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USAR GreenCoder™ Zero-Power™ Keyboard Encoder for Portable Systems

USAR KeyCoder™ family product specifications

Description

The USAR GreenCoder™ (UR5HCFJL) is a unique, Zero Power™ keyboard encoder that provides an optimum performance level for both battery-operated and desktop systems.

The USAR GreenCoder™ scans, debounces and encodes an 8 X 16 keyboard matrix, and will provide direct drive for 3 LEDs and two bi-directional channels for communication with a BIOS-compatible system as well as an additional keyboard-compatible device. It fully supports all three PS/2 scan code sets and will implement up to three alternate keyboard layers for full 101/102 functionality.

The USAR GreenCoder™ employs a unique Self-Power Management™ method that reduces the power consumption of the keyboard sub-system to an unprecedented minimum, transparently and without user intervention. In “Active” mode, the encoder consumes less than 2 mA (Typ @5V). In “Sleep” mode the encoder consumes less than 2 µA (Typ @5V) The encoder can even nap between keystrokes and therefore it is rarely active and rarely consumes significant levels of power.

A "stand-by" mode (600 µA Typ @5V) is entered for as long as a periodic task is active. After a programmed period of user inactivity the USAR GreenCoder™ gradually dims the LEDs for further power savings.

The USAR GreenCoder™ is ideal for use in battery laptop/notebook designs and Energy Star compliant keyboards.

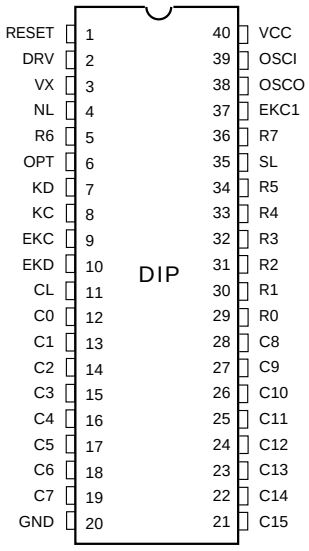
Features

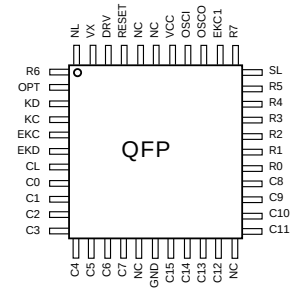
- Optimized power-saving operation with idle consumption of less than 2 µA
- Programmable LED dimming for further power savings
- Ready to interface to Fujitsu's 7316, 7654,7656, and 1406 keyboards
- 3, 3.3 and 5 Volt operation
- Wakes-up only to respond to an external event and for a minimum period of time (2 mA current consumption)
- Provides interface for external keyboard/keypad or other 8042-compatible device
- Custom versions available in small or large quantities

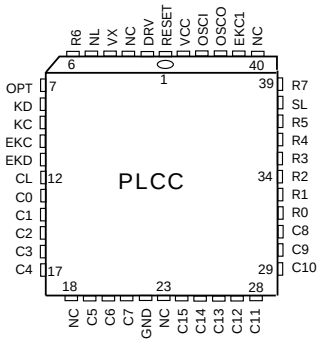
Applications

- Laptop/Notebook
- Portable Equipment
- Energy Star Compliant
- Medical Instruments
- Personal Digital Assistants

Pin Descriptions





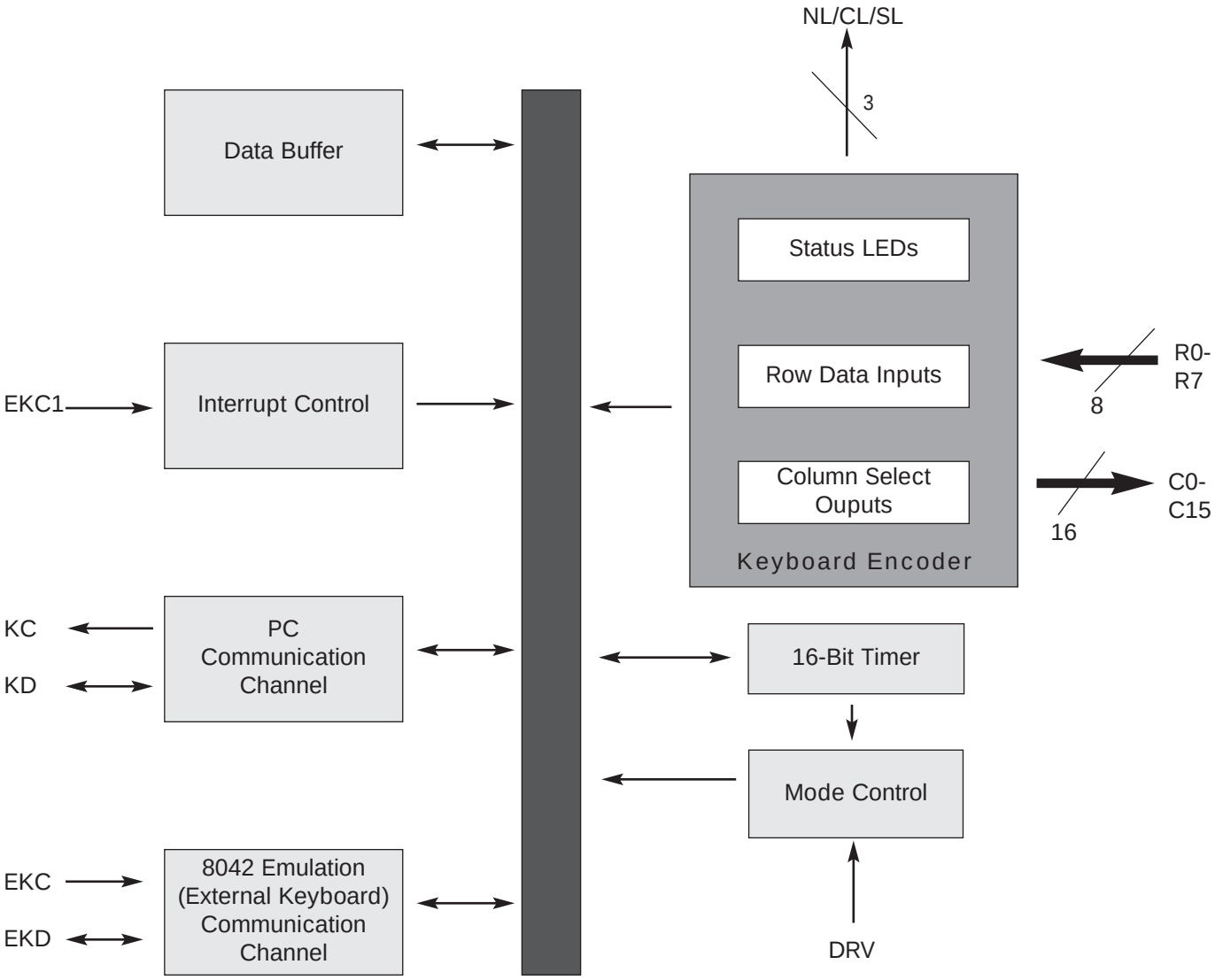


Ordering Code

Package options	Pitch In mm's	TA = -40°C to +85°C
40-pin Plastic DIP	2 54 mm	UR5HCFJL-XX-P
44-pin, Plastic PLCC	1.27 mm	UR5HCFJL-XX-FN
44-pin, Plastic QFP	0.8 mm	UR5HCFJL-XX-FB
44-pin, Plastic TQFP*	0.5 mm	UR5HCFJL-XX-FA

XX = 11 for FKB7211, 16 for FKB7136,06 for FKB1406 matrix compatibility
* Minimum quantities for the TQFP may apply

Functional Diagram



Functional Description

The USAR GreenCoder™ consists functionally of seven major sections (see Functional Diagram, previous page). These are 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 encoder 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. When active, the encoder selects 1 of the 16 column lines (C0-C15) every 512 µS and then reads the row data lines (R0-R7). A key closure is detected as a 0 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 keyboard communication channel.

Scan Code Table Sets

The UR5HCFJL 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.

Pin Definitions

Mnemonic	DIP	PLCC	QFP	Type	Name and Function
VCC	40	44	38	I	Power Supply: +5V
VSS	20	22	17	I	Ground
OSCI	39	43	37	I	Oscillator input
OSCO	38	42	36	O	Oscillator output
RESET	1	1	41	I	Reset: apply 0V to provide orderly start-up
EKC1	37	41	35	I	External Keyboard Clock 1: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
OPT	6	7	2	I	Used for options selection
KC	8	9	4	I/O	Keyboard Clock: connects to PC keyboard port data line
KD	7	8	3	I/O	Keyboard Data: connects to PC port data line
EKD	10	11	6	I/O	External Keyboard Data: connect to external keyboard clock line
EXC	9	10	5	I/O	External Keyboard Clock 1: connects to external keyboard data line
DRV	2	2	42	I	Wake-up line: used for sleep mode
R0-R5	29-34	32-37	27-32	I	Row Data Inputs
R6	5	6	1	I	
R7	36	39	34	I	
C0-C4	12-16	13-17	8-12	I/O	Column Select Outputs: select 1 of 16
C5-C7	17-19	19-21	13-15	O	columns
C8-C15	28-21	31-24	26-18	O	
CL	11	12	7	O	Caps Lock LED
NL	4	5	44	O	Num Lock LED
SL	35	38	33	O	Scroll Lock LED
NC		3,18 23,40	39-40 16,22		No Connects: these pins are unused

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

Keyboard Encoder, Cont.

Embedded Numeric Keypad

The USAR GreenCoder™ implements an embedded numeric keypad. The Numeric Keypad Function is invoked by pressing the Num Lock Key.

FN Key

A special FN Key has been implemented to perform the following functions while it is held pressed:

- Function Key F1 becomes F11
- Function Key F2 becomes F12
- Control Left Key becomes Ctrl Right
- Embedded numeric keypad keys become regular keys

If Num Lock is not set:

- Embedded numeric keypad keys provide the same codes as a numeric keypad when the Num Lock is not set (Arrow keys, PgUp, PgDn, etc.)

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. After approximately a one-minute period of keyboard inactivity, LEDs are dimmed to conserve power. They are set to full brightness again upon a new keystroke.

Mode Control

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) will be 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 5 mS, will set an error flag and will not be 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 held 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 USAR GreenCoder™ has built-in mechanisms to detect the presence of a "ghost" key, thus eliminating the necessity of external hardware.

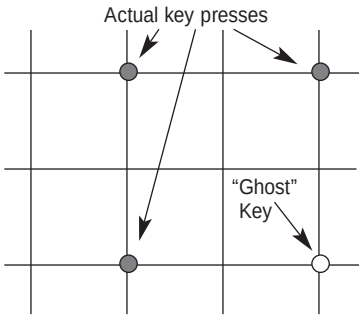


Figure 1: "Ghost" or "Phantom" Key Problem

8042 Emulation Channel

The USAR GreenCoder™ 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.

Special Handling

Connection of External Device

The UR5HCFJL will detect the presence of an external device. If an external keyboard or other device was not connected during power-on and is connected at a later time, the encoder will proceed with the normal reset routine in order to properly initialize the external device. After communication has been established, the encoder will continue to check for the presence of the external device. While the external device is connected, the encoder will not enter the sleep mode. If the device is disconnected at a later time, the encoder will become aware of it. If a subsequent connection takes place, the controller will re-initiate 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 affected on both keyboards. The LED status indicators are properly set after each new connection of an external keyboard.

PC Communication

The UR5HCFJL 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 UR5HCFJL 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 hex.

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 will also be directed to the external keyboard. Presence or absence of an external device will not effect the normal operation of the USAR GreenCoder™.

States of Operation

The USAR GreenCoder™ has three states of operation, implemented to minimize the power consumption of the keyboard subsystem. The following diagram illustrates the three states of operation of the GreenCoder™.

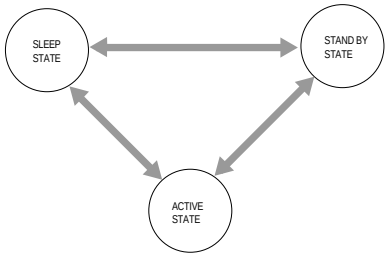


Figure 2: States of Operation of UR5HCFJL

Most of the time, the USAR GreenCoder™ is in the Sleep State. Power consumption in this state is approximately 2 µA at 5 Volts of operation. The GreenCoder™ enters the Active State only when there is an event to process, such as a keystroke, a command from the system, or data from the external PS/2-compatible device.

The USAR GreenCoder™ enters and stays in the Stand-By State if an external device is connected to the auxiliary port or if one or more LEDs are turned on.

In the Stand-By State, the IC consumes approximately 600 µA at 5 Volts. Transition from one state to the other does not require any input from the system.

Note: Self-Power Management™ is a feature protected under USAR Systems' patent and copyright rights. Purchase of any version of the UR5HCFJL encoder conveys a license to utilize the Self-Power Management feature only through use of the UR5HCFJL in a PS/2-compatible keyboard subsystem.

Using the GreenCoder™ for System Management Tasks

The USAR GreenCoder™ provides an ideal complement to low-power chip sets targeted to the portable and mobile computing market. The Green Coder™ can be used to handle several system management tasks for small, portable system designs, thus saving space and additional components for the System Designer. Such system management tasks include those listed below.

However, since most of the system management tasks are application and hardware-dependent, detailed implementation information is outside the scope of this document. For application examples and sample schematics, contact USAR Systems Technical Support.

System shut-down/wake-up signal

The USAR GreenCoder™ can provide the system power management unit with a shut-down/wake-up signal which can be invoked either by a special keyboard combination or after a programmed period of user inactivity.

Key Map for FKB7211 (UR5HCFJL-11)

Rows (R0–R7) \ Columns (C0–C13)	0	1	2	3	4	5	6	7	8	9	10	11	12	13
0	LCtrl*	Esc	Tab	Fn	LAlt*	Space		BQ	Insert	Delete	ArrLft	ArrDn	LShift	ArrRt
1		F1*	Z			X	C		> . Pad .	? / Pad /		ArrUp	RShift	End
2		! 1	CapLk			V	B	N	M Pad 0	< , (com)	“ RQ	Enter		PgDn
3		F2*	A			S	D	F	J Pad 1	K Pad 2	L Pad 3	: ; Pad +		PgUp
4		@ 2	# 3			$ 4	T	y	u Pad 4	i Pad 5	o Pad 6	p Pad -		BkSpc
5		F4	F5			F6	F7	F8	F9	F10	NumLk	ScrLk		PrtScr
6		F3	% 5			^ 6	& 7 Pad 7	* 8 Pad 8	(9 Pad 9	) 0 Pad *	__ -(dash)	+ =		Pause
7		Q	W			E	R	G	H	{ [	}]	| \		Home

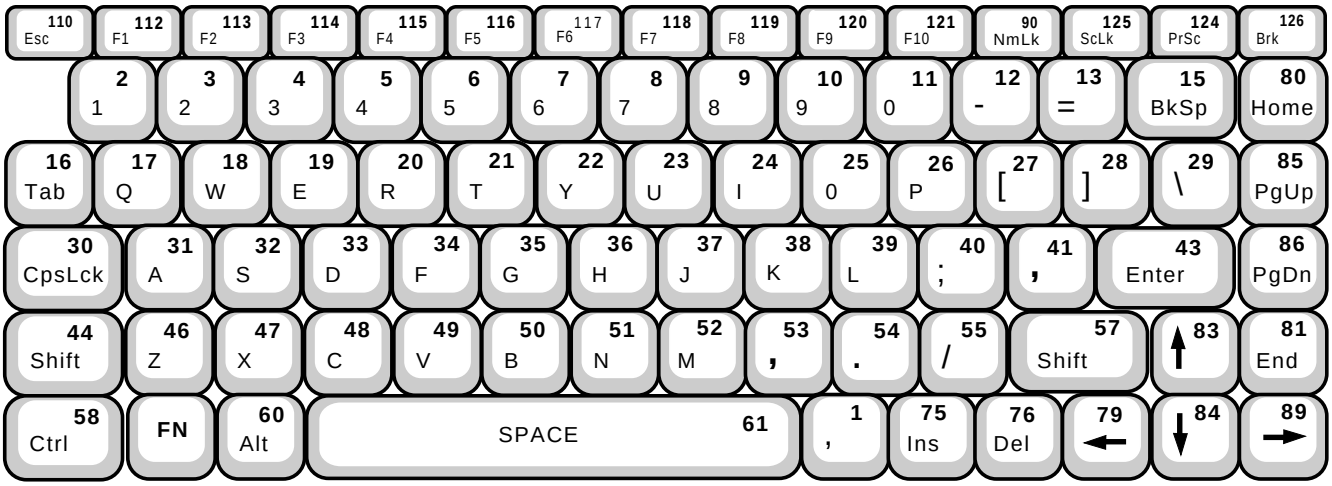
*In FN Case:
LCtrl = RCtrl
LAlt = RAlt
F1 = F11
F2 = F12

Refer to Page 4 for a description of FN key specifics.

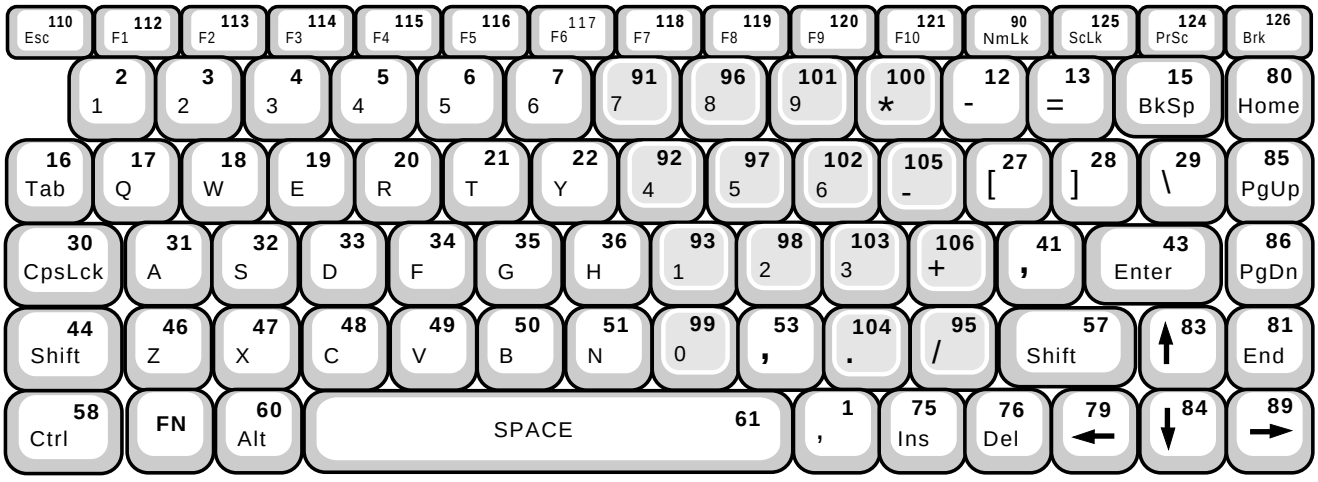
Keyboard Layouts (US English)

Depending on the status of the Num Lock and the FN Key, the UR5HCFJL implements one of four keyboard layouts. (Key numbering of a standard 101/102 keyboard is shown.)

Layout A (Default layout)



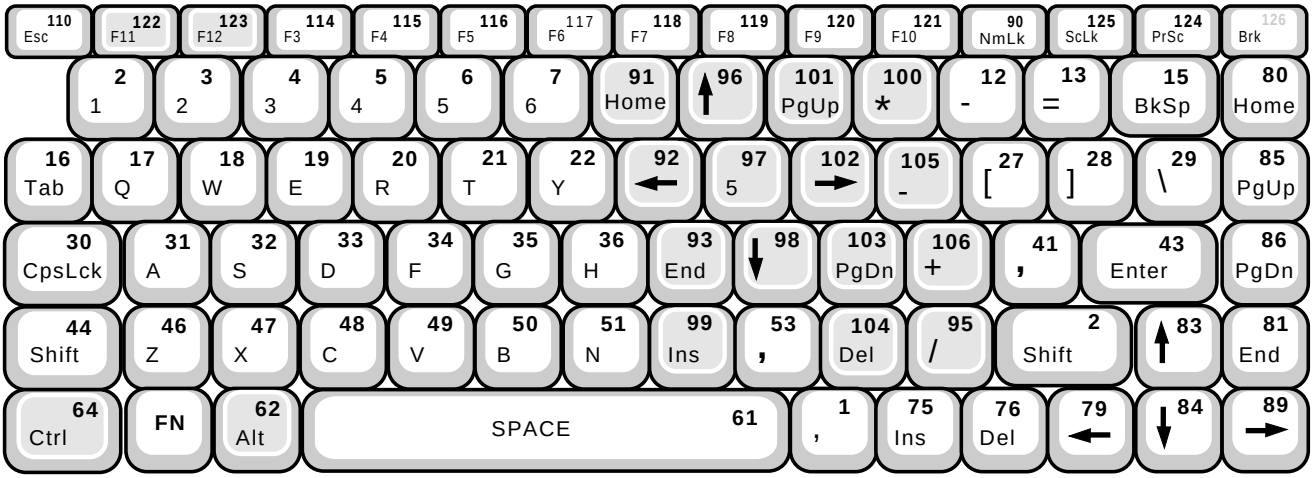
Layout B (Num Lock is set)



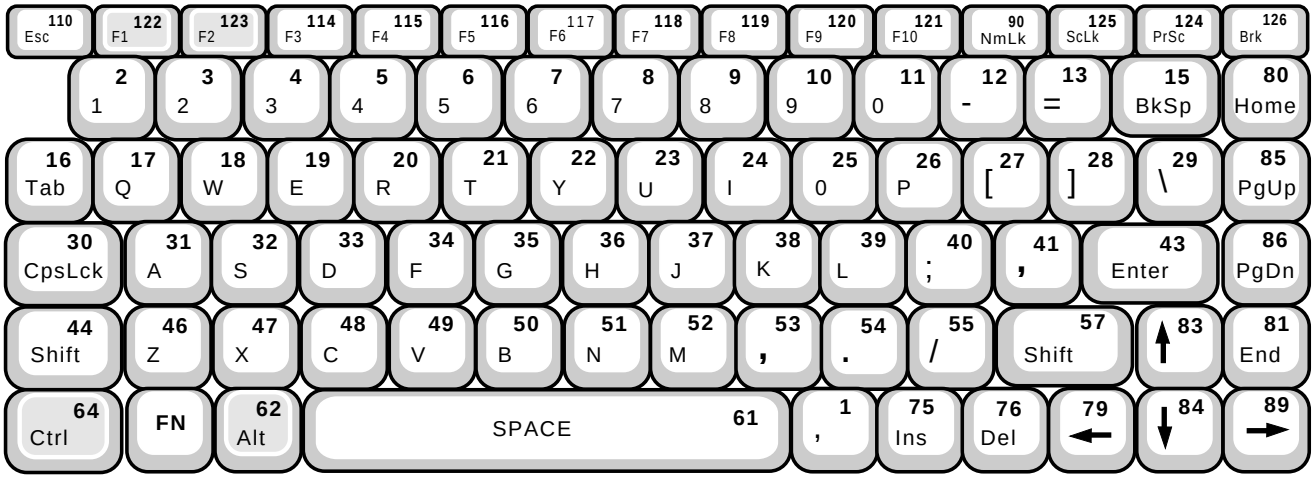
Keyboard Layouts (US English)

Depending on the status of the Num Lock and the FN Key, the USAR GreenCoder™ implements one of four keyboard layouts. (Key numbering of a standard 101/102 keyboard is shown.)

Layout C (FN key pressed)



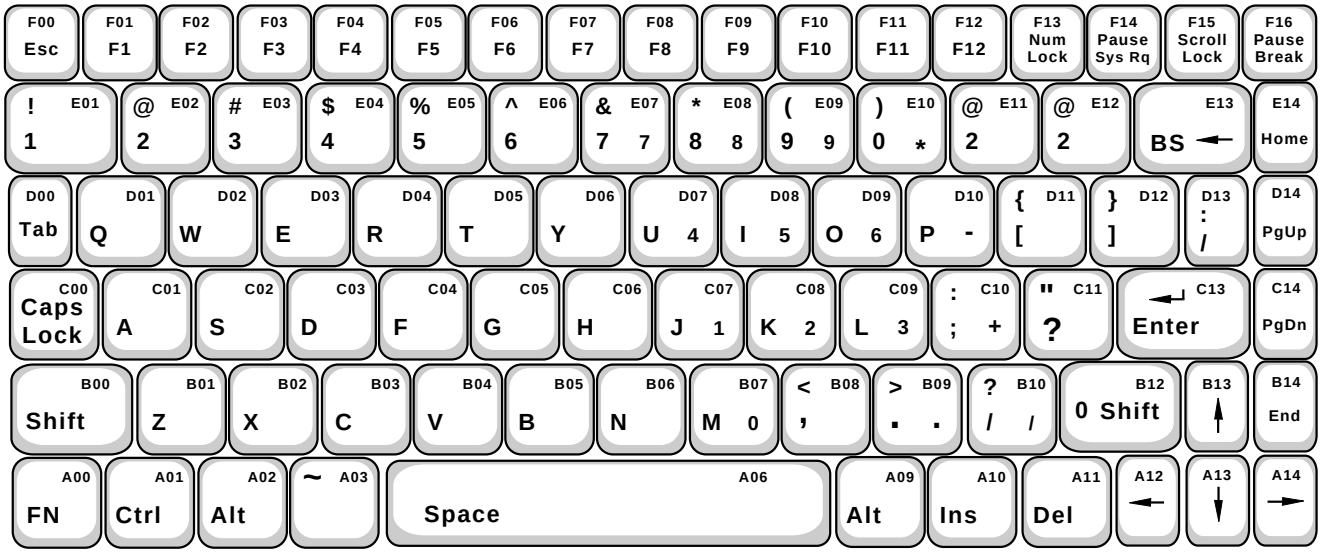
Layout D (Num Lock set and FN key pressed)



Key Map for Fujitsu FKB7316-001(UR5HCFJL-16)

Rows (R0–R7) \ Columns C0-C15	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0				Space	B				N		/		RAlt	ArrDn	ArrRt	ArrLft
1		Esc	F4	F5	G		F6		H		RQ		LAlt			ArrUp
2		Tab	F3	BkSpc	T	CapLk	RSB		Y	LShift	LBS	F7				
3	PgUp	LQ	F2	F9	K5	F1	=	FN	K6		Dash	F8		Del	Ins	Home
4	LCtrl	A	D	\	F	S	K		J		SCol	L				
5		Z	C	Enter	V	X	Comma		M	RShift		Period		NumLk		Pause
6	PgDn	K1	K3	F10	K4	K2	K8		K7		K0	PK	PrtScr	F11	F12	End
7		Q	E		R	W	I		U		P	O	ScrLk			

Keyboard layout for Fujitsu FKB7316-001(UR5HCFJL-16)



Key Map for Fujitsu FKB1406 (UR5HFJL-06)

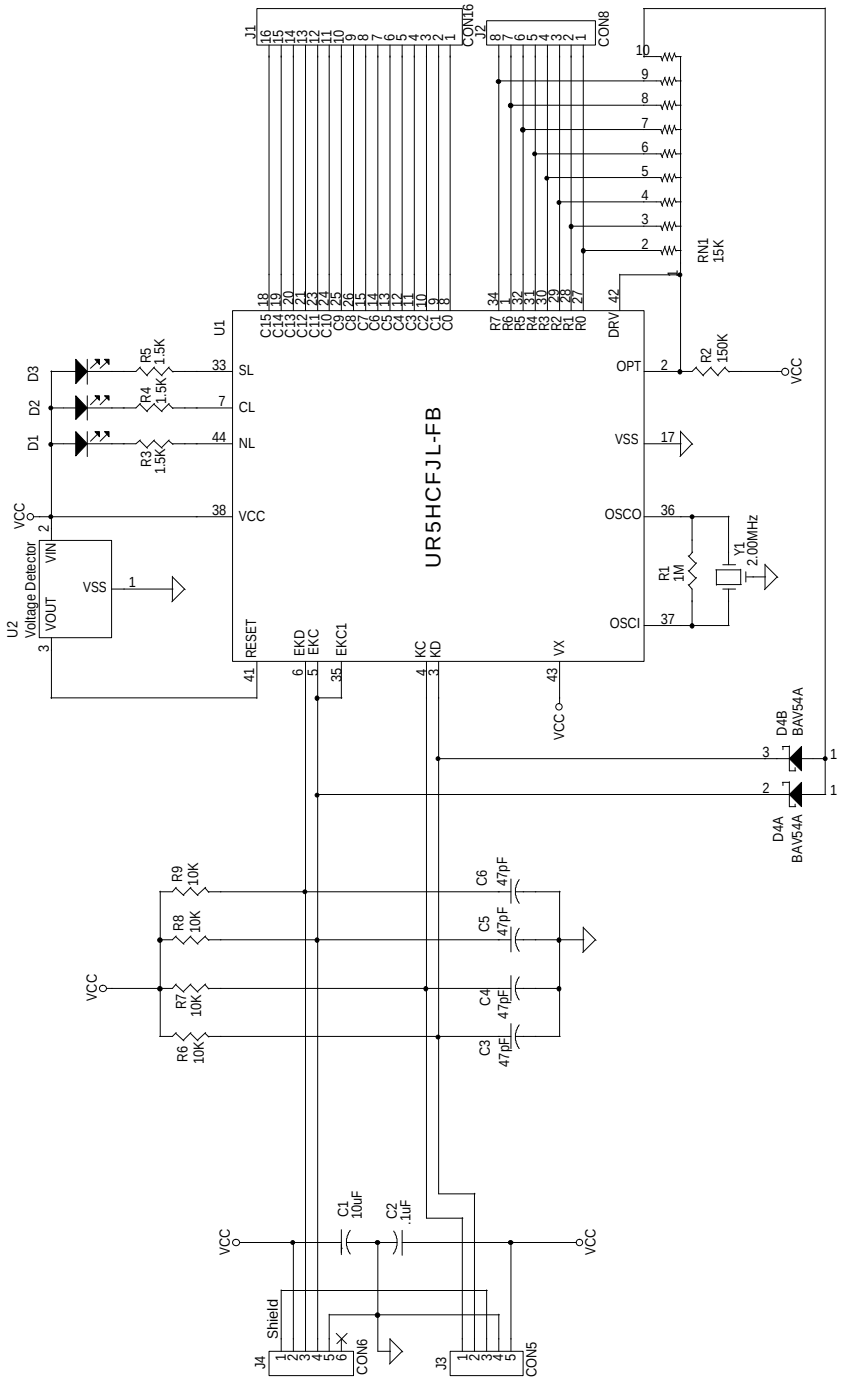
Rows (R0–R7) \ Columns (C0–C13)	0	1	2	3	4	5	6	7	8	9	10	11	12	13
0														
1	LAlt*	` (BkQt)		LCtrl*	FN	Esc	1 F1	2 F2	9/Pad 9 F9	0/ Pad * F10	- (dash) NmLk	= Bk		BkSpc
2		\	LShift			Del		T	Y	U/Pad 4	I/Pad5	Enter	RShift	PgDn
3		TAB				Q	W	E	R	O/Pad 6	P/Pad - Ins	[Pause		] ScrLk
4		Z				CapLk			K/Pad 2	L/Pad 3	;/Pad + PrtScr	, (appos) SysReq		PgUp
5		A				S	D	F	G	H	J/Pad 1	//Pad /		Home
6		X				C	V	B	N	M/Pad 0	, (com)	. (per)		Space
7						3 F3	4 F4	5 F5	6 F6	7/Pad 7 F7	8/Pad 8 F8	Prog		End

* In FN Case:
LCtrl = RCtrl
LAlt = RAlt

Refer to Page 4 for a description of FN key specifics.

Key Map for Fujitsu FKB1406 (UR5HFJL-06)

Suggested Interfacing for the USAR GreenCoder™ UR5HCFJL-FB



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 UR5HCFJL-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	
■ Plastic 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	3.5	mA
Data Retention Mode (0 to 70°C)	Vrm	2.0			V
Supply Current*	Idd				
■ Run			2.5	3.5	mA
■ Wait			0.8	1.5	mA
■ Start			2.0	50	µA
I/O Ports Hi-Z Leakage Current	Iil			+/-10	µA
Input Current	Iin			+/- 1	µA
I/O Port Capacitance	Cio		8	12	pF

*In a typical application circuit, including external A/D.

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			2.0	
■ External Clock Option		dc	2.0	
Crystal Oscillator Startup Time	fop			MHz
■Crystal (fosc/2)			2.0	
■External Clock Option		dc	2.0	
Cycle Time	tcyc	1000		ns
Crystal Oscillator Startup Time	toxov		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
OSC1Pulse Width	t_{OH}, t_{OL}	90		ns

*The minimum period t_{ILIL} 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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