

**HID & SYSTEM MANAGEMENT PRODUCTS, KEYCODER™ FAMILY**
**DESCRIPTION**

The DeskCoder™ keyboard encoder functions as a versatile, low-power desktop keyboard encoder, while providing two bi-directional channels for communication with a BIOS-compatible system as well as any optional keyboard-compatible devices, such as a 101/102/104 desktop keyboard, OCR, barcode reader, etc.

The DeskCoder™ fully supports the IBM standard keyboard communication protocol; each key press generates one of the scan codes designated in the IBM Technical Reference Manuals. The keyboard encoder handles the scanning, debounce, and encoding of 128 keys organized on an 8 x 16 matrix.

In addition to the system's keyboard communication port, the UR5HC418 provides a fully functional keyboard input port that can be used by a standard 101/102/104 keyboard or another 8042-compatible device, such as an external numeric keypad, an OCR, or a bar-code reader. Input from both the matrix and the external device is multiplexed and presented to the system as if it were coming from a single source.

The DeskCoder™ is ideal for use in low-power, low-cost and high-reliability AT / PS/2 - compatible keyboard designs.

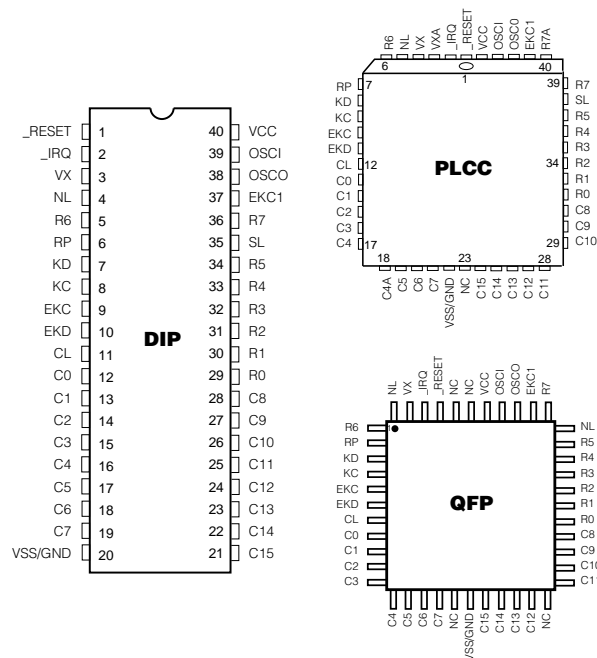
Note: A version of the IC that supports the PC/XT protocol is also available. Contact Semtech for more information.

**FEATURES**

- Interfaces contact switch matrix keyboards to a BIOS-compatible system
- Single IC desktop keyboard encoder
- Provides interface for an external keyboard/keypad or other 8042-compatible devices
- AT / PS/2 - compatible
- Implements all functions of a 101/102/104 keyboard
- Low-power HCMOS microcontroller, suitable for 3-volt battery-operated systems
- Available in DIP, PLCC and QFP packages
- Custom versions available in small or large quantities

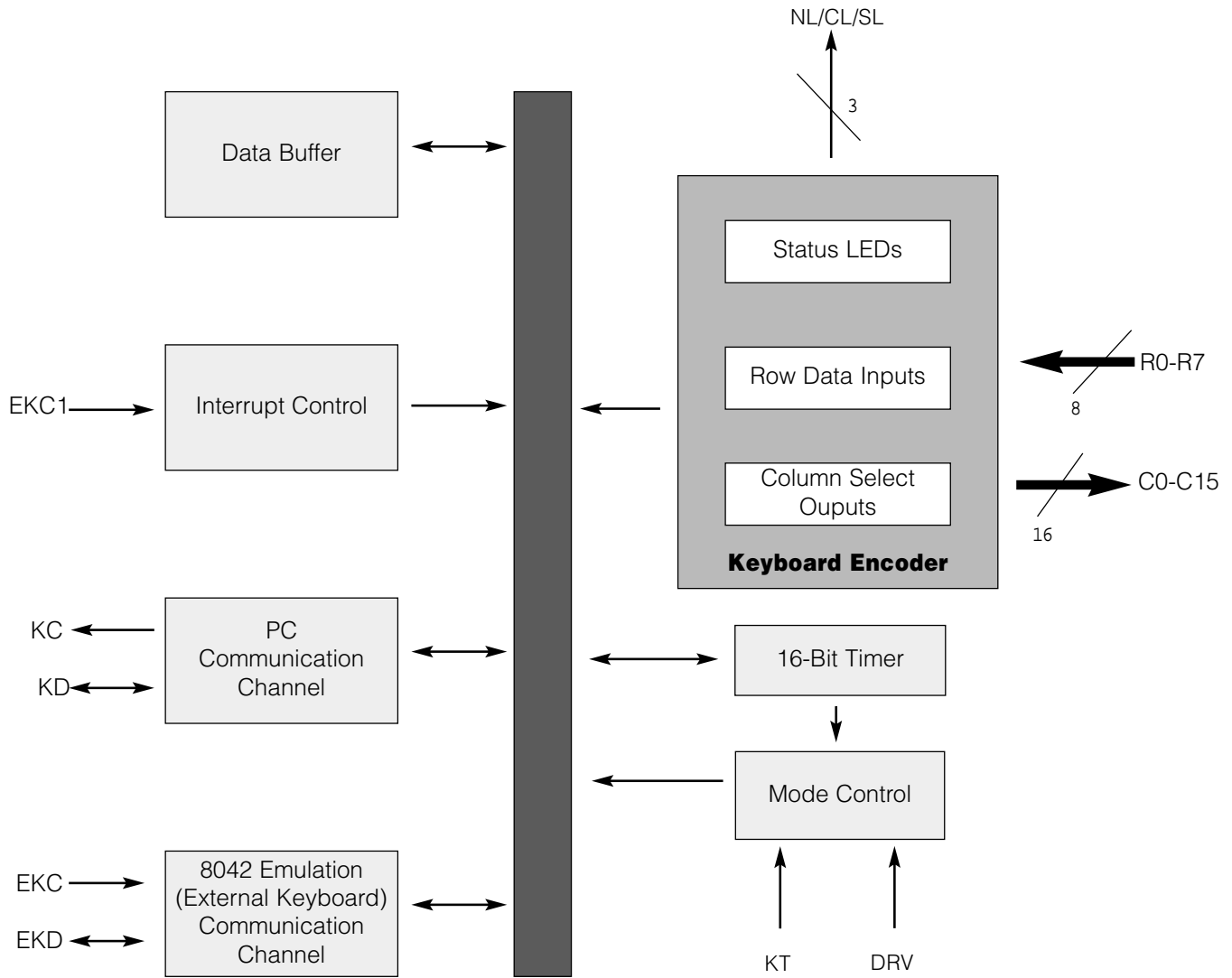
**APPLICATIONS**

- Desktop computers
- Instrumentation
- Industrial keyboards
- Point of sales terminals
- Public information kiosks

**PIN ASSIGNMENTS**


**ORDERING CODE**

Package options	Pitch in mm's	TA = -40°C to +85°C
40-pin, Plastic DIP	2.54	UR5HC418-P
44-pin, Plastic PLCC	1.27	UR5HC418-FN
44-pin, Plastic QFP	0.8	UR5HC418-FB

**FUNCTIONAL DIAGRAM**




## FUNCTIONAL DESCRIPTION

The DeskCoder™ consists functionally of seven major sections shown in the functional diagram on the previous page: the keyboard encoder, a 16-bit timer, the mode control unit, the data buffer, the interrupt control, the PC communication channel and the 8042 emulation channel. All sections communicate with each other and operate concurrently.

## KEYBOARD ENCODER

The controller continuously scans a keyboard organized as an 8 row by 16 column matrix for a maximum of 128 keys. Smaller-size keyboards are supported provided that all unused row lines are pulled to Vcc. The controller selects one of the 16 column lines (C0-C15) every 512 microseconds and then reads the row data lines (R0-R7). A key closure is detected as a zero in the corresponding position of the matrix.

A complete scan cycle for the entire keyboard takes approximately 9.2 mS. Each key found pressed is debounced for a period of 20 mS. Once the key is verified, the corresponding key code(s) are loaded into the transmit buffer of the PC communication channel.

### Status LED indicators

The controller provides an interface for three LED shift status indicators. All three pins are active low to indicate the status of the host system (Num Lock, Caps Lock and Scroll Lock) and are set by the system.

## PIN DEFINITIONS

Mnemonic	DIP	PLCC	QFP	Type	Name and Function
VCC	40	44	38	I	<b>Power Supply:</b> +5V
VSS (GND)	20	22	17	I	<b>Ground</b>
OSCI	39	43	37	I	<b>Oscillator input</b>
OSCO	38	42	36	O	<b>Oscillator output</b>
<u>RESET</u>	1	1	41	I	<b>Reset:</b> apply 0V to provide orderly start-up
EKC1	37	41	35	I	<b>External Keyboard Clock 1:</b> connects to external keyboard clock line and is used to generate an interrupt for every clock line transmission
VX	3	4	43	I	Tie to VCC
VXA		3		I	Tie to VCC
RP	6	7	2	I	Tie to VCC
KC	8	9	4	I/O	<b>Keyboard Clock:</b> connects to PC keyboard port clock data line
KD	7	8	3	I/O	<b>Keyboard Data:</b> connects to PC port data line
EKD	10	11	6	I/O	<b>External Keyboard Data:</b> connect to external keyboard data line
EKC	9	10	5	I/O	<b>External Keyboard Clock:</b> connects to external keyboard clock line
<u>IRQ</u>	2	2	42	I/O	<b>Interrupt Line:</b> reserved for low power applications
R0-R5	29-34	32-37	27-32	I	<b>Row Data Inputs</b>
R6	5	6	1	I	
R7	36	39	34	I	
R7A		40		I	
C0-C4	12-16	13-17	8-12	O	<b>Column Select Outputs:</b> select one of 16 columns
C5-C7	17-19	19-21	13-15	O	
C8-C15	28-21	31-24	26-23	O	
			21-18	O	
			16, 22	O	
C4A		18		O	
CL	11	12	7	O	<b>Caps Lock LED</b>
NL	4	5	44	O	<b>Num Lock LED</b>
SL	35	38	33	O	<b>Scroll Lock LED</b>
NC		23	39-40		<b>No Connects:</b> these pins are unused

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

## KEYBOARD ENCODER, (CONT)

### Scan Code Table Sets

The UR5HC418 supports all three scan code table sets. Scan code table set 3 allows the user to program individual key attributes such as make/break and Typematic or single-touch action. For more information, refer to the IBM Technical Reference Manuals. Custom scan code tables, including macros, are also available.

### Switch Matrix Encoding

Each matrix location is programmed to represent either a single key or a key combination of the IBM 101/102/104 standard keyboard.

### Connection of External Device

The DeskCoder™ detects the presence of an external device. If an external keyboard or other device is not connected at power-on and is connected at a later time, the encoder proceeds with the normal reset routine in order to properly initialize the external device. After communication has been established, the encoder continues to check for the presence of the external device. If the device is disconnected at a later time, the encoder becomes aware of it. If a subsequent connection takes place, the controller re-initiates a reset sequence. This unique feature allows the user to connect or disconnect an external device at any time without having to reset the system.

### Shift Status LEDs

Shift Status LEDs (Num Lock, Caps Lock and Scroll Lock) indicate the status of the system and are controlled by commands sent from the system. Set/Reset Status Indicator Commands from the system will be executed both by the external keyboard and the scanned matrix.

For example, if the user presses the Caps Lock Key on either keyboard, the Caps Lock LED will be effected on both keyboards. The LED status indicators are properly set after each new connection of an external keyboard.

### N-Key Rollover

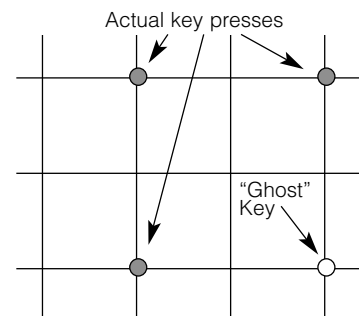
In this mode, the code(s) corresponding to each key press are transmitted to the host system as soon as that key is debounced, independently of the release of other keys.

If a key is defined to be Typematic, the corresponding make code(s) are transmitted while the key is held pressed. When a key is released, the corresponding break code(s) are then transmitted to the host system. If the released key happens to be the most recently pressed, then Typematic action is terminated. There is no limitation in the number of keys that can be held pressed at the same time. However, two or more key closures, occurring within a time interval less than five mS, set an error flag and are not processed. This procedure protects against effects of accidental key presses.

### “Ghost” Keys

In any scanned contact switch matrix, whenever three keys defining a rectangle on the switch matrix are pressed at the same time, a fourth key positioned on the fourth corner of the rectangle is sensed as being pressed. This is known as the “ghost” or “phantom” key problem. Although the problem cannot be totally eliminated without using external hardware, there are methods to neutralize its negative effects for most practical applications. Keys that are intended to be used in combinations or are likely to be pressed at the same time by a fast typist (i.e., keys located in adjacent positions on the keyboard) should be placed in the same row or column of the matrix whenever possible. Shift Keys (Shift, Alt, Ctrl) should not reside in the same row (or column) with any other keys.

The DeskCoder™ has built-in mechanisms to detect the presence of a “ghost” key, thus eliminating the necessity of external hardware.



**Figure 1:** “Ghost” or “Phantom” Key Problem

## 8042 EMULATION CHANNEL

The DeskCoder™ fully emulates a system's keyboard port, available to a standard 84/85/101/102 external keyboard or other 8042-compatible device. Communication with a keyboard-compatible device is accomplished by clock and data lines via EKC and EKD pins, respectively. A third pin, EKC1 that connects to the clock line, interrupts the controller whenever the external device initiates a communication session. When power is first applied, the controller proceeds with the standard reset sequence with the external device. Data and commands initiated from the external device are buffered in the controller's FIFO along with data from the scanned matrix, and then are presented to the system as if they were coming from a single source. Once they are acknowledged, commands and data from the system are then transmitted to the external device.

## PC COMMUNICATION

The DeskCoder™ implements all the standard functions of communication with a BIOS-compatible PC/XT or AT/PS/2 host system. Two lines, KC and KD, provide bi-directional clock and data signals. In addition, the DeskCoder™ supports all commands from and to the system, as described in the IBM Technical Reference Manuals.

The following table shows the commands that the system may send and their values in hexadecimal.

Command	Hex Value
Set/Reset Status Indicators	ED
Echo	EE
Invalid Command	EF
Select Alternate Scan Codes	F0
Invalid Command	F1
Read ID	F2
Set Typematic Rate/Delay	F3
Enable	F4
Default Disable	F5
Set Default	F6
Set All Keys	
■ Typematic	F7
■ Make/Break	F8
■ Make	F9
■ Typematic/Make/Break	FA
Set Key Type	
■ Typematic	FB
■ Make/Break	FC
■ Make	FD
Resend	FE
Reset	FF

**Table 2:** Keyboard Commands from the System (AT / PS/2 protocol)

These commands are supported in the AT / PS/2 protocol and can be sent to the keyboard at any time.

The following table shows the commands that the keyboard may send to the system.

Command	Hex Value
Key Detection Error/Overrun	00*
Keyboard ID	83AB
BAT Completion Code	AA
BAT Failure Code	FC
Echo	EE
Acknowledge (Ack)	FA
Resend	FE
Key Detection Error/Overrun	FF**

\*Code Sets 2 and 3

\*\*Code Set 1

**Table 3:** Keyboard Commands to the System (AT/PS/2 protocol)

When an external keyboard is connected, commands from the system are also directed to the external keyboard. Presence or absence of an external device does not affect the normal operation of the UR5HC418.

**STANDARD KEY MAP**

		<b>Columns (C0-C15)</b>															
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
<b>Rows (R0-R7)</b>	0	LCtrl	Esc	Tab	LAlt	Space	LWin (BkQt)	`	Ins	Del	LArr	DnArr	LSft	RArr	Pad /	Pad 9	Pad Ent
	1	RCtrl	F1	Z	RAlt	X	C	.	/	Key45*	UpArr	RSft	End	Pad *	Pad 8	Pad -	
	2		1	CpsLk		V	B	N	M (com)	,	,	Ent		PgDn	Pad 1	Pad 7	Win App
	3		F2	A		S	D	F	J	K	L	;		PgUp	Pad 2	F11	RWin
	4		2	3		4	T	Y	U	I	O	P		BkSpc	Pad 3	F12	
	5		F4	F5		F6	F7	F8	F9	F10	NumLk	ScrlLk		PntScr	Pad 4	Pad 0	
	6		F3	5		6	7	8	9	0	-	=		Pause	Pad 5	Pad .	
	7		Q	W		E	R	G	H	[	]	\		Home	Pad 6	Pad +	

**\*Note:** Key 45 = Additional European Key

**KEYBOARD LAYOUT, DEFAULT**

The UR5HC418 implements a standard keyboard layout. (Key numbering of a standard 101/102/104 keyboard is shown.)



#### IMPLEMENTATION NOTES FOR THE UR5HC418

The following notes pertain to the suggested schematics found on the next pages.

The built-in oscillator on the UR5HC418 requires the attachment of the 4.00 MHz ceramic resonators with built-in load capacitors. You can use either an AVX, part number PBRC-1.00 BR; or a Murata part number CSTCC4.00MG ceramic resonator.

It may also be possible to operate with the 4.00 MHz crystal, albeit with reduced performance. Due to their high Q, the crystal oscillator circuits start-up slowly. Since the DeskCoder™ constantly switches the clock on and off, it is important that a ceramic resonator is used (it starts up much quicker than the crystal). Resonators are also less expensive than crystals.

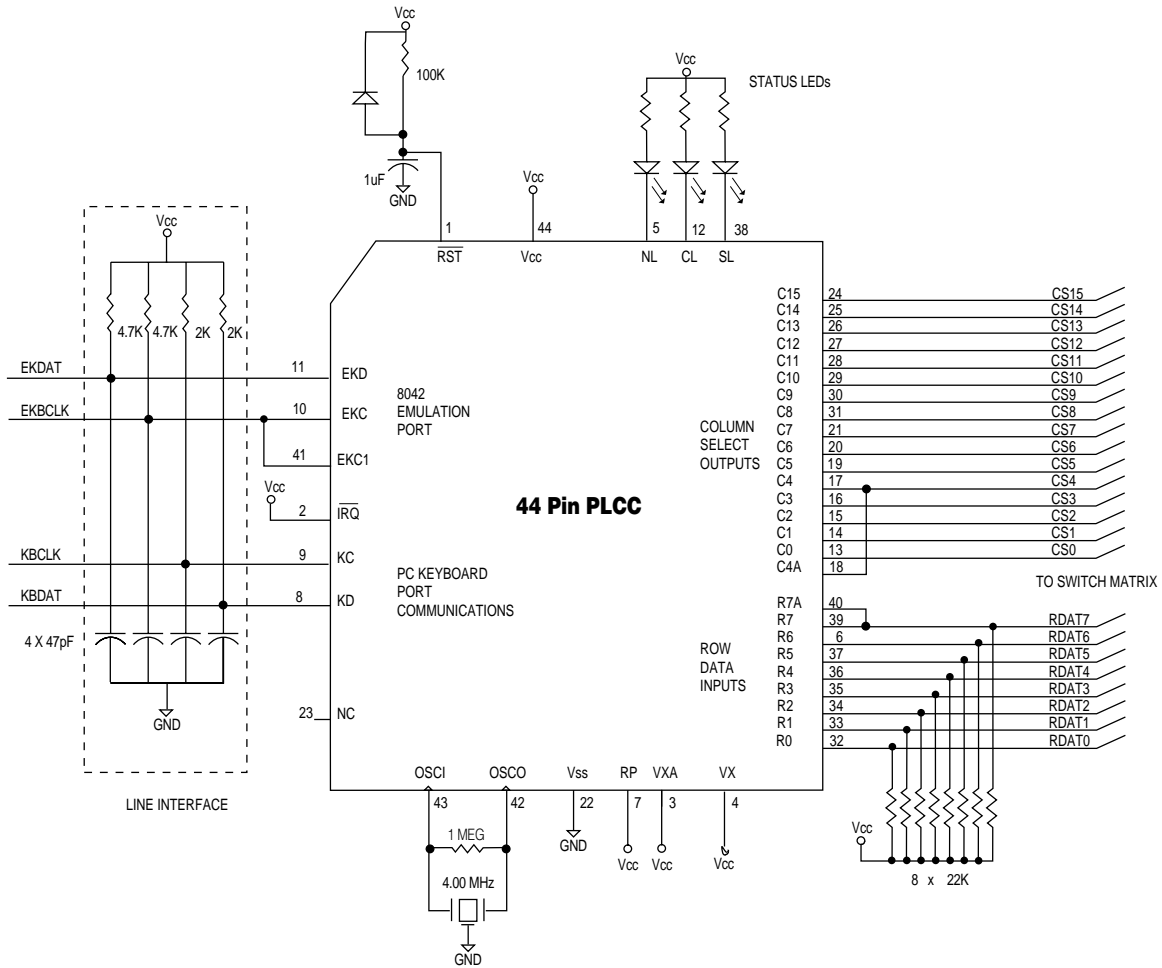
Also, if crystal is attached, two load capacitors (33pF to 47pF) should be added, a capacitor between each side of the crystal and ground.

In both cases, using ceramic resonator with built-in load capacitors, or crystal with external load capacitors, a feedback resistor of one MegaOhm should be connected between OSCin and OSCout.

Troubleshoot the circuit by looking at the output pin of the oscillator. If the voltage is half-way between supply and ground (while the oscillator should be running) --- the problem is with the load caps / crystal. If the voltage is all the way at supply or ground (while the oscillator should be running) --- there are shorts on the PCB.

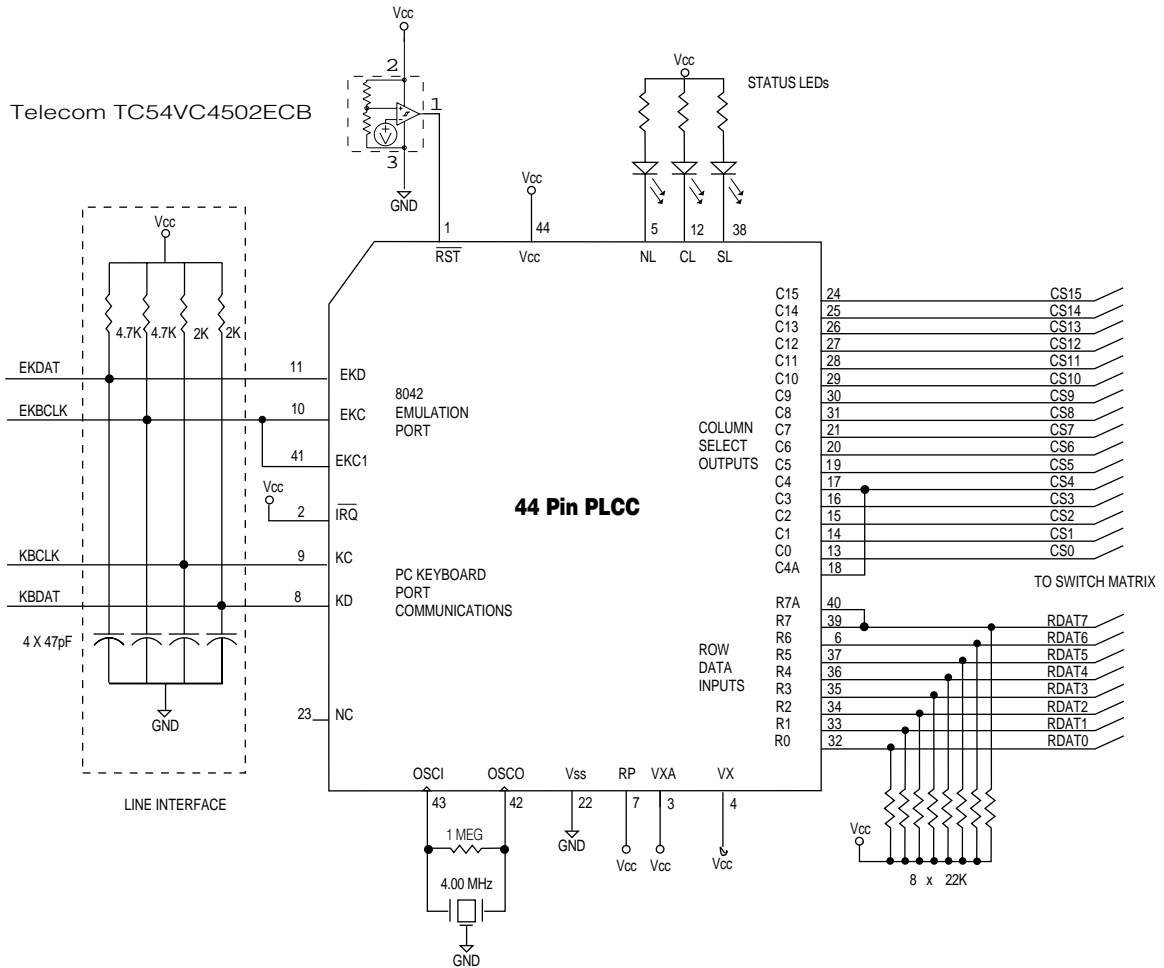
Note: when the oscillator is intentionally turned off, the voltage on the output pin of the oscillator is high (at the supply rail).

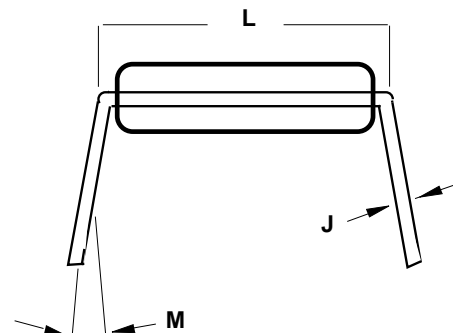
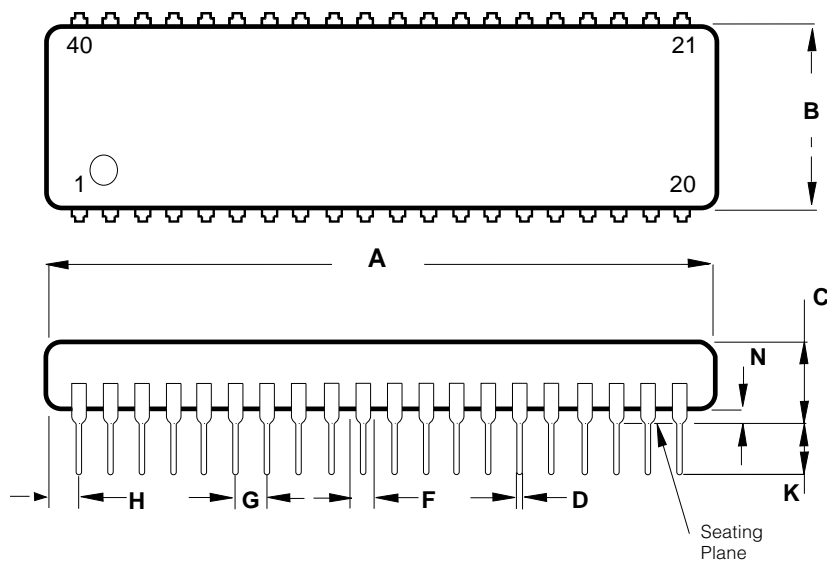
## SUGGESTED INTERFACING FOR THE UR5HC418





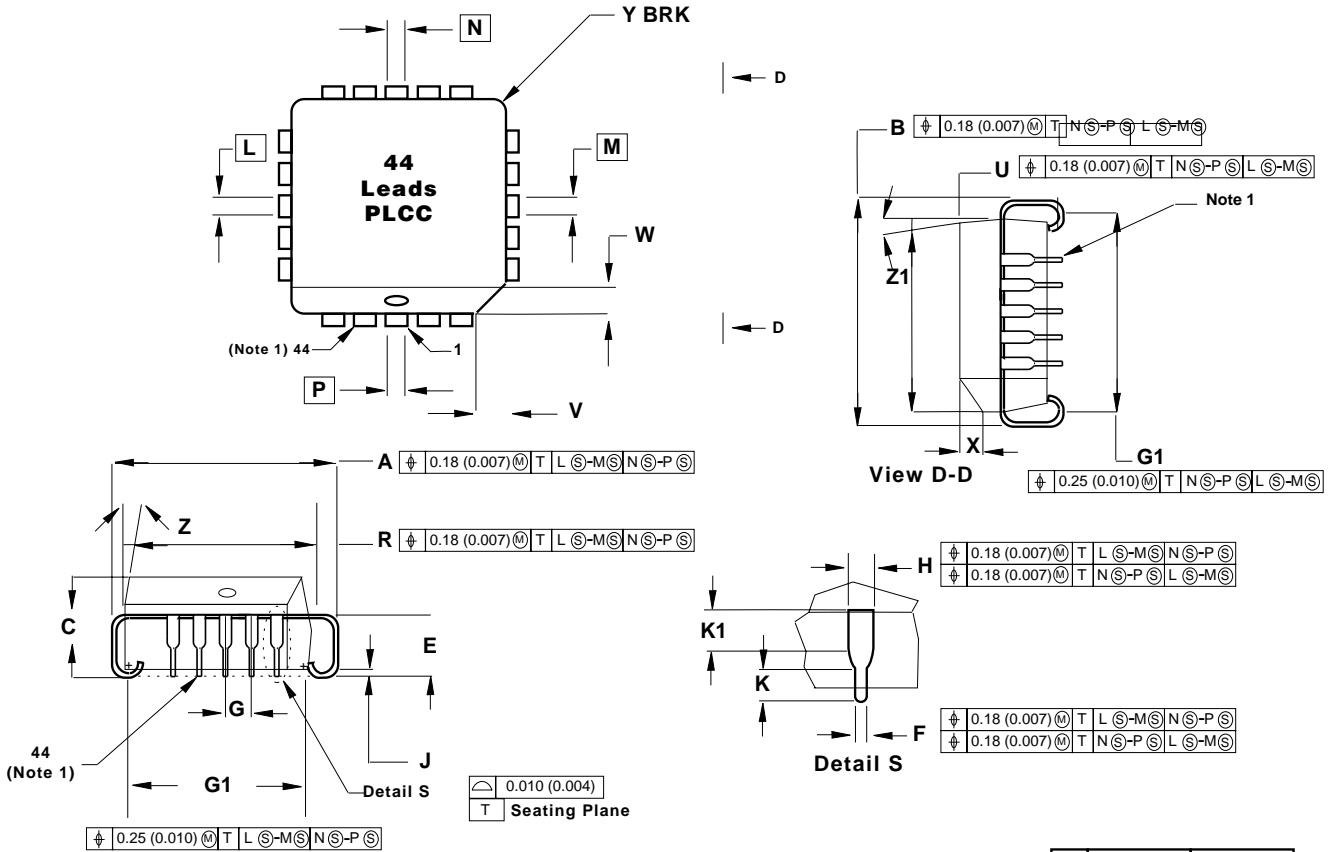
## ALTERNATE SCHEMATIC FOR THE UR5HC418 WITH RESET CIRCUIT




**Notes:**

1. Positional tolerance of leads (D) shall be within 0.25 mm (0.010) at maximum material condition, in relation to the seating plane and each other.
2. Dimension L is to the center of the leads when the leads are formed parallel.
3. Dimension B does not include mold flash.

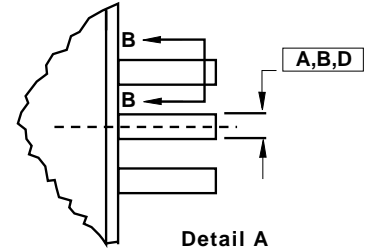
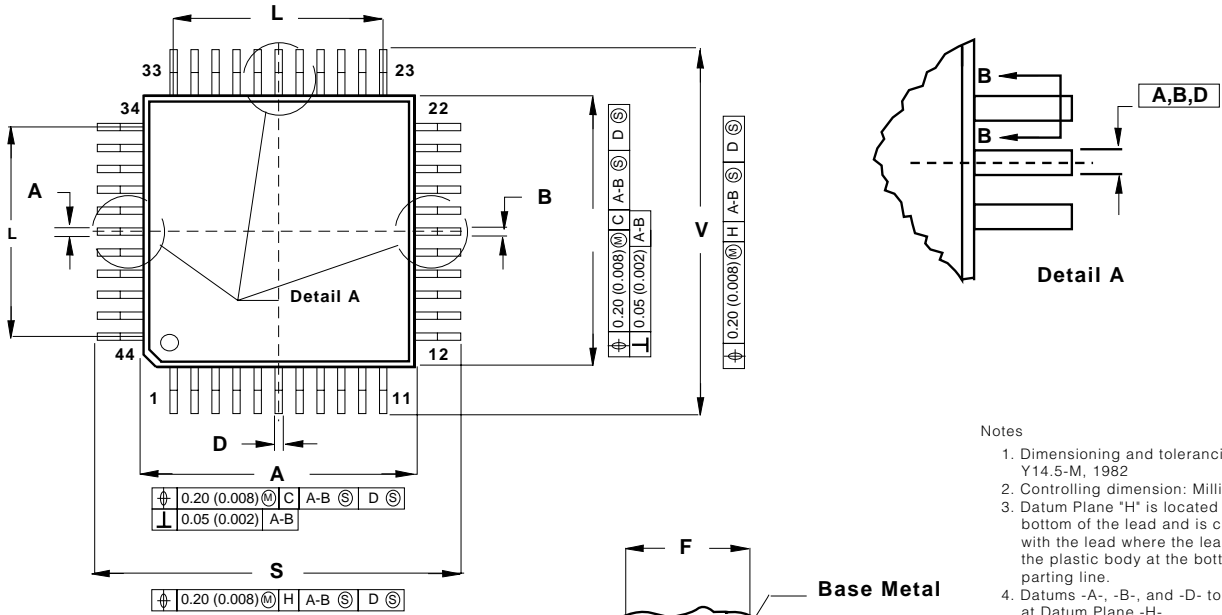
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	51.69	52.45	2.035	2.065
B	13.72	14.22	0.540	0.560
C	3.94	5.08	0.155	0.200
D	0.36	0.56	0.014	0.022
F	1.02	1.52	0.040	0.060
G	2.54 BSC		0.100 BSC	
H	1.65	2.16	0.065	0.085
J	0.20	0.38	0.008	0.015
K	2.92	3.43	0.015	0.135
L	15.24 BSC		0.600 BSC	
M	0°	15°	0°	15°
N	0.51	1.02	0.020	0.040



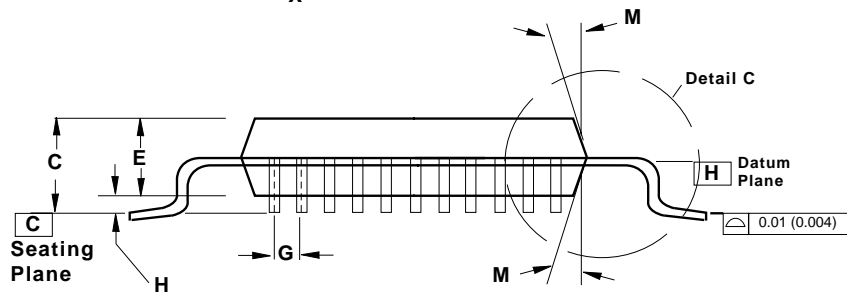
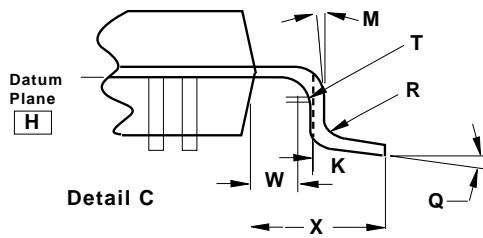
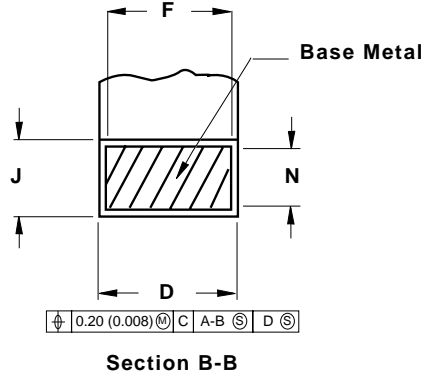
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	17.40	17.65	0.685	0.695
B	17.40	17.65	0.685	0.695
C	4.20	4.57	0.165	0.180
E	2.29	2.79	0.090	0.110
F	0.33	0.48	0.013	0.019
G	1.27 BSC	0.050 BSC		
H	0.66	0.81	0.026	0.032
J	0.51	-	0.020	-
K	0.64	-	0.025	-
R	16.51	16.66	0.650	0.656
U	16.51	16.66	0.650	0.656
V	1.07	1.21	0.042	0.048
W	1.07	1.21	0.042	0.048
X	1.07	1.42	0.042	0.056
Y	-	0.50	-	0.020
Z	2°	10°	2°	10°
G1	15.50	16.00	0.610	0.630
K1	1.02	-	0.040	-
Z1	2°	10°	2°	10°

**Notes:**

1. Due to space limitation, the chip is represented by a general (smaller) case outline drawing rather than showing all 44 leads.
2. Datums L, M, N, and P determine where the top of the lead shoulder exits plastic body at mold parting line
3. DIM G1, true position to be measured at Datum T, Seating Plane
4. DIM R and U do not include mold protusion. Allowable mold protusion is 0.25 (0.010) per side.
5. Dimensioning and tolerancing per Ansi Y14.5M, 1982
6. Controlling dimension: Inch


**Notes**

1. Dimensioning and tolerancing per Ansi Y14.5-M, 1982
2. Controlling dimension: Millimeter
3. Datum Plane "H" is located at the bottom of the lead and is coincident with the lead where the lead exits the plastic body at the bottom of the parting line.
4. Datums -A-, -B-, and -D- to be determined at Datum Plane -H-.
5. Dimensions S and V to be determined at seating plane -C-.
6. Dimensions A and B do not include Mold protusion. Allowable protusion is 0.25 (0.010) per side. Dimensions A and B do include mold mismatch and are determined at Datum Plane -H-.
7. Dimension D does not include Danbar protusion. Allowable Danbar protusion is 0.08 (0.003) total in excess of the D dimension at Maximum Material Condition. Danbar cannot be located on the lower radius or the foot.



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.90	10.10	0.390	0.398
B	9.90	10.10	0.390	0.398
C	2.10	2.45	0.083	0.096
D	0.30	0.45	0.012	0.018
E	2.00	2.10	0.079	0.083
F	0.30	0.40	0.012	0.016
G	0.80 BSC		0.031 BSC	
H	-	0.25	-	0.010
J	0.13	0.23	0.005	0.009
K	0.65	0.95	0.026	0.037
L	8.00 REF		0.315 REF	
M	5°	10°	5°	10°
N	0.13	0.17	0.005	0.007
Q	0°	7°	0°	7°
R	0.13	.30	0.005	0.012
S	12.95	13.45	0.510	0.530
T	0.13	-	0.005	-
U	0°	-	0°	-
V	12.95	13.45	0.510	0.530
W	0.40	-	0.016	-
X	1.6 REF		0.063 REF	



## 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	25	mA
Operating Temperature UR5HC418-XX	TA	T low to T high -40 to +85	°C
Storage Temperature Range	Tstg	-65 to +150	°C

### Thermal Characteristics

Characteristic	Symbol	Value	Unit
Thermal Resistance	Tja		°C per W
■ Plastic DIP		60	
■ Cerdip		-60	
■ PLCC		70	

### DC Electrical Characteristics (Vdd=5.0 Vdc +/-10%, Vss=0 Vdc, Temperature range=T low to T high unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Output Voltage (I load<10µA)	Vol			0.1	V
	Voh	Vdd-0.1			
Output High Voltage (I load=0.8mA)	Voh	Vdd-0.8			V
Output Low Voltage (I load=1.6mA)	Vol			0.4	V
Input High Voltage	Vih	0.7xVdd		Vdd	V
Input Low Voltage	Vil	Vss		0.2xVdd	V
User Mode Current	Ipp		5	10	mA
Data Retention Mode	Vrm	2.0			V
Supply Current (Run)	Idd		4.7	7.0	mA
I/O Ports Hi-Z Leakage Current	Iil			+/-10	µA
Input Current	Iin			+/- 1	µA
I/O Port Capacitance	Cio		8	12	pF

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

Characteristic	Symbol	Min	Max	Unit
Frequency of Operation	fosc			MHz
■ Crystal Option			4.0	
■ External Clock Option		dc	4.0	
Crystal Oscillator Startup Time	fop			MHz
■ Crystal (fosc/2)			2.0	
■ External Clock Option		dc	2.0	
Cycle Time	tcyc	500		ns
Crystal Oscillator Startup Time	toxov		100	ms
Stop Recovery Startup Time	tiLCH		100	ms
Reset Pulse Width	trl	8		tcyc
Interrupt Pulse Width Low	tlIH	125		ns
Interrupt Pulse Period	tiLIL	*		tcyc
OSC1Pulse Width	toH, TOL	90		ns



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