

**HID & SYSTEM MANAGEMENT PRODUCTS, MOUSECODER® FAMILY**
**PRELIMINARY**
**DESCRIPTION**

The HulaCoder™ UR7HCDMP is an easy-to-use single-chip encoder that interfaces to an innovative sensor developed by Fujitsu. The IC and sensor together make the HulaPoint™ ergonomic mouse. Equipped with an advanced motion algorithm, the HulaCoder™ offers low power consumption in a small-footprint package. The device connects to either a serial or a PS/2 mouse port on the host system.

The HulaCoder™ is compatible with the communication protocols for IBM and Microsoft two-button mice and Logitech three-button mice. The IC automatically detects the port type (serial or PS/2) and uses the appropriate protocol for that port type.

Serial communication by the HulaCoder™ is half-duplex at a fixed speed of 1200 Baud. PS/2 communication is bidirectional at 10 Kbps. The HulaCoder™ implements all commands to and from the host system, as defined in the IBM PS/2 mouse communication protocol.

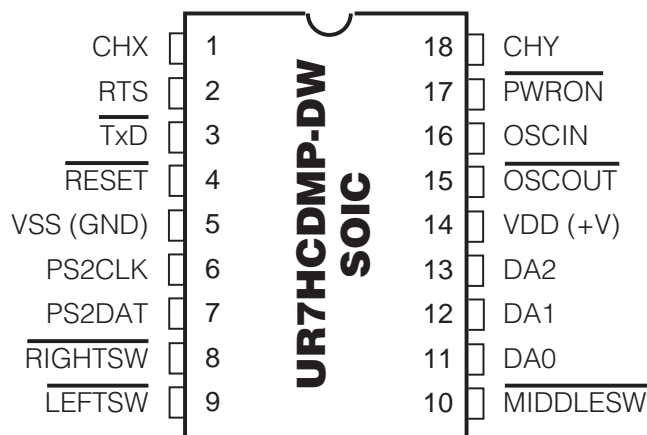
The HulaCoder™ is a CMOS device operating at 4 MHz. The low power consumption of the IC makes it suitable for battery operated systems. In serial mode, like any standard serial mouse, the IC can draw power from the RS232 lines of the host system.

**FEATURES**

- Equipped with advanced motion-control algorithm
- Low power consumption in a 3-volt to 6-volt operating range
- Effortless and accurate cursor control with 10-degree movement in every direction
- Compatible with IBM/Microsoft two-button mice and Logitech three-button mice
- Works with innovative, proprietary sensor technology developed by Fujitsu Microelectronics
- Responds to feather-light touch without resistance
- Available in a small 18-pin plastic SOIC package
- Autoselects RS232 or PS/2 hardware interface

**APPLICATIONS**

- Embedded HulaPoints™
- Industrial panels
- Industrial keyboards
- Instrumentation

**PIN ASSIGNMENTS**


### ORDERING CODE

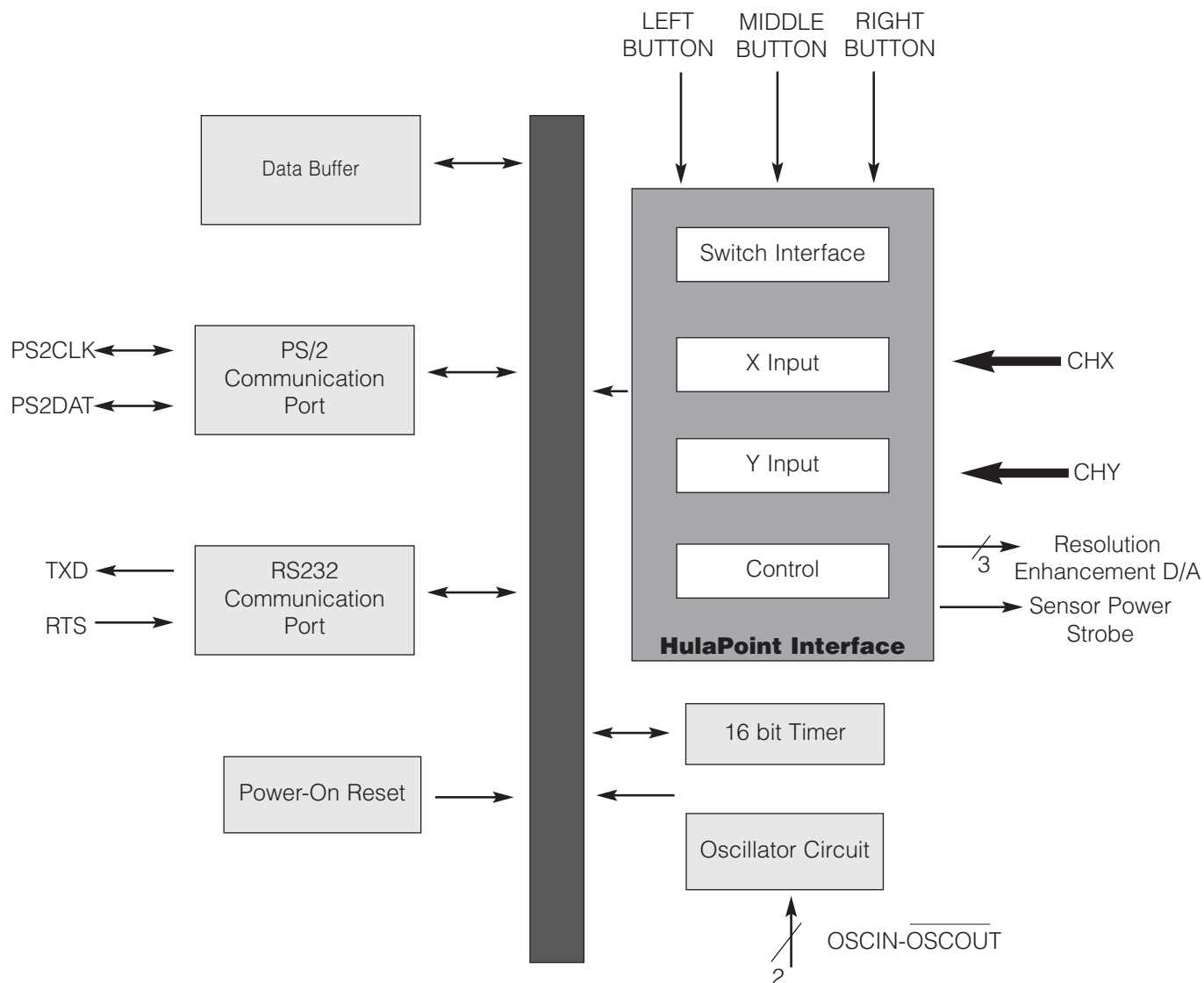
Package options	Sensor orientation	Pitch	TA = -40°C TO +85°C
18-pin SOIC	Inverted	1.270 mm	UR7HCDMP-A-DW
18-pin SOIC	Normal	1.270 mm	UR7HCDMP-B-DW

**Note:** See the sensor orientation section for sensor orientation diagrams.

### FUNCTIONAL DESCRIPTION

The HulaCoder™ consists functionally of five major sections (see Functional Diagram below). These are the Sensor Interface, the Sixteen Bit Timer, the Oscillator Circuit, the PS/2 Communication Port and the RS232 Communication Port. All sections communicate with each other and operate concurrently.

### FUNCTIONAL DIAGRAM





## AUTODETECT

At power-up the HulaCoder™ automatically detects the host interface type (PS/2 or serial), and uses the correct protocol.

## PS/2 MODE

At start-up or upon receiving a reset command, clock and data lines of the HulaCoder™ can be pulled to a positive level. The IC then waits between 300 and 500 milliseconds before sending an 0xAA to the host followed by a device ID of 0x00. Then the IC sets itself to its default values, i.e. Incremental Stream Mode with 1:1 scaling, and a report rate of 100 Hz. The device then disables itself until it receives a command from the host.

## ERROR HANDLING

For every correct command or parameter received from the host, the HulaCoder™ sends an Acknowledge (0xFA). If an invalid command or parameter is received, the HulaCoder™ issues a Resend Request (0xFE). If an invalid input is again received, the device transmits an Error Code (0xFC) 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 HulaCoder™ has responded or 25 milliseconds have elapsed.

## PIN DESCRIPTION

### Pin Numbers

Mnemonic	Pin	Type	Name and Function
CHX	1	Analog Input	<b>Horizontal input</b>
RTS	2	I/O	<b>Ready To Send (RTS) sense, power save out</b>
<u>TxD</u>	3	O, Open Drain	<b>Transmit serial data</b>
<u>RESET</u>	4	I	<b>Reset:</b> apply 0 V for orderly start up.
GND	5	Power	<b>Ground</b>
PS2CLK	6	I/O	<b>PS/2 clock</b>
PS2DAT	7	I/O	<b>PS/2 data</b>
<u>RIGHTSW</u>	8	I w/ Pullup	<b>Right switch:</b> low = on
<u>LEFTSW</u>	9	I w/ Pullup	<b>Left switch:</b> low = on
<u>MIDDLESW</u>	10	I w/ Pullup	<b>Middle switch:</b> low=on
DA0	11	O	<b>Resolution enhancement D/A 0:</b> least significant bit (LSb)
DA1	12	O	<b>Resolution enhancement D/A 1</b>
DA2	13	O	<b>Resolution enhancement D/A 2:</b> most significant bit (MSb)
VCC	14	Power	<b>Power supply</b>
<u>OSCOUT</u>	15	O	<b>Oscillator output</b>
OSCIN	16	I	<b>Oscillator input</b>
<u>PWRON</u>	17	O	<b>Sensor power strobing control</b>
CHY	18	Analog Input	<b>Vertical input</b>

**Note:** An underscore before a pin mnemonic denotes an active low signal.

## PIN DESCRIPTION NOTES

The internal oscillator has a built-in feedback resistor. Only one external component is needed for clock generation. Semtech recommends a 4.00 MHz ceramic resonator with built-in load capacitors.

RIGHTSW, LEFTSW, and MIDDLESW inputs have built-in pull-up resistors. No additional components are required for a three-button design. However, if high levels of ESD and EMI are expected, then series protection resistors (47 Ohms to 1K Ohms) are recommended between the switches' inputs on the IC.

## PS/2 MODE COMMANDS

When the **Reset Command** (0xFF) is enacted, the HulaCoder™ sets the following default parameters: Incremental Stream Mode, 1:1, scaling, disabled, and a report rate of 100 Hz and then sends 0xAA to the host followed by a device ID of 0x00.

The host sends the **Resend Last Data Stream Command** (0xFE) when it detects an error in any transmission from the HulaCoder™. The HulaCoder™ then resends the last output data stream to the host. This transmission occurs after a HulaCoder™ transmission and before the host enables the interface allowing the next HulaCoder™ output.

The **Set Default Status Command** (0xF6) re-initializes the device to its condition at power-up.

The **Disable Command** (0xF5) stops the device from transmitting all reports. However, the mode does not change; and the HulaCoder™ is still able to respond to commands. If the Disable Command is issued while the device is transmitting a report, the HulaCoder™ immediately stops the transmission and disables itself.

If the HulaCoder™ is in Incremental Stream Mode, the **Enable Command** (0xF4) allows it to begin data transmission. If the device is in Prompt Mode, the Enable Command updates the internal status of the HulaCoder™, but does not allow the device to transmit reports of motion or button data to the host.

## PS/2 DATA FORMAT

The following table shows the data report format. Values are expressed in a two's complement format with a separate sign bit. If there is an overflow of the accumulator, the maximum positive or negative count is reported and the corresponding overflow bit is set.

### Byte 1

b0	Left Button status	1 = depressed
b1	Right Button Status	1 = depressed
b2	Middle Button Status	1 = depressed
b3	Always = 1	
b4	X8: MSB (sign) of X data	1 = negative
b5	Y8: MSB (sign) of Y data	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

## Status Report Format Table

### Byte 1

b0	Right Button	1 = depressed
b1	Middle Button	1 = depressed
b2	Left Button	1 = depressed
b3	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
------	-----------------------

## PS/2 COMMANDS (CONT'D)

When the HulaCoder™ receives the **Set Sampling Rate Command** (0xF3), it responds in both stream and prompt modes, but updates its internal status only in stream mode.

The HulaCoder™ responds to the the **Read Device Type Command** (0xF2) immediately after the Acknowledge with a 0x00.

The **Set Prompt (Remote) Mode Command** (0xF0) sets the device to prompt mode. Data values are then reported only in response to a **Read Report Command** (0xEB).

The **Set Echo Mode Command** (0xEE) enables echo mode; with this mode enabled, the HulaCoder™ immediately returns any data bytes except 0xFF or 0xEC.

The **Reset Echo Mode Command** (0xEC) disables echo mode. If this command occurs while the HulaCoder™ is in either stream or prompt Modes, the command is ignored.

The **Read Report Command** (0xEB) prompts the HulaCoder™ for a report. The report occurs even if the device has not moved and the status of the switches has not changed. The report is sent by the HulaCoder™ following an Acknowledge.

The **Set Incremental Stream Mode Command** (0xEA) sets the HulaCoder™ to stream mode and disables the device.

## SEQUENTIAL COMMANDS

A sequential command consists of a strictly specified, unbroken sequence of individual commands.

The HulaCoder™ implements a special sequential command that can be used to determine its ability to report three buttons. This sequential command is a series of commands to the HulaCoder™ that cause the IC to give a special response to the last command (Read Status).

Sequence of commands:

1. Set Resolution = one count/mm  
Direct: 0xE8, 0x00    BIOS: INT0x15, AX=0xC203, BX=0
2. Set Scaling = 1:1  
Direct: 0xE6    BIOS: INT0x15, AX=0xC206, BX=1
3. Set Scaling = 1:1  
Direct: 0xE6    BIOS: INT0x15, AX=0xC206, BX=1
4. Set Scaling = 1:1  
Direct: 0xE6    BIOS: INT0x15, AX=0xC206, BX=1
5. Read Status  
Direct: 0xE9    BIOS: INT0x15, AX=0xC206, BX=0

The response to the Read Status Command is in the form:

Byte 1: Standard Status Information (buttons, scaling, etc.)

Byte 2: Number of mouse buttons (3)

Byte 3: Firmware Revision Number (encoded)

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

## PS/2 COMMANDS (CONT'D)

The **Status Request command** (0xE9) returns a 3 byte status report.

The **Set Resolution command** (0xE8) controls resolution, and the Set 2:1 Scaling Command (0xE7) enables a coarse/fine tracking response. The HulaCoder™ uses its advanced motion algorithm, so although Set Resolution and Scaling commands are acknowledged and reported as activated, their content is ignored. The Set 1:1 Scaling Command (0xE6) enables the values of movements to be transmitted to the host without any scaling.

## SERIAL MODE

Communication through the serial port is half-duplex at a fixed speed of 1200 Baud, 7N2 protocol.

At start-up and after each RTS toggle the HulaCoder™ sends a two-character ASCII string "M3" indicating 3-button capability to the host.

A data report is sent if motion is detected, or if buttons are pressed or released. Motion is reported relative to the last report sent, in a two's complement form and eight (8) bit resolution. In other words, the maximum motion values are -128 to +127, saturated at min/max for faster speeds. Byte 4 is sent only if the middle button is pressed, held-down, or released.

## SERIAL DATA REPORT FORMAT TABLE

### Byte 1

b0	X6	
b1	X7: MSB of X Data	
b2	Y6	
b3	Y7: MSB of Y Data	
b4	Right Button Status	1 = depressed
b5	Left Button Status	1 = depressed
b6	Always=1	

### Byte 2

b0	X0: LSB of X data
b1	X1
b2	X2
b3	X3
b4	X4
b5	X5
b6	Always=0

### Byte 3

b0	Y0: LSB of Y data
b1	Y1
b2	Y2
b3	Y3
b4	Y4
b5	Y5
b6	Always=0

### Byte 4

b0 - 4	Always = 0
b5	Middle Button Status 1=depressed
b6	Always=0



HULAPOINT SENSOR  
( TOP VIEW )

Y  
↑  
X

D.197

0.622

0.618

OVAL .099 x .197

0.886

0.315

D.788

D.662

0.374

0.197

0.599

D.126

GND

V+

X

FFC Conn.

On the Back Side  
of the Sensor PCB

1.575

**HULAPOINT SENSOR  
( TOP VIEW )**

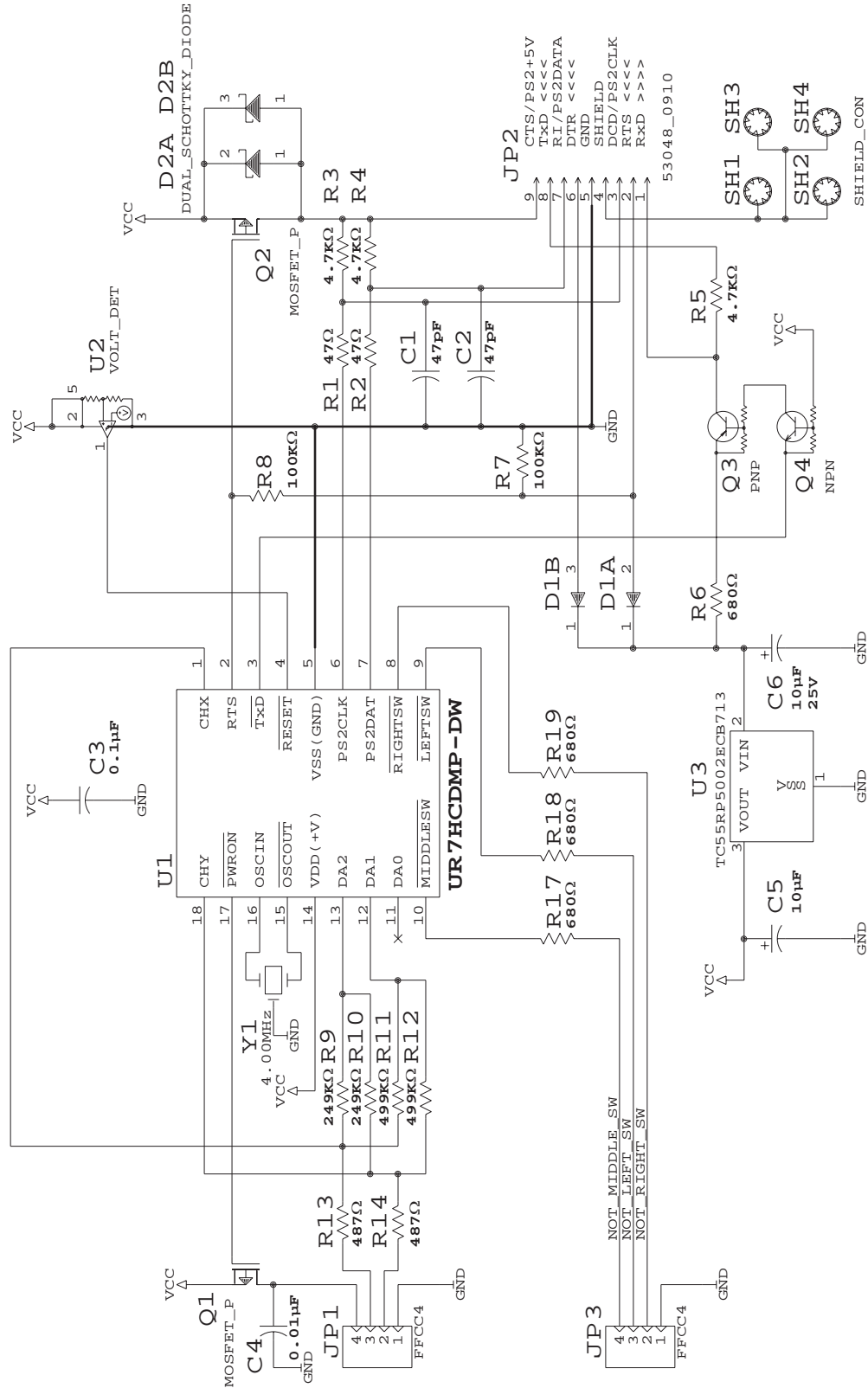
Orientation: X (Left), Y (Down)

Dimensions:

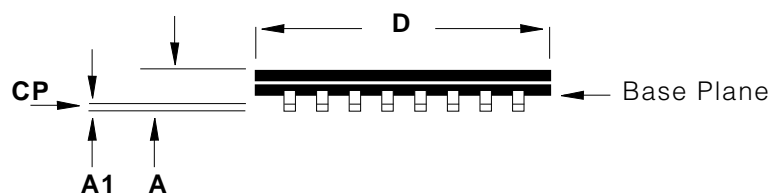
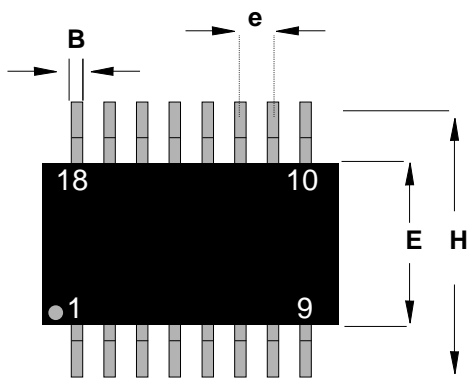
- Overall Width: 1.575
- Overall Height: 0.886
- Central Circle: D.662
- Inner Circle: D.788
- Top Left Circle: D.197
- Top Right Oval: OVAL .099 x .197
- Bottom Right Circle: D.126
- Bottom Left Circle: D.315
- Bottom Right Circle: D.374
- Bottom Left Circle: D.197
- Bottom Right Circle: D.599
- Bottom Left Circle: D.618
- Bottom Right Circle: D.622

FFC Conn. On the Back Side of the Sensor PCB

Labels: GND, Y, X, V+







DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
a	0°	8°	0°	8°
A	2.362	2.641	0.093	0.104
A1	0.101	0.299	0.004	0.011
B	0.355	0.482	0.014	0.019
C	0.241	0.317	0.009	0.012
D	11.35	11.73	0.447	0.046
E	7.416	7.594	0.292	0.299
e	1.270	1.270	0.050	0.050
H	10.00	10.64	0.394	0.419
L	0.406	1.143	0.016	0.045
CP	-	0.101	-	0.004

## ELECTRICAL SPECIFICATIONS FOR HULACODER™ UR7HCDMP

### Absolute Maximum Ratings

Ratings	Symbol	Value	Unit
Supply voltage	Vdd	0 to 7.5	V
Input voltage	Vin	Vss -0.6 to Vdd +0.6	V
Current drain per pin (not including Vss or Vdd)	I	20	mA
Operating temperature UR7HCDMP-xx	Ta	T low to T high -40 to +85	°C
Storage temperature range	Tstg	-65 to +150	°C
Ambient temperature under bias	Tbias	-55 to +125	°C
<b>ESD rating</b> (human body model)	VESD	TBD	KV

### 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	6.0	V
Output voltage	Voh	Vdd-0.1			V
	Vol			0.1	V
Input high voltage	Vih	0.7xVdd	Vdd		V
Input low voltage	Vil	Vss		0.2xVdd	V
Input current		Iin		+/- 1	µA
Internal pull-up current	I <sub>pup</sub>	50	250	500	µA
Supply current Vdd=0 5. Vdc+/-10%, Vss=0	I <sub>dd</sub>		2.0	3.5	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					
■ Crystal option	fosc		4.0		MHz
■ External clock option	fosc		4.0		MHz

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