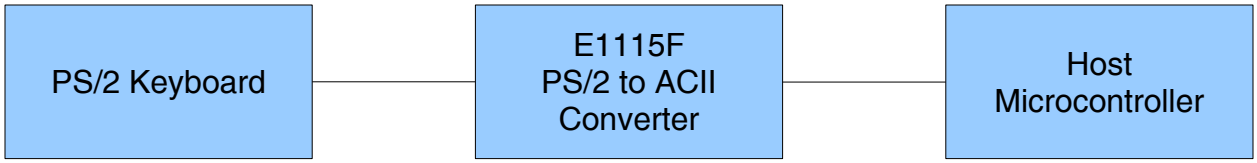
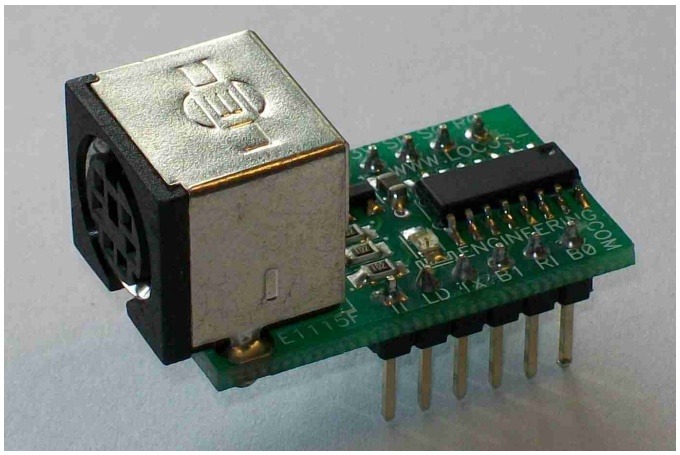
Locus Engineering Inc E1115F

PS/2 Keyboard to ASCII Converter



FEATURES

- **Decodes PS/2 Scanset 2 keystrokes to a single ASCII byte on make**
- **Offload process intensive PS/2 keyboard decoding**
- **Unique single byte codes for non-ASCII keys including multi-media keys**
- **Simple interface between PS/2 keyboard and any host microcontroller**
- **Selectable 57.6 & 115.2 KBaud serial data output**
- **100 KHz clocked serial data output**
- **Ctrl-Alt-Del reset & Escape key reset outputs**
- **Interrupt and LED flash output**
- **3.3V 120mA regulated output**
- **Low cost**
- **Upgrade from E1115B/D versions**



APPLICATIONS

- **Enhance microcontroller applications with keyboard data**
- **Process control**
- **Robotics control**

DESCRIPTION

The E1115F PS/2 Keyboard to ASCII Converter module allows a microcontroller application to be enhanced with keyboard numeric and text data without having to handle the tedious scancode detection and decoding process. This module receives the complex scancode sequence for each keystroke on the "make", and decodes it to a unique ASCII byte which is easier to use by a host application. This frees up the host microcontroller considerably since it does not have to wait for each bit to be determined, then for each scancode byte to be saved, and finally for the variable length byte sequence to be decoded. As the E1115F module is dedicated to the task and provides a single decoded byte corresponding to the keystroke, the host can concentrate on its own application while being interrupted only when necessary. Non-ASCII keys are also decoded to a unique code. The E1115F module provides both serial data and clocked serial data at ~100 KHz. An interrupt signal and a LED flash output are also provided. Pressing Ctrl-Alt-Del generates a one second reset output while pressing the Escape key generates a separate 8msec reset output. The E1115F module only requires +5.0V and a connection to the host. The outputs are compatible with 3.3V and 5.0V TTL-compatible inputs. The E1115F module is available in a 12 pin DIP package with integrated PS/2 connector.

Table 1. Absolute Maximum Ratings

Parameter	Rating
V_{dd} to GND	-0.3 to +6.5V
Digital input voltage to GND	-0.3 to +5.8V
Digital output voltage to GND	-0.3 to +5.8V
Operating temperature range	-40 to +85°C
Storage temperature range	-65 to +150°C
Maximum output current through port pin	100mA

Table 2. Electrical Characteristics

Test Conditions: Supply Voltage V_{dd} = +5.0V, $T_{ambient}$ = 25° C, unless otherwise specified

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{dd}	Supply voltage	4.75	5.0	5.25	V
I_{dd}	Supply current		6.0	14	mA
V_{IH}	Digital high input voltage	2.5V			V
V_{IL}	Digital low input voltage			0.6	V
V_{OH}	Digital high output voltage	2.5V @Iout -10mA	2.6V @Iout -3mA	3.2V @Iout -10µA	V
V_{OL}	Digital low output voltage	0.1V @Iout 10µA	0.6V @Iout 10mA	1.0V @Iout 25mA	V
$T_{operate}$	Operating temperature	-40		+85	°C
$T_{response}$	Response time		~5		µsec
	Output baud rate	57.6		115.2	KBaud
	Output clocked data rate	95	~100	105	Kbps

General Precautions

Charged devices and circuit boards can discharge without warning. Proper ESD precautions should be followed to avoid failure.

This device is not authorized for use in any product where the failure or malfunction of the product can reasonably be expected to cause failure in a life support system or to significantly affect its operation.

Locus Engineering Inc. reserves the right to make changes at any time without notice to improve product features or reliability.

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Table 3. Pin Descriptions

Pin#	Name	Function
1	NT	Interrupt output, ~50 usec active low pulse before and 10 usec after clocked serial data SD
2	LD	LED flash output, ~8msec active low pulse
3	TX	Serial data output 57.6 to 115.2 Kbaud
4	B1	Baud rate select, 0=57.6K, 1=115.2K
5	RI	Reset input, ~30usec minimum active low pulse
6	B0	Escape key reset output, ~8 msec active low pulse
7	RO	Ctrl-Alt-Del reset output, ~1 second active low pulse
8	SC	Serial clock output, ~100KHz
9	SD	Clocked serial data output, ~100KHz
10	3V	+3.3V regulator output, ~120mA for external devices
11	0V	Ground
12	5V	+5.0V input to +3.3V regulator input and to PS/2 keyboard connector

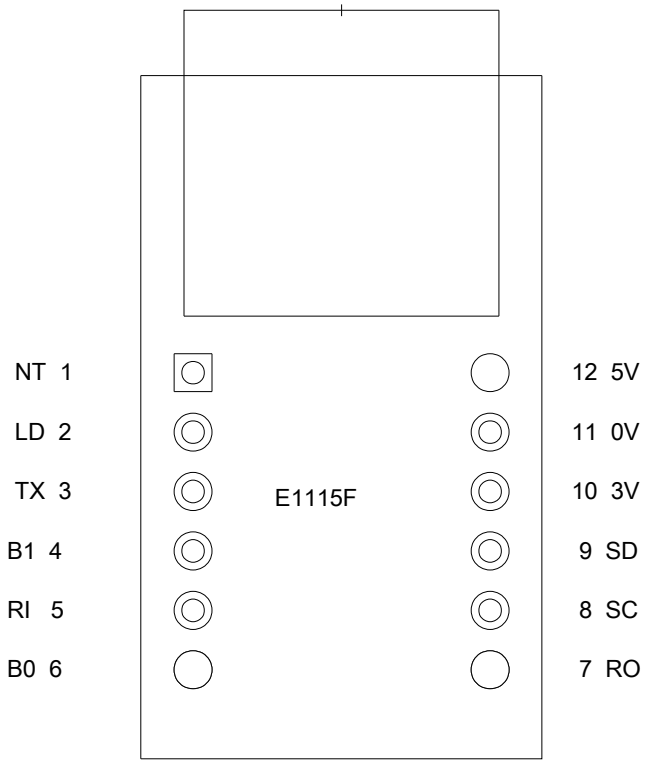

Figure 1. Pinout Diagram

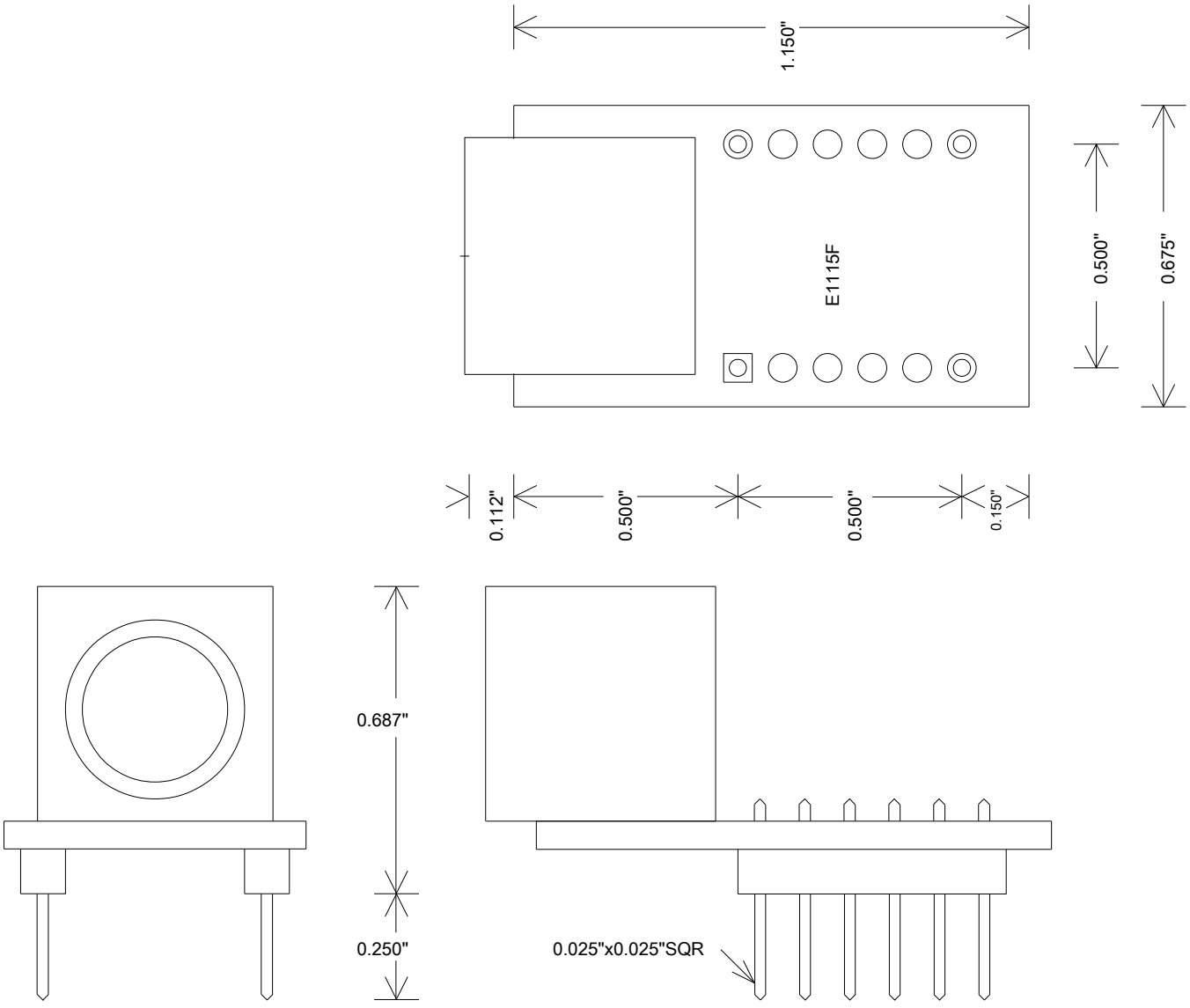

Figure 2. Module PCB Dimensions

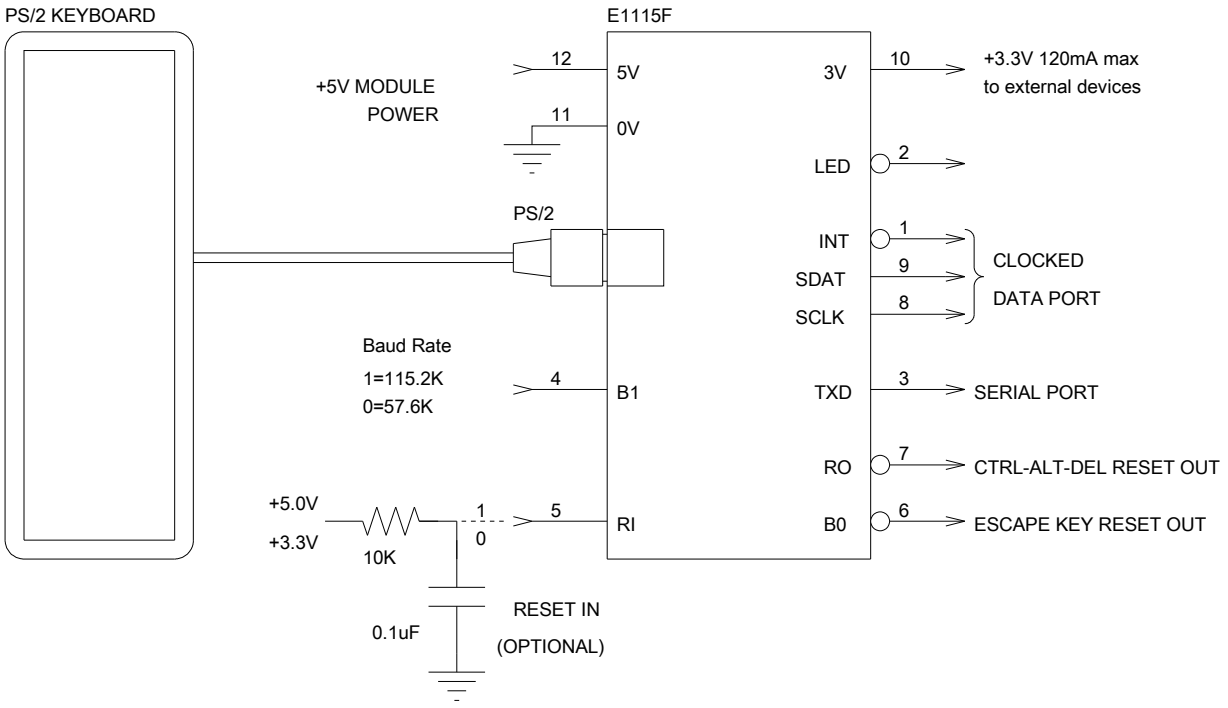

Figure 3. General Application Circuit

E1115B/D Compatibility

The E1115F is an upgrade to the original E1115B and E1115D versions. The module size and pinout are identical to the E1115B except for two extra pins providing the added functionality of Ctrl-Alt-Del reset output and <Escape> key reset output.

Power Supply

The E1115F module requires +5.0V to operate the module and power the PS/2 keyboard. The module consumes approximately 14 mA worst case with a keyboard connected; the keyboard supply current is additional and can be up to 200mA.

Digital I/O

The digital input/output pins are TTL compatible. Inputs have internal pullups and can be grounded or left floating for logic "0" or logic "1" levels respectively. Outputs are push-pull with 0 to +3.3V voltage swings.

Reset In

The power-on reset circuitry is self-contained within the module. A reset pin is provided however it is not needed unless the power supply ramp is slower than 1msec. The optional reset source can be from a microcontroller pin or an RC combination. The reset input needs to be an active low pulse at least 30usec duration. Typical RC values are 10K and 0.1uF respectively. For most applications, it can be left unconnected.

Serial Data Port

The serial port baud rate is selected using the B1 pin between 57.6K (B1=0) and 115.2K (B1=1). The TX pin is a single line connection to the host microcontroller's RX pin.

Clocked Data Port

The clocked data port is a three line connection to the host microcontroller which includes an interrupt pulse, serial data, and an active low ~100KHz clock pulse train. A single byte is sent to the serial port and then to the clocked data port on the "make" of every keystroke. A serial to parallel shift register can be used to capture the clocked data from the E1115F. The interrupt (NT) signal can also be used to indicate that the data has finished being loaded into the shift register.

Each clocked serial data bit time is approximately 10 usec. The data is output with the most significant bit first and the output is inverted. Note that either the rising or the falling edge of the SCLK can be used to clock the SDAT into a shift register as the SCLK edges are 3.3 usec inside the bit period.

Interrupt Output

The interrupt (NT pin) output is asserted 50 µsec in advance and held low until 10 µsec after the clocked serial data has been sent. This allows a host time to setup and receive the serial clock and data.

LED Flash Output

An onboard LED flashes for 8 msec following the termination of the interrupt signal. The L.Ctrl-L.Alt-Del sequence flashes the LED for one second.

Reset Outputs

Pressing the L.Ctrl-L.Alt-Del in sequence generates a one second active low reset output as well as sending 0xF0 to the serial port and to the clocked data port. This allows the keyboard to provide a hard reset to the host microcontroller.

The <Escape> key is also decoded to provide a ~8 msec active low reset output to an interrupt pin as an alternative signal to a hard reset. The active low pulse timing occurs at the same time as the LED active low pulse.

Module Operation

On power up or external reset, the E1115F clears the clocked serial data byte, and then waits for keyboard scancodes which are produced on both the make and the break of keyboard keys. Following the make of a keyboard key, the E1115F parses the keyboard scancodes as they are received so that the corresponding ASCII code is produced as quickly as possible. Typical response times are within 5 microseconds after the last bit of the last scancode for a keystroke is received. Note that ASCII codes are produced by the E1115F only on the make, i.e. when the key is pressed. No ASCII codes are produced for the scancodes produced on the release of the key.

The E1115F decodes the unshifted and shifted keys using the state of the Shift key or CapsLock key. Other control keys such as Alt, Ctrl, NumLock, and ScrollLock have no effect on the keys although outputs are produced. The CapsLock, NumLock, and ScrollLock toggle their respective indicators on the keyboard. While the CapsLock key produces no output, the NumLock and ScrollLock keys produce outputs which toggle between two values. All the non-ASCII keys on the PS/2 keyboard also produce unique codes. The E1115F allows typematic functionality where ASCII codes are repeated at a 10Hz rate when a key is held down for more than a second. The only exception to the typematic functionality is the Pause/Break key which only puts out one ASCII code when the key is held down.

The E1115F provides several outputs following a keyboard key closure. The output timing is shown in Figure 4. The E1115F first sends an ASCII code through the serial port at the selected data rate using one start bit, 8 data bits, no parity, and one stop bit (8N1 format). The interrupt pin (NT) is brought low 50 µsec prior to the clocked data to allow the host microcontroller time to service the interrupt. The clocked data is sent at approximately 100KHz. The NT pin is held low until 10 µsec after the end of the clocked data transmission. Once the NT pin is deasserted, the LED line is pulsed low for 8 msec. The keyboard is inhibited until all outputs are completed.

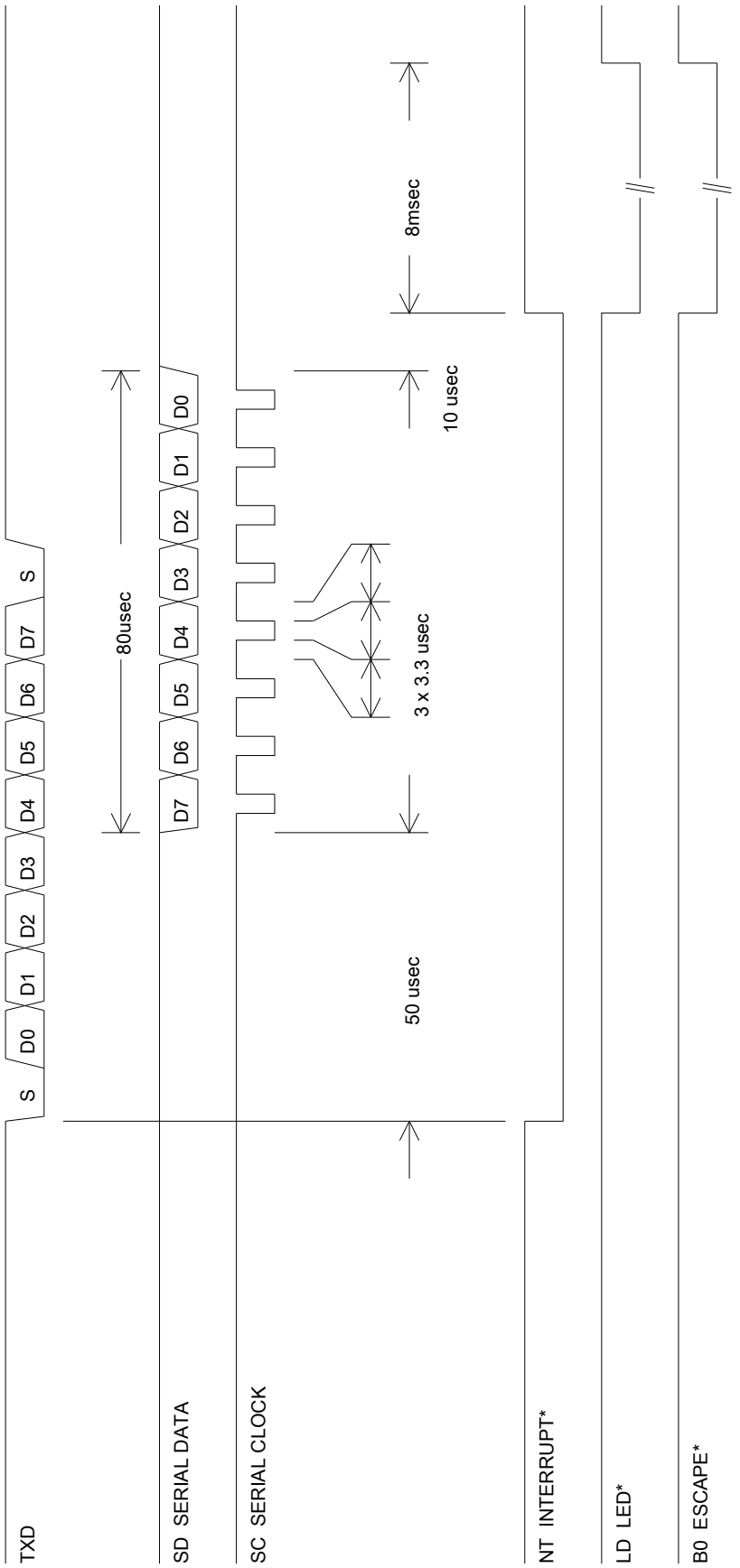

Figure 4. Signal Output Timing

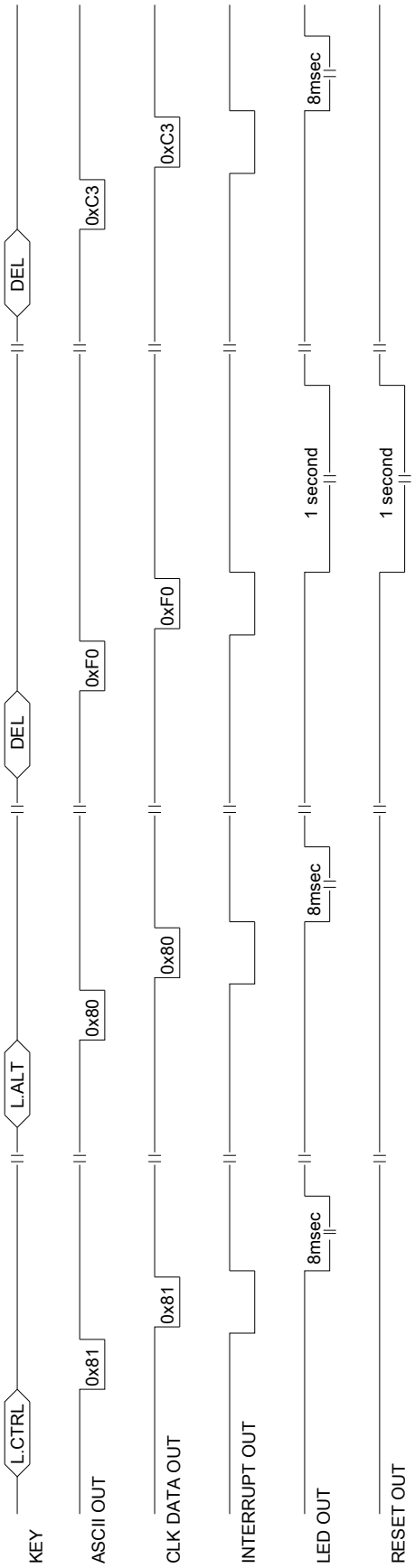

Figure 5. Ctrl-Alt-Del Reset Output Timing

SERIAL DATA INTERFACE

The simplest protocol is a serial data transfer using the host's UART in which case only TX is used. A typical interface to a microcontroller is shown below.

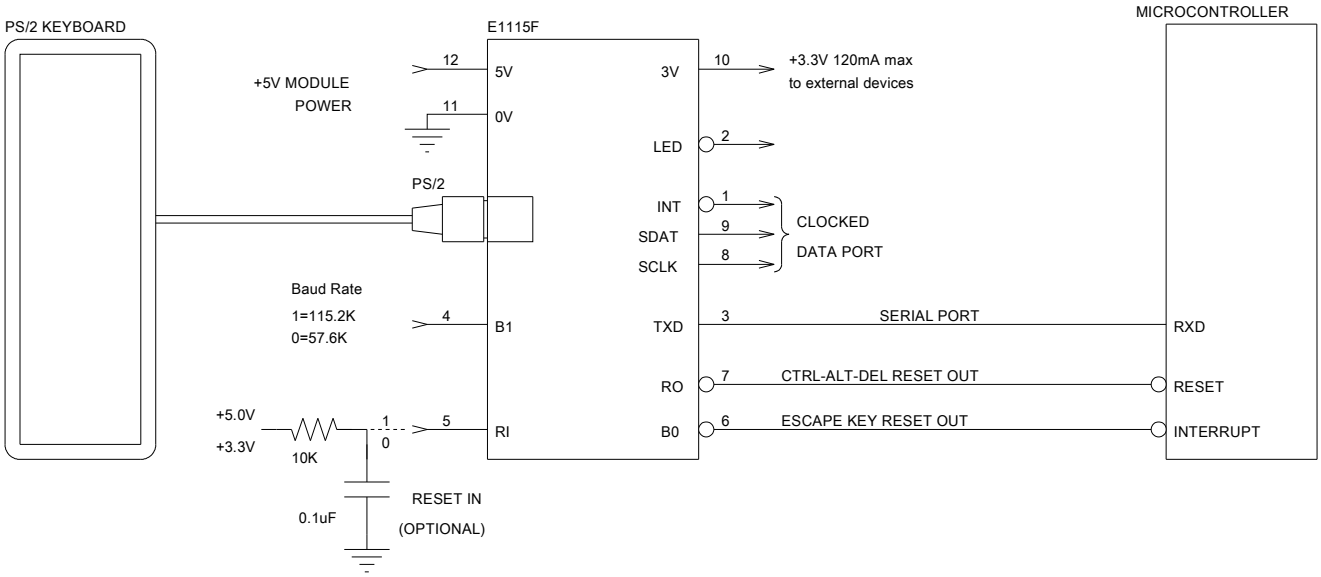

Figure 6. Serial Interface to Microcontroller

Data is output with the least significant bit first. The baud rate is selectable between 57.6 and 115.2 Kbaud using the B1 input. The serial data can be converted to bipolar RS-232 levels using a MAX232 type chip or equivalent for connection to a PC.

CLOCKED SERIAL DATA INTERFACE TO MICROCONTROLLER

If a UART is not available on the microcontroller, data can be received using the serial data, serial clock, and interrupt signals. The INT* signal can be used as an interrupt to the microcontroller whose falling edge occurs 50 usec prior to the first data bit. This delay allows the microcontroller to save any work in progress before reading the E1115F data. The microcontroller can read the serial data whenever the serial clock level is low, or use either clock edge to read the serial data bits which are sent most-significant-bit first.

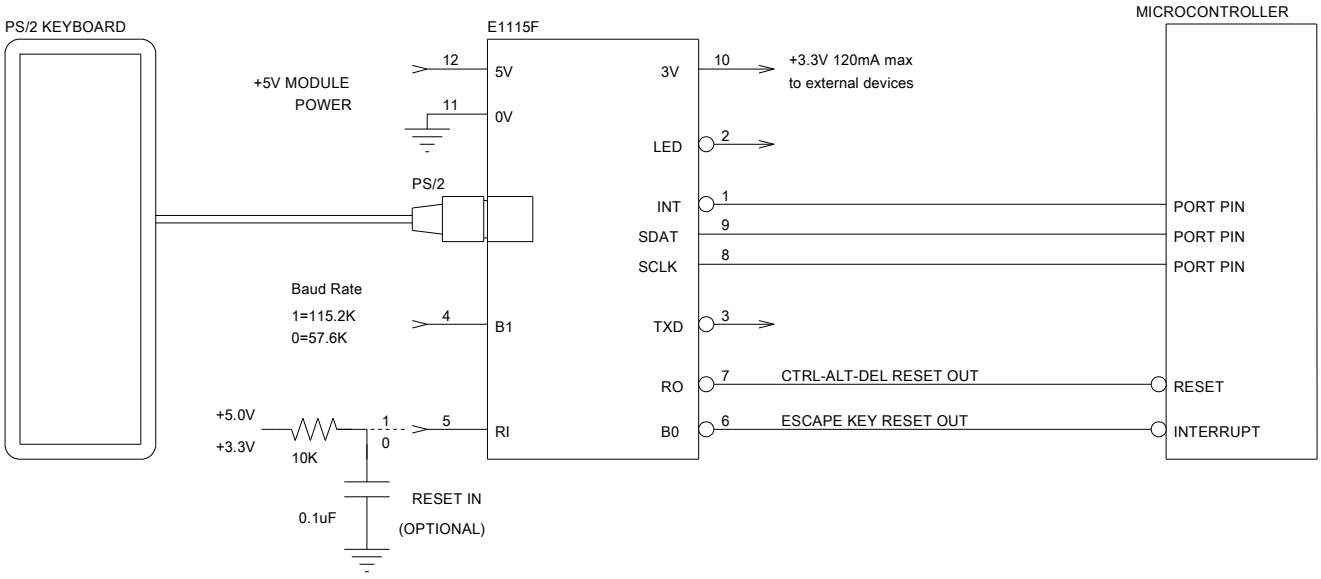

Figure 7. Clocked Data Interface to Microcontroller

CLOCKED SERIAL DATA INTERFACE TO SHIFT REGISTER

A shift register can also be used to capture the ASCII byte from the clocked serial data port. The following circuit illustrates the clocked data capture using a 74LV164 shift register. The 'LV series has TTL compatible inputs and rail to rail outputs while operating between 2.0V and 6.0V, so compatibility is maintained regardless of the shift registers' supply voltage.

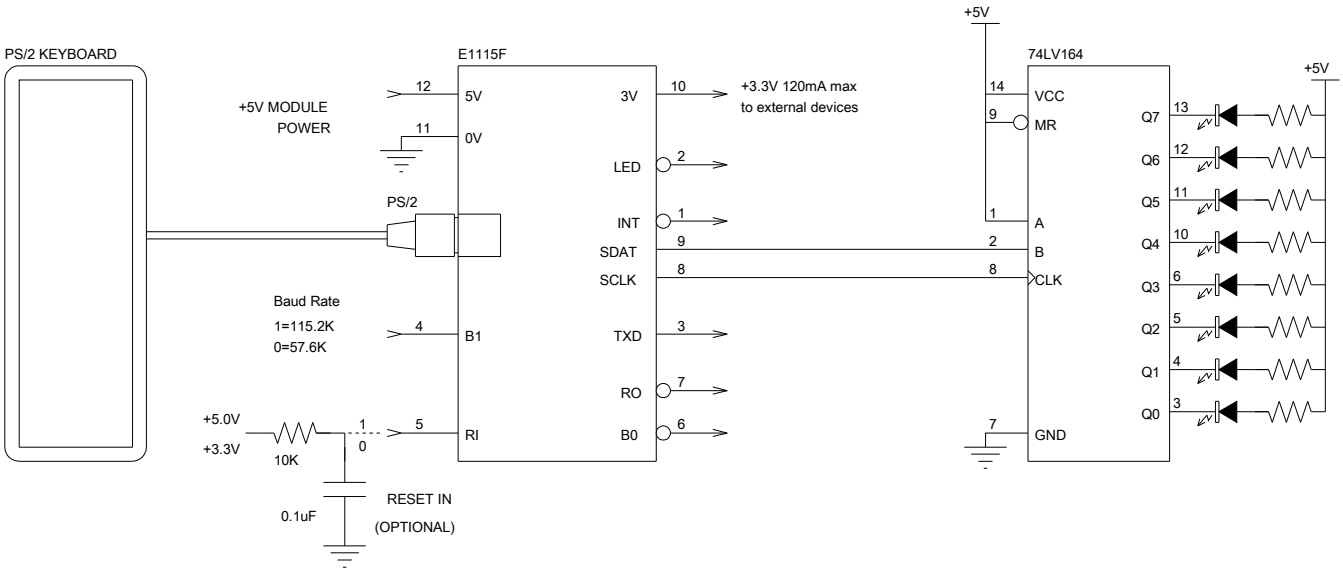

Figure 8. Clocked Data Interface to Shift Register

KEYBOARD CODE CORRESPONDENCES

The E1115F produces ASCII codes for all standard ASCII keys and unique single byte codes for the non-ASCII keys as shown in the folowing tables. It should be noted that there are variations between keyboard manufacturers for the scancodes produced, especially for the multi-media keys so care is needed in selecting the same keyboard for a particular application. The output produced by the E1115F represent the most common codes from keyboards. Where there are differences between keyboard models, the codes remain unique for the same model of keyboard keys.

On the main keyboard, the CAPS-Lock and SHIFT keys only modify keys with upper and lower case characters. The CAPS-Lock key also toggles its LED. The CTRL, GUI, ALT, and APP each produce unique non-ASCII codes. Figure 9 indicates the code correspondences for the various keys.

The extended keypad code correspondences are indicated in Figure 10. Note that the SCRL-Lock and NUM-Lock codes toggle between two values depending on the the state of the associated LED. Apart from the keypad arithmetic operators which have codes identical to the keys on the main keyboard, all other keys have unique non-ASCII codes.

The multi-media keypad code correspondences are all unique non-ASCII codes and are indicated in Figure 11.

Figure 9. Main Keyboard ASCII Code Correspondences

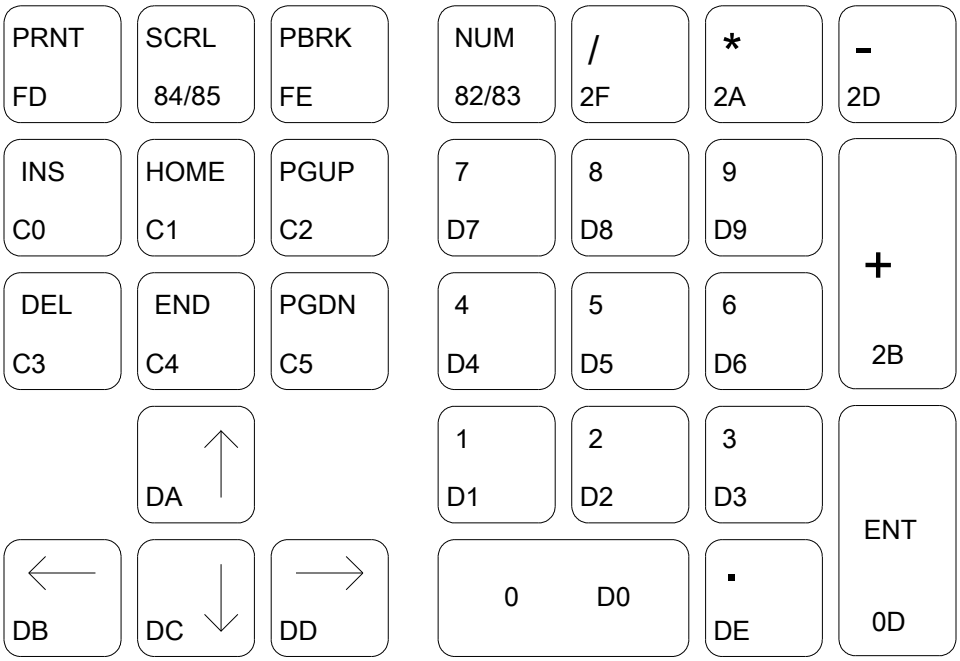

Figure 10. Extended Keyboard Code Correspondences

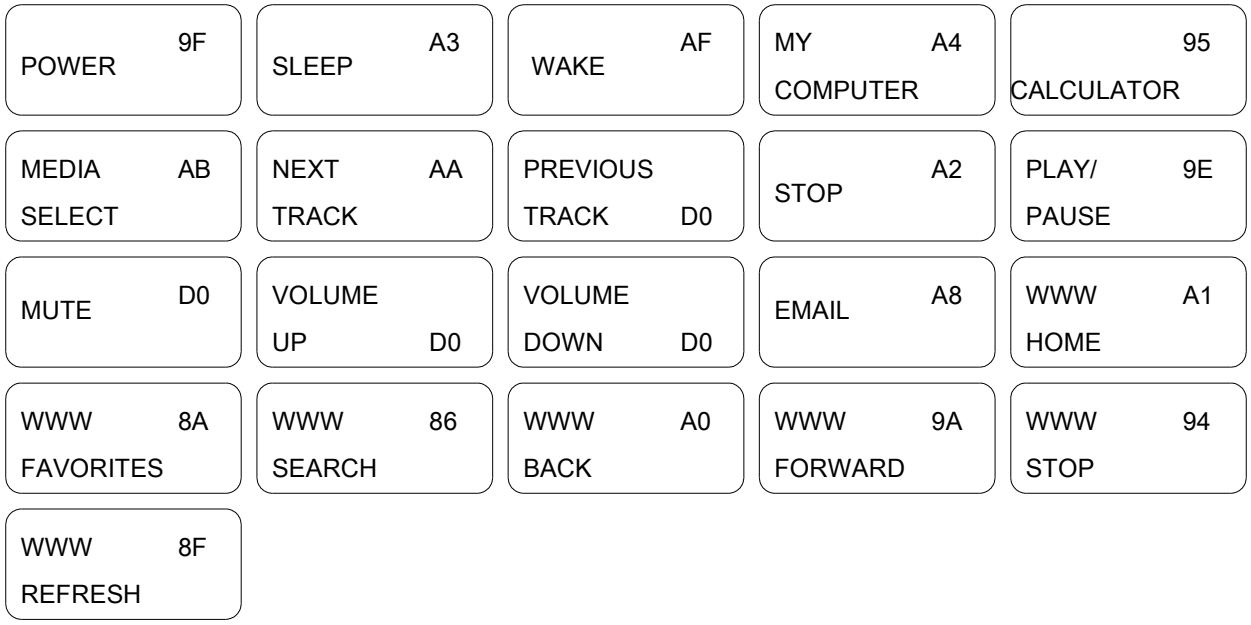

Figure 11. Multi-Media Keyboard Code Correspondences