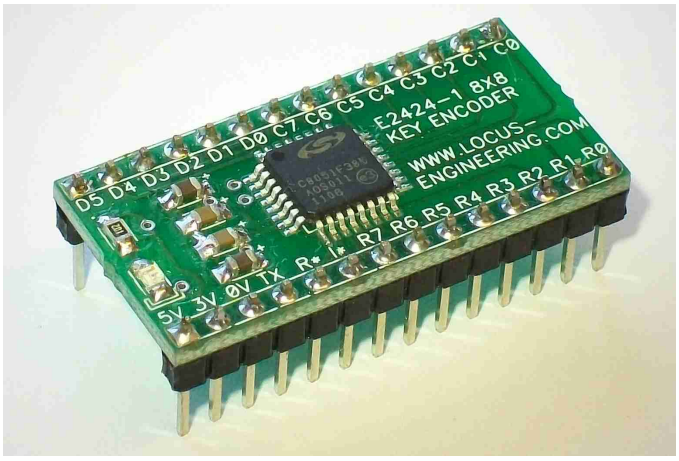
Locus Engineering Inc E2424

64 Key Encoder

FEATURES



- **encodes up to 64 keys in 8x8 array**
- **offloads process intensive keyboard encoding**
- **no external parts needed**
- **exclusive 8 bit code (0x00 to 0x3F) for each of 64 keys**
- **50ms key debounce period**
- **output on make of key closure**
- **2 key rollover**
- **typematic function, 5cps after 600ms**
- **57.6 KBaud serial data output**
- **6 bit parallel output**
- **TTL compatible outputs**
- **8ms LED flash and interrupt output**
- **+3.3V to +5.0V operation**
- **28 pin DIP package on 0.6" wide headers**

DESCRIPTION

The E2424 64 Key Encoder allows up to 64 normally open keyswitches in a 8x8 matrix to be encoded without external parts. This module simplifies the software overhead of the host microcontroller and reduces the I/O pins needed from 16 to one. Keys are fully debounced with no false outputs regardless of any other combination of keys pressed. Keys are encoded on the make of the key with a response time of ~50msec due to a high speed scan of the keyswitch matrix and a unique debounce algorithm. Outputs include a parallel 6 bit port, a 57.6Kbaud serial port, and an interrupt signal making interfacing easy. Power input is +2.7V to +5.2V. Custom baud rates are also available.

APPLICATIONS

- **Enhance microcontroller applications with custom keyboard data**
- **Process control**
- **Robotics control**
- **Data entry**
- **Security**

Table 1. Absolute Maximum Ratings

Parameter	Rating
Regulator Input (pin 1) to GND	-0.3 to +5.8V
Regulator Output (pin 2) to GND	50mA
Vdd Input (pin 1&2 shorted) to GND	-0.3 to +4.2V
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
Maximum total current through Vdd or GND	500mA

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 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 pin 1	3.6	5.0	5.25	V
I_{dd}	Supply current pin 1		3.5		mA
V_{dd}	Supply voltage pin 2	2.7	3.3	3.6	V
I_{dd}	Supply current pin 2		3.5		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_{reset}	Reset minimum pulse width	30			µsec
$T_{debounce}$	Debounce time		50		msec
T_{di}	Data valid to interrupt time		50		usec
$T_{interrupt}$	Interrupt pulse width		8		msec
$T_{typematic}$	Typematic delay		600		msec
F_{repeat}	Typematic repeat		5		cps
F_{baud}	Output baud rate, standard (custom baud rates available)		57.6		KBaud

Table 3. Pin Descriptions

Pin#	Name	Function
1	5V	+5.0V input; leave pin 2 unconnected
2	3V	+3.3V input; connect to pin 1 as well
3	0V	Ground
4	TX	Serial data output 57.6 Kbaud 8 bits no parity 1 stop bit
5	R*	Reset input, minimum ~30usec active low pulse
6	I*	Interrupt output ~8msec active low pulse following serial output
7	R7	Row 7 scan line
8	R6	Row 6 scan line
9	R5	Row 5 scan line
10	R4	Row 4 scan line
11	R3	Row 3 scan line
12	R2	Row 2 scan line
13	R1	Row 1 scan line
14	R0	Row 0 scan line
15	C0	Column 0 sense line
16	C1	Column 1 sense line
17	C2	Column 2 sense line
18	C3	Column 3 sense line
19	C4	Column 4 sense line
20	C5	Column 5 sense line
21	C6	Column 6 sense line
22	C7	Column 7 sense line
23	D0	Data 0 output
24	D1	Data 1 output
25	D2	Data 2 output
26	D3	Data 3 output
27	D4	Data 4 output
28	D5	Data 5 output

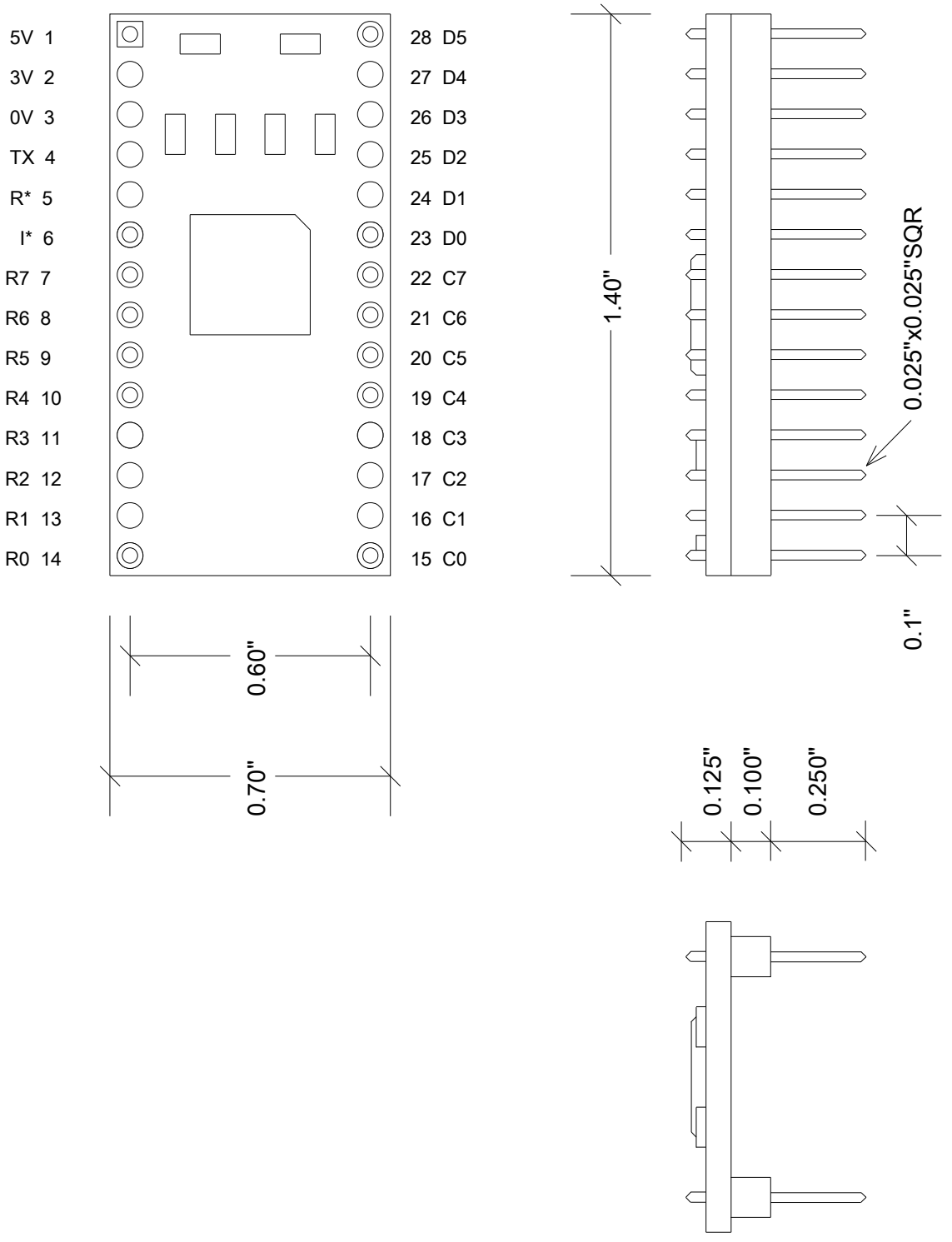

Figure 1. Module Dimensions & Pinout

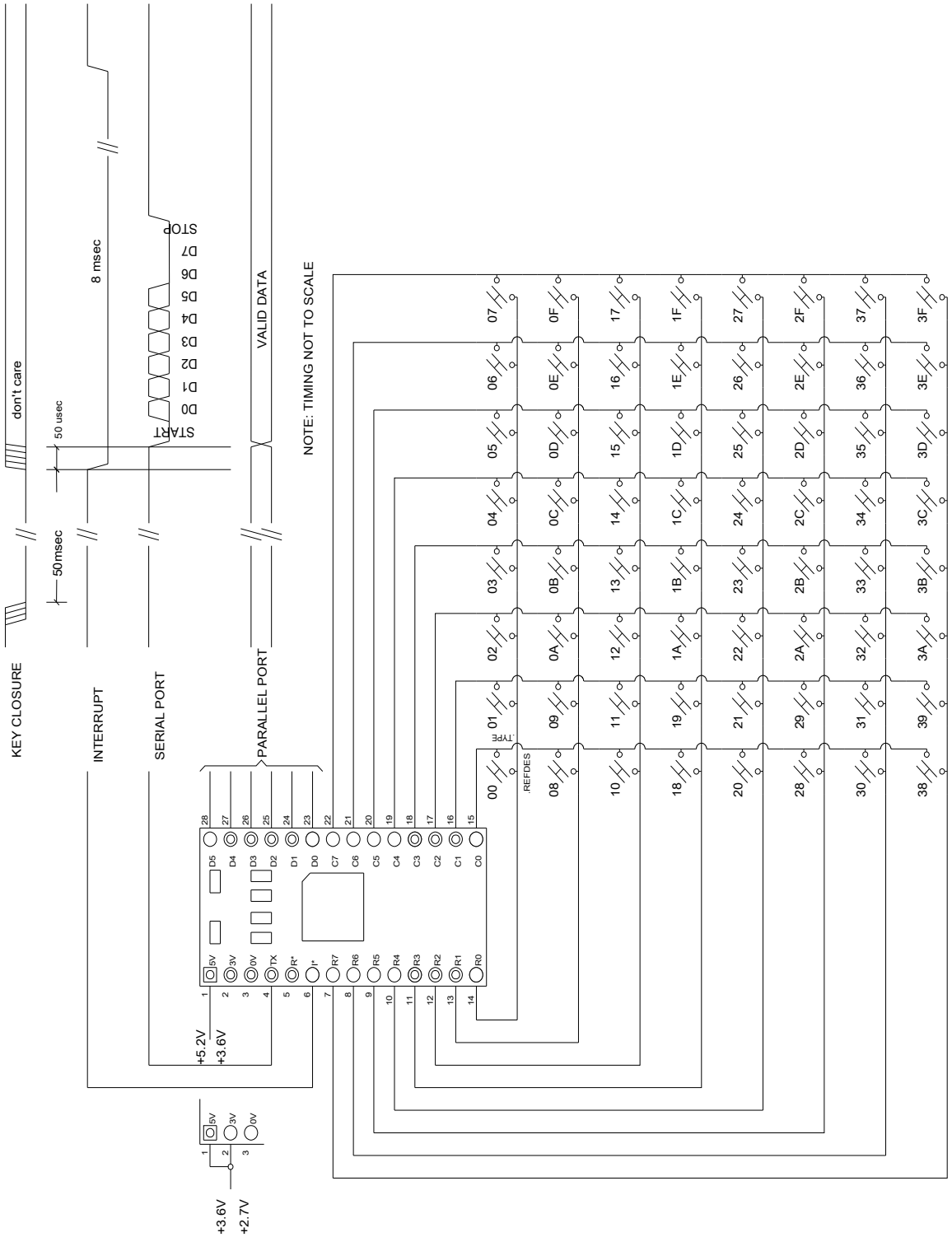

Figure 2. Application Circuit & Signal Timing

Power Supply

The E2424 module has a voltage regulator allowing two modes of operation. For supply voltages of +3.6V to +5.25V, connect to the voltage regulator input on Pin 1 and leave the voltage regulator output on Pin 2 open except for small loads to ground less than 50mA. For supply voltages of +2.7V to +3.6V, the regulator is bypassed by shorting Pin 1 and Pin 2 and using these as the supply voltage input. Thus the module can be powered by commonly available voltages +5V (pin 1) or +3.3V (pins 1&2). See Figure 2 Application Circuit.

Digital I/O

The digital input and output pins are TTL compatible. Inputs such as Reset have internal pullups and can be grounded or left floating for logic "0" or logic "1" levels respectively. Outputs such as serial output TX, interrupt output I*, and parallel data outputs D0-D7 are push-pull with 0 to +3.3V voltage swings and are compatible with TTL or LVC inputs.

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.

Keyswitches

Keys can be placed mechanically anywhere as long as they are electrically connected in the 8 column by 8 row format. Not all keys need to be in place. Keyswitches should have bounce times of <10msec; most tactile switches have bounce times <2msec.

Module Operation

On power up or external reset, the E2424 scans and debounces the 8x8 key matrix. The first key debounced on the make of the key closure locks out the rest and a single output is sent to both the serial port and to the parallel port along with an active low interrupt pulse.

The keyboard scan involves the rows being sequentially driven low by open drain drivers while the columns are sequentially sensed for a low due to a switch closure. As the open drain drivers have weak pullups, the cable connecting the keyboard to the module should be kept a reasonable length to minimize EMI pickup although the E2424 has good immunity to EMI interference due to the switch debounce algorithm. Keys are debounced when they are solidly low for ~50msec. Some encoders encode a key on the first falling edge however EMI could also trigger a similar event which would be erroneous and other real pressed keys would be locked out and not properly validated.

The E2424 debounces each of the 64 switches to provide immunity from EMI and also a fast response to a valid switch closure. During a key closure, the contacts bounce between logic states for several milliseconds. A switch is considered debounced and stable once the switch contacts stop bouncing past a threshold of ~20msec. At this point it is encoded to a value 0x00 to 0x3F and sent as serial data at the selected baud rate followed by the clocked data. The trigger output is asserted low 50µsec prior to the data being sent to provide the host microcontroller time to service the interrupt and get ready for the serial clock and clocked data to be read. The trigger output is held low another 8msec to flash the LED. The remaining keys are inhibited in turn to prevent erroneous outputs in the case of multiple key closures.

If several keys are pressed, the first key decoded in the scanned array is sent out. As long as the first decoded key is pressed, all other keys are locked out, i.e. there are no further outputs until the first key is released. If there are several keys still pressed, the next decoded output will belong to the next scanned key in the array. The last switch pressed will produce a code.

The key code assignments are shown in Figure 2 Application Circuit. As an example, the key code for a closed switch at row 4 and column 3 would be 0x23 in hexadecimal.

The typematic function waits for a key to be continually closed for ~600msec; after this the encoded switch value is sent to the serial port, parallel port, and the interrupt output is pulsed every ~200msec or ~5 characters per second rate (5cps) until the key is released.

Serial Data Port

The serial port baud rate is fixed at 57.6 Kbaud, 8 bits, no parity, and 1 stop bit. Of the 8 bits, only the lower 6 bits are used and the most significant 2 bits are zeroes. The data output ranges from 0x00 to 0x3F. The TX pin is a push-pull output with 0 to +3.3V signal swing with data sent least significant bit first. It is a single line connection to the host microcontroller's RX pin. The serial data can be converted to RS-232 levels using a MAX232 or equivalent. Custom baud rates are also available.

Parallel Data Port

The 6 bit data port provides hexadecimal codes 0x00 to 0x3F for keys #0 to #63 respectively. The interrupt signal I* on pin 6 validates the output code with an active low 8 msec pulse after the data is stable. The parallel port data remains after the interrupt signal is no longer active.

LED Flash & Interrupt Output

An onboard LED flashes at the same time as the 8msec active low interrupt signal following the debounced make of any key. To provide an audible key closure feedback, connect the I* output to a non-inverting open drain buffer such as a 74LVC1G07; connect a low power internally driver piezo sounder between the +5V and the buffer output.

Additional References

Locus Engineering application note AN102 describes how keyboard data can be parsed into commands and data.