 = negative
b5	Y8: MSB of Y data, sign bit	1 = negative
b6	X data overflow	1 = overflow
b7	Y data overflow	1 = overflow

Byte 2

b0	X0: LSB of X data
b1	X1
b2	X2
b3	X3
b4	X4
b5	X5
b6	X6
b7	X7

Byte 3

b0	Y0: LSB of Y data
b1	Y1
b2	Y2
b3	Y3
b4	Y4
b5	Y5
b6	Y6
b7	Y7

Byte 4 (for wheel function; sent only if output of Z data is enabled by the driver)

b0	Z0: LSB of Z data
b1	Z1
b2	Z2
b3	Z3
b4	Z4
b5	Z5
b6	Z6
b7	Z7: MSB or Z data, sign bit

STATUS REPORT FORMAT TABLE

Byte 1

b0	Right Button	1 = depressed
b1	Middle Button	1 = depressed
b2	Left Button	1 = depressed
b3	Reserved	Always = 0
b4	Scaling - 1:1 (0) / 2:1 (1)	
b5	Disable - (0) / enable (1)	
b6	Stream - (0) / prompt (1) mode	
b7		Always = 0

Byte 2

b0 - 1	Current resolution setting	
b2 - 7		Always = 0

Byte 3

b0-7	Current sampling rate

When the **Reset Command (FFh)** is received, the UR7HCPXZ-P440 sets the following default parameters: Incremental Stream Mode, 1:1 scaling, report rate of 100 Hz, and disabled. It then sends AAh to the host followed by a device ID of 00h.

The host sends the Resend Last Data Stream Command (FEh) when it detects an error in any UR7HCPXZ-P440 transmission. The device then resends the last output data packet to the host. This transmission occurs after a PixiPoint™ Z transmission and before the host enables the interface allowing the next PixiPoint™ Z output.

The **Set Default Status Command (F6h)** re-initializes the device to its condition at power-up.

The **Disable Command (F5h)** stops the device from transmitting all reports. However, the mode does not change; the PixiPoint™ Z is still able to respond to commands. If the Disable Command is issued while the device is transmitting a report, the UR7HCPXZ-P440 immediately stops the transmission and disables itself.

The **Reset Echo Mode Command (ECh)** returns the device to its previous mode, and disabled.

The **Set Prompt (Remote) Mode Command (F0h)** sets the device to Prompt Mode. Data values are then only reported in response to a **Read Report Command (EBh)**.

If the **Set Echo Mode Command (EEh)** is received, the PixiPoint™ Z will immediately return any data bytes except FFh or ECh.

If the PixiPoint™ Z is in Incremental Stream Mode, the **Enable Command (F4h)** will allow it to begin data transmission. If the device is in Prompt Mode, the Enable Command will only update the internal status of the PixiPoint™ Z.

The PixiPoint™ Z will respond to the **Set Sampling Rate Command (F3h)** in both Stream and Prompt Modes but will only update its internal status if this command is enacted while the device is in the Stream Mode.

The UR7HCPXZ-P440 responds to the **Read Device Type Command (F2h)** with the device ID of 00h.

The **Read Report Command (EBh)** prompts the PixiPoint™ Z for a report. The report occurs even if the device has not moved or if the status of the switches did not change.

The **Set Incremental Stream Mode Command (EAh)** sets the PixiPoint™ Z to Stream Mode and disables the device.

The **Status Request Command (E9h)** returns a 3-byte status report.

The **Set Resolution Command (E8h)** controls resolution, the **Set 2:1 Scaling Command (E7h)** enables a coarse/fine tracking response, and the **Set 1:1 Scaling Command (E6h)** enables the values of movements to be transmitted to the host without any scaling. Due to Semtech's Advanced Motion Algorithm, Set Resolution and Scaling Commands are acknowledged and reported as activated, but their status is ignored.

SEMTECH

SEQUENTIAL COMMANDS

Unlike normal commands, sequential commands must be enacted with a sequence of commands. If the sequence is not consecutive or is incorrect, the PixiPoint™ Z aborts the detection and responds the way it would normally respond to a command.

The individual commands that comprise a sequential command have been designed so that the elements of a sequential command can be sent to the PixiPoint™ Z via the standard IBM PS/2 BIOS calls and the device returns a valid response to the Status Request. This ensures that, if the sequential command is sent via the BIOS, the status response will be accurately returned even if the BIOS performs error detection. Thus, a programmer can have complete control of the mouse without having to access the device hardware port directly.

The UR7HCPXZ-P440 implements a special sequential command that can be used to determine its ability to report three buttons. The sequential command is a series of commands to the PixiPoint™ Z that cause the device to respond to the last command (Read Status) with alternate information.

The sequence of commands is as follows.

1. Set Resolution = one count/ mm   (E8H)
2. Set Scaling = 1:1   (E6H)
3. Set Scaling = 1:1   (E6H)
4. Set Scaling = 1:1   (E6H)
5. Read Status   (E9H)

The response to the Read Status Command is in the following format.

Byte 1: Standard Status Information (buttons, scaling, etc.)
Byte 2: Number of mouse buttons (3)
Byte 3: Firmware Revision Number (encoded) or current sampling rate

www.semtech.com
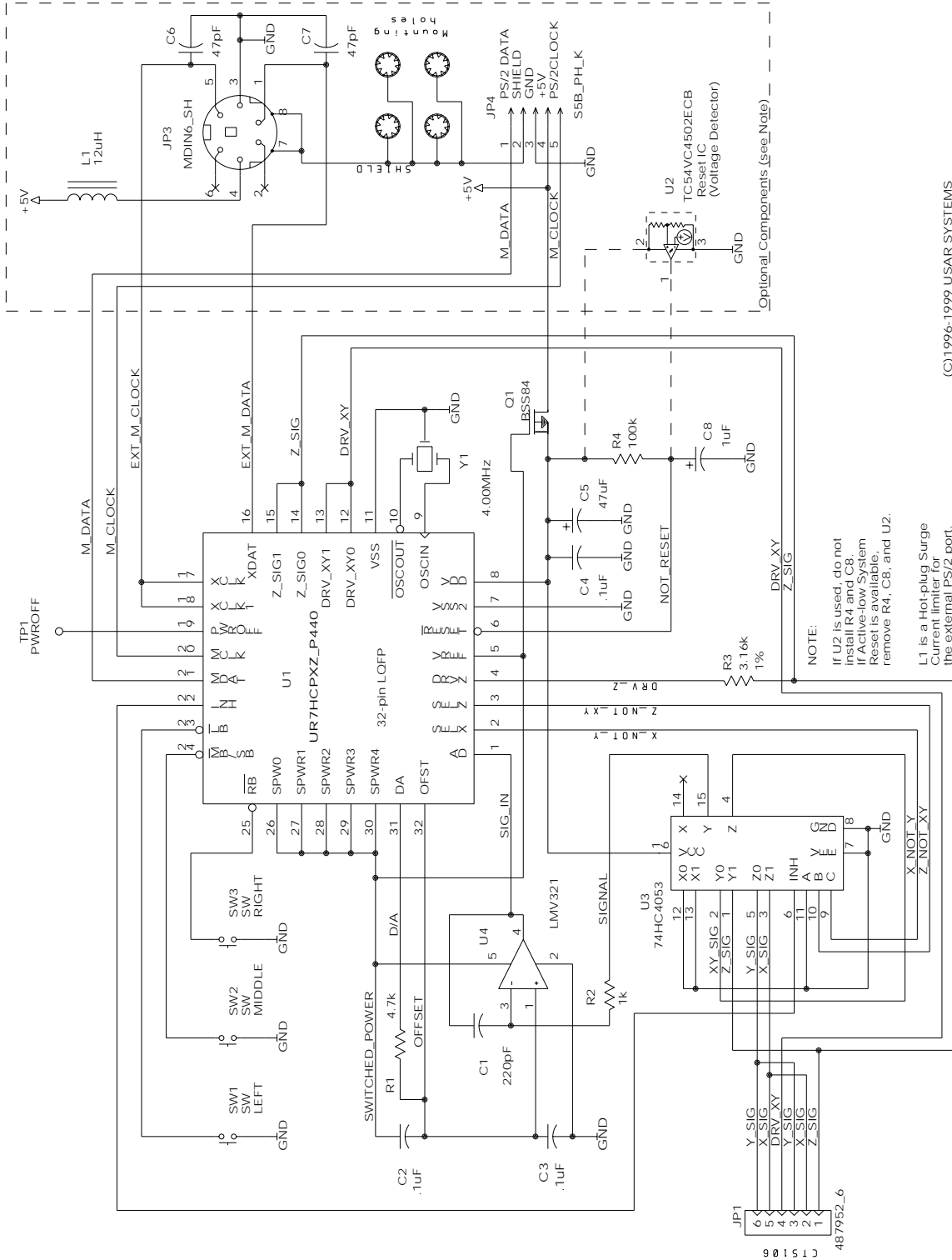
(C)1996-1999 USAR SYSTEMS

8

SEMTECH

ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings

Ratings	Symbol	Value	Unit
Supply Voltage	Vdd	-0.3 to 7.0	V
Input Voltage	Vin	Vss -0.3 to Vdd +0.3	V
Current Drain per Pin (not including Vss or Vdd)	I	20	mA
Operating Temperature	Ta	T low to T high	° C
UR7HCPXZ-P440		-20 to +85	° C
Storage Temperature Range	Tstg	-40 to +125	° C

DC Electrical Characteristics, Temperature range=T low to T high unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Supply Voltage		3.0	5.0	5.5	V
Output Voltage (10 µA load)	Voh	Vdd–0.1			V
	Vol			0.1	
Input High Voltage	Vih	0.8 x Vdd		Vdd	V
Input Low Voltage	Vil	Vss		0.2xVdd	V
Input Current	Iin			+/- 1	µA
Supply Current (Vdd=5.0 Vdc+/-10%, Vss=0)	Idd		3.0	TBD	mA

Control Timing (Vdd=5.0 Vdc +/-10%, Vss=0 Vdc, Temperature range=T low to T high unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency of Operation	fosc				MHz
■ Crystal Option			4.0		
■ External Clock Option			4.0		

Sensor Characteristics

Characteristic	Symbol	Min	Typ	Max	Unit
Resistance	Rx	2K		10K	Ohms
Matching	Rx1/Rx2	75		125	%
	Ry1/Ry2	75		125	%

Detail F

Recommended PCB Footprint
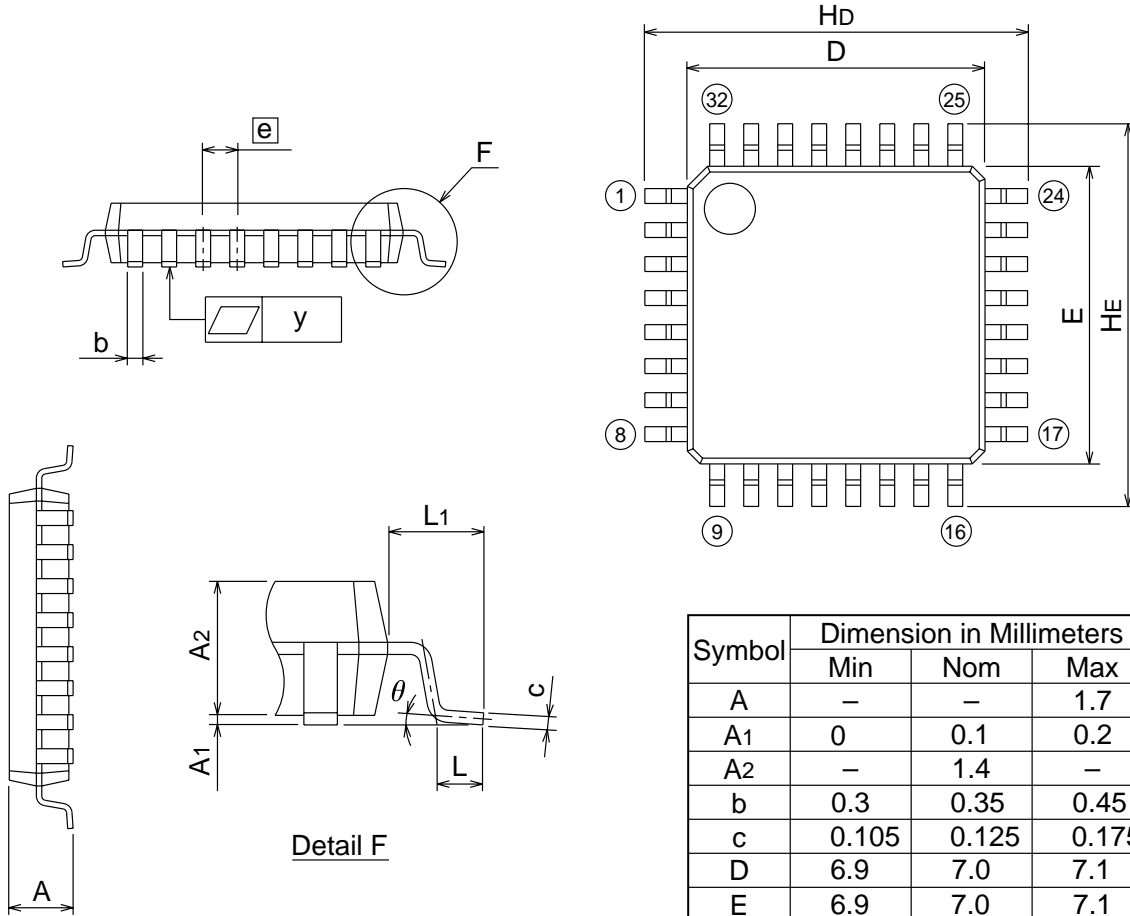
Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	–	–	1.7
A1	0	0.1	0.2
A2	–	1.4	–
b	0.3	0.35	0.45
c	0.105	0.125	0.175
D	6.9	7.0	7.1
E	6.9	7.0	7.1
e	–	0.8	–
HD	8.8	9.0	9.2
HE	8.8	9.0	9.2
L	0.3	0.5	0.7
L1	–	1.0	–
y	–	–	0.1
θ	0ϒ	–	10ϒ
b2	–	0.5	–
l2	1.0	–	–
MD	–	7.4	–
ME	–	7.4	–

www.semtech.com

This Page Left Intentionally Blank

www.semtech.com

SEMTECH

**For sales information
and product literature,
contact:**

HID & System Mgmt Division
Semtech Corporation
568 Broadway
New York, NY   10012
hidinfo@semtech.com
http://www.semtech.com
212 226 2042 Telephone
212 226 3215 Telefax

Semtech Western Regional Sales
805-498-2111 Telephone
805-498-3804 Telefax

Semtech Central Regional Sales
972-437-0380 Telephone
972-437-0381 Telefax

Semtech Eastern Regional Sales
203-964-1766 Telephone
203-964-1755 Telefax

Semtech Asia-Pacific Sales Office
+886-2-2748-3380 Telephone
+886-2-2748-3390 Telefax

Semtech Japan Sales Office
+81-45-948-5925 Telephone
+81-45-948-5930 Telefax

Semtech Korea Sales Sales
+82-2-527-4377 Telephone
+82-2-527-4376 Telefax

Northern European Sales Office
+44 (0)2380-769008 Telephone
+44 (0)2380-768612 Telefax

Southern European Sales Office
+33 (0)1 69-28-22-00 Telephone
+33 (0)1 69-28-12-98 Telefax

Central European Sales Office
+49 (0)8161 140 123 Telephone
+49 (0)8161 140 124 Telefax