

### HID & SYSTEM MANAGEMENT PRODUCTS, KEYCODER® FAMILY

#### DESCRIPTION

The SH2165 PixiKey™ is a cost-effective, high-functionality combination keyboard and mouse encoder which offers a programmable keyboard matrix and a PixiPoint® strain gauge sensor interface. It is a USB 2.0 full-speed device. The SH2165 is ideal for industrial applications.

The SH2165 scans and encodes an 8-row by 18-column keyboard matrix. The encoder retrieves matrix information from built-in ROM or a separate serial EEPROM. Semtech provides Windows® applications to create the binary matrix file, and to upload the matrix to the EEPROM.

The SH2165 PixiKey interfaces various strain gauge pointing device sensors.

Typically consuming about 10 mA, the SH2165 PixiKey is ideal for battery-operated systems. The IC supports USB "Selective Suspend" that allows host system to enter power saving mode.

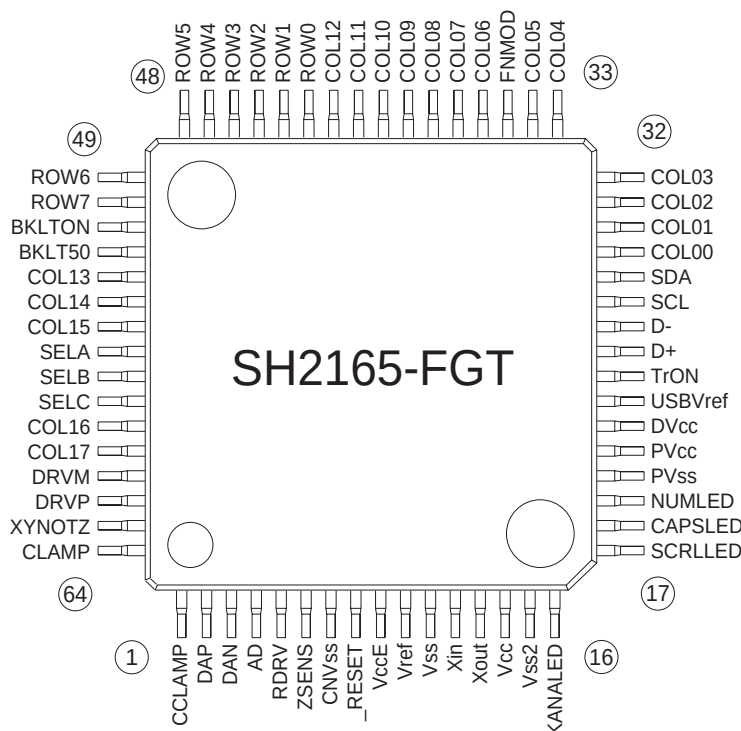
#### FEATURES

- USB 2.0 full-speed HID keyboard and mouse combo device
- Works with standard Windows keyboard and mouse drivers
- Bootable USB keyboard device
- Bootable USB mouse device
- Programmable 8 x 18 keyboard matrix
- Multimedia key support
- Windows applications provided to design and load keyboard matrix
- Up to 22 custom / macro keys
- Provides direct drive for four LEDs (caps lock, numeric lock, scroll lock, katakana)
- Advanced motion control algorithm provides accurate cursor control
- Provides built-in profiles to interface popular force-stick sensors from several manufacturers
- 3.0 V – 3.6 V operation over extended temperature range
- Low power consumption: 10 mA (typical)
- 64-pin LQFP package

#### APPLICATIONS

- Industrial keyboards
- Point-of-sale (POS) terminals
- Notebook PCs
- Portable devices
- Accessories
- Embedded keyboards

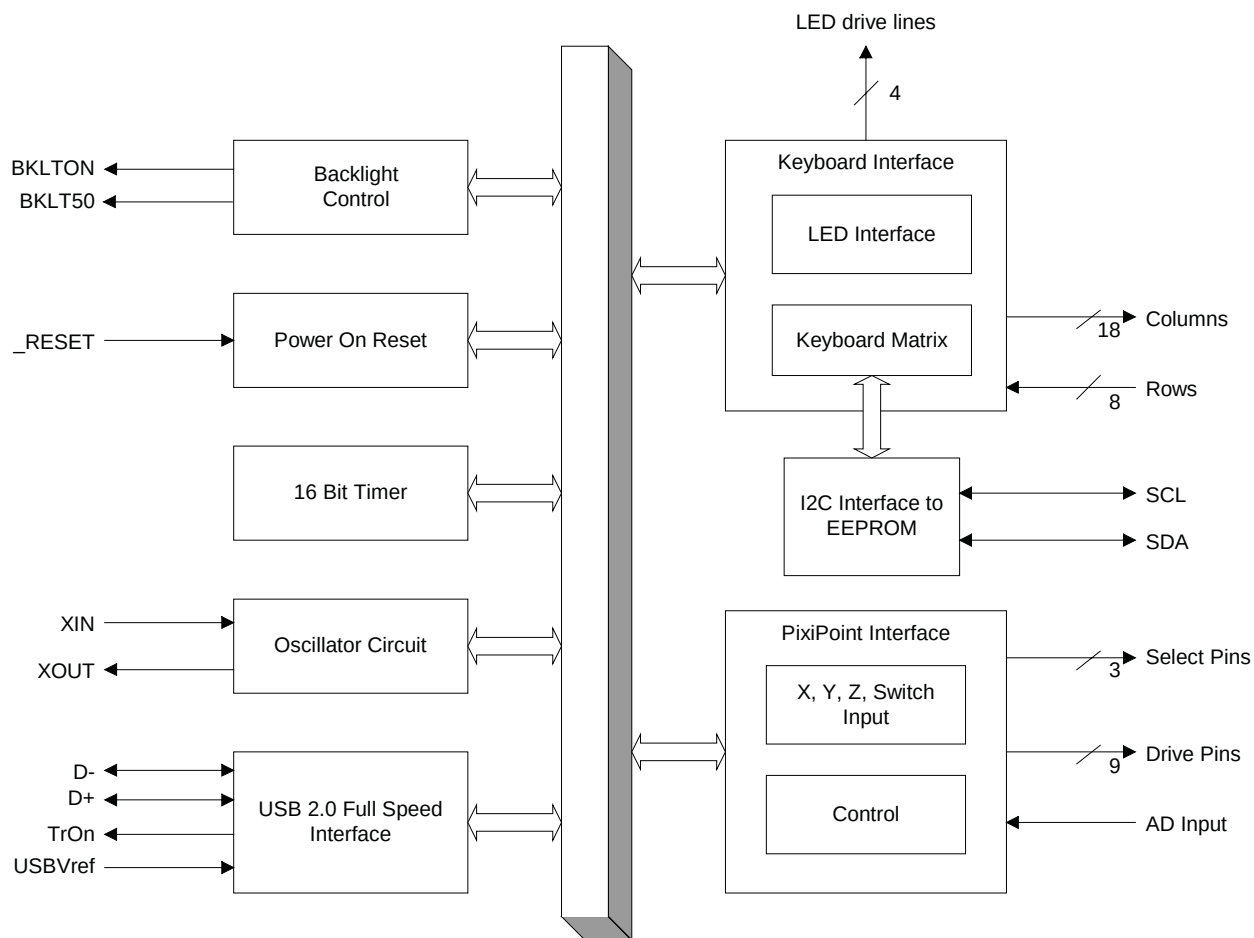
#### PIN ASSIGNMENTS



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**ORDERING CODE**

| Package Options | Pitch | TA = -20° C to +85° C     |
|-----------------|-------|---------------------------|
| 64-pin LQFP     | 0.5mm | SH2165-FGT                |
|                 |       | Lead free, fully RoHS and |
|                 |       | WEEE compliant            |
| Evaluation kit  |       | SH2165-EVK                |

**BLOCK DIAGRAM FOR THE SH2165 PIXIKEY**


## DESCRIPTION

The SH2165 consists functionally of several major sections (see the block diagram on the previous page). These include the PixiPoint interface, the keyboard interface, the 16-bit timer, the oscillator circuit, the USB 2.0 full-speed communication port, and the I2C® EEPROM communication port. All sections communicate with each other and operate concurrently.

## OSCILLATOR

The SH2165 has a built-in oscillator circuit intended to work with an external 6.00 MHz crystal or ceramic resonator with built-in load capacitors.

## EEPROM SERIAL INTERFACE

If an EEPROM is used, it must be an industry standard 32-Kbit or larger EEPROM, such as a 24LC32; the I2C serial data and serial clock pins must be connected to it.

## PIN DESCRIPTIONS

| Mnemonic          | Pin    | Type | Name and Function                                                                |
|-------------------|--------|------|----------------------------------------------------------------------------------|
| <b>Power</b>      |        |      |                                                                                  |
| Vcc               | 14     | P    | Power supply: 3.0 V – 3.6 V                                                      |
| VccE              | 9      | P    | Connect to Vcc                                                                   |
| DVcc, PVcc        | 22, 21 |      |                                                                                  |
| Vref              | 10     | P    | Reference voltage; connect to Vcc                                                |
| Vss               | 11     | P    | Ground                                                                           |
| CNVss, Vss2       | 7, 11  | P    | Connect to Vss                                                                   |
| PVss              | 20     |      |                                                                                  |
| Vref              | 10     | P    | Reference voltage; connect to Vcc                                                |
| <b>Reset</b>      |        |      |                                                                                  |
| RESET             | 8      | I    | Reset                                                                            |
| <b>Oscillator</b> |        |      |                                                                                  |
| Xin               | 12     | I    | Oscillator Input                                                                 |
| Xout              | 13     | O    | Oscillator Output                                                                |
| <b>USB</b>        |        |      |                                                                                  |
| D-                | 26     | I/O  | USB D- line                                                                      |
| D+                | 25     | I/O  | USB D+ line                                                                      |
| TrON              | 24     | O    | USB reference voltage output                                                     |
| USBVref           | 23     | P    | USB reference voltage input; connect to Vcc                                      |
| <b>Keyboard</b>   |        |      |                                                                                  |
| CAPSLED           | 18     | I/O  | Caps lock LED: direct drive pin                                                  |
| KANALED           | 16     | I/O  | Katakana LED/emergency LED: direct drive pin                                     |
| NUMLED            | 19     | I/O  | Num lock LED: direct drive pin                                                   |
| SCRLLLED          | 17     | I/O  | Scroll lock LED: direct drive pin                                                |
| COL00-05          | 29-34  | I/O  | Columns for scan matrix                                                          |
| COL06-12          | 36-42  | I/O  | Columns for scan matrix                                                          |
| COL13-15          | 53-55  | I/O  | Columns for scan matrix                                                          |
| COL16-17          | 59-60  | I/O  | Columns for scan matrix                                                          |
| ROW0-7            | 43-50  | I/O  | Row lines for scan matrix                                                        |
| FNMOD             | 35     | I/O  | Function operation mode: simple mode: tie to ground; sticky mode: leave floating |
| BKLT50            | 52     | I/O  | Backlight control (leave floating if no backlight used)                          |
| BKLT0N            | 51     | I/O  | Backlight control (leave floating if no backlight used)                          |
| <b>Pointer</b>    |        |      |                                                                                  |
| SELA              | 56     | I/O  | PixiPoint mux select A                                                           |
| SELB              | 57     | I/O  | PixiPoint mux select B                                                           |
| SELC              | 58     | I/O  | PixiPoint mux select C                                                           |
| AD                | 4      | I/O  | Analog to digital converter pin                                                  |
| CCLAMP            | 1      | I/O  | Sample capacitor minus drive                                                     |
| CLAMP             | 64     | I/O  | Sample capacitor plus drive                                                      |
| DAN               | 3      | I/O  | Reference resistor minus drive                                                   |
| DAP               | 2      | I/O  | Reference resistor plus drive                                                    |
| RDRV              | 5      | I/O  | Integration drive                                                                |
| DRVM              | 61     | I/O  | Positive drive                                                                   |
| DRVP              | 62     | I/O  | Negative drive                                                                   |
| XYNOTZ            | 63     | I/O  | High: XY drive; low: Z drive                                                     |
| ZSENS             | 6      | I    | Z sensitivity setting                                                            |
| <b>I2C</b>        |        |      |                                                                                  |
| SCL               | 27     | I/O  | I2C serial clock to and from matrix EEPROM                                       |
| SDA               | 28     | I/O  | I2C serial data to and from matrix EEPROM                                        |

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

**Pin Types Legend:** I=Input; O=Output; I/O=Input or Output; P=Power

### USB POWER MANAGEMENT

The SH2165 supports the USB suspend command and remote wake-up feature. In suspend state, the SH2165 still runs normally, consuming about 5 mA, because the PixiPoint sampling circuit must run continuously. This does not comply with the USB specification, which requires power consumption under 500  $\mu$ A when suspended. But the host system can still put the USB hub and other related circuits into low power consumption mode. When the SH2165 gets any keyboard report or PixiPoint report, it wakes up the host.

Windows® XP supports "selective suspend", which works very well with SH2165. But Windows XP does not normally turn on "selective suspend" for a composite device like the SH2165. Semtech provides a driver initialization file (smtchid.inf) to enable "selective suspend" for the SH2165 under Windows XP. To enable "selective suspend" for the SH2165 under Windows XP, take the following steps:

1. Connect the SH2165 to the host system.
2. Go to Windows Control Panel > System > Hardware Manager
3. Under Human Interface Devices, you see two USB Human Interface Devices, one for the SH2165 keyboard and one for the SH2165 mouse (force stick). Follow step 4 for each item.
4. Right-click the item, choose update the driver manually and choose "have disk." Then select the smychid.inf file.

**Note:** Semtech does not and need not provide drivers. Semtech provides this driver initialization file so that the selective suspend feature is supported for the SH2165, using the existing Microsoft mouse and keyboard drivers.

## SMTCHID.INF LISTING

```
; Copyright (c) 1999-2004 Semtech
;
; smtchid.inf
;
[Version]
Signature="$WINDOWS NT$"
Class=HIDClass
ClassGuid={745a17a0-74d3-11d0-b6fe-00a0c90f57da}
Provider=%SMTC%
CatalogFile=smtchid.cat
DriverVer=05/07/2003,1.0.0.0

;[SourceDisksNames]
;1=%DiskDescription%, "", ,

;[SourceDisksFiles]
; No files are installed by this INF

[Manufacturer]
%SMTC%=SMTC_HID

[SMTC_HID]
;
%USB\VID_047A&PID_0004.DeviceDesc%=SMTC_HID_Inst, , USB\VID_047A&PID_0001

%USB\VID_047A&PID_1101&MI_00.DeviceDesc%=SMTC_HID_Inst, , USB\VID_047A&PID_1101&MI_00
%USB\VID_047A&PID_1101&MI_01.DeviceDesc%=SMTC_HID_Inst, , USB\VID_047A&PID_1101&MI_01

%USB\VID_047A&PID_1102&MI_00.DeviceDesc%=SMTC_HID_Inst, , USB\VID_047A&PID_1102&MI_00
%USB\VID_047A&PID_1102&MI_01.DeviceDesc%=SMTC_HID_Inst, , USB\VID_047A&PID_1102&MI_01

%USB\VID_047A&PID_3301&MI_00.DeviceDesc%=SMTC_HID_Inst, , USB\VID_047A&PID_3301&MI_00
%USB\VID_047A&PID_3301&MI_01.DeviceDesc%=SMTC_HID_Inst, , USB\VID_047A&PID_3301&MI_01

%USB\VID_047A&PID_2165&MI_00.DeviceDesc%=SMTC_HID_Inst, , USB\VID_047A&PID_2165&MI_00
%USB\VID_047A&PID_2165&MI_01.DeviceDesc%=SMTC_HID_Inst, , USB\VID_047A&PID_2165&MI_01

[SMTC_HID_Inst.NT]
Include=input.inf
Needs = HID_SelSus_Inst.NT

[SMTC_HID_Inst.NT.HW]
Include=input.inf
Needs = HID_SelSus_Inst.NT.HW
AddReg = SMTC_HID_Inst.AddReg.NT.HW

[SMTC_HID_Inst.AddReg.NT.HW]
HKR,, "SelectiveSuspendOn", 0x00000001, 0x1

[SMTC_HID_Inst.NT.Services]
Include=input.inf
Needs = HID_SelSus_Inst.NT.Services
;
;Strings
;
[Strings]
SMTC = "Semtech"
DiskDescription = "Semtech USB devices"

USB\VID_047A&PID_0004.DeviceDesc = "Semtech USB ScreenCoder"
USB\VID_047A&PID_1101&MI_00.DeviceDesc = "Semtech USB Keyboard"
USB\VID_047A&PID_1101&MI_01.DeviceDesc = "Semtech USB Pointing Device"
USB\VID_047A&PID_1102&MI_00.DeviceDesc = "Semtech USB Keyboard"
USB\VID_047A&PID_1102&MI_01.DeviceDesc = "Semtech USB Pointing Device"
USB\VID_047A&PID_3301&MI_00.DeviceDesc = "Semtech USB Keyboard"
USB\VID_047A&PID_3301&MI_01.DeviceDesc = "Semtech USB Pointing Device"
USB\VID_047A&PID_2165&MI_00.DeviceDesc = "Semtech USB Keyboard"
USB\VID_047A&PID_2165&MI_01.DeviceDesc = "Semtech USB Pointing Device"
```

**PIXIPOINT BUILT-IN FEATURES**

*Tap* — Select

*Double Tap* — Execute

*Press Hold* — Drag

*EasyDrag™* — reduces the speed of the cursor when the user is dragging an object on the desktop, making it simple to accurately handle the object

*CleanStop™* — ensures that the cursor stops precisely

**PIXIPOINT SIGNAL CONDITIONING CIRCUIT**

The PixiPoint interfaces with a sensor that has four strain gauges – one on each of the sides. If force is applied precisely in the X direction, it produces a change of resistance of only the two X gauges. Force in the Y direction causes changes only in the Y gauges. One of the pair of gauges increases, while the other decreases in resistance.

If the user presses on the sensor from the top (Z axis), all of the strain gauges decrease in resistance.

When the test current is passed through the gauges, these resistance changes are converted into voltage changes. These signals are very small, typically under 1 mV Full Scale.

The signal conditioning circuit balances and amplifies the incoming signals for digitizing by a built-in A/D converter.

Semtech's circuit can correct a significant imbalance between the gauges in each X and Y pair ( $\pm 25\%$ ), allowing relaxed manufacturing tolerances for the sensors and cabling. There is no performance degradation over the full operating temperature range, and no degradation for large temperature gradients between the paired gauges.

**LEDS AND BACKLIGHT**

The SH2165 supports a keyboard backlight and four LEDs: Num Lock, Caps Lock, Scroll Lock, and Katakana Lock. The Katakana Lock LED also serves as an emergency signal.

Three special keys can be defined in the keyboard matrix that affect the backlight and the LEDs.

When the backlight increment key (BLINC) is pressed, the SH2165 cycles through backlight states, from backlight off (the default starting state), to half intensity, to full intensity, to off, and so on.

When the blackout key (BLKOUT) is pressed, the backlight and all LEDs are turned off; when it is pressed again, the backlight and all LEDs are returned to their former state. (Note that the blackout key affects the external lights only; it does not affect the internal state or operation of the keyboard; for example, it turns off the Num Lock LED, but it does not affect the Num Lock state.)

When the emergency key (ALERT) is pressed, the emergency LED (the Katakana Lock LED) turns on for 30 seconds, then turns off.

The pins BKLTON and BKLT50 (pins 51 and 52) control the backlight circuit. If no backlight is used, leave these pins floating.

### BUILT-IN SENSOR PROFILES

The SH2165 has built-in profiles to interface with several sensors; the user selects a profile by the ratio of resistor values:  $B = R2 / (R1 + R2)$  where  $R2 = 100\text{ K}\Omega$ .

- 1 > B > 5/8: reserved
- 5/8 > B > 4/8: Alps 3.2 K $\Omega$   
R1 = 76.8 K $\Omega$
- 4/8 > B > 3/8: Elantech 3.2 K $\Omega$   
with tail  
R1 = 76.8 K $\Omega$
- 3/8 > B > 2/8: Elantech 3.2 K $\Omega$   
without tail  
R1 = 220 K $\Omega$
- 2/8 > B > 1/8: NMB 636  $\Omega$   
R1 = 431 K $\Omega$
- 1/8 > B > 0: NMB 350  $\Omega$   
R1 open

### Z-AXIS GAIN

The SH2165 has built-in Z-axis functionality to recognize click and double-click on the force stick itself.

Z-axis sensitivity depends on the values of resistors R19 and R20.

$$A = R19 / (R19 + R20)$$

D = default value for Z sensitivity

S = actual value for Z sensitivity

If  $1.0 \geq A > 0.9$ :

$$S = D$$

If  $0.1 > A \geq 0.0$ :

$$S = 0 \text{ (Z disabled)}$$

For other values of A:

$$S = D * A * 2$$

Note: Z can also be disabled by tying ZSENS to GND

### SENSOR RESISTANCE

The value of resistor R6 should match the resistance of the sensor.

### SENSOR CONFIGURATION VALUES

#### SENSOR CONFIGURATION VALUES

The SH2165 includes three single-byte registers for the following values:

- X- and Y-axis gain
- Z-axis gain
- X and Y direction

With the appropriate values in these registers, the SH2165 can support any strain-gauge pointing device.

The user can adjust the values in these registers in any of the following ways:

- Pick resistance values for R1 and R2 that correspond to one of the sensor profiles built in to the SH2165
- Pick resistance values for R19 and R20 to set Z axis gain/sensitivity
- Set values for the registers in the EEPROM (note that valid values in the EEPROM override values specified by resistances)

### EEPROM sensor registers

| Offset | Register           | Valid values |
|--------|--------------------|--------------|
| 0x0FC2 | X- and Y-axis gain | 0x01-0xFE    |
| 0x0FC3 | Z-axis gain        | 0x01-0xFE    |
| 0x0FC4 | Direction control  | 0x01-0xFE    |

### Direction control register bits

| Bit | Default | Description                                 |
|-----|---------|---------------------------------------------|
| 7   | 1       | 0: select only; 1: select & drag            |
| 6   | 0       | 0: slow drag enabled; 1: slow drag disabled |
| 5   | 1       | 0: Z-tap disabled; 1: slow drag disabled    |
| 4   | 1       | Always 1                                    |
| 3   | (None)  | Z sign: 0: positive; 1: reversed            |
| 2   | 0       | XY swap: 0: no swap; 1: swap                |
| 1   | 0       | Y sign: 0: positive; 1: reversed            |
| 0   | 0       | X sign: 0: positive; 1: reversed            |

If the EEPROM is present and valid, and any of these register locations contains a valid value, the SH2165 uses that value for that register, regardless of the resistor values for R1, R2, etc.

**SENSOR CONFIGURATION VALUES (CONT'D)**

| <b>R1 value<br/>(R2 = 100 K<math>\Omega</math>)</b> | <b>XY gain</b> | <b>XY integration<br/>time</b> | <b>Z gain</b> | <b>Z integration<br/>time</b> | <b>Z sign</b> | <b>Sensor</b>                        |
|-----------------------------------------------------|----------------|--------------------------------|---------------|-------------------------------|---------------|--------------------------------------|
| Short                                               | 0x80           | 174 $\mu$ s                    | 0xA0          | 431 us                        | 0 (positive)  | Reserved                             |
| 23.2 K $\Omega$                                     | 0xD0           | 282 $\mu$ s                    | 0xD0          | 559 us                        | 0 (positive)  | Reserved                             |
| 45.3 K $\Omega$                                     | 0xD0           | 282 $\mu$ s                    | 0xFE          | 677 us                        | 0 (positive)  | Reserved                             |
| 76.8 K $\Omega$                                     | 0x20           | 47 $\mu$ s                     | 0x14          | 58 us                         | 1 (reversed)  | Alps 3.2 K $\Omega$                  |
| 127 K $\Omega$                                      | 0x1C           | 42 $\mu$ s                     | 0x0E          | 42 us                         | 1 (reversed)  | Elantech 3.2 K $\Omega$ (tail)       |
| 220 K $\Omega$                                      | 0x50           | 112 $\mu$ s                    | 0x20          | 89 us                         | 1 (reversed)  | Elantech 3.2 K $\Omega$<br>(no tail) |
| 432 K $\Omega$                                      | 0x60           | 128 $\mu$ s                    | 0x20          | 89 us                         | 1 (reversed)  | NMB 636 $\Omega$                     |
| Open                                                | 0x6E           | 152 $\mu$ s                    | 0x44          | 185 us                        | 1 (reversed)  | NMB 350 $\Omega$                     |



## FUNCTION MODE FOR KEYBOARD

The SH2165 includes a single-byte register for function mode. There are three function modes: **simple**, **sticky** and **lock**.

(Note that for this the section, the function key can be any combination of the left and right function keys.)

### Function mode pin

If the FNMOD pin (pin 35) is tied to ground, the function mode is simple; if it is left floating, the function mode is sticky. (Note that lock mode can be set only in the EEPROM, not with this pin.)

The FNMOD pin state can be overridden by the contents of the EEPROM.

### EEPROM function register

| Offset | Register      | Valid values                              |
|--------|---------------|-------------------------------------------|
| 0x0FC1 | Function mode | 0x00-0x02 (0: simple; 1: sticky; 2: lock) |

If the EEPROM is present and valid, and this register location contains a valid value, the SH2165 uses that value for the function mode, regardless of the state of the FNMOD pin.

### Function mode description: simple mode

In **simple** mode (the default), the function-key-down state turns on when the function key is pressed, and turns off when the function key is released. In other words, function key state always changes according to this scenario:

*Function-key-down state is off*  
 Function key is pressed  
*Function-key-down state turns on*  
 0 or more other keys are pressed  
 Function key is released  
*Function-key-down state turns off*

**FUNCTION MODE FOR KEYBOARD (CONT'D)****Function mode description: sticky mode**

In **sticky** mode, the function-key-down state can persist after the function key is released, but terminates after another key is pressed. Function key state changes according to any of these scenarios:

- (1) *Function-key-down state is off*  
Function key is pressed  
    *Function-key-down state turns on*  
1 or more other keys are pressed  
Function key is released  
    *Function-key-down state turns off*
- (2) *Function-key-down state is off*  
Function key is pressed  
    *Function-key-down state on*  
(no other keys pressed)  
Function key is released  
Another key is pressed  
    *Function-key-down state turns off*
- (3) *Function-key-down state is off*  
Function key is pressed  
    *Function-key-down state turns on*  
(no other keys pressed)  
Function key is released  
Function key is pressed  
0 or more other keys are pressed  
Function key is released  
    *Function-key-down state turns off*

**Function mode description: lock mode**

In **lock** mode, the function-key-down state can persist after the function key is released and any number of other keys are pressed. Function key state changes according to either of these scenarios:

- (1) *Function-key-down state is off*  
Function key is pressed  
    *Function-key-down state turns on*  
1 or more other keys are pressed  
Function key is released  
    *Function-key-down state turns off*
- (2) *Function-key-down state is off*  
Function key is pressed  
    *Function-key-down state turns on*  
(no other keys are pressed)  
Function key is released  
0 or more other keys are pressed  
Function key is pressed  
0 or more other keys are pressed  
Function key is released  
    *Function-key-down state turns off*

### KEYBOARD SCANNER

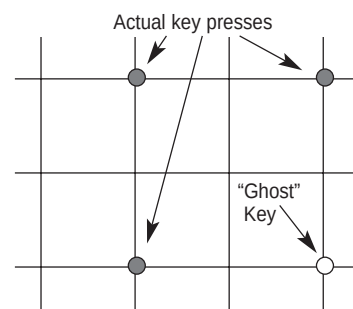
The SH2165 scans a keyboard organized as an 8 row by 18 column matrix for a maximum of 144 keys. Smaller size matrixes can be accommodated by leaving unused pins open. The SH2165 provides internal pull-ups for the row input pins. When active, the encoder selects each column line (C00-C17); for each column selected, it reads the row data lines (R0-R7). A key closure is detected as a zero in the corresponding position of the matrix.

Each key found pressed is debounced for a period of 30 ms. Once the key is verified, the corresponding key code(s) are loaded into the transmit buffer of the serial communication channel.

### "GHOST" KEY ELIMINATION

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 should be placed in the same row or column of the matrix, whenever possible. Shift-type keys (Shift, Alt, Ctrl, Window) should not reside in the same row (or column) as keys of any other type. The SH2165 has built-in mechanisms to detect and reject most "ghost" keys.



### SELECTING MATRIX

The SH2165 attempts to read from the EEPROM at offset 0x0FC0, expecting to find the value 0xAA.

If this value is found there, the SH2165 uses the keyboard matrix from the EEPROM.

If this value is not found for any reason (because there is a different value there, or because the EEPROM is absent or disabled), the SH2165 uses the built-in matrix shown at right (stored in the SH2165 ROM).

### BUILT-IN MATRIX

This table shows the key values for the populated row-column combinations in the built-in matrix for each of the four cases:

1. Num lock not set and function key up
2. Num lock set and function key up
3. Num lock not set and function key down
4. Num lock set and function key down

The built-in matrix includes five custom macro keys, defined as follows:

**CUSTKEY0**

= LSHIFT + F1 + ALERT

**CUSTKEY1** = LSHIFT + F2

**CUSTKEY2** = LSHIFT + F3

**CUSTKEY3** = LSHIFT + F4

**LOGON**

= LCTRL + LALT + DELETE

### SH2165 BUILT-IN KEYBOARD MATRIX

| Row | Col. | Key       | NumLock   | Fn        | NumLock+ Fn |
|-----|------|-----------|-----------|-----------|-------------|
| 0   | 0    | F19       | F19       | F19       | F19         |
| 1   | 0    | F20       | F20       | F20       | F20         |
| 2   | 0    | F21       | F21       | F21       | F21         |
| 3   | 0    | F22       | F22       | F22       | F22         |
| 4   | 0    | F23       | F23       | F23       | F23         |
| 5   | 0    | F24       | F24       | F24       | F24         |
| 6   | 0    | LCTRL     | LCTRL     | RCTRL     | RCTRL       |
| 7   | 0    | RCTRL     | RCTRL     | LCTRL     | LCTRL       |
| 0   | 1    | ESC       | ESC       | ESC       | ESC         |
| 1   | 1    | F1        | F1        | F11       | F12         |
| 2   | 1    | 1         | 1         | 1         | 1           |
| 3   | 1    | F2        | F2        | F12       | F12         |
| 4   | 1    | 2         | 2         | 2         | 2           |
| 5   | 1    | F4        | F4        | F4        | F4          |
| 6   | 1    | F3        | F3        | F3        | F3          |
| 7   | 1    | Q         | Q         | Q         | Q           |
| 0   | 2    | TAB       | TAB       | TAB       | TAB         |
| 1   | 2    | Z         | Z         | Z         | Z           |
| 2   | 2    | CAPS LOCK | CAPS LOCK | CAPS LOCK | CAPS LOCK   |
| 3   | 2    | A         | A         | A         | A           |
| 4   | 2    | 3         | 3         | 3         | 3           |
| 5   | 2    | F5        | F5        | F5        | F5          |
| 6   | 2    | 5         | 5         | 5         | 5           |
| 7   | 2    | W         | W         | W         | W           |
| 0   | 3    | F13       | F13       | F13       | F13         |
| 1   | 3    | F14       | F14       | F14       | F14         |
| 2   | 3    | F15       | F15       | F15       | F15         |
| 3   | 3    | F16       | F16       | F16       | F16         |
| 4   | 3    | F17       | F17       | F17       | F17         |
| 5   | 3    | F18       | F18       | F18       | F18         |
| 6   | 3    | LALT      | LALT      | RALT      | RALT        |
| 7   | 3    | RALT      | RALT      | LALT      | LALT        |
| 0   | 4    | SPACE     | SPACE     | SPACE     | SPACE       |
| 1   | 4    | X         | X         | X         | X           |
| 2   | 4    | V         | V         | V         | V           |
| 3   | 4    | S         | S         | S         | S           |
| 4   | 4    | 4         | 4         | 4         | 4           |
| 5   | 4    | F6        | F6        | F6        | F6          |
| 6   | 4    | 6         | 6         | 6         | 6           |
| 7   | 4    | E         | E         | E         | E           |
| 0   | 5    | SLEEP     | SLEEP     | SLEEP     | SLEEP       |
| 1   | 5    | LWIN      | LWIN      | LWIN      | LWIN        |
| 2   | 5    | EURO      | EURO      | EURO      | EURO        |
| 3   | 5    | `/~       | `/~       | `/~       | `/~         |
| 4   | 5    | F11       | F11       | F11       | F11         |
| 5   | 5    | F12       | F12       | F12       | F12         |
| 6   | 5    | LOGON     | LOGON     | LOGON     | LOGON       |
| 7   | 5    | FUNCTION  | FUNCTION  | FUNCTION  | FUNCTION    |
| 0   | 6    | C         | C         | C         | C           |
| 1   | 6    | B         | B         | B         | B           |
| 2   | 6    | D         | D         | D         | D           |
| 3   | 6    | T         | T         | T         | T           |
| 4   | 6    | F7        | F7        | F7        | F7          |
| 5   | 6    | 7         | 7         | N7        | N7          |
| 6   | 6    | R         | R         | R         | R           |
| 7   | 6    | G         | G         | G         | G           |

**SH2165 BUILT-IN KEYBOARD MATRIX (CONT'D)**

| Row | Col. | Key          | NumLock      | Fn           | NumLock+ Fn  |
|-----|------|--------------|--------------|--------------|--------------|
| 0   | 7    | RWIN         | RWIN         | RWIN         | RWIN         |
| 1   | 7    | N            | N            | N            | N            |
| 2   | 7    | F            | F            | F            | F            |
| 3   | 7    | Y            | Y            | Y            | Y            |
| 4   | 7    | F8           | F8           | F8           | F8           |
| 5   | 7    | 8            | 8            | N8           | N8           |
| 6   | 7    |              |              |              |              |
| 7   | 7    |              |              |              |              |
| 0   | 8    | INS          | INS          | INS          | INS          |
| 1   | 8    | >/.          | >/.          | N.           | N.           |
| 2   | 8    | M            | M            | N0           | N0           |
| 3   | 8    | J            | J            | N1           | N1           |
| 4   | 8    | U            | U            | N4           | N4           |
| 5   | 8    | F9           | F9           | F9           | F9           |
| 6   | 8    | 9            | 9            | N9           | N9           |
| 7   | 8    | H            | H            | H            | H            |
| 0   | 9    | DELETE       | DELETE       | DELETE       | DELETE       |
| 1   | 9    | //?          | //?          | N+           | N+           |
| 2   | 9    | ,/<          | ,/<          | ,/<          | ,/<          |
| 3   | 9    | K            | K            | N2           | N2           |
| 4   | 9    | I            | I            | N5           | N5           |
| 5   | 9    | F10          | F10          | F10          | F10          |
| 6   | 9    | O            | O            | N/           | N/           |
| 7   | 9    | [/{          | [/{          | [/{          | [/{          |
| 0   | 10   | ARWL         | ARWL         | ARWL         | ARWL         |
| 1   | 10   | APPLICATION  | APPLICATION  | APPLICATION  | APPLICATION  |
| 2   | 10   | '/'          | '/'          | '/'          | '/'          |
| 3   | 10   | L            | L            | N3           | N3           |
| 4   | 10   | O            | O            | N6           | N6           |
| 5   | 10   | NUM LOCK     | NUM LOCK     | NUM LOCK     | NUM LOCK     |
| 6   | 10   | -/_          | -/_          | -/_          | -/_          |
| 7   | 10   | ]}/          | ]}/          | ]}/          | ]}/          |
| 0   | 11   | ARWDN        | ARWDN        | ARWDN        | ARWDN        |
| 1   | 11   | ARWUP        | ARWUP        | ARWUP        | ARWUP        |
| 2   | 11   | ENTER        | ENTER        | ENTER        | ENTER        |
| 3   | 11   | :/           | :/           | N-           | N-           |
| 4   | 11   | P            | P            | N*           | N*           |
| 5   | 11   | SCROL LOCK   | SCROL LOCK   | SCROL LOCK   | SCROL LOCK   |
| 6   | 11   | =/+          | =/+          | =/+          | =/+          |
| 7   | 11   | V            | V            | V            | V            |
| 0   | 12   | BLINC        | BLINC        | BLINC        | BLINC        |
| 1   | 12   | BLKOUT       | BLKOUT       | BLKOUT       | BLKOUT       |
| 2   | 12   | CUSTKEY0     | CUSTKEY0     | CUSTKEY0     | CUSTKEY0     |
| 3   | 12   | CUSTKEY1     | CUSTKEY1     | CUSTKEY1     | CUSTKEY1     |
| 4   | 12   | CUSTKEY2     | CUSTKEY2     | CUSTKEY2     | CUSTKEY2     |
| 5   | 12   | CUSTKEY3     | CUSTKEY3     | CUSTKEY3     | CUSTKEY3     |
| 6   | 12   | RSHIFT       | RSHIFT       | RSHIFT       | RSHIFT       |
| 7   | 12   | LSHIFT       | LSHIFT       | LSHIFT       | LSHIFT       |
| 0   | 13   | ARWR         | ARWR         | ARWR         | ARWR         |
| 1   | 13   | END          | END          | END          | END          |
| 2   | 13   | PAGE DOWN    | PAGE DOWN    | PAGE DOWN    | PAGE DOWN    |
| 3   | 13   | PAGE UP      | PAGE UP      | PAGE UP      | PAGE UP      |
| 4   | 13   | BKSP         | BKSP         | BKSP         | BKSP         |
| 5   | 13   | PRINT SCREEN | PRINT SCREEN | PRINT SCREEN | PRINT SCREEN |
| 6   | 13   | PAUSE        | PAUSE        | PAUSE        | PAUSE        |
| 7   | 13   | HOME         | HOME         | HOME         | HOME         |

**SH2165 BUILT-IN KEYBOARD MATRIX (CONT'D)**

| Row | Col. | Key    | NumLock | Fn     | NumLock+ Fn |
|-----|------|--------|---------|--------|-------------|
| 0   | 14   | N/     | N/      | N/     | N/          |
| 1   | 14   | N*     | N*      | N*     | N*          |
| 2   | 14   | N1     | N1      | N1     | N1          |
| 3   | 14   | N2     | N2      | N2     | N2          |
| 4   | 14   | N3     | N3      | N3     | N3          |
| 5   | 14   | N4     | N4      | N4     | N4          |
| 6   | 14   | N5     | N5      | N5     | N5          |
| 7   | 14   | N6     | N6      | N6     | N6          |
| 0   | 15   | N9     | N9      | N9     | N9          |
| 1   | 15   | N8     | N8      | N8     | N8          |
| 2   | 15   | N7     | N7      | N7     | N7          |
| 3   | 15   | N0     | N0      | N0     | N0          |
| 4   | 15   | N.     | N.      | N.     | N.          |
| 5   | 15   | N+     | N+      | N+     | N+          |
| 6   | 15   | NENTER | NENTER  | NENTER | NENTER      |
| 7   | 15   | N-     | N-      | N-     | N-          |
| 0   | 16   | HOME   | HOME    | END    | END         |
| 1   | 16   | >/.    | N.      | >/.    | N.          |
| 2   | 16   | //?    | N+      | //?    | N+          |
| 3   | 16   | L      | N3      | L      | N3          |
| 4   | 16   | :/.    | N-      | :/.    | N-          |
| 5   | 16   | O      | N6      | O      | N6          |
| 6   | 16   | P      | N*      | P      | N*          |
| 7   | 16   | K      | N2      | K      | N2          |
| 0   | 17   | I      | N5      | I      | N5          |
| 1   | 17   | M      | N0      | M      | N0          |
| 2   | 17   | J      | N1      | J      | N1          |
| 3   | 17   | U      | N4      | U      | N4          |
| 4   | 17   | 7      | N7      | 7      | N7          |
| 5   | 17   | 8      | N8      | 8      | N8          |
| 6   | 17   | 9      | N9      | 9      | N9          |
| 7   | 17   | 0      | N/      | 0      | N/          |

### KEYBOARD MATRIX DESIGN

The following factors must be considered when designing a keyboard matrix.

Because of the “ghost” key problem described in a previous section, shift-type keys should be treated carefully when designing a matrix. Shift-type keys are keys that are held down while other keys are pressed: Shift, Alt, Control, Win (or GUI), and Function.

(A) Some columns (or rows) should be set aside for shift-type keys only, and all shift-type keys should be assigned to those columns (or rows).

(B) Cases where shift-type keys share a row or a column should be kept to a minimum. If possible, two shift-type keys should not share a row or column with each other unless their function is the same, or they are very unlikely to be used together, or both.

For example, see this diagram of the standard matrix for the Fujitsu FKB7654 laptop-type keyboard.

(A) All shift-type keys are assigned to columns 0, 1, 3, 12, 14, and 15, and only shift-type keys are assigned to those columns.

(B) There are only four cases where shift-type keys share a row or a column, and only two keys in each case, seven keys total:

1. Function and Left Alt in row 7
2. Right Alt and Left Alt in column 3
3. Right Control and Left Control in column 14
4. Right Shift and Left Shift in column 15

### EXAMPLE KEYBOARD MATRIX (FUJITSU FKB7654)

| Columns<br>C00 | C01 | C02 | C03 | C04 | C05 | C06 | C07 | C08 | C09 | C10 | C11 | C12 | C13 | C14 | C15 |
|----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Rows           |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| R0             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| NL             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Fn             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| R1             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| NL             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Fn             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| R2             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| NL             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Fn             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| R3             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| NL             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Fn             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| R4             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| NL             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Fn             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| R5             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| NL             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Fn             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| R6             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| NL             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Fn             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| R7             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| NL             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Fn             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

### CREATING A KEYBOARD MATRIX

The Ultimate KeyCoder® Designer program is used to create keyboard matrix and macro key data, then save them in Intel hex and binary formats. This program was designed specifically for the Semtech family of Ultimate KeyCoder products, including the SH2165. One file this program creates is the binary matrix file which, in a separate process, is stored in an external EEPROM and accessed by the SH2165.

The Designer program is used to assign a logical key to any position in the 8 x 18 matrix for each of four situations:

1. Num Lock off and Function key up
2. Num Lock on and Function key up
3. Num Lock off and Function key down
4. Num Lock on and Function key down

The Designer program is also used to create up to 22 macro keys, which can then be assigned to positions in the matrix.

Once a matrix has been created, it should be saved in text format (for editing and reference) and as a binary file (for uploading to the EEPROM.)

For detailed information and instructions for the Ultimate KeyCoder Designer program, see the help file provided with the program.

The Designer program is available from Semtech.



## UPLOADING THE KEYBOARD MATRIX TO THE EEPROM

The Semtech Upgrader program loads a binary file (containing keyboard matrix and custom key data) to an EEPROM, where it can be accessed by the SH2165.

(This binary matrix file must first be created by the Ultimate KeyCoder Designer program, as described on the previous page.)

The latest version of the Upgrader program should be used. The latest version of the program can be obtained from Semtech.

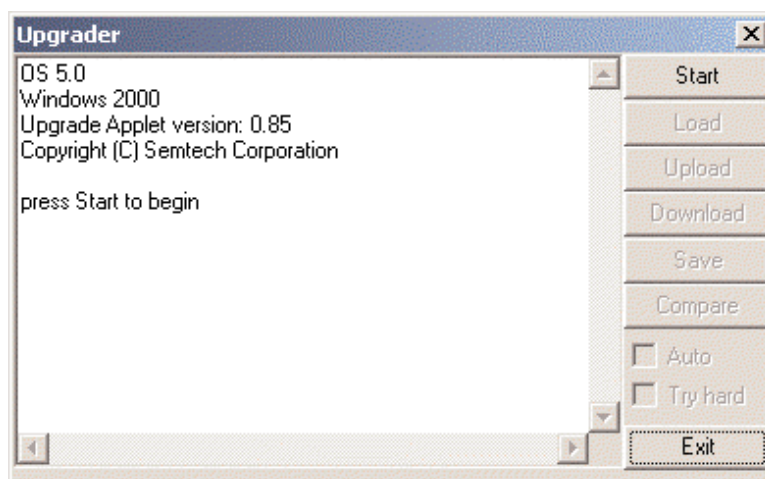
The Upgrader program can upload the file to the EEPROM only if the EEPROM is part of an SH2165 assembly; that is, a complete and correct circuit (as shown in the schematic) including the EEPROM, the SH2165, and a USB connector. The keyboard itself need not be present and connected in the assembly; it is irrelevant to the uploading process.

### Using the Upgrader program

1. Connect the SH2165 assembly, with the EEPROM, to the host PC with a USB cable. Windows® then automatically detects the assembly as a new USB HID (human interface device).

- Windows may prompt the user to load the Windows installation media to install the necessary USB HID files, including "hidclass.sys" and "hidusb.sys." Load the indicated media or find the files elsewhere. The assembly can not work until all necessary class and driver files are installed.

2. Start Upgrader by double-clicking on the executable file.



3. The Upgrader window appears. It consists of a message space and 7 buttons: Start, Load, Upload, Download, Save, Compare, and Exit.

- The message space shows which Windows operating system is running. It also shows the version number of the Upgrader application that is running.

4. Click on the Start button. Upgrader looks for the SH2165 assembly device. Upgrader indicates, in the message space, whether the device is found or not.

- If the device is not found, it might not have been installed correctly in step 1.

5. To upload a binary keyboard-matrix file to the EEPROM:

- Click on the Load button. An Open dialog box appears, looking for a file with the ".bin" extension.
- If the required file does not have the ".bin" extension, click the down arrow next to "Files of type" and pick "Any Files (\*.\*)".
- Select the required file. Upgrader loads the data from the file selected into its upload buffer.
- Click on the Upload button. Upgrader uploads the data from its upload buffer to the EEPROM.

**UPLOADING THE KEYBOARD MATRIX TO THE EEPROM (CONT'D)**

6. To download the binary keyboard-matrix file from the EEPROM:

- Click on the Download button. Upgrader downloads the data from the EEPROM into its download buffer.
- Click on the Save button. Upgrader saves the data from its download buffer to a file, prompting the user for the file name and location.

7. To compare a binary keyboard-matrix loaded from a file to the data downloaded from the EEPROM:

- Click on the Load button. An Open dialog box appears, looking for a file with the ".bin" extension.
- If the required file does not have the ".bin" extension, click the down arrow next to "Files of type" and pick "Any Files (\*.\*)".
- Select the required file. Upgrader loads the data from the file selected into memory.
- Click on the Download button. Upgrader downloads the data from the EEPROM to memory.
- Click on the Compare button. Upgrader compares the data loaded from the file to the data downloaded from the EEPROM. Upgrader indicates, in the message space, whether the data is identical or not.

**Note:** What Upgrader actually compares are its upload buffer and its download buffer. Data must be uploaded from a disk file to the upload buffer, and data must be downloaded from the EEPROM to the download buffer, for comparison to take place. If the message "Nothing to compare" appears, it means at least one of these steps was skipped and at least one of these buffers is empty.

8. Click on the Exit button to exit Upgrader.

9. Start using the the SH2165 assembly, or disconnect it from the host PC.

## KEY CODES TABLE

### Notes on the key codes table

**Note:** Contents of this table are subject to change.

**SEUSB** is the Semtech extended USB key number

**Program code** is the code entered by the user in the Designer program to identify the key

**AT-101** is the key reference number on the standard AT-101 keyboard layout, shown in the diagram below

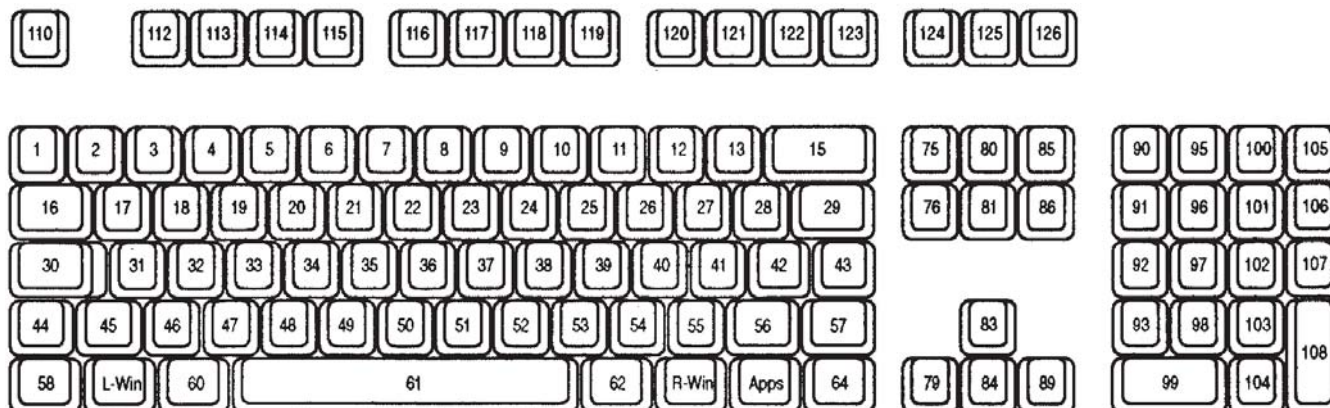
The **USB page** column contains the Universal Serial Bus (USB) Human Interface Device (HID) usage page for the key. Most keys are on the keyboard page, page 0x07. For information about USB codes, see the USB HID specifications, published by the USB-IF (<http://www.usb.org/>).

The **USB usage** column contains the USB HID usage ID for the key on the specified USB HID page.

**PS/2® codes** are the make (key press) and break (key release) codes for PS/2 scan sets 1, 2, and 3; U/A means unassigned. Note that some keys, by default, do not generate break codes, even if the break codes are shown in this table.

PS/2 codes are included in the table for completeness; the SH2165 does not support PS/2.

### AT-101 key reference numbers





## KEY CODES TABLE (CONT'D)

| SEUSB | Program code | Description    | Unshifted literal | Shifted literal | AT-101 | USB page | USB usage | Scan 1 make | Scan 1 break | Scan 2 make | Scan 2 break | Scan 3 make | Scan 3 break |
|-------|--------------|----------------|-------------------|-----------------|--------|----------|-----------|-------------|--------------|-------------|--------------|-------------|--------------|
| 0     | No Key       | No Event       | (none)            | (none)          | N/A    | 0x07     | 0x0000    | None        | None         | None        | None         | None        | None         |
| 1     | ROLLOVER     | Overrun Error  | (none)            | (none)          | N/A    | 0x07     | 0x0001    | 0xFF        | None         | 0x00        | None         | None        | None         |
| 2     | POSTFAIL     | POST Fail      | (none)            | (none)          | N/A    | 0x07     | 0x0002    | 0xFC        | None         | 0xFC        | None         | None        | None         |
| 3     | UNDEFINED    | ErrorUndefined | (none)            | (none)          | N/A    | 0x07     | 0x0003    | U/A         | U/A          | U/A         | U/A          | U/A         | U/A          |
| 4     | A            | literal        | a                 | A               | 31     | 0x07     | 0x0004    | 0x1E        | 0x9E         | 0x1C        | 0xF0 1C      | 0x1C        | 0xF0 1C      |
| 5     | B            | literal        | b                 | B               | 50     | 0x07     | 0x0005    | 0x30        | 0xB0         | 0x32        | 0xF0 32      | 0x32        | 0xF0 32      |
| 6     | C            | literal        | c                 | C               | 48     | 0x07     | 0x0006    | 0x2E        | 0xAE         | 0x21        | 0xF0 21      | 0x21        | 0xF0 21      |
| 7     | D            | literal        | d                 | D               | 33     | 0x07     | 0x0007    | 0x20        | 0xA0         | 0x23        | 0xF0 23      | 0x23        | 0xF0 23      |
| 8     | E            | literal        | e                 | E               | 19     | 0x07     | 0x0008    | 0x12        | 0x92         | 0x24        | 0xF0 24      | 0x24        | 0xF0 24      |
| 9     | F            | literal        | f                 | F               | 34     | 0x07     | 0x0009    | 0x21        | 0xA1         | 0x2B        | 0xF0 2B      | 0x2B        | 0xF0 2B      |
| 10    | G            | literal        | g                 | G               | 35     | 0x07     | 0x000A    | 0x22        | 0xA2         | 0x34        | 0xF0 34      | 0x34        | 0xF0 34      |
| 11    | H            | literal        | h                 | H               | 36     | 0x07     | 0x000B    | 0x23        | 0xA3         | 0x33        | 0xF0 33      | 0x33        | 0xF0 33      |
| 12    | I            | literal        | i                 | I               | 24     | 0x07     | 0x000C    | 0x17        | 0x97         | 0x43        | 0xF0 43      | 0x43        | 0xF0 43      |
| 13    | J            | literal        | j                 | J               | 37     | 0x07     | 0x000D    | 0x24        | 0xA4         | 0x3B        | 0xF0 3B      | 0x3B        | 0xF0 3B      |
| 14    | K            | literal        | k                 | K               | 38     | 0x07     | 0x000E    | 0x25        | 0xA5         | 0x42        | 0xF0 42      | 0x42        | 0xF0 42      |
| 15    | L            | literal        | l                 | L               | 39     | 0x07     | 0x000F    | 0x26        | 0xA6         | 0x4B        | 0xF0 4B      | 0x4B        | 0xF0 4B      |
| 16    | M            | literal        | m                 | M               | 52     | 0x07     | 0x0010    | 0x32        | 0xB2         | 0x3A        | 0xF0 3A      | 0x3A        | 0xF0 3A      |
| 17    | N            | literal        | n                 | N               | 51     | 0x07     | 0x0011    | 0x31        | 0xB1         | 0x31        | 0xF0 31      | 0x31        | 0xF0 31      |
| 18    | O            | literal        | o                 | O               | 25     | 0x07     | 0x0012    | 0x18        | 0x98         | 0x44        | 0xF0 44      | 0x44        | 0xF0 44      |
| 19    | P            | literal        | p                 | P               | 26     | 0x07     | 0x0013    | 0x19        | 0x99         | 0x4D        | 0xF0 4D      | 0x4D        | 0xF0 4D      |
| 20    | Q            | literal        | q                 | Q               | 17     | 0x07     | 0x0014    | 0x10        | 0x90         | 0x15        | 0xF0 15      | 0x15        | 0xF0 15      |
| 21    | R            | literal        | r                 | R               | 20     | 0x07     | 0x0015    | 0x13        | 0x93         | 0x2D        | 0xF0 2D      | 0x2D        | 0xF0 2D      |
| 22    | S            | literal        | s                 | S               | 32     | 0x07     | 0x0016    | 0x1F        | 0x9F         | 0x1B        | 0xF0 1B      | 0x1B        | 0xF0 1B      |
| 23    | T            | literal        | t                 | T               | 21     | 0x07     | 0x0017    | 0x14        | 0x94         | 0x2C        | 0xF0 2C      | 0x2C        | 0xF0 2C      |
| 24    | U            | literal        | u                 | U               | 23     | 0x07     | 0x0018    | 0x16        | 0x96         | 0x3C        | 0xF0 3C      | 0x3C        | 0xF0 3C      |
| 25    | V            | literal        | v                 | V               | 49     | 0x07     | 0x0019    | 0x2F        | 0xAF         | 0x2A        | 0xF0 2A      | 0x2A        | 0xF0 2A      |
| 26    | W            | literal        | w                 | W               | 18     | 0x07     | 0x001A    | 0x11        | 0x91         | 0x1D        | 0xF0 1D      | 0x1D        | 0xF0 1D      |
| 27    | X            | literal        | x                 | X               | 47     | 0x07     | 0x001B    | 0x2D        | 0xAD         | 0x22        | 0xF0 22      | 0x22        | 0xF0 22      |
| 28    | Y            | literal        | y                 | Y               | 22     | 0x07     | 0x001C    | 0x15        | 0x95         | 0x35        | 0xF0 35      | 0x35        | 0xF0 35      |
| 29    | Z            | literal        | z                 | Z               | 46     | 0x07     | 0x001D    | 0x2C        | 0xAC         | 0x1A        | 0xF0 1A      | 0x1A        | 0xF0 1A      |
| 30    | 1            | literal        | 1                 | !               | 2      | 0x07     | 0x001E    | 0x02        | 0x82         | 0x16        | 0xF0 16      | 0x16        | 0xF0 16      |
| 31    | 2            | literal        | 2                 | @               | 3      | 0x07     | 0x001F    | 0x03        | 0x83         | 0x1E        | 0xF0 1E      | 0x1E        | 0xF0 1E      |
| 32    | 3            | literal        | 3                 | #               | 4      | 0x07     | 0x0020    | 0x04        | 0x84         | 0x26        | 0xF0 26      | 0x26        | 0xF0 26      |
| 33    | 4            | literal        | 4                 | \$              | 5      | 0x07     | 0x0021    | 0x05        | 0x85         | 0x25        | 0xF0 25      | 0x25        | 0xF0 25      |
| 34    | 5            | literal        | 5                 | %               | 6      | 0x07     | 0x0022    | 0x06        | 0x86         | 0x2E        | 0xF0 2E      | 0x2E        | 0xF0 2E      |
| 35    | 6            | literal        | 6                 | ^               | 7      | 0x07     | 0x0023    | 0x07        | 0x87         | 0x36        | 0xF0 36      | 0x36        | 0xF0 36      |
| 36    | 7            | literal        | 7                 | &               | 8      | 0x07     | 0x0024    | 0x08        | 0x88         | 0x3D        | 0xF0 3D      | 0x3D        | 0xF0 3D      |
| 37    | 8            | literal        | 8                 | *               | 9      | 0x07     | 0x0025    | 0x09        | 0x89         | 0x3E        | 0xF0 3E      | 0x3E        | 0xF0 3E      |
| 38    | 9            | literal        | 9                 | (               | 10     | 0x07     | 0x0026    | 0x0A        | 0x8A         | 0x46        | 0xF0 46      | 0x46        | 0xF0 46      |
| 39    | 0            | literal        | 0                 | )               | 11     | 0x07     | 0x0027    | 0x0B        | 0x8B         | 0x45        | 0xF0 45      | 0x45        | 0xF0 45      |
| 40    | ENTER        | Return         | (return)          | (return)        | 43     | 0x07     | 0x0028    | 0x1C        | 0x9C         | 0x5A        | 0xF0 5A      | 0x5A        | 0xF0 5A      |
| 41    | ESC          | Escape         | (none)            | (none)          | 110    | 0x07     | 0x0029    | 0x01        | 0x81         | 0x76        | 0xF0 76      | 0x08        | 0xF0 08      |
| 42    | BACKSPACE    | Backspace      | (none)            | (none)          | 15     | 0x07     | 0x002A    | 0x0E        | 0x8E         | 0x66        | 0xF0 66      | 0x66        | 0xF0 66      |
| 43    | TAB          | Tab            | (tab)             | (tab)           | 16     | 0x07     | 0x002B    | 0x0F        | 0x8F         | 0x0D        | 0xF0 0D      | 0x0D        | 0xF0 0D      |
| 44    | SPACE        | Space          | (space)           | (space)         | 61     | 0x07     | 0x002C    | 0x39        | 0xB9         | 0x29        | 0xF0 29      | 0x29        | 0xF0 29      |
| 45    | -/+          | literal        | -                 | +               | 12     | 0x07     | 0x002D    | 0x0C        | 0x8C         | 0x4E        | 0xF0 4E      | 0x4E        | 0xF0 4E      |
| 46    | =/÷          | literal        | =                 | ÷               | 13     | 0x07     | 0x002E    | 0x0D        | 0x8D         | 0x55        | 0xF0 55      | 0x55        | 0xF0 55      |
| 47    | [/{          | literal        | [                 | {               | 27     | 0x07     | 0x002F    | 0x1A        | 0x9A         | 0x54        | 0xF0 54      | 0x54        | 0xF0 54      |
| 48    | ]}/          | literal        | ]                 | }               | 28     | 0x07     | 0x0030    | 0x1B        | 0x9B         | 0x5B        | 0xF0 5B      | 0x5B        | 0xF0 5B      |



## KEY CODES TABLE (CONT'D)

| SEUSB | Program<br>code | Description            | Unshifted<br>literal | Shifted<br>literal | AT-101 | USB<br>page | USB<br>usage | Scan 1<br>make         | Scan 1<br>break | Scan 2<br>make                  | Scan 2<br>break | Scan 3<br>make | Scan 3<br>break |
|-------|-----------------|------------------------|----------------------|--------------------|--------|-------------|--------------|------------------------|-----------------|---------------------------------|-----------------|----------------|-----------------|
| 49    | Vl              | literal                | \                    |                    | 29     | 0x07        | 0x0031       | 0x2B                   | 0xAB            | 0x5D                            | 0xF0 5D         | 0x5C           | 0xF0 5C         |
| 50    | KEY42           | Europe 1               | #                    | ~                  | 42     | 0x07        | 0x0031       | 0x2B                   | 0xAB            | 0x5D                            | 0xF0 5D         | 0x5C           | 0xF0 5C         |
| 51    | ;               | literal                | ;                    | :                  | 40     | 0x07        | 0x0033       | 0x27                   | 0xA7            | 0x4C                            | 0xF0 4C         | 0x4C           | 0xF0 4C         |
| 52    | '               | literal                | '                    | "                  | 41     | 0x07        | 0x0034       | 0x28                   | 0xA8            | 0x52                            | 0xF0 52         | 0x52           | 0xF0 52         |
| 53    | ~               | literal                | ~                    | ~                  | 1      | 0x07        | 0x0035       | 0x29                   | 0xA9            | 0x0E                            | 0xF0 0E         | 0x0E           | 0xF0 0E         |
| 54    | ,<              | literal                | ,                    | <                  | 53     | 0x07        | 0x0036       | 0x33                   | 0xB3            | 0x41                            | 0xF0 41         | 0x41           | 0xF0 41         |
| 55    | ,>              | literal                | ,                    | >                  | 54     | 0x07        | 0x0037       | 0x34                   | 0xB4            | 0x49                            | 0xF0 49         | 0x49           | 0xF0 49         |
| 56    | /?              | literal                | /                    | ?                  | 55     | 0x07        | 0x0038       | 0x35                   | 0xB5            | 0x4A                            | 0xF0 4A         | 0x4A           | 0xF0 4A         |
| 57    | CAPS LOCK       | Caps Lock              | (none)               | (none)             | 30     | 0x07        | 0x0039       | 0x3A                   | 0xBA            | 0x58                            | 0xF0 58         | 0x14           | 0xF0 14         |
| 58    | F1              | F1                     | (none)               | (none)             | 112    | 0x07        | 0x003A       | 0x3B                   | 0xBB            | 0x05                            | 0xF0 05         | 0x07           | 0xF0 07         |
| 59    | F2              | F2                     | (none)               | (none)             | 113    | 0x07        | 0x003B       | 0x3C                   | 0xBC            | 0x06                            | 0xF0 06         | 0x0F           | 0xF0 0F         |
| 60    | F3              | F3                     | (none)               | (none)             | 114    | 0x07        | 0x003C       | 0x3D                   | 0xBD            | 0x04                            | 0xF0 04         | 0x17           | 0xF0 17         |
| 61    | F4              | F4                     | (none)               | (none)             | 115    | 0x07        | 0x003D       | 0x3E                   | 0xBE            | 0x0C                            | 0xF0 0C         | 0x1F           | 0xF0 1F         |
| 62    | F5              | F5                     | (none)               | (none)             | 116    | 0x07        | 0x003E       | 0x3F                   | 0xBF            | 0x03                            | 0xF0 03         | 0x27           | 0xF0 27         |
| 63    | F6              | F6                     | (none)               | (none)             | 117    | 0x07        | 0x003F       | 0x40                   | 0xC0            | 0x0B                            | 0xF0 0B         | 0x2F           | 0xF0 2F         |
| 64    | F7              | F7                     | (none)               | (none)             | 118    | 0x07        | 0x0040       | 0x41                   | 0xC1            | 0x83                            | 0xF0 83         | 0x37           | 0xF0 37         |
| 65    | F8              | F8                     | (none)               | (none)             | 119    | 0x07        | 0x0041       | 0x42                   | 0xC2            | 0x0A                            | 0xF0 0A         | 0x3F           | 0xF0 3F         |
| 66    | F9              | F9                     | (none)               | (none)             | 120    | 0x07        | 0x0042       | 0x43                   | 0xC3            | 0x01                            | 0xF0 01         | 0x47           | 0xF0 47         |
| 67    | F10             | F10                    | (none)               | (none)             | 121    | 0x07        | 0x0043       | 0x44                   | 0xC4            | 0x09                            | 0xF0 09         | 0x4F           | 0xF0 4F         |
| 68    | F11             | F11                    | (none)               | (none)             | 122    | 0x07        | 0x0044       | 0x57                   | 0xD7            | 0x78                            | 0xF0 78         | 0x56           | 0xF0 56         |
| 69    | F12             | F12                    | (none)               | (none)             | 123    | 0x07        | 0x0045       | 0x58                   | 0xD8            | 0x07                            | 0xF0 07         | 0x5E           | 0xF0 5E         |
| 70    | PRINT SCREEN    | Print Screen           | (none)               | (none)             | 124    | 0x07        | 0x0046       | 0x50                   | 0xE0            | 0x7C                            | 0xF0 7C         | 0x57           | 0xF0 57         |
| 71    | SCROL LOCK      | Scroll Lock            | (none)               | (none)             | 125    | 0x07        | 0x0047       | 0x46                   | 0xC6            | 0x7E                            | 0xF0 7E         | 0x5F           | 0xF0 5F         |
| 72    | PAUSE           | Pause                  | (none)               | (none)             | 126    | 0x07        | 0x0048       | 0xE1 1D 45<br>E1 9D C5 | None            | 0xE1 14 77<br>E1 F0 14<br>F0 77 | None            | 0x62           | 0xF0 62         |
| 72    | PAUSE           | Break<br>(Ctl + Pause) | (none)               | (none)             | 126    | 0x07        | 0x0048       | E0 C6                  | None            | 0xE0 7E E0<br>F0 7E             | None            | None           | None            |
| 73    | INSERT          | Insert                 | (none)               | (none)             | 75     | 0x07        | 0x0049       | 0xE0 52                | 0xE0 D2         | 0xE0 70                         | 0xE0 F0 70      | 0x67           | 0xF0 67         |
| 74    | HOME            | Home                   | (none)               | (none)             | 80     | 0x07        | 0x004A       | 0xE0 47                | 0xE0 C7         | 0xE0 6C                         | 0xE0 F0 6C      | 0x6E           | 0xF0 6E         |
| 75    | PAGE UP         | Page Up                | (none)               | (none)             | 85     | 0x07        | 0x004B       | 0xE0 49                | 0xE0 C9         | 0xE0 7D                         | 0xE0 F0 7D      | 0x6F           | 0xF0 6F         |
| 76    | DELETE          | Delete                 | (none)               | (none)             | 76     | 0x07        | 0x004C       | 0xE0 53                | 0xE0 D3         | 0xE0 71                         | 0xE0 F0 71      | 0x64           | 0xF0 64         |
| 77    | END             | End                    | (none)               | (none)             | 81     | 0x07        | 0x004D       | 0xE0 4F                | 0xE0 CF         | 0xE0 69                         | 0xE0 F0 69      | 0x65           | 0xF0 65         |
| 78    | PAGE DOWN       | Page Down              | (none)               | (none)             | 86     | 0x07        | 0x004E       | 0xE0 51                | 0xE0 D1         | 0xE0 7A                         | 0xE0 F0 7A      | 0x6D           | 0xF0 6D         |
| 79    | ARWR            | Right Arrow            | (none)               | (none)             | 89     | 0x07        | 0x004F       | 0xE0 4D                | 0xE0 CD         | 0xE0 74                         | 0xE0 F0 74      | 0x6A           | 0xF0 6A         |
| 80    | ARWL            | Left Arrow             | (none)               | (none)             | 79     | 0x07        | 0x0050       | 0xE0 4B                | 0xE0 CB         | 0xE0 6B                         | 0xE0 F0 6B      | 0x61           | 0xF0 61         |
| 81    | ARWDN           | Down Arrow             | (none)               | (none)             | 84     | 0x07        | 0x0051       | 0xE0 50                | 0xE0 D0         | 0xE0 72                         | 0xE0 F0 72      | 0x60           | 0xF0 60         |
| 82    | ARWUP           | Up Arrow               | (none)               | (none)             | 83     | 0x07        | 0x0052       | 0xE0 48                | 0xE0 C8         | 0xE0 75                         | 0xE0 F0 75      | 0x63           | 0xF0 63         |
| 83    | NUM LOCK        | Num Lock               | (none)               | (none)             | 90     | 0x07        | 0x0053       | 0x45                   | 0xC5            | 0x77                            | 0xF0 77         | 0x76           | 0xF0 76         |
| 84    | N/              | Keypad literal /       | /                    | /                  | 95     | 0x07        | 0x0054       | 0xE0 35                | 0xE0 B5         | 0xE0 4A                         | 0xE0 F0 4A      | 0x77           | 0xF0 77         |
| 85    | N*              | Keypad literal *       | *                    | *                  | 100    | 0x07        | 0x0055       | 0x37                   | 0xB7            | 0x7C                            | 0xF0 7C         | 0x7E           | 0xF0 7E         |
| 86    | N-              | Keypad literal -       | -                    | -                  | 105    | 0x07        | 0x0056       | 0x4A                   | 0xCA            | 0x7B                            | 0xF0 7B         | 0x84           | 0xF0 84         |
| 87    | N+              | Keypad literal +       | +                    | +                  | 106    | 0x07        | 0x0057       | 0x4E                   | 0xCE            | 0x79                            | 0xF0 79         | 0x7C           | 0xF0 7C         |
| 88    | NENTER          | Keypad Enter           | (enter)              | (enter)            | 108    | 0x07        | 0x0058       | 0xE0 1C                | 0xE0 9C         | 0xE0 5A                         | 0xE0 F0 5A      | 0x79           | 0xF0 79         |
| 89    | N1              | Keypad 1 End           | 1                    | (none)             | 93     | 0x07        | 0x0059       | 0x4F                   | 0xCF            | 0x69                            | 0xF0 69         | 0x69           | 0xF0 69         |
| 90    | N2              | Keypad 2 Down          | 2                    | (none)             | 98     | 0x07        | 0x005A       | 0x50                   | 0xD0            | 0x72                            | 0xF0 72         | 0x72           | 0xF0 72         |
| 91    | N3              | Keypad 3 PageDn        | 3                    | (none)             | 103    | 0x07        | 0x005B       | 0x51                   | 0xD1            | 0x7A                            | 0xF0 7A         | 0x7A           | 0xF0 7A         |
| 92    | N4              | Keypad 4 Left          | 4                    | (none)             | 92     | 0x07        | 0x005C       | 0x4B                   | 0xCB            | 0x6B                            | 0xF0 6B         | 0x6B           | 0xF0 6B         |
| 93    | N5              | Keypad 5               | 5                    | (none)             | 97     | 0x07        | 0x005D       | 0x4C                   | 0xCC            | 0x73                            | 0xF0 73         | 0x73           | 0xF0 73         |



## KEY CODES TABLE (CONT'D)

| SEUSB | Program code | Description                             | Unshifted literal | Shifted literal | AT-101 | USB page | USB usage | Scan 1 make | Scan 1 break | Scan 2 make | Scan 2 break | Scan 3 make | Scan 3 break |
|-------|--------------|-----------------------------------------|-------------------|-----------------|--------|----------|-----------|-------------|--------------|-------------|--------------|-------------|--------------|
|       | N6           | Keypad 6 Right                          | 6                 | (none)          | 102    | 0x07     | 0x005E    | 0x4D        | 0xCD         | 0x74        | 0xF0 74      | 0x74        | 0xF0 74      |
|       | N7           | Keypad 7 Home                           | 7                 | (none)          | 91     | 0x07     | 0x005F    | 0x47        | 0xC7         | 0x6C        | 0xF0 6C      | 0x6C        | 0xF0 6C      |
|       | N8           | Keypad 8 Up                             | 8                 | (none)          | 96     | 0x07     | 0x0060    | 0x48        | 0xC8         | 0x75        | 0xF0 75      | 0x75        | 0xF0 75      |
|       | N9           | Keypad 9 PageUp                         | 9                 | (none)          | 101    | 0x07     | 0x0061    | 0x49        | 0xC9         | 0x7D        | 0xF0 7D      | 0x7D        | 0xF0 7D      |
|       | N0           | Keypad 0 Insert                         | 0                 | (none)          | 99     | 0x07     | 0x0062    | 0x52        | 0xD2         | 0x70        | 0xF0 70      | 0x70        | 0xF0 70      |
|       | N.           | Keypad . Delete                         | .                 | (none)          | 104    | 0x07     | 0x0063    | 0x53        | 0xD3         | 0x71        | 0xF0 71      | 0x71        | 0xF0 71      |
|       | KEY45        | Europe 2                                | (none)            | (none)          | 45     | 0x07     | 0x0064    | 0x56        | 0xD6         | 0x61        | 0xF0 61      | 0x13        | 0xF0 61      |
|       | APPLICATION  | App                                     | (none)            | (none)          | 129    | 0x07     | 0x0065    | 0xE0 5D     | 0xE0 DD      | 0xE0 2F     | 0xE0 F0 2F   | 0x8D        | 0xF0 8D      |
|       | F13          | F13                                     | (none)            | (none)          | N/A    | 0x07     | 0x0068    | 0x5B        | 0xDB         | 0x1F        | 0xF0 1F      | 0x08        | 0xF0 08      |
|       | F14          | F14                                     | (none)            | (none)          | N/A    | 0x07     | 0x0069    | 0x5C        | 0xDC         | 0x27        | 0xF0 27      | 0x10        | 0xF0 10      |
|       | F15          | F15                                     | (none)            | (none)          | N/A    | 0x07     | 0x006A    | 0x5D        | 0xDD         | 0x2F        | 0xF0 2F      | 0x18        | 0xF0 18      |
|       | F16          | F16                                     | (none)            | (none)          | N/A    | 0x07     | 0x006B    | 0x63        | 0xE3         | 0x5E        | 0xF0 5E      | 0x20        | 0xF0 20      |
|       | F17          | F17                                     | (none)            | (none)          | N/A    | 0x07     | 0x006C    | 0x64        | 0xE4         | 0x08        | 0xF0 08      | 0x28        | 0xF0 28      |
|       | F18          | F18                                     | (none)            | (none)          | N/A    | 0x07     | 0x006D    | 0x65        | 0xE5         | 0x10        | 0xF0 10      | 0x30        | 0xF0 30      |
|       | F19          | F19                                     | (none)            | (none)          | N/A    | 0x07     | 0x006E    | 0x66        | 0xE6         | 0x18        | 0xF0 18      | 0x38        | 0xF0 38      |
|       | F20          | F20                                     | (none)            | (none)          | N/A    | 0x07     | 0x006F    | 0x67        | 0xE7         | 0x20        | 0xF0 20      | 0x40        | 0xF0 40      |
|       | F21          | F21                                     | (none)            | (none)          | N/A    | 0x07     | 0x0070    | 0x68        | 0xE8         | 0x28        | 0xF0 28      | 0x48        | 0xF0 48      |
|       | F22          | F22                                     | (none)            | (none)          | N/A    | 0x07     | 0x0071    | 0x69        | 0xE9         | 0x30        | 0xF0 30      | 0x50        | 0xF0 50      |
|       | F23          | F23                                     | (none)            | (none)          | N/A    | 0x07     | 0x0072    | 0x6A        | 0xEA         | 0x38        | 0xF0 38      | 0x57        | 0xF0 57      |
|       | F24          | F24                                     | (none)            | (none)          | N/A    | 0x07     | 0x0073    | 0x6B        | 0xEB         | 0x40        | 0xF0 40      | 0x5F        | 0xF0 5F      |
|       | BRAZKEYP     | Keypad literal , , (Brazilian keypad .) | ,                 | ,               | 107    | 0x07     | 0x0085    | 0x7E        | 0xFE         | 0x6D        | 0xF0 6D      | 0x6D        | 0xF0 6D      |
|       | INTL1        | Keypad Intl'1 (Ro)                      | (none)            | (none)          | 56     | 0x07     | 0x0087    | 0x73        | 0xF3         | 0x51        | 0xF0 51      | 0x51        | 0xF0 51      |
|       | INTL2        | Keypad Intl'2 (Katakana /Hiragana)      | (none)            | (none)          |        | 0x07     | 0x0088    | 0x70        | 0xF0         | 0x13        | 0xF0 13      | 0x87        | 0xF0 87      |
|       | INTL3        | Keypad Intl'3 3 ¥ (Yen)                 | (none)            | (none)          |        | 0x07     | 0x0089    | 0x7D        | 0xFD         | 0x6A        | 0xF0 6A      | 0x5D        | 0xF0 5D      |
|       | INTL4        | Keypad Intl'4 (Henkan)                  | (none)            | (none)          |        | 0x07     | 0x008A    | 0x79        | 0xF9         | 0x64        | 0xF0 64      | 0x86        | 0xF0 86      |
|       | INTL5        | Keypad Intl'5 (Muhenkan)                | (none)            | (none)          |        | 0x07     | 0x008B    | 0x7B        | 0xFB         | 0x67        | 0xF0 67      | 0x85        | 0xF0 85      |
|       | INTL6        | Keypad Intl'6 (PC9800 keypad .)         | (none)            | (none)          |        | 0x07     | 0x008C    | 0x5C        | 0xDC         | 0x27        | 0xF0 27      | None        | None         |
|       | INTL7        | INTL7                                   | (none)            | (none)          | N/A    | 0x07     | 0x008D    | None        | None         | None        | None         | None        | None         |
|       | INTL8        | INTL8                                   | (none)            | (none)          | N/A    | 0x07     | 0x008E    | None        | None         | None        | None         | None        | None         |
|       | INTL9        | INTL9                                   | (none)            | (none)          | N/A    | 0x07     | 0x008F    | None        | None         | None        | None         | None        | None         |
|       | LANG1        | LANG1                                   | (none)            | (none)          |        | 0x07     | 0x0090    | 0xF2        | 0xF2         | 0xF2        | 0xF0 F2      | 0xF2        | 0xF0 F2      |
|       | LANG2        | LANG2                                   | (none)            | (none)          |        | 0x07     | 0x0091    | 0xF1        | 0xF1         | 0xF1        | 0xF0 F1      | 0xF1        | 0xF0 F1      |
|       | LANG3        | LANG3                                   | (none)            | (none)          |        | 0x07     | 0x0092    | 0x78        | 0xF8         | 0x63        | 0xF0 63      | None        | None         |
|       | LANG4        | LANG4                                   | (none)            | (none)          |        | 0x07     | 0x0093    | 0x77        | 0xF7         | 0x62        | 0xF0 62      | None        | None         |
|       | LANG5        | LANG5                                   | (none)            | (none)          |        | 0x07     | 0x0094    | 0x76        | 0xF6         | 0x5F        | 0xF0 5F      | None        | None         |
|       | LANG6        | LANG6                                   | (none)            | (none)          | N/A    | 0x07     | 0x0095    | None        | None         | None        | None         | None        | None         |
|       | LANG7        | LANG7                                   | (none)            | (none)          | N/A    | 0x07     | 0x0096    | None        | None         | None        | None         | None        | None         |
|       | LANG8        | LANG8                                   | (none)            | (none)          | N/A    | 0x07     | 0x0097    | None        | None         | None        | None         | None        | None         |
|       | LANG9        | LANG9                                   | (none)            | (none)          | N/A    | 0x07     | 0x0098    | None        | None         | None        | None         | None        | None         |

**KEY CODES TABLE (CONT'D)**

| SEUSB | Program code | Description                          | Unshifted literal | Shifted literal | AT-101 | USB page | USB usage | Scan 1 make | Scan 1 break | Scan 2 make | Scan 2 break | Scan 3 make | Scan 3 break |
|-------|--------------|--------------------------------------|-------------------|-----------------|--------|----------|-----------|-------------|--------------|-------------|--------------|-------------|--------------|
| 154   | SYSRQ        | Keyboard SysReq /Attention           | (none)            | (none)          | N/A    | 0x07     | 0x009A    | U/A         | U/A          | U/A         | U/A          | U/A         | U/A          |
| 165   | PWR          | System power down                    | (none)            | (none)          | N/A    | 0x01     | 0x0081    | 0xE0 5E     | 0xE0 DE      | 0xE0 37     | 0xE0 F0 37   | None        | None         |
| 166   | SLEEP        | System sleep                         | (none)            | (none)          | N/A    | 0x01     | 0x0082    | 0xE0 5F     | 0xE0 DF      | 0xE0 3F     | 0xE0 F0 3F   | None        | None         |
| 167   | WAKE         | System wake up                       | (none)            | (none)          | N/A    | 0x01     | 0x0083    | 0xE0 63     | 0xE0 E3      | 0xE0 5E     | 0xE0 F0 5E   | None        | None         |
| 168   | NXTRK        | Scan next track                      | (none)            | (none)          | N/A    | 0x0C     | 0x00B5    | 0xE0 19     | 0xE0 99      | 0xE0 4D     | 0xE0 F0 4D   | None        | None         |
| 169   | PVTRK        | Scan previous track                  | (none)            | (none)          | N/A    | 0x0C     | 0x00B6    | 0xE0 10     | 0xE0 90      | 0xE0 15     | 0xE0 F0 15   | None        | None         |
| 170   | STOP         | Stop                                 | (none)            | (none)          | N/A    | 0x0C     | 0x00B7    | 0xE0 24     | 0xE0 A4      | 0xE0 3B     | 0xE0 F0 3B   | None        | None         |
| 171   | PLAY         | Play/Pause                           | (none)            | (none)          | N/A    | 0x0C     | 0x00CD    | 0xE0 22     | 0xE0 A2      | 0xE0 34     | 0xE0 F0 34   | None        | None         |
| 172   | MUTE         | Mute                                 | (none)            | (none)          | N/A    | 0x0C     | 0x00E2    | 0xE0 20     | 0xE0 A0      | 0xE0 23     | 0xE0 F0 23   | None        | None         |
| 173   | BASSBOOST    | Bass boost                           | (none)            | (none)          | N/A    | 0x0C     | 0x00E5    | None        | None         | None        | None         | None        | None         |
| 174   | INCVOL       | Volume increment                     | (none)            | (none)          | N/A    | 0x0C     | 0x00E9    | 0xE0 30     | 0xE0 B0      | 0xE0 32     | 0xE0 F0 32   | None        | None         |
| 175   | DCRVOL       | Volume decrement                     | (none)            | (none)          | N/A    | 0x0C     | 0x00EA    | 0xE0 2E     | 0xE0 AE      | 0xE0 21     | 0xE0 F0 21   | None        | None         |
| 176   | INCBASS      | Bass increment                       | (none)            | (none)          | N/A    | 0x0C     | 0x0152    | None        | None         | None        | None         | None        | None         |
| 177   | DCRBASS      | Bass decrement                       | (none)            | (none)          | N/A    | 0x0C     | 0x0153    | None        | None         | None        | None         | None        | None         |
| 178   | INCTREB      | Treble increment                     | (none)            | (none)          | N/A    | 0x0C     | 0x0154    | None        | None         | None        | None         | None        | None         |
| 179   | DCRTREB      | Treble decrement                     | (none)            | (none)          | N/A    | 0x0C     | 0x0155    | None        | None         | None        | None         | None        | None         |
| 180   | MAIL         | AL (application launch) email reader | (none)            | (none)          | N/A    | 0x0C     | 0x018A    | 0xE0 63     | 0xE0 E3      | 0xE0 48     | 0xE0 F0 48   | None        | None         |
| 181   | WSEARCH      | AC (application control) web search  | (none)            | (none)          | N/A    | 0x0C     | 0x0221    | 0xE0 65     | 0xE0 E5      | 0xE0 48     | 0xE0 F0 48   | None        | None         |
| 182   | ACHome       | AC web home                          | (none)            | (none)          | N/A    | 0x0C     | 0x0223    | 0xE0 32     | 0xE0 B2      | 0xE0 3A     | 0xE0 F0 3A   | None        | None         |
| 183   | WBACK        | AC web back                          | (none)            | (none)          | N/A    | 0x0C     | 0x0224    | 0xE0 6A     | 0xE0 EA      | 0xE0 38     | 0xE0 F0 38   | None        | None         |
| 184   | WFWD         | AC web forward                       | (none)            | (none)          | N/A    | 0x0C     | 0x0225    | 0xE0 69     | 0xE0 E9      | 0xE0 30     | 0xE0 F0 30   | None        | None         |
| 185   | WSTOP        | AC web stop                          | (none)            | (none)          | N/A    | 0x0C     | 0x0226    | 0xE0 68     | 0xE0 E8      | 0xE0 28     | 0xE0 F0 28   | None        | None         |
| 186   | WRFSH        | AC web refresh                       | (none)            | (none)          | N/A    | 0x0C     | 0x0227    | 0xE0 67     | 0xE0 E7      | 0xE0 20     | 0xE0 F0 20   | None        | None         |
| 187   | WBKMK        | AC web bookmarks                     | (none)            | (none)          | N/A    | 0x0C     | 0x022A    | 0xE0 66     | 0xE0 E6      | 0xE0 18     | 0xE0 F0 18   | None        | None         |
| 188   | CALC         | AL calculator                        | (none)            | (none)          | N/A    | 0x0C     | 0x0192    | 0xE0 21     | 0xE0 A1      | 0xE0 2B     | 0xE0 F0 2B   | None        | None         |
| 189   | LBRWS        | AL local machine browser             | (none)            | (none)          | N/A    | 0x0C     | 0x0194    | 0xE0 6B     | 0xE0 EB      | 0xE0 40     | 0xE0 F0 40   | None        | None         |
| 190   | CCFG         | AL consumer control configuration    | (none)            | (none)          | N/A    | 0x0C     | 0x0183    | 0xE0 6D     | 0xE0 ED      | 0xE0 50     | 0xE0 F0 50   | None        | None         |
| 191   | FBWRS        | AL file browser                      | (none)            | (none)          | N/A    | 0x0C     | 0x01B4    | None        | None         | None        | None         | None        | None         |
| 192   | REDO         | AC redo/repeat                       | (none)            | (none)          | N/A    | 0x0C     | 0x0279    | None        | None         | None        | None         | None        | None         |
| 193   | UNDO         | AC undo                              | (none)            | (none)          | N/A    | 0x0C     | 0x021A    | None        | None         | None        | None         | None        | None         |

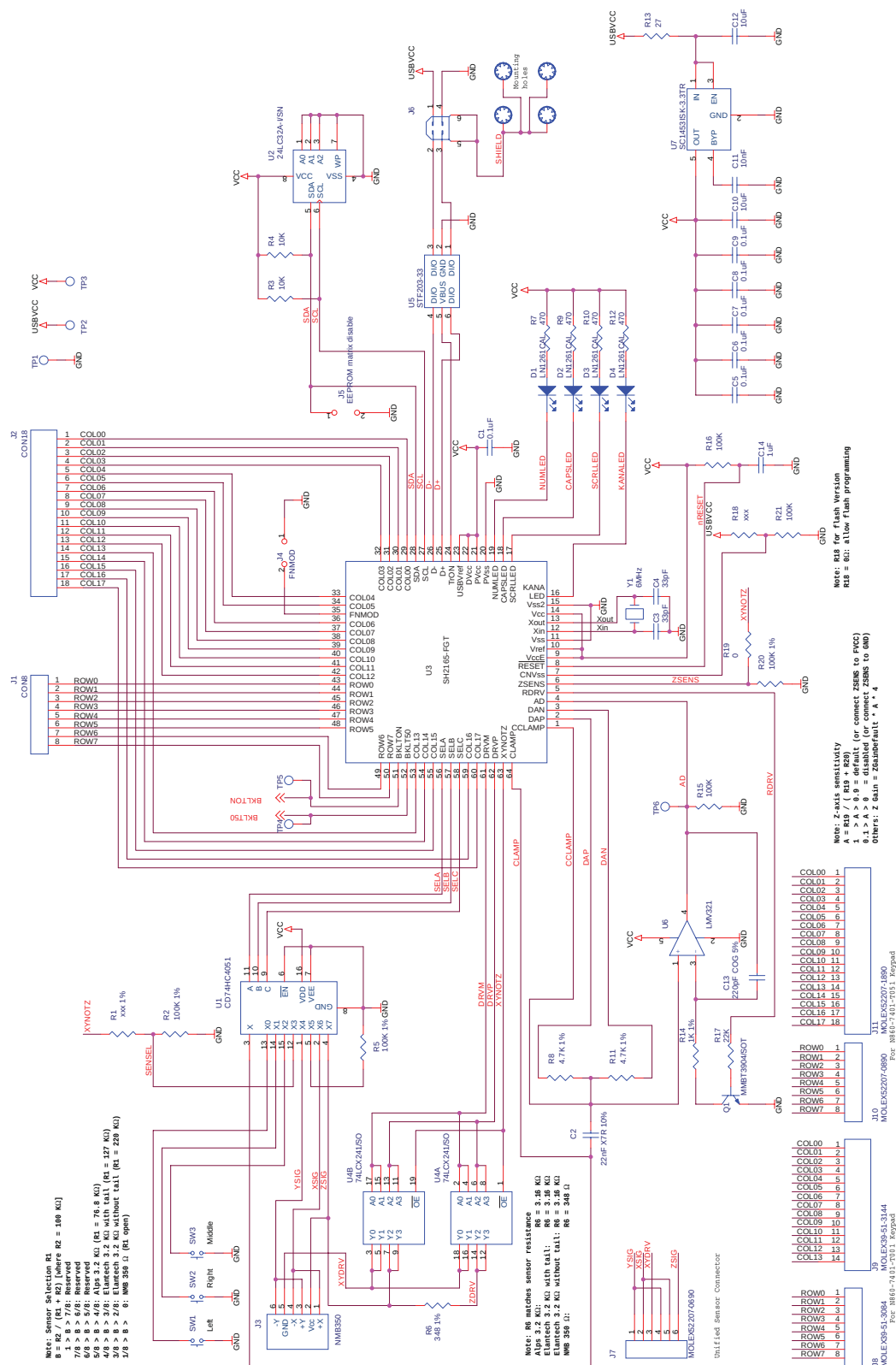


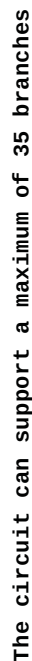
**KEY CODES TABLE (CONT'D)**

| SEUSB | Program code | Description                   | Unshifted literal | Shifted literal | AT-101 | USB page | USB usage | Scan 1 make | Scan 1 break | Scan 2 make | Scan 2 break | Scan 3 make | Scan 3 break |
|-------|--------------|-------------------------------|-------------------|-----------------|--------|----------|-----------|-------------|--------------|-------------|--------------|-------------|--------------|
| 194   | PVAPP        | AL previous task /application | (none)            | (none)          | N/A    | 0x0C     | 0x01A4    | None        | None         | None        | None         | None        | None         |
| 195   | PASTE        | AC paste                      | (none)            | (none)          | N/A    | 0x0C     | 0x021D    | None        | None         | None        | None         | None        | None         |
| 196   | WORD         | AL word processor             | (none)            | (none)          | N/A    | 0x0C     | 0x0184    | None        | None         | None        | None         | None        | None         |
| 197   | SPRD         | AL spreadsheet                | (none)            | (none)          | N/A    | 0x0C     | 0x0186    | None        | None         | None        | None         | None        | None         |
| 198   | CALND        | AL calendar /schedule         | (none)            | (none)          | N/A    | 0x0C     | 0x018E    | None        | None         | None        | None         | None        | None         |
| 199   | LGOFF        | AL logoff                     | (none)            | (none)          | N/A    | 0x0C     | 0x019C    | None        | None         | None        | None         | None        | None         |
| 200   | CUT          | AC cut                        | (none)            | (none)          | N/A    | 0x0C     | 0x021C    | None        | None         | None        | None         | None        | None         |
| 201   | COPY         | AC copy                       | (none)            | (none)          | N/A    | 0x0C     | 0x021B    | None        | None         | None        | None         | None        | None         |
| 202   | NXAPP        | AL next task /application     | (none)            | (none)          | N/A    | 0x0C     | 0x01A3    | None        | None         | None        | None         | None        | None         |
| 203   | SPELL        | AL spell check                | (none)            | (none)          | N/A    | 0x0C     | 0x01AB    | None        | None         | None        | None         | None        | None         |
| 204   | HELP         | Help                          | (none)            | (none)          | N/A    | 0x0C     | 0x0095    | None        | None         | None        | None         | None        | None         |
| 205   | OFC          | Office                        | (none)            | (none)          | N/A    | 0x0C     | 0x029D    | None        | None         | None        | None         | None        | None         |
| 206   | TASK         | Task panel                    | (none)            | (none)          | N/A    | 0x0C     | 0x029E    | None        | None         | None        | None         | None        | None         |
| 207   | NEW          | AC new                        | (none)            | (none)          | N/A    | 0x0C     | 0x0201    | None        | None         | None        | None         | None        | None         |
| 208   | OPEN         | AC open                       | (none)            | (none)          | N/A    | 0x0C     | 0x0202    | None        | None         | None        | None         | None        | None         |
| 209   | CLOSE        | AC close                      | (none)            | (none)          | N/A    | 0x0C     | 0x0203    | None        | None         | None        | None         | None        | None         |
| 210   | REPLY        | AC reply                      | (none)            | (none)          | N/A    | 0x0C     | 0x0289    | None        | None         | None        | None         | None        | None         |
| 211   | MSFWD        | AC forward message            | (none)            | (none)          | N/A    | 0x0C     | 0x028B    | None        | None         | None        | None         | None        | None         |
| 212   | SEND         | AC send                       | (none)            | (none)          | N/A    | 0x0C     | 0x028C    | None        | None         | None        | None         | None        | None         |
| 213   | SAVE         | AC save                       | (none)            | (none)          | N/A    | 0x0C     | 0x0207    | None        | None         | None        | None         | None        | None         |
| 214   | APRNT        | AC print                      | (none)            | (none)          | N/A    | 0x0C     | 0x0208    | None        | None         | None        | None         | None        | None         |
| 215   | ALAYCAP      | AL AVCap                      | (none)            | (none)          | N/A    | 0x0C     | 0x0193    | None        | None         | None        | None         | None        | None         |
| 216   | ALINTERNET   | AL Internet                   | (none)            | (none)          | N/A    | 0x0C     | 0x0196    | None        | None         | None        | None         | None        | None         |
| 217   | ALNETCHAT    | AL NetChat                    | (none)            | (none)          | N/A    | 0x0C     | 0x0199    | None        | None         | None        | None         | None        | None         |
| 221   | ALERT        | Emergency key                 | (none)            | (none)          |        |          |           |             |              |             |              |             |              |
| 222   | RFUNCTION    | Right Function                | (none)            | (none)          |        |          |           |             |              |             |              |             |              |
| 223   | FUNCTION     | Function                      | (none)            | (none)          |        |          |           |             |              |             |              |             |              |
| 224   | LCTRL        | Left Control                  | (none)            | (none)          | 58     | 0x07     | 0x00E0    | 0x1D        | 0x9D         | 0x14        | 0xF0 14      | 0x11        | 0xF0 11      |
| 225   | LSHIFT       | Left Shift                    | (none)            | (none)          | 44     | 0x07     | 0x00E1    | 0x2A        | 0xAA         | 0x12        | 0xF0 12      | 0x12        | 0xF0 12      |
| 226   | LALT         | Left Alt                      | (none)            | (none)          | 60     | 0x07     | 0x00E2    | 0x38        | 0xB8         | 0x11        | 0xF0 11      | 0x39        | 0xF0 39      |
| 227   | LWIN         | Left GUI                      | (none)            | (none)          | 127    | 0x07     | 0x00E3    | 0xE0 5B     | 0xE0 5B      | 0xE0 1F     | 0xF0 1F      | 0x8B        | 0xF0 8B      |
| 228   | RCTRL        | Right Control                 | (none)            | (none)          | 64     | 0x07     | 0x00E4    | 0xE0 1D     | 0xE0 9D      | 0xE0 14     | 0xE0 F0 14   | 0x58        | 0xF0 58      |
| 229   | RSHIFT       | Right Shift                   | (none)            | (none)          | 57     | 0x07     | 0x00E5    | 0x36        | 0xB6         | 0x59        | 0xF0 59      | 0x59        | 0xF0 59      |
| 230   | RALT         | Right Alt                     | (none)            | (none)          | 62     | 0x07     | 0x00E6    | 0xE0 38     | 0xE0 B8      | 0xE0 11     | 0xE0 F0 11   | 0x39        | 0xF0 39      |
| 231   | RWIN         | Right GUI                     | (none)            | (none)          | 128    | 0x07     | 0x00E7    | 0xE0 5C     | 0xE0 DC      | 0xE0 27     | 0xE0 F0 27   | 0x8C        | 0xF0 8C      |
| 232   | BLINC        | Backlight increment           | (none)            | (none)          | N/A    | N/A      | N/A       | N/A         | N/A          | N/A         | N/A          | N/A         | N/A          |
| 233   | BLKOUT       | Blackout                      | (none)            | (none)          | N/A    | N/A      | N/A       | N/A         | N/A          | N/A         | N/A          | N/A         | N/A          |



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SH2165 data sheet v1.08 (2005-05-17)





**BILL OF MATERIALS FOR THE EVALUATION BOARD**

| Qty | Reference                                                                                               | Part Description                                                           | Mfr       | Part No.      |
|-----|---------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|-----------|---------------|
| 7   | C1, C5, C6,<br>C7, C8, C9,<br>C20                                                                       | Ceramic capacitor, 0.1 $\mu$ F, 0603                                       | Generic   |               |
| 1   | C2                                                                                                      | Ceramic capacitor, 22 nF, X7R 10%, 0603                                    | Generic   |               |
| 2   | C3, C4                                                                                                  | Ceramic capacitor, 33 pF, 0603                                             | Generic   |               |
| 2   | C10, C12                                                                                                | Ceramic capacitor, 10 $\mu$ F, Y5V, 1206                                   | Generic   |               |
| 1   | C11                                                                                                     | Ceramic capacitor, 10 nF, 0603                                             | Generic   |               |
| 1   | C13                                                                                                     | Ceramic capacitor, 220 pF, COG 5%, 0603                                    | Generic   |               |
| 2   | C17, C14                                                                                                | Ceramic capacitor, 1 $\mu$ F, 0603                                         | Generic   |               |
| 1   | C15                                                                                                     | Tantalum capacitor, 22 $\mu$ F, 6.3 V, 6032                                | Generic   |               |
| 1   | C16                                                                                                     | Tantalum capacitor, 4.7 $\mu$ F, 16 V, 3216                                | Generic   |               |
| 1   | C18                                                                                                     | Ceramic capacitor, 0.1 $\mu$ F, 16 V, 0603                                 | Generic   |               |
| 2   | C21, C19                                                                                                | Do not populate: ceramic capacitor 0603                                    | Generic   |               |
| 19  | D1, D2, D3,<br>D4, D6, D7,<br>D8, D9, D10,<br>D11, D12, D13,<br>D14, D15, D16,<br>D17, D18, D19,<br>D20 | Red/green LED, LN1261CAL, GW3022                                           | Panasonic |               |
| 1   | D5                                                                                                      | Schottky rectifier, DO-214AA                                               | Microsemi | SMB5819       |
| 1   | FB1                                                                                                     | Ferrite chip, 220 Ohm, 2 A, 0805                                           | Murata    | BLM21P221SG   |
| 1   | J1                                                                                                      | DIP connector, 2.54 mm, single, 8 position                                 | Generic   |               |
| 1   | J2                                                                                                      | DIP connector, 2.54 mm, single, 18 position                                | Generic   |               |
| 1   | J3                                                                                                      | 3D strain gauge sensor, NMB 350 Ohm                                        | NMB       | NMB350        |
| 1   | J4                                                                                                      | Jumper, 2.54 mm, 0.54 mm diameter                                          | Generic   |               |
| 1   | J5                                                                                                      | Jumper, 2.54 mm, 0.54 mm diameter                                          | Generic   |               |
| 1   | J6                                                                                                      | USB connector, right angle, male, type B, PCB                              | Assmann   | AU-Y1007      |
| 1   | J7                                                                                                      | Flat flex connector, 1 mm, SMT, right angle, ZIF, top contact, 6 position  | Molex     | 52207-0690    |
| 1   | J8                                                                                                      | FFC connector, 1.25 mm, vertical, ZIF, 8 position                          | Molex     | 39-51-3084    |
| 1   | J9                                                                                                      | FFC connector, 1.25 mm, vertical, ZIF, 14 position                         | Molex     | 39-51-3144    |
| 1   | J10                                                                                                     | Flat flex connector, 1 mm, SMT, right angle, ZIF, top contact, 8 position  | Molex     | 52207-0890    |
| 1   | J11                                                                                                     | Flat flex connector, 1 mm, SMT, right angle, ZIF, top contact, 18 position | Molex     | 52207-1890    |
| 1   | L1                                                                                                      | Fixed inductor 33 $\mu$ H type D62CB                                       | Toko      | A920CY-33M=P3 |
| 1   | Q1                                                                                                      | NPN transistor, MMBT3904, SOT-23                                           | Fairchild | MMBT3904      |
| 1   | R1                                                                                                      | Do not populate: chip resistor, xxx Ohm, 1%, 0603                          | Generic   |               |
| 3   | R2, R5, R20                                                                                             | Chip resistor, 100 KOhm, 1%, 0603                                          | Generic   |               |
| 2   | R3, R4                                                                                                  | Chip resistor, 10 KOhm, 5%, 0603                                           | Generic   |               |
| 1   | R6                                                                                                      | Chip resistor, 348 Ohm, 1%, 0603                                           | Generic   |               |
| 4   | R7, R9, R10,<br>R12                                                                                     | Chip resistor, 470 Ohm, 5%, 0603                                           | Generic   |               |
| 2   | R8, R11                                                                                                 | Chip resistor, 4.7 KOhm, 1%, 0603                                          | Generic   |               |
| 1   | R13                                                                                                     | Chip resistor, 27 Ohm, 5%, 0603                                            | Generic   |               |
| 1   | R14                                                                                                     | Chip resistor, 1 KOhm, 1%, 0603                                            | Generic   |               |
| 4   | R15, R16, R21,<br>R26                                                                                   | Chip resistor, 100 KOhm, 5%, 0603                                          | Generic   |               |

**BILL OF MATERIALS FOR THE EVALUATION BOARD (CONT'D)**

| <b>Qty</b> | <b>Reference</b>                                        | <b>Part Description</b>                                       | <b>Mfr</b> | <b>Part No.</b> |
|------------|---------------------------------------------------------|---------------------------------------------------------------|------------|-----------------|
| 31         | R17                                                     | Chip resistor, 22 KOhm, 5%, 0603                              | Generic    |                 |
| 1          | R18                                                     | Do not populate: chip resistor, xxx Ohm, 5%, 0603             | Generic    |                 |
| 1          | R19                                                     | Chip resistor, 0 Ohm, 5%, 0603                                | Generic    |                 |
| 1          | R22                                                     | Chip resistor, 10 KOhm, 1%, 0603                              | Generic    |                 |
| 3          | R23,R28,R29                                             | Chip resistor, 240 Ohm, 5%, 0603                              | Generic    |                 |
| 1          | R24                                                     | Chip resistor, 33 KOhm, 1%, 0603                              | Generic    |                 |
| 1          | R25                                                     | Chip resistor, 5.1 KOhm, 5%, 0603                             | Generic    |                 |
| 1          | R27                                                     | Chip resistor, 1 KOhm, 5%, 0603                               | Generic    |                 |
| 4          | SH1, SH2,<br>SH3, SH4                                   | Mounting hole                                                 | Generic    |                 |
| 3          | SW1, SW2,<br>SW3                                        | 6 mm square light touch switch                                | Panasonic  | EVQ-QS205K      |
| 7          | TP1, TP2, TP3, Test point<br>TP4, TP5, TP6,<br>TP7, TP8 |                                                               | Generic    |                 |
| 1          | U1                                                      | 8 to 1 analog MUX, TSSOP-16                                   | TI         | CD74HC4051PWR   |
| 1          | U2                                                      | I2C EEPROM 32 Kb, SOIC-8                                      | Microchip  | 24LC32A-I/SN    |
| 1          | U3                                                      | PixiKey keyboard/mouse encoder IC,<br>LQFP-64 10 x 10 mm      | Semtech    | SH2165-FGT      |
| 1          | U4                                                      | Bus driver 74LCX241, TSSOP-20                                 | Fairchild  | 74LCX241        |
| 1          | U5                                                      | USB upstream EMI filtering & ESD protection IC,<br>SC70-6     | Semtech    | STF203-33.TC    |
| 1          | U6                                                      | General purpose OpAmp , single, rail-rail output,<br>SOT-23-5 | National   | LMV321M5        |
| 1          | U7                                                      | LDO regulator, 3.3 V, low noise, SOT-23-5                     | Semtech    | SC1453ISK-3.3TR |
| 1          | U8                                                      | Step-up DC-DC convertor, MSOP-8                               | Semtech    | SC1417BIMSTR    |
| 1          | Y1                                                      | Crystal 6 Mhz, SMD                                            | Generic    |                 |

## CIRCUIT NOTES

### Power Circuit

The SH2165 reference design uses the SC1453 3.3 V LDO regulator, which is recommended. Any low-noise LDO regulator with output voltage 3.0 V to 3.6 V can be used.

### Operational amplifier

Only the LMV321 from Fairchild, National Semiconductor, and Texas Instruments have been tested and approved.

### Integration circuit

The integration capacitor is 220 pF. A greater capacitance would reduce X, Y, Z axis sampling gain. The capacitor can be used to adjust XY speed and Z sensitivity. Z sensitivity can also be adjusted by itself by changing the value of R19.

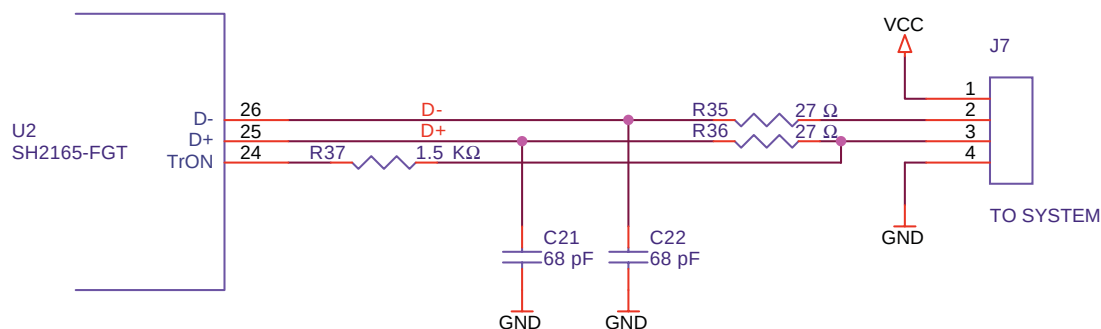
### Backlight circuit

If no backlight is used, leave the backlight control pins (BKLTON and BKLT50, pins 51 and 52) floating.

### USB interface circuit

When the SH2165 is used in a hot-pluggable environment, we recommend the use of an ESD protection chip like Semtech's STF203-33 for the USB interface, as shown in the evaluation board schematic.

When the SH2165 is built in to a product, and ESD protection for the USB port is not necessary, the customer can omit the protection chip and use resistors and capacitors instead, as shown in the diagram below.



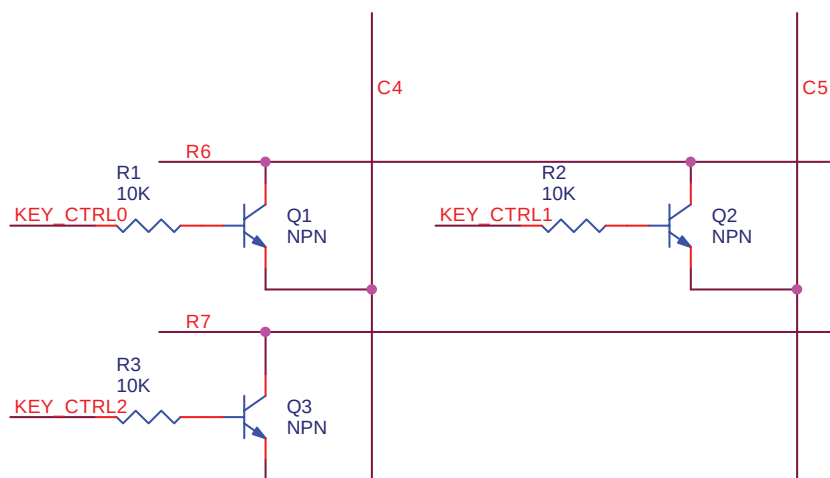
## CIRCUIT NOTES (CONT'D)

### Oscillation circuit

A quartz crystal, ( $\leq 2500$  ppm with 33 pF load capacitors) is recommended. A ceramic resonator ( $\leq 2500$  ppm) with built-in load capacitors can also be used.

### Key strike simulation

Some applications require another controller to control the key strike to generate key-press and key-release signals. Semtech recommends the design below. Do NOT use MOSFETs and PNP transistors in the design.

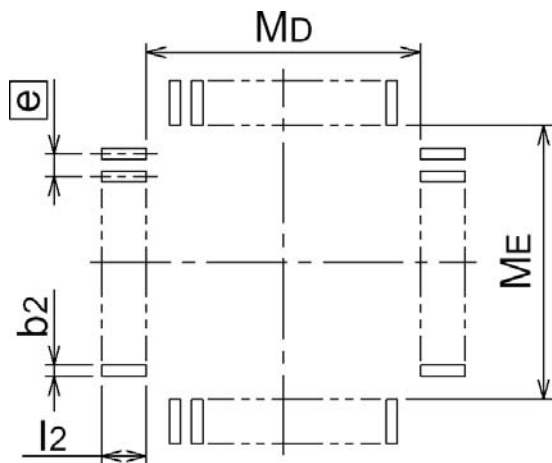
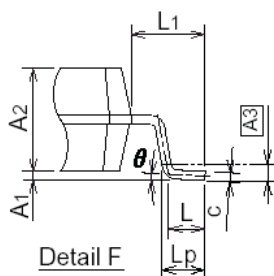
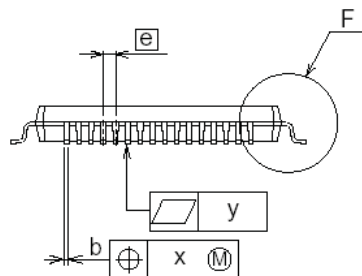
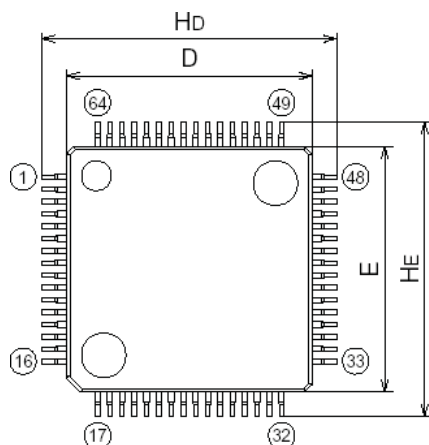


**KEY\_CTRL high: key press**

**KEY\_CTRL low: key release**

**Pulse width should be at least 35 ms for good, stable results.**

**MOSFETs and PNP transistors can NOT be used.**

**MECHANICALS FOR THE QFP PACKAGE**


| Symbol   | Dimension in Millimeters |       |       |
|----------|--------------------------|-------|-------|
|          | Min                      | Nom   | Max   |
| A        | —                        | —     | 1.7   |
| A1       | 0                        | 0.1   | 0.2   |
| A2       | —                        | 1.4   | —     |
| b        | 0.13                     | 0.18  | 0.28  |
| c        | 0.105                    | 0.125 | 0.175 |
| D        | 9.9                      | 10.0  | 10.1  |
| E        | 9.9                      | 10.0  | 10.1  |
| e        | —                        | 0.5   | —     |
| HD       | 11.8                     | 12.0  | 12.2  |
| HE       | 11.8                     | 12.0  | 12.2  |
| L        | 0.3                      | 0.5   | 0.7   |
| L1       | —                        | 1.0   | —     |
| Lp       | 0.45                     | 0.6   | 0.75  |
| A3       | —                        | 0.25  | —     |
| x        | —                        | —     | 0.08  |
| y        | —                        | —     | 0.1   |
| $\theta$ | 0°                       | —     | 10°   |
| b2       | —                        | 0.225 | —     |
| l2       | 1.0                      | —     | —     |
| MD       | —                        | 10.4  | —     |
| ME       | —                        | 10.4  | —     |

**ELECTRICAL SPECIFICATIONS**
**Absolute maximum ratings**

| Ratings                                                                      | Symbol                             | Value                         | Unit |
|------------------------------------------------------------------------------|------------------------------------|-------------------------------|------|
| Supply voltage                                                               | V <sub>CC</sub>                    | -0.3 to 6.5                   | V    |
| Input and output voltage                                                     | V <sub>IN</sub> , V <sub>OUT</sub> | -0.3 to V <sub>CC</sub> +0.3  | V    |
| Current drain per pin<br>(not including V <sub>SS</sub> or V <sub>DD</sub> ) | I                                  | 20                            | mA   |
| Operating temperature<br>SH2165                                              | T <sub>A</sub>                     | T low to T high<br>-20 to +85 | °C   |
| Storage temperature range                                                    | T <sub>STG</sub>                   | -40 to +125                   | °C   |
| <b>ESD rating</b> (human body model)                                         | V <sub>ESD</sub>                   | 2.0                           | KV   |

**DC electrical characteristics (T<sub>A</sub> = -20°C to +85°C, V<sub>DD</sub> = 3.0 V to 3.6 V)**

| Characteristic                                      | Symbol            | Min                   | Typ | Max                   | Unit |
|-----------------------------------------------------|-------------------|-----------------------|-----|-----------------------|------|
| Supply voltage                                      | V <sub>DD</sub>   | 3.0                   | 3.3 | 3.6                   | V    |
| Input high voltage                                  |                   |                       |     |                       |      |
| ■ high                                              | V <sub>IH</sub>   | 0.8 x V <sub>CC</sub> |     | V <sub>CC</sub>       | V    |
| ■ low                                               | V <sub>IL</sub>   | V <sub>SS</sub>       |     | 0.2 x V <sub>CC</sub> | V    |
| Output voltage (except D-, D+)                      |                   |                       |     |                       |      |
| ■ high (I <sub>OH</sub> = -1 µA)                    | V <sub>OH</sub>   | V <sub>CC</sub> -1.0  |     |                       | V    |
| ■ low (I <sub>OL</sub> = 1 mA)                      | V <sub>OL</sub>   |                       |     | 1                     | V    |
| Output low current<br>(pins 16 – 19 only)           | I <sub>OL</sub>   |                       |     | 10                    | mA   |
| Input leakage current                               |                   |                       |     |                       |      |
| ■ high (all inputs except XIN, XOUT, RESET, D+, D-) | I <sub>LIH1</sub> |                       |     | 4                     | µA   |
| ■ high (XIN, XOUT, RESET)                           | I <sub>LIH2</sub> |                       |     | 5                     | µA   |
| ■ low (all inputs except XIN, XOUT, RESET, D+, D-)  | I <sub>LIL1</sub> |                       |     | -4                    | µA   |
| ■ low (XIN, XOUT, RESET)                            | I <sub>LIL2</sub> |                       |     | -5                    | µA   |
| Pull-up resistors (row pins, V <sub>IN</sub> =0V)   | R <sub>L</sub>    | 30                    | 60  | 200                   | KΩ   |
| Supply current                                      |                   |                       |     |                       |      |
| ■ Normal operation mode                             | I <sub>DD1</sub>  |                       | 10  | 30                    | mA   |
| ■ Idle (wait) mode                                  | I <sub>DD2</sub>  |                       | 5   |                       | mA   |

**Control timing (T<sub>A</sub> = -20°C to +85°C, V<sub>DD</sub> = 3.0 V to 3.6 V)**

| Characteristic          | Symbol           | Min | Typ | Max | Unit |
|-------------------------|------------------|-----|-----|-----|------|
| Frequency of operation  |                  |     |     |     |      |
| ■ Crystal option        | f <sub>osc</sub> |     | 6.0 |     | MHz  |
| ■ External clock option | f <sub>osc</sub> |     | 6.0 |     | MHz  |

**Force stick sensor**

|                                |     |
|--------------------------------|-----|
| Sensor resistor tolerance      | 25% |
| Sensor resistor matching ratio | 25% |



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and product literature,  
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