ECE1099

GPIO Expansion, 23x8 Keyscan Matrix Interface via SMBus or BC-Link Bus

Highlights

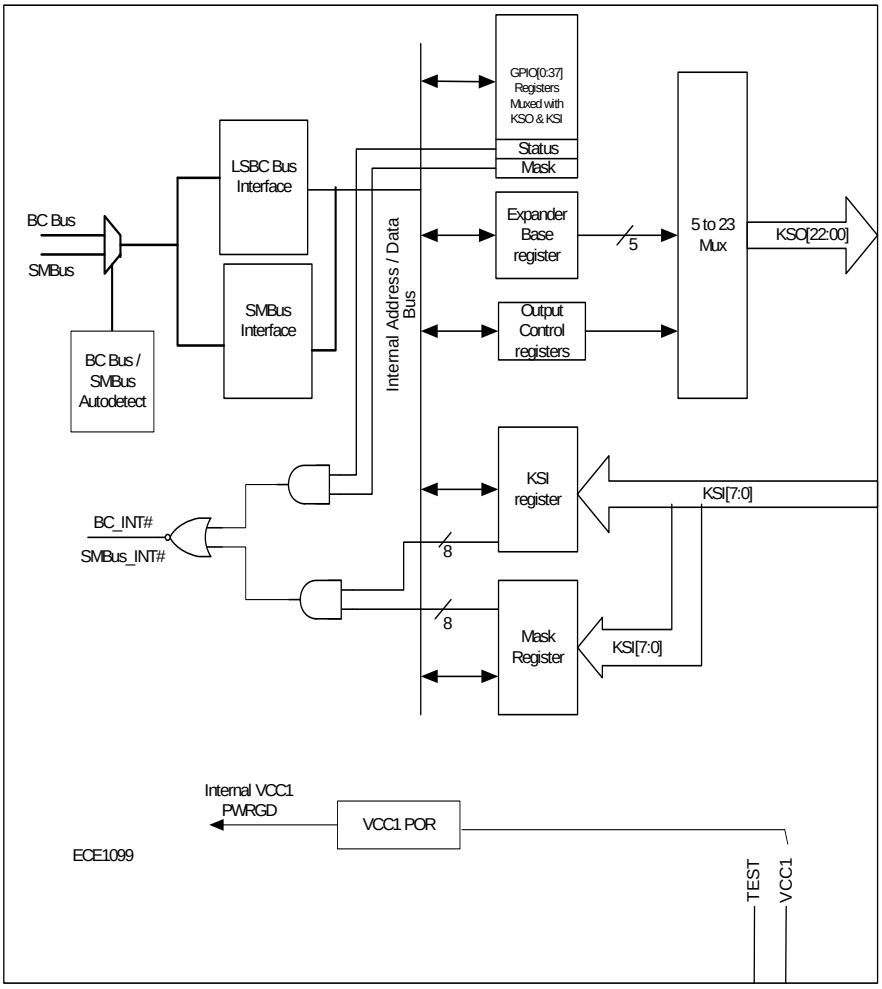
The ECE1099 is a 40-Pin 3.3V Keyboard Scan Expansion or GPIO Expansion device. The device supports a keyboard scan matrix of 23x8. The device is connected to a Master via the BC-Link interface or via the SMBus.

KSI and KSO signals are multiplexed with GPIOs.

Features

- Up to 23x8 Keyboard Scan Matrix
- 32 Multiplexed General Purpose I/O pins
  - All are MCU addressable I/O Pins
- BC-Link Interconnect Bus
  - Link to embedded controller
- SMBus Interconnect
  - One of two address selection
- 3.3V Operation
  - 40-Pin, QFN RoHS Compliant package
  - 0.5mm Pitch
  - 6x6mm Body size

Block Diagram



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1.0 PIN FUNCTIONS

TABLE 1-1: ECE1099 PIN TABLE

Pin #	Name	Pin #	Name
1	GPIO12/KSI2	21	GPIO35/KSO13
2	GPIO13/KSI3	22	GPIO36/KSO14
3	GPIO14/KSI4	23	GPIO37/KSO15
4	GPIO15/KSI5	24	GPIO00/KSO16
5	GPIO16/KSI6	25	GPIO01/KSO17
6	GPIO17/KSI7	26	GPIO02/KSO18
7	GPIO20/KSO00	27	GPIO03/KSO19
8	VCC1	28	VCC1
9	GPIO21/KSO01	29	GPIO04/KSO20
10	GPIO22/KSO02	30	GPIO05/KSO21
11	GPIO23/KSO03	31	GPIO06/KSO22
12	GPIO24/KSO04	32	BC_DAT/SMB_DATA
13	GPIO25/KSO05	33	BC_CLK/SMB_CLK
14	GPIO26/KSO06	34	BC_INT#/SMB_INT#
15	GPIO27/KSO07	35	SMB_ADDR
16	GPIO30/KSO08	36	GPIO07
17	GPIO31/KSO09	37	RESERVED
18	GPIO32/KSO10	38	TEST_PIN
19	GPIO33/KSO11	39	GPIO10/KSI0
20	GPIO34/KSO12	40	GPIO11/KSI1

FIGURE 1-1: ECE1099 PIN DIAGRAM (TOP VIEW, EXPOSED PAD IS ON THE BOTTOM)

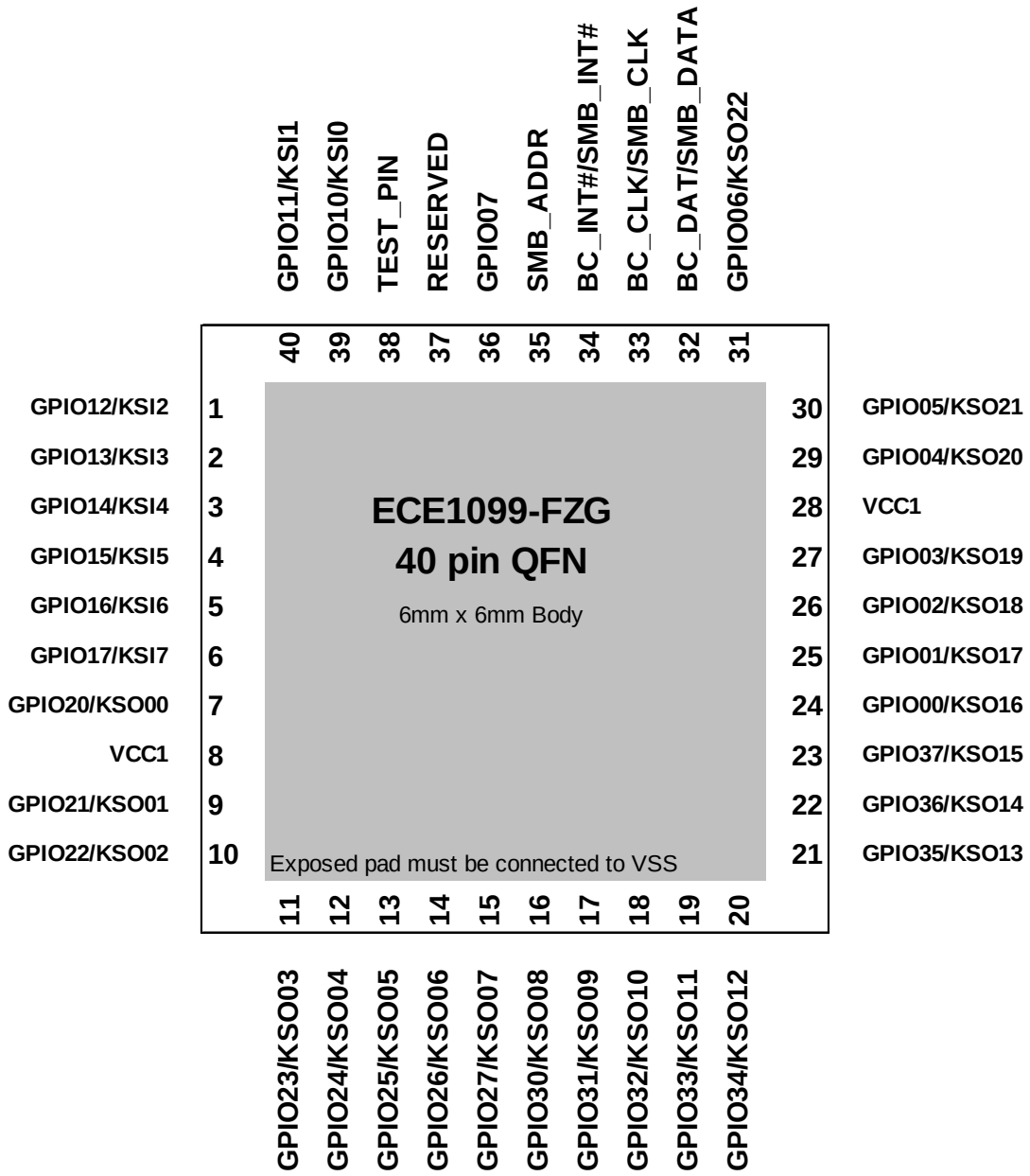


TABLE 1-2: ECE1099 PIN DESCRIPTIONS

Pin #	Name	Signal Description	Buffers	Notes
1	GPIO12/KSI2	General Purpose IO. May be configured as an OD output Keyboard Scan Input	ISP/O8	3
2	GPIO13/KSI3	General Purpose IO. May be configured as an OD output Keyboard Scan Input	ISP/O8	3
3	GPIO14/KSI4	General Purpose IO. May be configured as an OD output Keyboard Scan Input	ISP/O8	3
4	GPIO15/KSI5	General Purpose IO. May be configured as an OD output Keyboard Scan Input	ISP/O8	3
5	GPIO16/KSI6	General Purpose IO. May be configured as an OD output Keyboard Scan Input	ISP/O8	3
6	GPIO17/KSI7	General Purpose IO. May be configured as an OD output Keyboard Scan Input	ISP/O8	3
7	GPIO20/KSO00	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
8	VCC1	PWR	PWR	
9	GPIO21/KSO01	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
10	GPIO22/KSO02	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
11	GPIO23/KSO03	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
12	GPIO24/KSO04	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
13	GPIO25/KSO05	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
14	GPIO26/KSO06	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
15	GPIO27/KSO07	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
16	GPIO30/KSO08	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
17	GPIO31/KSO09	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3

Pin #	Name	Signal Description	Buffers	Notes
18	GPIO32/KSO10	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
19	GPIO33/KSO11	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
20	GPIO34/KSO12	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
21	GPIO35/KSO13	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
22	GPIO36/KSO14	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
23	GPIO37/KSO15	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
24	GPIO00/KSO16	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
25	GPIO01/KSO17	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
26	GPIO02/KSO18	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
27	GPIO03/KSO19	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
28	VCC1	PWR	PWR	
29	GPIO04/KSO20	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
30	GPIO05/KSO21	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
31	GPIO06/KSO22	General Purpose IO. May be configured as an OD output Keyboard Scan Output	IP/O8	3
32	BC_DAT/SMB_DATA	BC_DAT IO. SMBus Data IO	I/O8	
33	BC_CLK/SMB_CLK	BC_CLK. SMBus Slave Clock I	I	
34	BC_INT#/SMB_INT#	BC_INT# Output Active Low . SMBus Interrupt Output Active Low	O8	4

Pin #	Name	Signal Description	Buffers	Notes
35	SMB_ADDR	SMBus Address Select Strap. Selects between one of two SMBus Slave Addresses	I	
36	GPIO07	General Purpose IO. May be configured as an OD output	IP/O8	3
37	RESERVED	Reserved	NC	2
38	TEST_PIN	Test Pin Input	I	1
39	GPIO10/KSI0	General Purpose IO. May be configured as an OD output Keyboard Scan Input	ISP/O8	3
40	GPIO11/KSI1	General Purpose IO. May be configured as an OD output Keyboard Scan Input	ISP/O8	3
Exposed pad must be connected to VSS				

Note 1: This pin requires an external pull-down resister to ensure that the pin remains de-asserted.

2: NC Not Connected.

3: Full Function GPIO Refer to Table 2-4, “GPIO Configuration Register,” on page 15.

4: SMB_INT# is Open Drain / BC_INT# is Push-pull. SMBus is default.

TABLE 1-3: ALTERNATE PIN FUNCTIONS

Pin #	Primary	Alternate
1	GPIO12	KSI2
2	GPIO13	KSI3
3	GPIO14	KSI4
4	GPIO15	KSI5
5	GPIO16	KSI6
6	GPIO17	KSI7
7	GPIO20	KSO00
8	VCC1	VCC1
9	GPIO21	KSO01
10	GPIO22	KSO02
11	GPIO23	KSO03
12	GPIO24	KSO04
13	GPIO25	KSO05
14	GPIO26	KSO06
15	GPIO27	KSO07
16	GPIO30	KSO08
17	GPIO31	KSO09
18	GPIO32	KSO10
19	GPIO33	KSO11
20	GPIO34	KSO12
21	GPIO35	KSO13
22	GPIO36	KSO14
23	GPIO37	KSO15
24	GPIO00	KSO16
25	GPIO01	KSO17
26	GPIO02	KSO18
27	GPIO03	KSO19
28	VCC1	VCC1
29	GPIO04	KSO20
30	GPIO05	KSO21
31	GPIO06	KSO22
32	BC_DAT	SMB_DATA
33	BC_CLK	SMB_CLK
34	BC_INT#	SMB_INT#
35	SMB_ADDR	
36	GPIO07	
37	RESERVED	RESERVED
38	TEST_PIN	TEST_PIN
39	GPIO10	KSI0
40	GPIO11	KSI1

1.1 XNOR Chain Test Mode

An XNOR Chain test structure is in to the ECE1099 to allow users to confirm that all pins are in contact with the motherboard during assembly and test operations (Figure 1-2, "XNOR Chain Test Structure").

The XNOR Chain test structure must be activated to perform these tests. When the XNOR Chain is activated, the ECE1099 pin functions are disconnected from the device pins, which all become input pins except for one output pin at the end of XNOR Chain.

The tests that are performed when the XNOR Chain test structure is activated require the board-level test hardware to control the device pins and observe the results at the XNOR Chain output pin.

1.2 Pins in XNOR Chain Structure

All pins are inputs into the XNOR Chain with the exception of the following pins:

- TEST_PIN (this is the XNOR Chain enable input)
- RESERVED
- SMB_ADDR
- BC_INT#/SMB_INT#

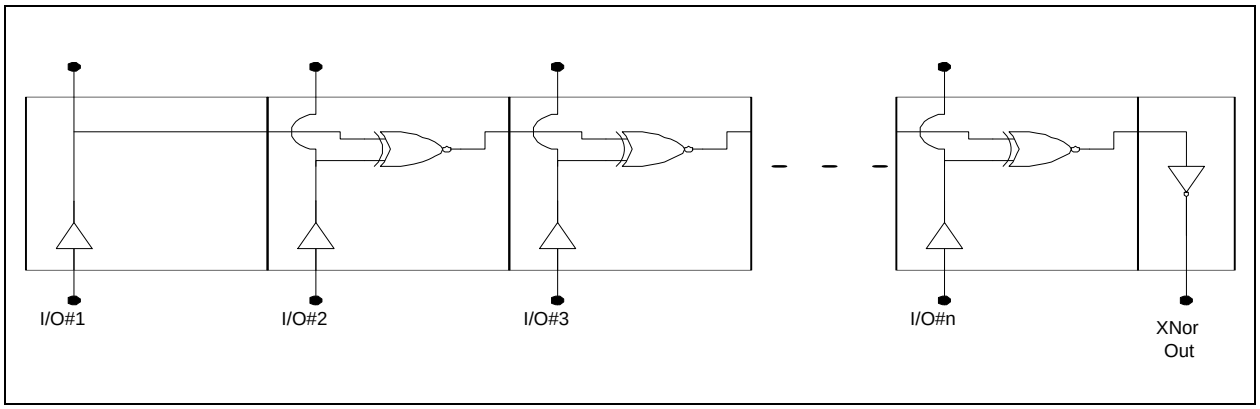
1.3 Entering and Exiting the XNOR Chain

The XNOR Chain test is entered by setting TEST_PIN to 1 while SMB_ADDR is 0.

When activated, the test mode allows one single input pin, when switched, to toggle the BC_INT#/SMB_INT# output.

The XNOR Chain is exited by setting TEST_PIN to 0, independent of the value of SMB_ADDR.

FIGURE 1-2: XNOR CHAIN TEST STRUCTURE



2.0 PRODUCT DESCRIPTION

2.1 Summary

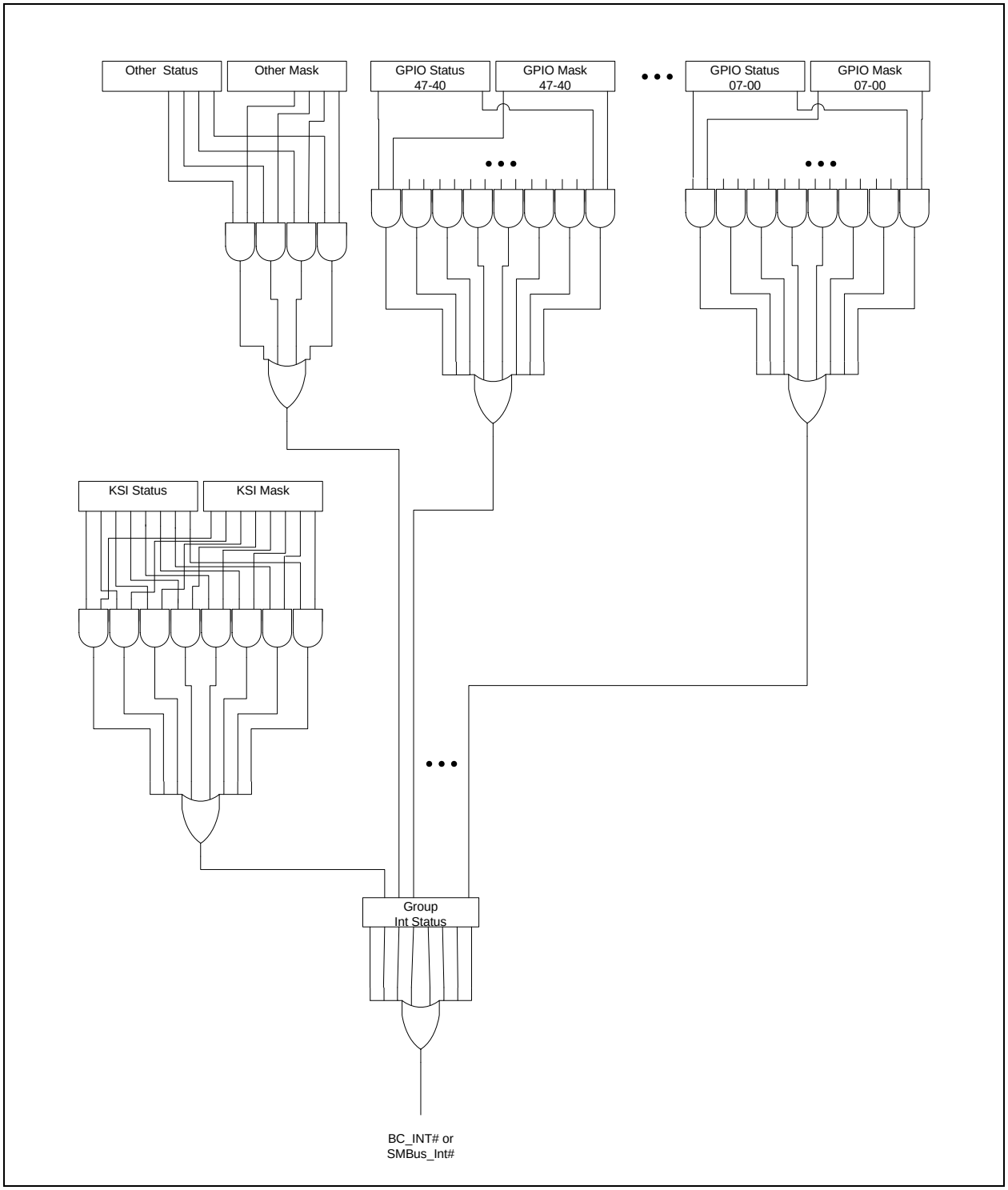
The ECE1099 is a 40-pin 3.3V GPIO and Keyboard Scan Expansion device.The device supports a keyboard scan matrix of 23x8. The device is connected to a Master via the BC-Link interface or via the SMBus.

KSI and KSO signals are multiplexed with GPIOs.

2.2 Interrupt Generation

Interrupts can be generated by an edge detection on a GPIO pin or an edge detection on one of the bus interface pins. Interrupts can also be detected on the keyboard scan interface. The bus interrupt pin (BC_INT# or SMBUS_INT#) is asserted if any bit in one of the Interrupt Status registers is 1 and the corresponding Interrupt Mask bit is also 1. Interrupt generation is illustrated in Figure 2-1, "Interrupt Generation".

FIGURE 2-1: INTERRUPT GENERATION



In order for software to determine which device is the source of an interrupt, it should first read the Group Interrupt Status Register to determine which Status register group is a source for the interrupt. Software should read both the Status register and the associated Mask register, then AND the two values together. Bits that are 1 in the result of the AND are active interrupts.

Software clears an interrupt by writing a 1 to the corresponding bit in the Status register.

Note:	Although the ECE1099 can generate the SMBus interrupt signal SMBUS_INT# as described above, it will not respond to the SMBus Alert Response Address transaction unless Bit4 ARA in the Clock Control Register (Register FAh) is set to 1.

2.3 Integrated VCC1 Reset Generator

When VCC1 power is applied to the ECE1099, a VCC1 POR will be generated. This VCC1 POR will reset the device.

2.4 Register Address Table

TABLE 2-1: REGISTER SUMMARY

Address (HEX)	Register	VCC1 POR Default
00h	GPIO[7:0] Input	00h
01h	GPIO[17:10] Input	00h
02h	GPIO[27:20] Input	00h
03h	GPIO[37:30] Input	00h
04h	Reserved	00h
05h	GPIO[7:0] Output	00h
06h	GPIO[17:10] Output	00h
07h	GPIO[27:20] Output	00h
08h	GPIO[37:30] Output	00h
09h	Reserved	00h
0Ah	GPIO00 Configuration	00h
0Bh	GPIO01 Configuration	00h
0Ch	GPIO02 Configuration	00h
0Dh	GPIO03 Configuration	00h
0Eh	GPIO04 Configuration	00h
0Fh	GPIO05 Configuration	00h
10h	GPIO06 Configuration	00h
11h	GPIO07 Configuration	00h
12h	GPIO10 Configuration	00h
13h	GPIO11 Configuration	00h
14h	GPIO12 Configuration	00h
15h	GPIO13 Configuration	00h
16h	GPIO14 Configuration	00h
17h	GPIO15 Configuration	00h
18h	GPIO16 Configuration	00h
19h	GPIO17 Configuration	00h
1Ah	GPIO20 Configuration	00h
1Bh	GPIO21 Configuration	00h
1Ch	GPIO22 Configuration	00h
1Dh	GPIO23 Configuration	00h

TABLE 2-1: REGISTER SUMMARY (CONTINUED)

Address (HEX)	Register	VCC1 POR Default
1Eh	GPIO24 Configuration	00h
1Fh	GPIO25 Configuration	00h
20h	GPIO26 Configuration	00h
21h	GPIO27 Configuration	00h
22h	GPIO30 Configuration	00h
23h	GPIO31 Configuration	00h
24h	GPIO32 Configuration	00h
25h	GPIO33 Configuration	00h
26h	GPIO34 Configuration	00h
27h	GPIO35 Configuration	00h
28h	GPIO36 Configuration	00h
29h	GPIO37 Configuration	00h
2A-31h	Reserved	00h
32h	GPIO[7:0] Interrupt Status	00h
33h	GPIO[17:10] Interrupt Status	00h
34h	GPIO[27:20] Interrupt Status	00h
35h	GPIO[37:30] Interrupt Status	00h
36h	Reserved	00h
37h	GPIO[7:0] Interrupt Mask	00h
38h	GPIO[17:10] Interrupt Mask	00h
39h	GPIO[27:20] Interrupt Mask	00h
3Ah	GPIO[37:30] Interrupt Mask	00h
3B-3Fh	Reserved	00h
40h	KSO Select	40h
41h	KSI Input	00h
42h	KSI Status	00h
43h	KSI Interrupt Mask	00h
44-F4h	Reserved	00h
F5h	Reset	00h
F6h	MCHP test	00h
F7h-F8h	Reserved	00h
F9h	Group Interrupt	00h
FAh	Clock Control	00h
FBh	Wakeup Control	00h
FCH	Device ID	41h
FDh	Device Version Number	Current version
FEh	Vendor ID (LSB)	55h
FFh	Vendor ID (MSB)	10h

2.5 Detailed Register Descriptions

2.5.1 GPIO REGISTERS

Note:	When the GPIO function is selected, the buffer has full GPIO functionality. When KSO is selected the buffer is set to Open-Drain output operation.

2.5.2 GPIO INPUT REGISTER

TABLE 2-2: GPIO INPUT REGISTER

ADDRESS	**REFER TO** Table 2-1, "Register Summary"			8-bit			**SIZE**	
POWER	VCC1			N/A			**VCC1 POR DEFAULT**	
BIT	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
BC-LINK TYPE	R	R	R	R	R	R	R	R
BIT NAME	GPIOx7	GPIOx6	GPIOx5	GPIOx4	GPIOx3	GPIOx2	GPIOx1	GPIOx0

2.5.3 GPIO OUTPUT REGISTER

TABLE 2-3: GPIO OUTPUT REGISTER

ADDRESS	**REFER TO** Table 2-1, "Register Summary"			8-bit			**SIZE**	
POWER	VCC1			00h			**VCC1 POR DEFAULT**	
BIT	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
BC-LINK TYPE	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
BIT NAME	GPIOx7	GPIOx6	GPIOx5	GPIOx4	GPIOx3	GPIOx2	GPIOx1	GPIOx0

2.5.4 GPIO CONFIGURATION REGISTER

TABLE 2-4: GPIO CONFIGURATION REGISTER

ADDRESS	**REFER TO** Table 2-1, "Register Summary"			8-bit			**SIZE**	
POWER	VCC1			00h			**VCC1 POR DEFAULT**	
BIT	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
BC-LINK TYPE	R	R/W	R/W	R/W	R/W	R/W	R	R/W
BIT NAME	RES	ALT	DIR	TYPE		POL	RES	PU

2.5.4.1 ALT

Alternate Function select. When this bit is 0, the primary pin function is selected. When this bit is 1, the alternate function is selected. See Table 1-3, "Alternate Pin Functions".

2.5.4.2 DIR, TYPE

The level/edge and output type are controlled by these fields. The effects are defined in Table 2-5, "Direction, Level/Edge, Output Type Bit Definition".

TABLE 2-5: DIRECTION, LEVEL/EDGE, OUTPUT TYPE BIT DEFINITION

Direction Bit 5	Type Bit 4	Type Bit 3	Selected Function
0	0	0	Input, Level Sensitive Low
0	0	1	Input, Rising Edge Triggered
0	1	0	Input, Falling Edge Triggered
0	1	1	Input, Both Edge Triggered
1	0	x	Output, Push-Pull
1	1	x	Output, Open Drain

In order to enable oscillator wakeup from Low Power Mode for any GPIO pin, the GPIO Configuration Register for that GPIO must be configured for Input in Bit 5). To enable oscillator wakeup from Low Power Mode for any pin that is an alternate function, the GPIO Configuration Register must still be configured for input. This applies to Keyscan pin functions. See Section 2.6.2, "Clock Control".

2.5.4.3 POL

When the **POL** bit is set to '1'' the signal output is inverted when routed to its pin and the interrupt level sense is inverted when a level-sensitive interrupt is selected by the **DIR, TYPE** fields. POL does not affect any output when the **ALT** bit is "1".The state of the pin is always reported without inversion in the GPIO Input Register.

2.5.4.4 PU

When this bit is 1, an internal pull-up resistor is connected to the pin. When this bit is 0, the pullup is disabled.

2.5.5 GPIO INTERRUPT STATUS REGISTER

TABLE 2-6: GPIO INTERRUPT STATUS REGISTER

ADDRESS	**REFER TO** Table 2-1, "Register Summary"			8-bit			**SIZE**
POWER	VCC1			00h			**VCC1 POR DEFAULT**
BIT	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
BC-LINK TYPE	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC
BIT NAME	GPIOX7	GPIOX6	GPIOX5	GPIOX4	GPIOX3	GPIOX2	GPIOX1	GPIOX0

A bit in a GPIOX Interrupt Status Register is set to 1 when the DIRECTION field for that bit in the corresponding GPIOX*n* Configuration Register is set for Input and the bit in the corresponding GPIOX Input Register matches the conditions defined by the TYPE field in the GPIOX Configuration Register. For example, if the TYPE field for GPIO X*n* is set for Level Sensitive Low, then bit *n* in the GPIOX Interrupt Status Register is set to 1 when bit *n* in the GPIOX Input Register is 0. If the TYPE field specifies edge triggering, then the Status Register bit is set when the Input Register bit transitions with the specified edge.

Writing a bit in a GPIOX Interrupt Status Register clears that bit. Writing a bit with a 0 has no effect.

2.5.6 GPIO INTERRUPT MASK REGISTER

TABLE 2-7: GPIO INTERRUPT MASK REGISTER

ADDRESS	REFER TO Table 2-1, "Register Summary"			8-bit			SIZE
POWER	VCC1			00h			VCC1 POR DEFAULT
BIT	D7	D6	D5	D4	D3	D2	D1	D0
BC-LINK TYPE	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
BIT NAME	GPIOX7 0 No Int 1 Int	GPIOX6 0 No Int 1 Int	GPIOX5 0 No Int 1 Int	GPIOX4 0 No Int 1 Int	GPIOX3 0 No Int 1 Int	GPIOX2 0 No Int 1 Int	GPIOX1 0 No Int 1 Int	GPIOX0 0 No Int 1 Int

An interrupt is signaled on either BC_INT# or SMBus_INT# when a GPIOX bit in a GPIO Interrupt Status Register is 1 and the corresponding GPIOX bit in the GPIO Interrupt Mask Register is also 1.

2.6 Other Control Registers

2.6.1 GROUP INTERRUPT STATUS

TABLE 2-8: GROUP INTERRUPT STATUS REGISTER

ADDRESS	F9h			8-bit			SIZE
POWER	VCC1			00h			VCC1 POR DEFAULT
BIT	D7	D6	D5	D4	D3	D2	D1	D0
BC-LINK TYPE	R	R	R	R	R	R	R	R
BIT NAME	Reserved	KSI	Reserved	Reserved	Grp3	Grp2	Grp1	Grp0

2.6.1.1 Bit6 KSI

0 No KSI interrupts asserted

1 At least one KSI interrupt asserted

2.6.1.2 Bit3 Grp3

0 No interrupts in GPIO Group 3

1 Interrupt in at least one of GPIO37-GPIO30

2.6.1.3 Bit2 Grp2

0 No interrupts in GPIO Group2

1 Interrupt in at least one of GPIO27-GPIO20

2.6.1.4 Bit1 Grp1

0 No interrupts in GPIO Group1

1 Interrupt in at least one of GPIO17-GPIO10

2.6.1.5 Bit0 Grp0

0 No interrupts in GPIO Group0

1 Interrupt in at least one of GPIO07-GPIO00

2.6.2 CLOCK CONTROL

TABLE 2-9: CLOCK CONTROL REGISTER

ADDRESS	FAh					8-bit	SIZE
POWER	VCC1					00h	VCC1 POR DEFAULT
BIT	D7	D6	D5	D4	D3	D2	D1	D0
BC-LINK TYPE	R	R	R	R/W	R/W	R/W	R/W	R/W
BIT NAME	Reserved			ARA	Reserved	OSC Control	Interface Selection	

2.6.2.1 Bit4 ARA

If this bit is 1b and the SMBus interface is enabled (either by setting the Interface Selection field to 11b or by setting the Interface Selection field to 0xb and an SMBus transaction is detected), the ECE1099 will respond to an SMBus Alert Response Address Read Byte command as defined in the SMBus specification. If this bit is 0b, the ECE1099 will ignore the Alert Response Address at all times.

APPLICATION NOTE: Software must insure that the field Interface Selection in this register is ‘11b’ (SMBus Interface enabled) before setting ARA to ‘1b’.

2.6.2.2 Bit2 OSC Control

0b Oscillator Enabled (Default)

1b Oscillator Low Power Enable.

The Oscillator may be stopped and once stopped may be restarted by activity on either the bus interface pins or on inputs that are enabled for interrupts. See Section 2.6.3, "Wakeup Control" for conditions that restart the Oscillator

When OSC Control is set to Low Power Enable (1b) the Oscillator will stop only when the SMBus or BC-Link are idle. This means:

No Interrupts are pending

No traffic is on the bus

Transactions on the bus have completed

APPLICATION NOTE: When OSC Control is set to ‘1b’, the ring oscillator will be shut down after every BC-Link or SMBus transaction completes and no interrupts are pending. The oscillator will restart when a wakeup enabled by the Wakeup Control registers occurs. The Wakeup Control register **must** be configured properly before setting OSC Control to ‘1b’.

2.6.2.3 Bit[1:0] Interface Selection

0Xb Autodetect Mode (default)

10b BC-Link interface enabled.

11b SMBus interface enabled

APPLICATION NOTE: The first access to the ECE1088ECE1099 must be a write to the Clock Control register to configure the Interface Selection field to the desired interface type (10b or 11b). This is required so that Oscillator control works properly and so that the bus type does not inadvertently switch during use.

2.6.3 WAKEUP CONTROL

The Wakeup Control Register determines which events restart the Oscillator when the Oscillator is in Low Power Mode.

TABLE 2-10: WAKEUP CONTROL REGISTER

ADDRESS	**FBh**			8-bit			**SIZE**	
POWER	VCC1			00h			**VCC1 POR DEFAULT**	
BIT	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
BC-LINK TYPE	R	R	R/W	R/W	R/W	R/W	R/W	R/W
BIT NAME	Reserved	Reserved	Reserved	Reserved	Keyscan	GPIO	BUS_DAT	BUS_CLK

2.6.3.1 Bit3 KSI

0 The KSI interface does not affect the Oscillator

1 A Keyscan interrupt that is requested on any Keyscan pin for which Keyscan interrupts are enabled will restart the Oscillator when the Oscillator is stopped in Low Power mode.

For edge detection on any Keyscan pin the direction and edge configuration must be set in the GPIO Configuration registers for the GPIO pins that correspond to each Keyscan pin.

2.6.3.2 Bit2 GPIO

0 GPIO Interrupts do not affect the Oscillator

1 A GPIO interrupt that is requested on any GPIO pin for which GPIO function is selected and a GPIO interrupt is enabled will restart the Oscillator when the Oscillator is stopped in Low Power mode.

In order for edge detection to work on any GPIO pin the pin must be selected for input and the desired edges configured, as described in Table 2-5, "Direction, Level/Edge, Output Type Bit Definition", in the GPIO configuration register.

2.6.3.3 Bit1 BUS_DAT

0 The BUS_DAT signal (BC_DAT or SMB_DAT) does not affect the Oscillator

1 Either a rising edge or a falling edge on the BUS_DAT signal will restart the Oscillator when the Oscillator is stopped in Low Power mode.

2.6.3.4 Bit0 BUS_CLK

0 The BUS_Clk signal (BC_CLK or SMB_CLK) does not affect the Oscillator

1 Either a rising edge or a falling edge on the BUS_Clk signal will restart the Oscillator when the Oscillator is stopped in Low Power mode.

2.6.4 KEYBOARD SCAN REGISTERS

2.6.4.1 KSO Select

TABLE 2-11: KSO SELECT REGISTER

ADDRESS	40h					8-bit	SIZE
POWER	VCC1					40h	VCC1 POR DEFAULT
BIT	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
BC-LINK TYPE	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
BIT NAME	KSO INVERT	KSEN	KSO ALL	KSO Driver Select[4:0]				

2.6.4.1.1 Bit[7] KSO INVERT

KSO INVERT = 1 inverts KSO[22:0]. When KSO INVERT = 0 KSO[22:00] operate normally See Table 2-13, “Keyboard Scan Out Control Summary,” on page 21.

2.6.4.1.2 Bit[6] KSEN

KSEN = 1 disables keyboard scan and drives. KSEN = 0 enables keyboard scan.

2.6.4.1.3 Bit[5] KSO ALL

KSO ALL = 1, drives all KSO lines according to KSO INVERT bit. See Table 3.9, “Keyboard Scan Out Control summary,” on page 23.

2.6.4.1.4 Bits[4:0] KSO Driver Select

KSO Driver Select controls the corresponding KSO line (00000b = KSO[0] etc.) according to KSO INVERT. See Table 2-12, "KSO Select Decode".

TABLE 2-12: KSO SELECT DECODE

KSO Select [4:0]	KSO Selected
00h	KSO00
01h	KSO01
02h	KSO02
03h	KSO03
04h	KSO04
05h	KSO05
06h	KSO06
07h	KSO07
08h	KSO08
09h	KSO09
0Ah	KSO10
0Bh	KSO11
0Ch	KSO12
0Dh	KSO13
0Eh	KSO14
0Fh	KSO15
10h	KSO16
11h	KSO17
12h	KSO18

TABLE 2-12: KSO SELECT DECODE (CONTINUED)

KSO Select [4:0]	KSO Selected
13h	KSO19
14h	KSO20
15h	KSO21
16h	KSO22
17h - 1Fh	Reserved

TABLE 2-13: KEYBOARD SCAN OUT CONTROL SUMMARY

D7 KSO Invert	D6 KSEN	D5 KSO ALL	D[5:0] KSO Drivers Address	Description
X	1	x	x	Keyboard Scan disabled KSO[22:00] driven high.
0	0	0	10110b-00000b	KSO[Drive Selected] asserted low. All others de-asserted high
1	0	0	10110b-00000b	KSO[Drive Selected] de-asserted high. All others asserted low
0	0	0	11111b-10111b	ALL KSO's de-asserted high
1	0	-	11111b-10111b	All KSO's asserted low
0	0	1	x	KSO[22:0] drive low
1	0	1	x	KSO[22:00] driven high

2.6.4.2 KSI Input

TABLE 2-14: KSI INPUT REGISTER

ADDRESS	**41h**			8-bit			**SIZE**
POWER	VCC1			00h			**VCC1 POR DEFAULT**
BIT	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
BC-LINK TYPE	R	R	R	R	R	R	R	R
BIT NAME	KS7	KS6	KS5	KS4	KS3	KS2	KS1	KS0

2.6.4.3 KSI Status

TABLE 2-15: KSI STATUS REGISTER

ADDRESS	**42h**			8-bit			**SIZE**
POWER	VCC1			00h			**VCC1 POR DEFAULT**
BIT	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
BC-LINK TYPE	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC
BIT NAME	Status of KI7	Status of KSI6	Status of KSI5	Status of KSI4	Status of KSI3	Status of KSI2	Status of KSI1	Status of KSI0

Note 2-1 The status bit is set by a falling edge of the KS input.

Note 2-2 Writing a 1 to a bit will clear that bit to 0.

2.6.4.3.1 Operation:

KSI interrupt is generated when one of the KSI signals transitions from High to Low (Edge Triggered). This interrupt will not be signalled again until all KSI signals are brought high and one then transitions low.

2.6.4.4 KSI Mask

TABLE 2-16: KSI INTERRUPT MASK REGISTER

ADDRESS	**43h**			8-bit			**SIZE**
POWER	VCC1			00h			**VCC1 POR DEFAULT**
BIT	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
BC-LINK TYPE	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
BIT NAME	KSI7 1= Inten 0= No Int	KSI6 1= Inten 0= No Int	KSI5 1= Inten 0= No Int	KSI4 1= Inten 0= No Int	KSI3 1= Inten 0= No Int	KSI2 1= Inten 0= No Int	KSI1 1= Inten 0= No Int	KSI0 1= Inten 0= No Int

2.6.5 DEVICE ID REGISTER

TABLE 2-17: DEVICE ID REGISTER

ADDRESS	**FCH**			8-bit			**SIZE**
POWER	VCC1			41h			**VCC1 POR DEFAULT**
BIT	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
BC-LINK TYPE	R	R	R	R	R	R	R	R
ECE1099	**41h**							

TABLE 2-18: DEVICE REVISION REGISTER

ADDRESS	**FDh**			8-bit			**SIZE**
POWER	VCC1			00h			**VCC1 POR DEFAULT**
BIT	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
BC-LINK TYPE	R	R	R	R	R	R	R	R
BIT NAME	Current Revision Number							

TABLE 2-19: VENDOR ID (LSB) REGISTER

ADDRESS	FEh			8-bit			SIZE	
POWER	VCC1			55h			VCC1 POR DEFAULT	
BIT	D7	D6	D5	D4	D3	D2	D1	D0
BC-LINK TYPE	R	R	R	R	R	R	R	R
BIT NAME	55h							

TABLE 2-20: VENDOR ID (MSB) REGISTER

ADDRESS	FFh			8-bit			SIZE	
POWER	VCC1			10h			VCC1 POR DEFAULT	
BIT	D7	D6	D5	D4	D3	D2	D1	D0
BC-LINK TYPE	R	R	R	R	R	R	R	R
BIT NAME	10h							

2.6.6 RESET REGISTER

TABLE 2-21: RESET REGISTER

ADDRESS	F5H			8-bit			SIZE	
POWER	VCC1			00h			VCC1 POR DEFAULT	
BIT	D7	D6	D5	D4	D3	D2	D1	D0
BC-LINK TYPE	R	R	R	R	R	R	R	W
BIT NAME	Reserved							Force_ POR

2.6.6.1 Force_POR

Writing this bit with a 1 will force a VCC1 POR. All registers and state machines in the device will be reset to their default power-on values. Writing a 0 to this bit has no effect. This is a self clearing bit.

Note: The Force_POR bit does not affect the **Interface Selection** setting of the Clock Control register. Whichever bus interface is in effect at the time Force_POR is set (BC-Link or SMBus) will remain in effect after the POR.

2.6.7 MCHP TEST REGISTER

TABLE 2-22: MCHP TEST REGISTER

ADDRESS	F6H			8-bit			SIZE
POWER	VCC1			00h			VCC1 POR DEFAULT
BIT	D7	D6	D5	D4	D3	D2	D1	D0
BC-LINK TYPE	R	R	R	R	R	R	R	R
BIT NAME	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

2.6.7.1 RESERVED

Reserved for Microchip test purposes. Should not be written.

2.7 SMBus / BC-Link Autodetect Circuit

2.7.1 OVERVIEW

For either the SMBus or the BC-Link, by detecting difference in start conditions, the Bus type is indicated. From an idle condition, the device will sample the data line on the first falling edge of the clock. If it is low, a SMBus interface is selected; if it is high, a BC-Link interface is selected. The idle condition is defined as a POR or no activity for 75 ms. To safeguard against glitches selecting the wrong bus and locking the system, the device use time-outs that reload on a start from the respective bus interface. For SMBus, the timeout is 75 ms. For BC-Link, the timeout is 75 µs.

2.8 SMBus Slave Interface

The host processor communicates with the ECE1099 device through a series of read/write registers via the SMBus interface. SMBus is a serial communication protocol between a computer host and its peripheral devices.

The SMBus data rate is 10KHz minimum to 400 KHz maximum.

2.8.1 CLOCKING

The SMBus Slave interface is driven by an internal Ring Oscillator. This oscillator runs at a nominal frequency of 32MHz.

The Ring Oscillator may be started and stopped through firmware interactions. The that controls the operation of the Oscillator is described in Section 2.6.2, "Clock Control" and Section 2.6.3, "Wakeup Control".

2.8.2 SLAVE ADDRESS

Upon power up, the ECE1099 device will be placed into Address Select mode and assign itself an SMBus address according to the Address Select input. The device will latch the address during the first valid SMBus transaction in which the first five bits of the targeted address match those of the ECE1099 address. This feature eliminates the possibility of a glitch on the SMBus interfering with address selection.

TABLE 2-23: SMBUS SLAVE ADDRESS OPTIONS

Address Select	Board Implementation	SMBus Address [7:1]
0	Address Select Pulled to ground through a 10kΩ resistor	0111 000b
1	Address Select pulled to VCC1 through a 10kΩ resistor	0111 001b

2.8.3 SLAVE BUS INTERFACE

The ECE1099 device SMBus implementation is a subset of the SMBus interface to the host. The device is a *slave-only* SMBus device. The implementation in the device is a subset of SMBus since it only supports four protocols.

The Write Byte, Read Byte, Send Byte, and Receive Byte protocols are the only valid SMBus protocols for the device. This part responds to other protocols as described in the Invalid Protocol Section. Reference the System Management Bus Specification, Rev 2.0.

The SMBus interface is used to read and write the registers in the device. The register set is shown in Table 2-1, "Register Summary".

2.8.4 WRITE BYTE

The Write Byte protocol is used to write data to the registers. The data will only be written if the protocol shown in Table 2-24, "SMBus Write Byte Protocol" is performed correctly. Only one byte is transferred at time for a Write Byte protocol.

TABLE 2-24: SMBUS WRITE BYTE PROTOCOL

Field	Start	Slave Addr	Wr	Ack	Reg. Addr	Ack	Reg. Data	Ack	Stop
Bits	1	7	1	1	8	1	8	1	1

2.8.5 READ BYTE

The Read Byte protocol is used to read data from the registers. The data will only be read if the protocol shown in Table 2-25, "SMBus Read Byte Protocol" is performed correctly. Only one byte is transferred at time for a Read Byte protocol.

TABLE 2-25: SMBUS READ BYTE PROTOCOL

Field:	Start	Slave Addr	Wr	Ack	Reg. Addr	Ack	Start	Slave Addr	Rd	Ack	Reg. Data	Nack	Stop
Bits:	1	7	1	1	8	1	1	7	1	1	8	1	1

2.8.6 SEND BYTE

The Send Byte protocol is used to set the Internal Address Register to the correct register in the ECE1099. No data is transferred for a Send Byte protocol.The send byte protocol is shown in Table 2-26, "SMBus Send Byte Protocol".

TABLE 2-26: SMBUS SEND BYTE PROTOCOL

Field:	Start	Slave Addr	Wr	Ack	Reg. Addr	Ack	Stop
Bits:	1	7	1	1	8	1	1

2.8.7 RECEIVE BYTE

The Receive Byte protocol is used to read data from the registers when the register address is known to be at the desired address (using the Internal Address Register). Only one byte is transferred at time for a Receive Byte protocol.

TABLE 2-27: SMBUS RECEIVE BYTE PROTOCOL

Field:	Start	Slave Addr	Rd	Ack	Reg. Data	Nack	Stop
Bits:	1	7	1	1	8	1	1

Note: Some simple devices do not contain a clock low drive circuit; this simple kind of device typically may reset its communications port after a start or stop condition.

2.8.8 STRETCHING THE SCLK SIGNAL

The ECE1099 supports stretching of the SCLK by other devices on the SMBus.

2.8.9 SMBUS TIMING

The SMBus Slave Interface complies with the SMBus AC Timing Specification. See the SMBus timing diagram shown in Section 4.2, "SMBus Timing".

2.8.10 SMBUS ALERT RESPONSE ADDRESS

This device responds to protocols with the SMBus Alert Response Address of 0001_100 if the ARA bit in the Clock Control register is set.

2.8.11 SMBUS TIME-OUT

The ECE1099 includes an SMBus time-out feature. Following a 30 ms period of inactivity on the SMBus, the device time-out and reset the SMBus interface.

2.9 BC-Link Interface

The BC-Link is a proprietary bus that allows communication between a Master device and a Companion device. The Master device uses this serial bus to read and write registers located on the Companion device.

The bus comprises three signals, BC_CLK, BC_DAT and BC_INT#. The Master device always provides the clock, BC_-CLK, and the Companion device is the source for an independent asynchronous interrupt signal, BC_INT#.

The ECE1099 supports BC-Link speeds up to 24MHz.

3.0 OPERATIONAL DESCRIPTION

3.1 Maximum Ratings

Maximum V_{cc1} ..... +5V

Negative Voltage on any pin, with respect to Ground ..... -0.3V

Operating Temperature Range ..... 0^oC to $+70^oC$

Storage Temperature Range ..... -55^o to $+150^oC$

Lead Temperature Range ..... Refer to JEDEC Spec. J-STD-020

Note: Stresses above those listed above and below could cause permanent damage to the device. This is a stress rating only and functional operation of the device at any other condition above those indicated in the operation sections of this specification is not implied. When powering this device from laboratory or system power supplies, it is important that the Absolute Maximum Ratings not be exceeded or device failure can result. Some power supplies exhibit voltage spikes on their outputs when the AC power is switched on or off. In addition, voltage transients on the AC power line may appear on the DC output. If this possibility exists, it is suggested that a clamp circuit be used.

3.2 DC Electrical Characteristics

TABLE 3-1: DC ELECTRICAL CHARACTERISTICS $T_A = 0^oC – 70^oC$, $V_{CC1} = +3.3 V ± 10\%$

Parameter	Symbol	MIN	TYP	MAX	Units	Comments
I Type Input Buffer						
Low Input Level	V_{ILI}			0.8	V	TTL Levels
High Input Level	V_{IHI}	2.0		5.5	V	
ISP Type Input Buffer with 90µA Pull-up						Note 3-1 Schmitt Trigger
Low Input Level	V_{ILIS}			0.8	V	
High Input Level	V_{IHIS}	2.2		5.5	V	Schmitt Trigger
Schmitt Trigger Hysteresis	V_{HYS}		100		mV	
IP/O8 Type Buffer with 90µA Pull-up						Note 3-1 TTL Levels
Low Input Level	V_{ILI}			0.8	V	
High Input Level	V_{IHI}	2.0		5.5	V	
Low Output Level	V_{OL}			0.4	V	I_{OL} = 8mA
High Output Level	V_{OH}	2.4		V_{cc1} + 0.3	V	I_{OH} = -4mA
I/O8 Type Buffer						TTL Levels
Low Input Level	V_{ILI}			0.8	V	
High Input Level	V_{IHI}	2.0		5.5	V	
Low Output Level	V_{OL}			0.4	V	I_{OL} = 8mA
High Output Level	V_{OH}	2.4		V_{cc1} + 0.3	V	I_{OH} = -4mA
O8 Type Buffer						
Low Output Level	V_{OL}			0.4	V	I_{OL} = 8mA
High Output Level	V_{OH}	2.4		V_{cc1} + 0.3	V	I_{OH} = -4mA

TABLE 3-1: DC ELECTRICAL CHARACTERISTICS T_A = 0°C – 70°C, V_{CC1} = +3.3 V ± 10%

Parameter	Symbol	MIN	TYP	MAX	Units	Comments
Leakage Current (ALL – except Buffers)						Note 3-2
Input High Current	$ILEAK_{IH}$			10	µA	V_{IN} = V_{cc1}
Input Low Current	$ILEAK_{IL}$			-10	µA	V_{IN} = 0V
5V Tolerant Pins						V_{cc1} = 3.3V
Input High Current	$ILEAK_{IH}$			100	µA	V_{IN} =5.5V Max
Input High Current	$ILEAK_{IH}$			10	µA	V_{IN} <= V_{cc1}
Input Low Current	$ILEAK_{IL}$			-10	µA	V_{IN} = 0V
V_{CC1} Supply Current Active	I_{CC}		3	8	mA	measured with SMBus/BC-Link traffic
V_{CC1} Supply Current Active with Ring Oscillator Off	I_{CC}			500	µA	measured with Ring Oscillator off (OCS Control bit set to Oscillator Low Power Enable mode)
Reset Voltage	V_{RST}	1.6	1.8	2.1	V	Device is in internal reset state when V_{cc1} is below min V_{RST}

- Voltages are measured from the local ground potential, unless otherwise specified.
- Typicals are at TA=25°C and represent most likely parametric norm.
- The maximum allowable power dissipation at any temperature is PD = (TJmax - TA) / QJA.
- Timing specifications are tested at the TTL logic levels, VIL=0.4V for a falling edge and VIH=2.4V for a rising edge. TRI-STATE output voltage is forced to 1.4V.
- All pins except power and ground are 5V tolerant.

Note 3-1 90µA Pull-up with +/- 40% variation

Note 3-2 leakage currents are measured with all pins in high impedance.

3.3 AC Timing Specifications

Refer to the LSBC Bus Specification.

3.4 Capacitance Values for Pins

CAPACITANCE T_A = 25°C; fc = 1MHz; V_{CC1} = 3.3V ±10%

TABLE 3-2: CAPACITANCE VALUES FOR PINS

Parameter	Symbol	Limits			Unit	Test Condition
		MIN	TYP	MAX		
Clock Input Capacitance	C_{IN}			20	pF	All pins except pin under test tied to AC ground
Input Capacitance	C_{IN}			10	pF	
Output Capacitance	C_{OUT}			20	pF	

Note 3-3 The input capacitance of a port is measured at the connector pins.

4.0 TIMING DIAGRAMS

4.1 V_{CC1} Power

FIGURE 4-1: V_{CC1} POWER

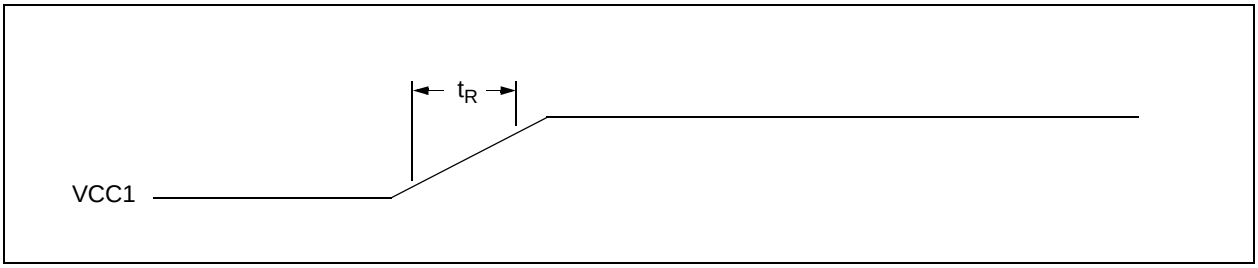


TABLE 4-1: V_{CC1} POWER PARAMETERS

Symbol	Parameter	Limits		Units	Comments
		Min	Max		
t_R	V_{CC1} Rise time, 10% to 90%	0.150	30	msec	

4.2 SMBus Timing

FIGURE 4-2: SMBUS TIMING

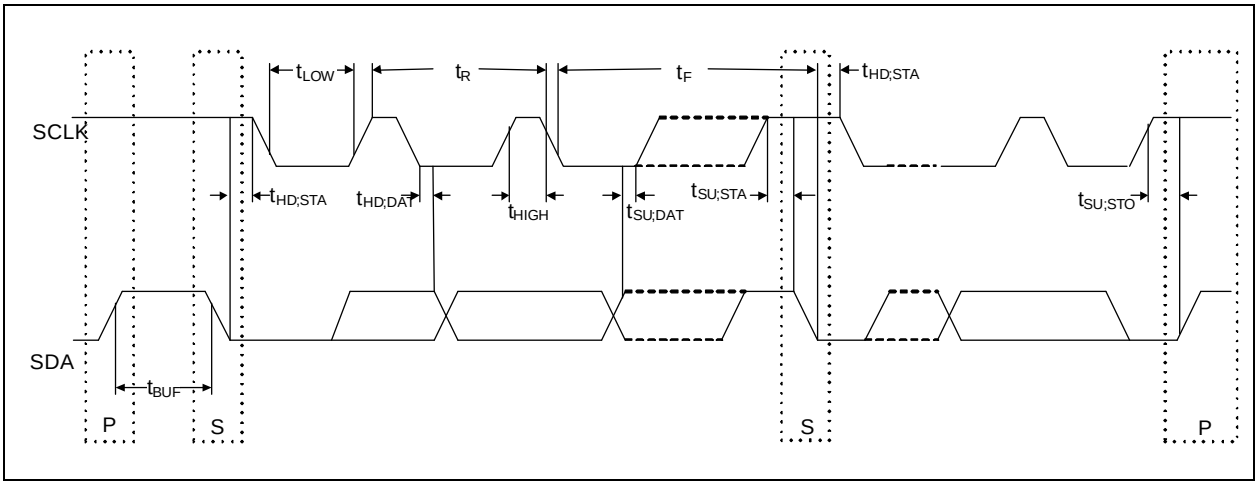


TABLE 4-2: SMBUS TIMING PARAMETERS

Symbol	Parameter	Limits		Units	Comments
		Min	Max		
Fsmb	SMB Operating Frequency	10	400	KHz	Note 4-1
Tsp	Spike Suppression		50	ns	Note 4-2
Tbuf	Bus free time between Stop and Start Condition	1.3		µs	
Thd:sta	Hold time after (Repeated) Start Condition. After this period, the first clock is generated.	0.6		µs	
Tsu:sta	Repeated Start Condition setup time	0.6		µs	
Tsu:sto	Stop Condition setup time	0.6		µs	
Thd:dat	Data hold time	0.3	0.9	µs	
Tsu:dat	Data setup time	100		ns	Note 4-3
Tlow	Clock low period	1.3		µs	
Thigh	Clock high period	0.6		µs	
Tf	Clock/Data Fall Time	$20+0.1C_b$	300	ns	
Tr	Clock/Data Rise Time	$20+0.1C_b$	300	ns	
C_b	Capacitive load for each bus line		400	pF	

Note 4-1 The max SMBus timing operating frequency exceeds that specified in the System Management Bus Specification, Rev 1.1, but corresponds to the maximum clock frequency for fast mode devices on the I^2C bus (see the I^2C Bus Specification).

Note 4-2 At 400kHz, the input filter suppresses spikes of a maximum pulse width of 50ns.

Note 4-3 if using 100 KHz clock frequency, the next data bit output to the SDA line will be 1250 ns (1000 ns (T_R max) + 250 ns ($T_{SU:DAT}$ min) @ 100 kHz) before the SCLK line is released.

5.0 PACKAGE OUTLINE

FIGURE 5-1: PACKAGE OUTLINE: 40-PIN QFN BODY 6X6 MM BODY

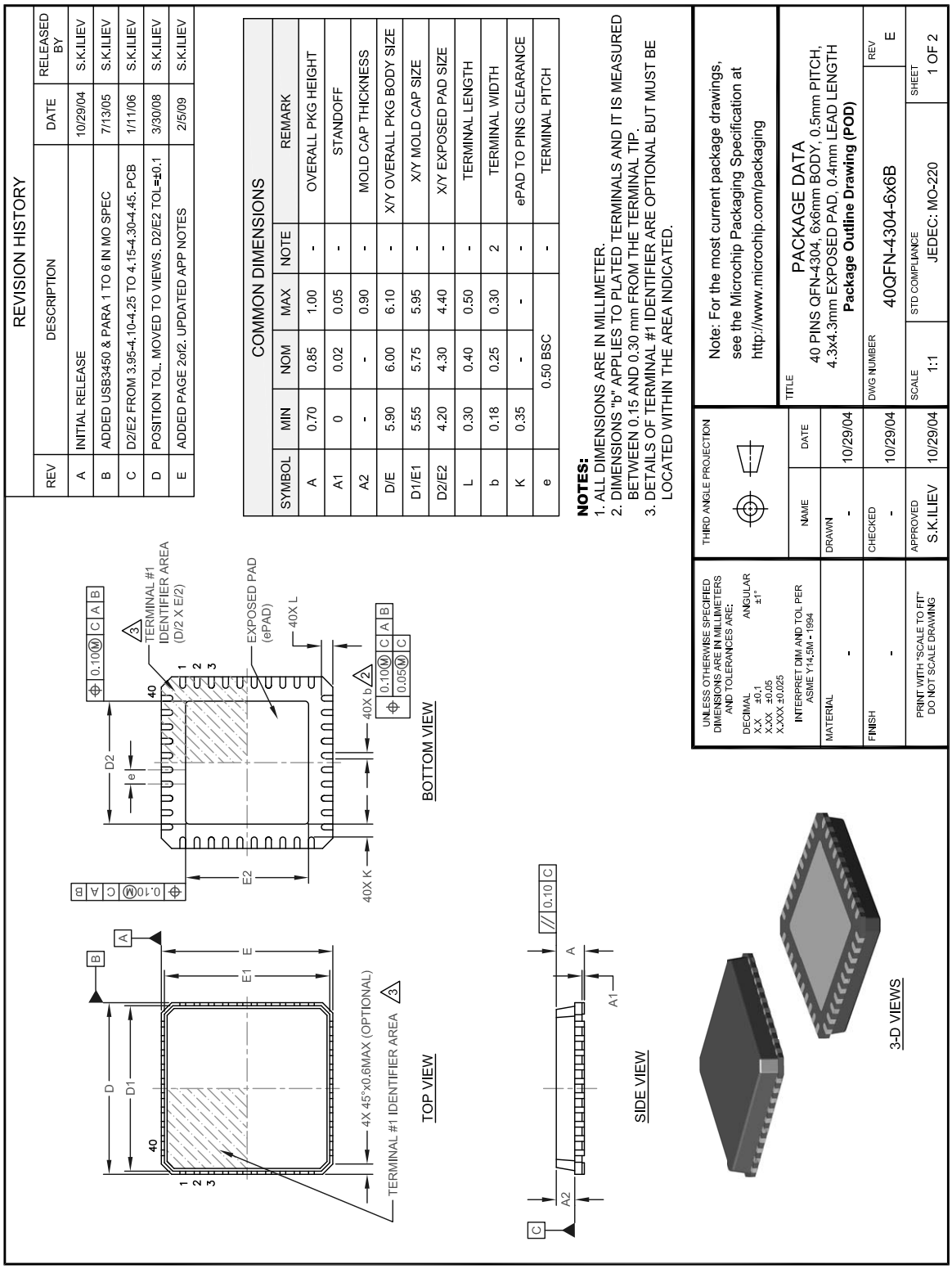
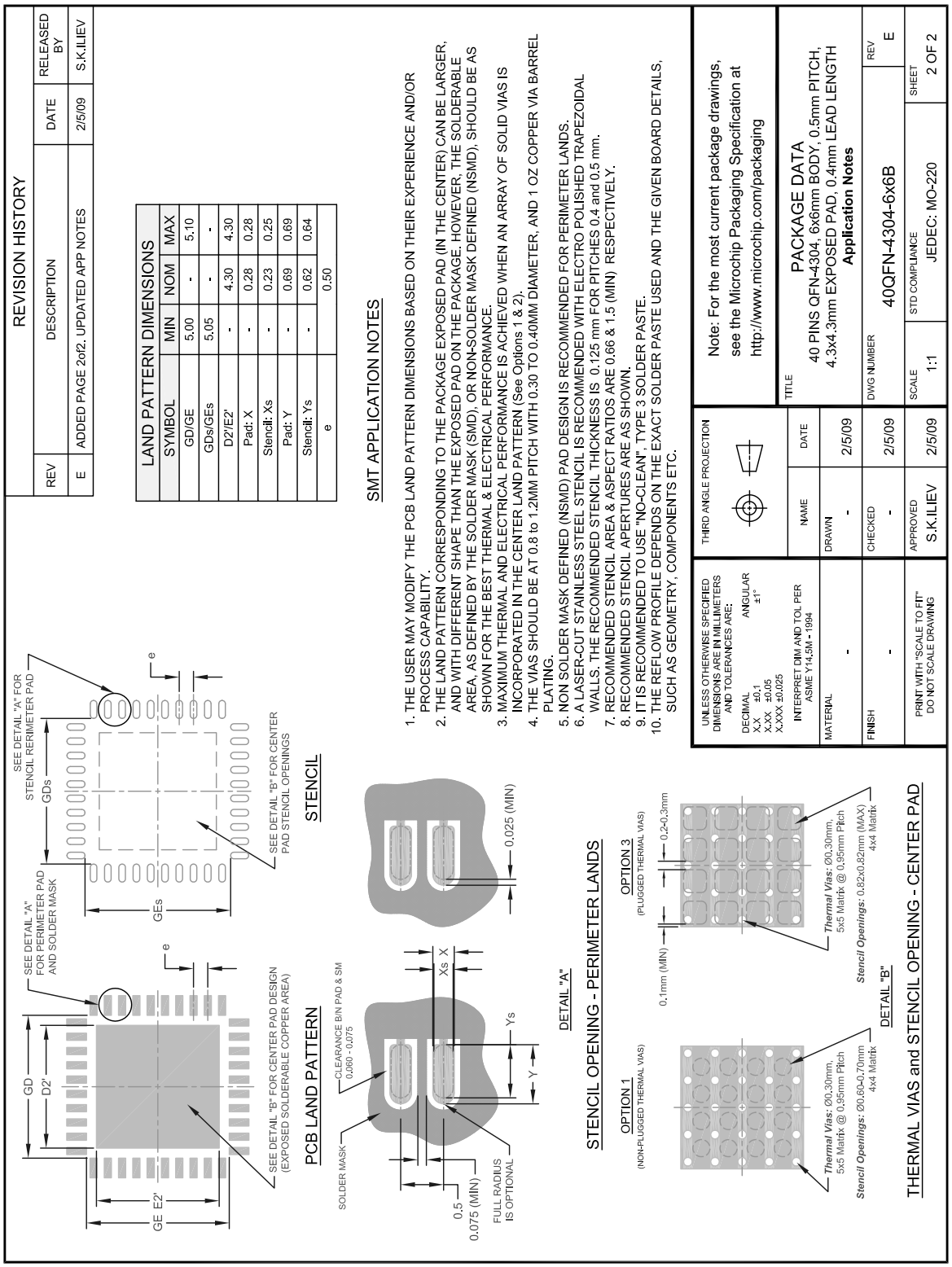


FIGURE 5-1: PACKAGE OUTLINE: 40-PIN QFN BODY 6X6 MM BODY (CONTINUED)



APPENDIX A: DATA SHEET REVISION HISTORY

TABLE A-1: REVISION HISTORY

Revision Level & Date	Section/Figure/Entry	Correction
DS00002624A (01-15-18)	Public Release, REV A replaces previous SMSC version Rev. 1.6 (02-21-11)	

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PART NO. [1]	[X]	-	XXX [2]	-	[X] [3]
Device	Temperature Range		Package		Tape and Reel Option

Device:	ECE1099 [1]	
Temperature Range:	Blank =	Commercial 0°C to 70°C
	X =	Extended 0°C to 85°C
Package:	FZG =	40 pin QFN [2]
Tape and Reel Option:	Blank =	Tray packaging
	TR =	Tape and Reel [3]

Examples:

a) ECE1099-FZG = 40-pin QFN, Commercial

b) ECE1099X-FZG = 40-pin QFN, Extended

Note 1: These products meet the halogen maximum concentration values per IEC61249-2-21.

Note 2: All package options are RoHS compliant. For RoHS compliance and environmental information, please visit http://www.microchip.com/pagehandler/en-us/aboutus/ehs.html .

Note 3: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

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