PS/2 Keyboard to RS232/Parallel Protocol Interpreter

Interpreter UR6HCPCS

Description

The UR6HCPCS is an easy-to-use single chip protocol interpreter that can link a AT/PS2-compatible User Input Device (UID), such as a keyboard, mouse, bar-code reader, etc., to any host system equipped with a serial or parallel port. The UR6HCPCS emulates all the functions of the 8042 keyboard controller which typically resides on the AT/PS2 motherboard. In addition, the protocol interpreter implements all levels of the keyboard BIOS protocol that handles two-way communication with the keyboard, performs error detection and elimination, and can translate all scan code information into an ASCII format understandable to application programs.

The UR6HCPCS also supports a set of commands from the host system that can be used to control communication and functional characteristics of the UID. In a single chip, the UR6HCPCS offers the input device functionality previously achieved only by utilizing several ICs and BIOS modules set on a AT/PS2 motherboard.

Features

- *PC Keyboard Emulation Port*
- *Full-duplex Serial interface (RS232)*
- *Strobed Parallel Output Port*
- *Pass-Through or ASCII Translation Mode*
- *Jumper selectable baud rate*
- *Auto repeat or single action mode*
- *Single chip solution*
- *HCMOS Technology*
- *40 pin DIP or 44 pin PLCC packages*

Applications

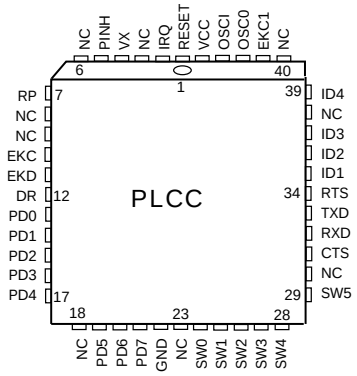
The UR6HCPCS is ideal for proprietary system designs needing to interface PC-compatible UIDs for data entry purposes.

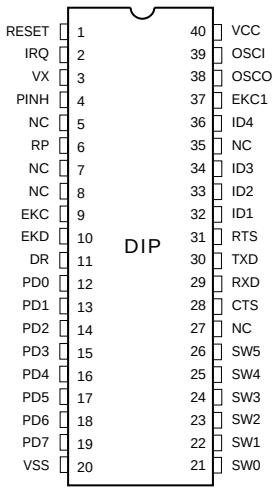
Because the UR6HCPCS allows any system with a serial or parallel port to interface inexpensive, off-the-shelf UIDs without regards to that system's architecture or firmware, system designers and integrators can achieve maximum data entry performance without needing to spend the development time and costs associated with custom input device designs.

As the UR6HCPCS implements all levels of input device protocol, no complicated software drivers are needed - translating in further savings for the system developer.

The UR6HCPCS is also highly suitable for use in systems where multiple, concurrently operable UIDs are needed, such as Point of Sales Terminals, multi-user systems, industrial control systems, etc.

Pin Configurations

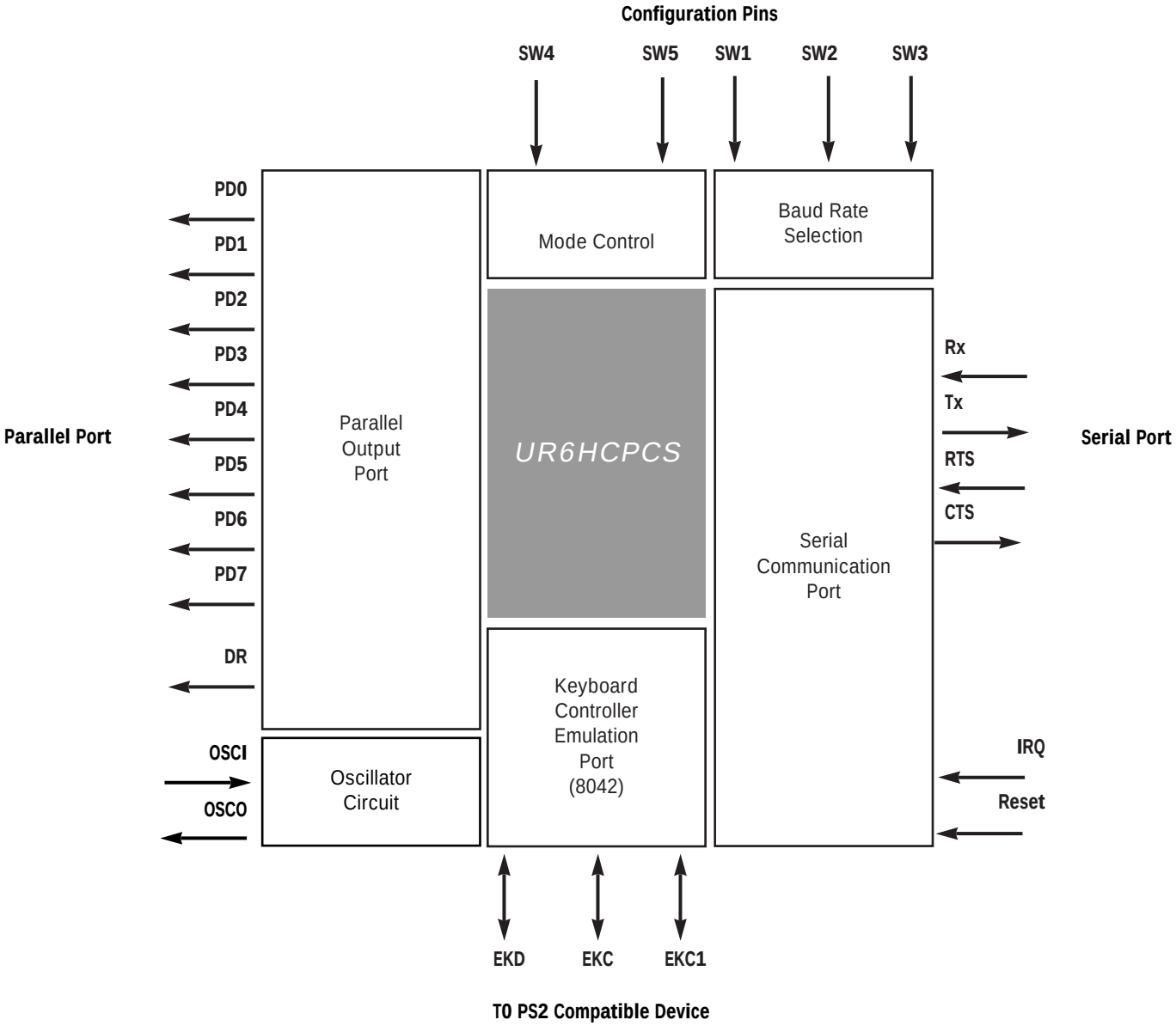




Ordering Code

PACKAGES	TA = 0°C TO +70°C	TA = -40°C TO +85°C
40 pin, Plastic DIP	UR6HCPCS-P	UR6HCPCS-CP
44 pin, Plastic PLCC	UR6HCPCS-FN	UR6HCPCS-CFN

Block Diagram



Keyboard Input Port

The UR6HCPCS provides a fully functional keyboard controller (8042) emulation port. Keyboard-compatible devices connected to this port will receive all the signals, commands and responses as if they were connected to a PS/2-compatible system. Furthermore, when the UR6HCPCS is set in the ASCII mode, it will perform all the BIOS functions necessary to interface the input device all the way up to the application level. If, for example, the user presses the Num Lock key, the IC will set the NumLock LED properly and will start interpreting scan codes into their capital ASCII equivalent.

Communication with the keyboard-compatible device is achieved through the EKC, EKC1 and EKD Lines. EKC and EKC1 are both connected to the Clock Line of the keyboard-compatible device. EKD is connected to the Data Line.

Upon power-on, the UR6HCPCS will set the keyboard to the default Scan Code Set 2, which is the most widely supported mode for AT keyboards.

Output Modes

The UR6HCPS provides two output modes: Strobed Parallel and Serial. Data from the keyboard-compatible device is presented simultaneously on both the parallel and the serial output ports. The serial port also supports bidirectional communication between the host system and the keyboard.

Parallel Output Mode

In this mode the UR6HCPCS provides a Strobed Parallel Output of the equivalent ASCII data input entered from the keyboard-compatible device. The DR Output Line provides an active low signal to the host whenever new data is present on the output port. The host system can disable the DR line by holding the PINH line low. For parallel output, RTS and CTS should be tied together.

Pin Description

	Pin Number			
Mnemonic	**DIP**	**PLCC**	**TYPE**	**NAME AND FUNCTION**
Vcc	40	44	I	**Power Supply:** +5V.
Vss	20	22	I	**Ground**
OSCI OSCO	39 38	43 42	I O	**Oscillator Input/Output:** these pins provide input for an on-chip clock oscillator circuit. A 4MHZ crystal or ceramic resonator or an external signal (OSCI) connects to these pins providing the converter clock.
RST	1	1	I	**Reset:** used to reset the converter to the default start-up state. The reset signal is active low.
EKC EKC1 EKD	9 37 10	10 41 11	I/O I/O I/O	These three open collector bidirectional pins implement the electrical interface with the keyboard-compatible device. EKD is connected to the Data Line, while both EKC and EKC1 are connected to the Clock Line of the keyboard compatible device.
TxD RxD CTS RTS	30 29 28 31	33 32 31 34	I/O I/O O I	These four pins implement the RS232 Protocol. TxD and RxD are used to Transmit data in an NRZ format. CTS (Clear to Send) is an output pin. When it is high, data can be transferred to the converter from the host. RTS (Request to Send) is an active low signal input. A high level on this pin prohibits the converter from sending data to the host.
SW0	21	24		**Reserved:** for future applications.
SW1-SW5	22-26	25-29	I	The SW1-SW3 input pins are used to select the baud rate of the serial transmission. SW4 input selects Pass-Through or ASCII Ttranslation Mode. SW5 determines whether keys will be repeating or not.
PD0-PD4 PD5-PD7	12-16 17-19	13-17 19-21	O	These seven output lines comprise the Parallel Output Port.
DR	11	12	O	**Data Ready:** an active low output pin that is sued to signal the host system when new data is present on the Parallel Output Port.
PINH	4	5	I	An active low input pin that can be used to inhibit the DR Line from going low, disabling communications for both serial and parallel port.
ID1-ID4	32-34,	35-37,	I	**Device identity pins:** reserved.

Serial Output Mode

The UR6HCPCS provides a full-duplex bidirectional serial port to exchange command and data information with the host system. The serial port has two functional modes of operation: the Pass-Through and the ASCII Modes. In the Pass-Through Mode, scan code data is passed to the host system without any translation. In the ASCII Mode, scan code data from the keyboard-compatible device is translated into the equivalent extended ASCII characters. In both modes, the default repeat action of keys is either determined during power-on or after a reset command, by the setting of pin SW5, as shown in Table 1.

The RTS and CTS pins can be used to control traffic flow between the host and the system. A high level on the RTS input indicates that the host is requesting data from the converter. A low signal on this pin will inhibit the converter from sending data to the host. CTS is an output pin, normally in a high state, indicating that the converter is ready to accept data from the host. Use of these two lines is optional.

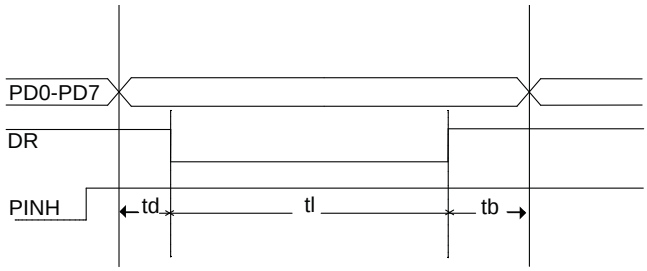
Typematic Control

The repeating action of key input from the keyboard-compatible device can be enabled or disabled by switch SW5.

SW5	Action
0	Repeat enable
1	Repeat disable

Table 1: **Repeat Action Control**

Parallel Output Port Timing



Characteristic	Symbol	Minimum	Type	Maximum	Unit
Data Ready to DR strobe	t_d	1		2	us
DR low	t_l		1*		ms

Data Format

The NRZ data format in the serial mode is one start bit, 8 data bits, no parity and one stop bit. The signals are at HCMOS levels. A level converter, such as the Maxim 232, can be used to convert the Tx and Rx signals into RS232 levels, if that is required for off board connections. The data format is shown in Figure 2.

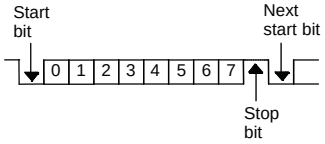


Figure 2: **Serial Data Format**

Baud Rate Selection

The Baud rate of communication is selected through the SW1-SW3 bank of switches, as shown below.

SW1	SW2	SW3	Baud Rate
0	0	0	300
0	0	1	1200
0	1	0	2400

Table 2: **Baud Rate Selection**

Higher baud rates are recommended whenever possible in order to avoid data loss from a high throughput keyboard-compatible devices.

Power-on Defaults

After power on, the converter is set with the following status:

- Scan code mode (SW4=0).
- ASCII mode (SW4=1).
- Repeat enable (SW5=0).
- Repeat disable (SW5=1).
- Reset the baud rate according to the switch settings.
- Keyboard uses Scan Set 2.
- If in the ASCII mode, the Num Lock LED is on and the Caps Lock and Scroll Lock are off.
- Typematic rate and delay are both default settings of the external keyboard, and are usually set with a10cps and 500ms initial delay.

Mode Selection During Power-on

ASCII or Pass-Through Mode of operation is determined during power-on by the setting of SW4. The mode can also be changed dynamically by a command from the host system.

SW1	Mode
0	Pass-Through
1	ASCII

Table 3: **Mode Selection**

Commands from the System

In serial mode, the UR6HCPCS supports the following set of commands issued by the system.

Commands Supported in Both ASCII and Pass-Through Mode

The following table lists the commands from the system supported in both the ASCII and Pass-Through Modes:

Hex Code	Command
FF	Reset
F6	Set default
F5	Default disable
F4	Enable
E7	Set ASCII mode
E6	Set Scan Code mode

Table 4: **Commands Supported in Both the ASCII and Pass-Through Modes**

Software Reset

The reset command (Hex FF) resets everything just as power-on does, except the baud rate. If the default mode is the Pass-Through Mode (SW4=0), then the UR6HCPCS will respond with a BAT completion code (Hex AA), the same as after power-on.

Set Default and Default Disable Command

Set Default Command will set default key types (affects Scan Set 3 operation only) and typematic rate/delay.

Commands in ASCII Mode Only

The following set of commands is supported only in ASCII Mode.

Hex Code	Command
EC	Disable repeat
EA	Enable repeat

Table 5: **Commands Supported in ASCII Mode Only**

Commands in Pass-Through Mode Only[1]

The following set of commands is supported only when the UR6HCPCS is set in pass-through mode. These commands correspond to the AT/PS2 set of commands. A detailed description can be found in the IBM Technical Reference Manual.

Hex Code	Command
FE	Resend
FD	Set key make
FC	Set key make/break[2]
FB	Set key typematic[2]
FA	Set all key typematic/ make/break[2]
F9	Set all key make[2]
F8	Set all key make/ break[2]
F7	Set all key typematic[2]
F3	Set typematic rate/ delay
F2	Read ID
F1	Invalid command
F0	Select alternate scan codes
EF	Invalid command
EE	Echo
ED	Set/Reset status indicators

Table 6: **Commands Supported in Pass-Through Mode Only**

1. These commands are part of the standard AT/PS2 keyboard protocol. Some keyboard-compatible devices may not support all of them. Please check your device manual for more details.

2. The keyboard responds with ACK, but affects only the operation of Scan Code Set 3

Commands to the System

Acknowledge (Hex FA):

The keyboard responds to the system with an Acknowledge (ACK) for any valid input other than an Echo and Resend command.

Special Commands in Pass-Through Mode Only

The following commands to the system are supported in Pass-Through Mode only. They correspond one to one to the set of commands from the keyboard in the AT/PS2 protocol. A detailed description can be found in the IBM Technical Reference Manual.

Hex Code	Command
FF	Key detection error/ overrun (Code Set 1)
FE	Resend
EE	Echo
FC	BAT failure
AA	BAT completion code
86AB	122 key keyboard ID
84AB	84/85 key keyboard ID
83AB	101/102 key keyboard ID
00	Key detection error/ overrun (Code Sets 2 & 3)

Table 7: **Special Commands Supported in Pass-Through Mode Only**

Functional Description

Scan Code Data Translation in ASCII Mode (Parallel & Serial ASCII Output)

PC-compatible keyboard devices encode key press and key release information into scan codes. There are typically three scan code sets supported by these keyboards. A detailed description of the scan code sets can be found in the IBM Technical Reference Manual. The UR6HCPCS in both the Serial ASCII and the Parallel Output Mode, will translate scan code information into its extended ASCII equivalent. The UR6HCPCS sets the keyboard-compatible device into the default Scan Code Set 2, which is the default scan code set for AT-compatible systems.

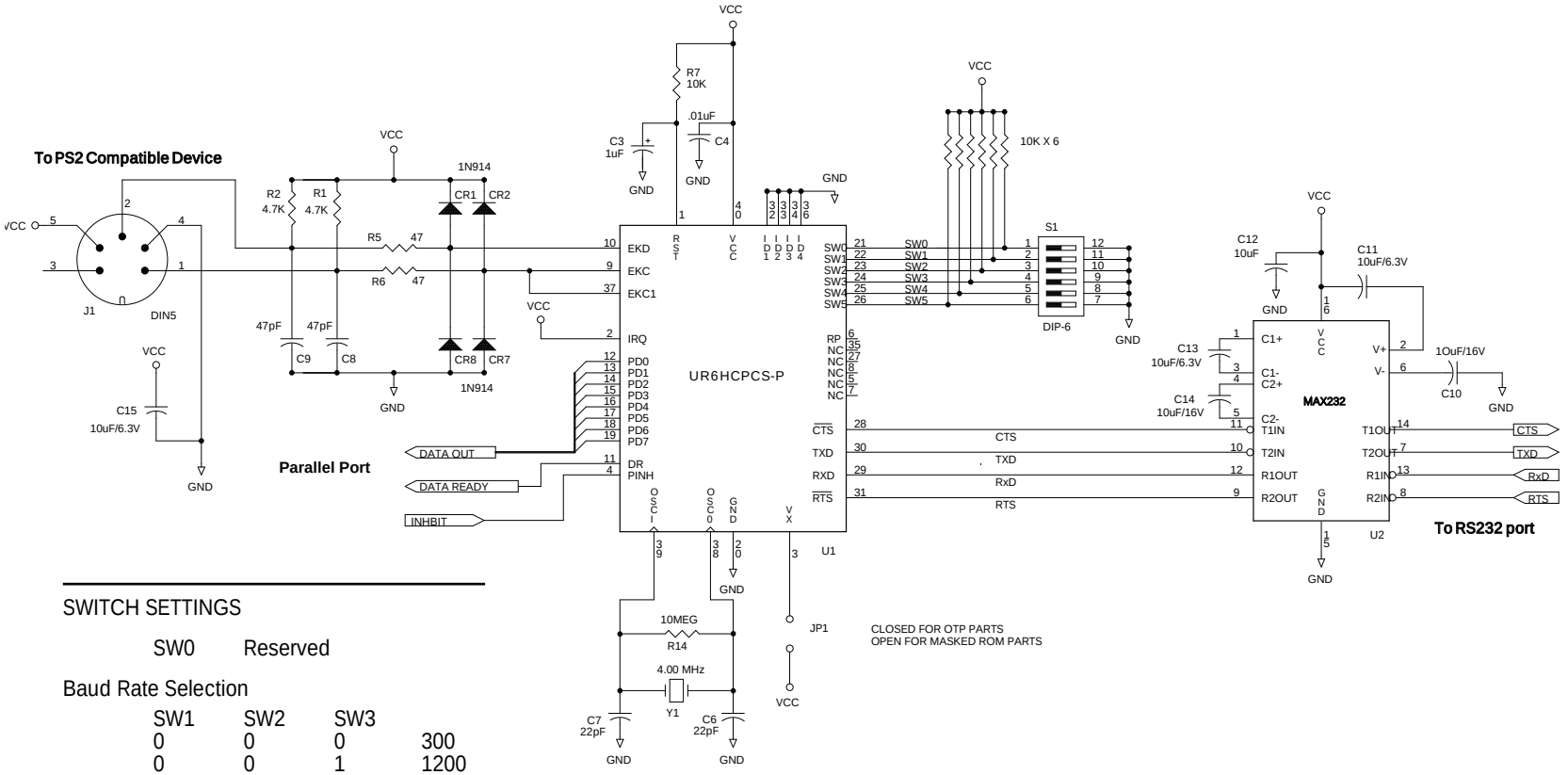
Scan Codes to ASCII Translation Table

The following table lists the extended ASCII equivalents of the keys on a standard 101 AT-type of keyboard. The key numbers on the first column correspond to the key numbers in the IBM Technical Reference Manual. When the user presses the Caps Lock Key or the Num Lock Key, the UR6HCPCS will set the keyboard Status LEDs (Caps Lock, Num Lock) and will output the shifted version of the relevant ASCII codes.

KEY #	KEY LEGEND	ASCII NORMAL	ASCII SHIFTED	ASCII L CONTROL	ASCII ALT
1	`~	60	7E		
2	1!	31	21		00 78
3	2@	32	40	00 03	00 79
4	3#	33	23		00 7A
5	4$	34	24		00 7B
6	5%	35	25		00 7C
7	6^	36	5E	1E	00 7D
8	7&	37	26		00 7E
9	8*	38	2A		00 7F
10	9(	39	28		00 80
11	0)	30	29		00 81
12	-_	2D	5F	1F	00 82
13	=+	3D	2B		00 83
15	BKSP	08	08	7F	
16	TAB	09	00 0F		
17	Q	71	51	11	00 10
18	W	77	57	17	00 11
19	E	65	45	05	00 12
20	R	72	52	12	00 13
21	T	74	54	14	00 14
22	Y	79	59	19	00 15
23	U	75	55	15	00 16
24	I	69	49	09	00 17
25	O	6F	4F	0F	00 18

KEY #	KEY LEGEND	ASCII NORMAL	ASCII SHIFTED	ASCII L CONTROL	ASCII ALT
2 6	P	70	50	10	00 19
27	[{	5B	7B	1B	
28	]}	5D	7D	1D	
29	\	5C	7C	1C	
30	CAPSLK				
31	A	61	41	01	00 1E
32	S	73	53	13	00 1F
33	D	64	44	04	00 20
34	F	66	46	06	00 21
35	G	67	47	07	00 22
36	H	68	48	08	00 23
37	J	6A	4A	0A	00 24
38	K	6B	4B	0B	00 25
39	L	6C	4C	0C	00 26
40	;:	3B	3A		
41	‘“	27	22		
43	ENTER	0D	0D	0A	
44	L SHIFT				
46	Z	7A	5A	1A	00 2C
47	X	78	58	18	00 20
48	C	63	43	03	00 2E
49	V	76	56	16	00 2F
50	B	62	42	02	00 30
51	N	6E	4E	0E	00 31

KEY #	KEY LEGEND	ASCII NORMAL	ASCII SHIFTED	ASCII L CONTROL	ASCII ALT
52	M	6D	4D	0D	00 32
53	,<	2C	3C		
54	.>	2E	3E		
55	/?	2F	3F		
57	R SHIFT				
58	L CTRL				
60	L ALT				
61	SPACE	20	20	20	20
62	R ALT				
64	R CTRL				
75	INSERT	00 52	00 52		
76	DEL	00 53	00 53		
79	LEFT	00 4B	00 4B	00 73	
80	HOME	00 47	00 47	00 77	
81	END	00 4F	00 4F	00 75	
83	UP	00 48	00 48		
84	DOWN	00 50	00 50		
85	Pg Up	00 49	00 49	00 84	
86	Pg Dn	00 51	00 51	00 76	
89	RIGHT	00 4D	00 4D	00 74	
90	Num Lk				
91	7 HOME	00 47	37	00 77	
92	4 LEFT	00 4B	34	00 73	
93	1 END	00 4F	31	00 75	
95	/	2F	2F		
96	8 UP	00 48	38		
97	5	00 4C	35		
98	2 DOWN	00 50	32		
99	0 INS	00 52	30		
100	*	2A	2A		
101	9 PGUP	00 49	39	00 84	
102	6 RIGHT	00 4D	36	00 74	
103	3 PGDN	00 51	33	00 76	
104	.DEL	00 53	2E		
105	-	2D	2D		
106	+	2B	2B		
108	ENTER	0D	0D	0A	
110	ESC	1B	1B	1B	
112	F1	00 3B	00 54	00 5E	00 68
113	F2	00 3C	00 55	00 5F	00 69
114	F3	00 3D	00 56	00 60	00 6A
115	F4	00 3E	00 57	00 61	00 6B
116	F5	00 3F	00 58	00 62	00 6C
117	F6	00 40	00 59	00 63	00 6D
118	F6	00 41	00 5A	00 64	00 6E
119	F8	00 42	00 5B	00 65	00 6F
120	F9	00 43	00 5C	00 66	00 70
121	F10	00 44	00 5D	00 67	00 71
122	F11	00 85	00 87	00 89	00 8B
123	F12	00 86	00 88	00 8A	00 8C
124	PrSc			00 72	
125	ScLk				
126	PAUSE			00 00	



SWITCH SETTINGS

SW0 Reserved

Baud Rate Selection

SW1	SW2	SW3	
0	0	0	300
0	0	1	1200
0	1	0	2400
0	1	1	4800
1	0	0	9600

Mode Selection

SW4	0	Scan Codes
	1	ASCII Codes

Repeat Enable

SW5	0	Enable
	1	Disable

Electrical Specifications

Absolute Maximum Ratings

Ratings	Symbol	Value	Unit
Supply Voltage	V_{DD}	-0.3 TO +7.0	V
Input Voltage	V_{IN}	V_{SS} -0.3 to V_{DD} +0.3	V
Current Drain per Pin (not including V_{SS} or V_{DD})	I	25	mA
Operating Temperature UR6HCPCS-XX UR6HCPCS-CXX	T_A	T LOW to T HIGH 0 to +70 -40 to +85	° C
Storage Temperature Range	T_{STG}	-65 to +150	° C

Thermal Characteristics

Characteristic	Symbol	Value	Unit
Thermal Resistence	T_{JA}		° C per W
■ Plastic		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}<10uA)	V_{OL} V_{OH}	 V_{DD}–0.1		0.1	V
Output High Voltage (I_{LOAD}=.0.8mA)	V_{OH}	V_{DD}–0.8			V
Output Low Voltage (I_{LOAD}=1.6mA)	V_{OL}:			0.4	V
Input High Voltage	V_{IH}	0.7xV_{DD}		V_{DD}	V
Input Low Voltage	V_{IL}	V_{SS}		0.2xV_{DD}	V
User Mode Current	I_{PP}		5	10	mA
Data Retention Mode (0 to 70°C)	V_{RM}	2.0			V
Supply Current (Run)	I_{DD}		4.7	7.0	mA
I/O Ports Hi-Z Leakage Current	I_{IL}			+/-10	uA
Input Current	I_{IN}			+/- 1	uA
I/O Port Capacitance	C_{IO}		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	f_{OSC}			MHz
■ Crystal Option			4.0	
■ External Clock Option		dc	4.0	
Internal Operating Frequency	f_{OP}			MHz
■ Crystal (f_{OSC}/ 2)			2.0	
■ External Clock (f_{OSC}/ 2)		dc	2.0	
Cycle Time	tcyc	500		ns
Crystal Oscillator Startup Time	t_{OXOV}		100	MS
Stop Recovery Startup Time	t_{ILCH}		100	ms
RESET Pulse Width	t_{RL}	8		tcyc
Interrupt Pulse Width Low	t_{LIH}	125		ns
Interrupt Pulse Period	t_{ILIL}	*		tcyc
OSC1 Pulse Width	t_{OH}, t_{OL}	90		ns

*The minimum period t_{LIL} should not be less than the number of cycle times it takes to execute the interrupt service routine plus 21 tcyc.

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