MAX7365

1MHz I2C-Interfaced 8 x 7 Key-Switch Controller with GPIO Ports

General Description

The MAX7365 is an I²C-interfaced peripheral that provides microprocessors with management of up to 56 key switches.

Key codes generated for each keypress and release enable easier implementation of multiple key entries. Key inputs monitored statically, not dynamically, ensure low-EMI operation. The switches can be metallic or resistive (carbon) with up to 5kΩ of resistance.

The device features autosleep and autowake to further minimize the power consumption of the device. The autosleep feature puts the device in a low-power state (1µA typ) after a programmable sleep timeout period. The autowake feature configures the device to return to normal operating mode from sleep upon a keypress.

The key controller debounces and maintains a FIFO of keypress and release events (including autorepeat, if enabled). An interrupt ($\overline{INT}$) output can be configured to alert keypresses either as they occur or at the maximum rate.

Unused key switches can be used as GPI. In addition, there are five additional general-purpose input/output (GPIO) ports. GPOs can be programmed as push-pull or open-drain to high- or low-side output drivers. When programmed as open drain, an optional on-chip 100kΩ pullup/pulldown resister can be enabled.

The device is available in a small (2mm x 2mm) 25-bump wafer-level package (WLP) for cell phones, pocket PCs, and other portable consumer electronic applications. The device operates over the -40°C to +85°C extended temperature range.

Applications

Netbooks

Cell Phones

PDAs

Handheld Games

Portable Consumer Electronics

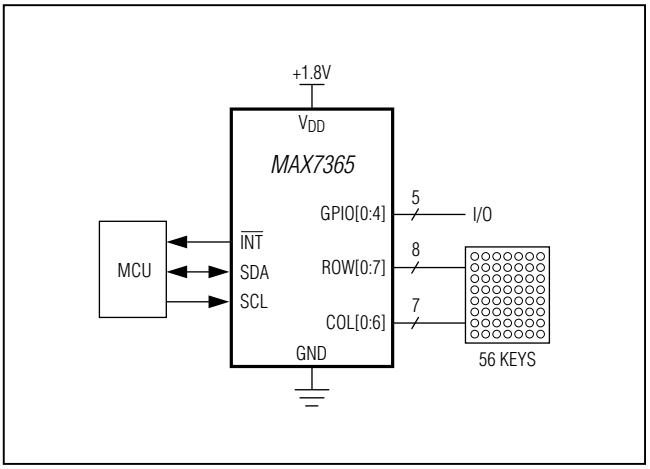
***Ordering Information* appears at end of data sheet.**

For related parts and recommended products to use with this part, refer to **www.maximintegrated.com/MAX7365.related**.

Benefits and Features

- **Reduce Processor Load**
  - **Monitor Up to 56 Keys**
  - **FIFO Queues Up to 16 Debounced Key Events**
  - **Hardware Interrupt at the FIFO Level or at the End-of-Definable Time Period**
- **Increased Battery Life**
  - **Autosleep and Autowake Minimize Current Consumption**
  - **Less Than 1µA Sleep Current**
- **Save Board Space**
  - **Small (2mm x 2mm) and Low-Profile 25-Bump WLP**
- **Flexible Design Requirements**
  - **1.62V to 3.6V Operation**
  - **Proprietary Ghost-Key Detection and Removal**
  - **Key Debounce Time User Configurable from 1ms to 31ms**
  - **Low-EMI Design Uses Static Matrix Monitoring**
  - **Five Additional GPIO Ports**
  - **All Key Switches Can Be Used as GPIs**
  - **1Mbps, 5.5V Tolerant, Two-Wire Serial Interface**
  - **Selectable Two-Wire, Serial-Bus Timeout**

Typical Operating Circuit



For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim's website at www.maximintegrated.com.

19-6036; Rev 0; 9/11

ABSOLUTE MAXIMUM RATINGS

V_{DD} to GND ..... -0.3V to 4.0V
ROW7–ROW0, COL6–COL0, GPIO4–GPIO0 to GND ..... -0.3V to (V_{DD} + 0.3V)
SDA, SCL, $\overline{INT}$ to GND ..... -0.3V to 6V
DC Current on ROW7–ROW0, COL6–COL0 to GND 1mA
DC Current on GPIO4–GPIO0 to GND 12mA
GND Current 12mA

Continuous Power Dissipation (T_A = +70°C)
WLP (derate 19.2mW/°C above +70°C) 1536mW
Operating Temperature Range ..... -40°C to +85°C
Junction Temperature ..... +150°C
Storage Temperature Range ..... -65°C to +150°C
Soldering Temperature (reflow) ..... +260°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

PACKAGE THERMAL CHARACTERISTICS (Note 1)

Junction-to-Ambient Thermal Resistance (θ_{JA}) ..... 52°C/W

Note 1: Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to **www.maximintegrated.com/thermal-tutorial**.

ELECTRICAL CHARACTERISTICS

(V_{DD} = 1.62V to 3.6V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{DD} = 3.3V, T_A = +25°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating Supply Voltage	V_{DD}		1.62	3.3	3.6	V
Operating Supply Current	I_{DD}	N keys pressed; GPI static		34 + (25 x N)		µA
		All 56 key switches open		60	85	µA
Sleep-Mode Supply Current	I_{SL}			0.8	5	µA
Key-Switch Source Current	I_{KEY}			20	36	µA
Key-Switch Source Voltage	V_{KEY}			0.42	0.55	V
Key-Switch Resistance	R_{KEY}	(Note 4)			5	kΩ
Startup Time from Shutdown	t_{START}			2	2.4	ms
Keyscan Frequency	f_{KEY}		51	64	82	kHz
Maximum Allowable Load Capacitance for Keyscan Function		N keys pressed simultaneously (Note 4)			500	pF
GPIO SPECIFICATIONS						
Input High Voltage GPIO_, ROW_, COL_, SDA, SCL	V_{IH}		0.7 x V_{DD}			V
Input Low Voltage GPIO_, ROW_, COL_, SDA, SCL	V_{IL}				0.3 x V_{DD}	V
Input Leakage Current GPIO_, ROW_, COL_, SDA, SCL	I_{IN}	Input voltage = V_{DD} or V_{GND}	-2		-2	µA
Output Logic Low Voltage $\overline{INT}$, SDA		I_{SINK} = 6mA			0.5	V
Output Low Voltage GPIO_	V_{OL}	V_{DD} = 1.8V and I_{SINK} = 5mA		40	100	V
		V_{DD} = 1.8V and I_{SINK} = 10mA		80	200	

ELECTRICAL CHARACTERISTICS (continued)

(V_{DD} = 1.62V to 3.6V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{DD} = 3.3V, T_A = +25°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Output High Voltage GPIO_	V_{OH}	V_{DD} = 1.8V and I_{SOURCE} = 5mA	V_{DD} - 0.1	V_{DD} - 0.05		V
		V_{DD} = 1.8V and I_{SOURCE} = 10mA	V_{DD} - 0.2	V_{DD} - 0.1		
I²C TIMING SPECIFICATIONS						
Input Capacitance SCL, SDA	C_{IN}	(Notes 3, 4)			10	pF
SCL Serial-Clock Frequency	f_{SCL}	Bus timeout enabled	0.05		1000	kHz
		Bus timeout disabled	0		1000	
Bus Free Time Between a STOP and START Condition	t_{BUF}		0.5			µs
Hold Time (Repeated) START Condition	$t_{HD, STA}$		0.26			µs
Repeated START Condition Setup Time	$t_{SU, STA}$		0.26			µs
STOP Condition Setup Time	$t_{SU, STO}$		0.26			µs
Data Hold Time	$t_{HD, DAT}$	(Note 5)			0.9	µs
Data Setup Time	$t_{SU, DAT}$		50			ns
SCL Clock Low Period	t_{LOW}		0.5			µs
SCL Clock High Period	t_{HIGH}		0.26			µs
Rise Time of Both SDA and SCL Signals, Receiving	t_R	(Notes 4, 6)			120	ns
Fall Time of Both SDA and SCL Signals, Receiving	t_F	(Notes 4, 6)			120	ns
Fall Time of SDA Signal, Transmitting	$t_{F, TX}$	(Notes 4, 7)	20 + 0.1C_B		120	ns
Pulse Width of Spike Suppressed	t_{SP}	(Notes 4, 8)			50	ns
Capacitive Load for Each Bus Line	C_B	(Notes 3, 4)			550	pF
Bus Timeout	$t_{TIMEOUT}$		20		40	ms

Note 2: All parameters are tested at T_A = +25°C. Specifications over temperature are guaranteed by design.

Note 3: All digital inputs at V_{DD} or V_{GND}.

Note 4: Guaranteed by design.

Note 5: A master device must provide a hold time of at least 300ns for the SDA signal (referred to V_{IL} of the SCL signal) to bridge the undefined region of SCL's falling edge.

Note 6: C_B = total capacitance of one bus line in pF. t_R and t_F measured between 0.8V and 2.1V.

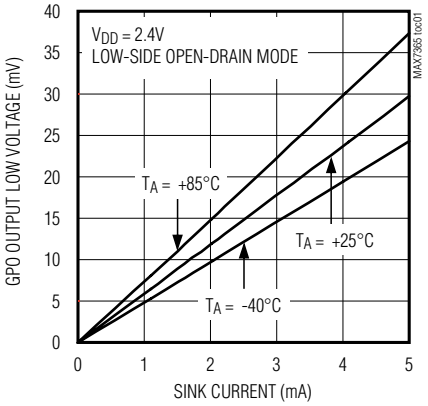
Note 7: I_{SINK} = 6mA. C_B = total capacitance of one bus line in pF. t_R and t_F measured between 0.8V and 2.1V.

Note 8: Input filters on the SDA and SCL inputs suppress noise spikes less than 50ns.

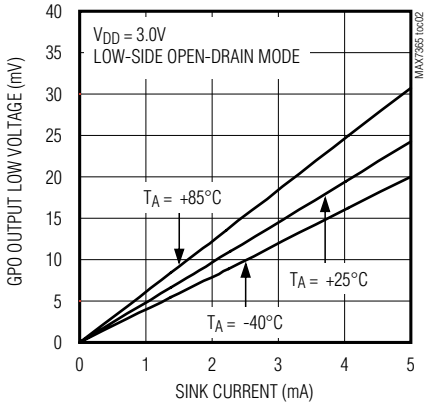
Typical Operating Characteristics

(V_{DD} = +2.5V, T_A = +25°C, unless otherwise noted.)

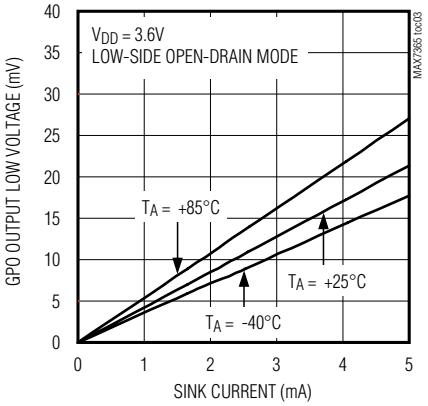
GPO OUTPUT LOW VOLTAGE vs. SINK CURRENT (GPIO4–GPIO0)



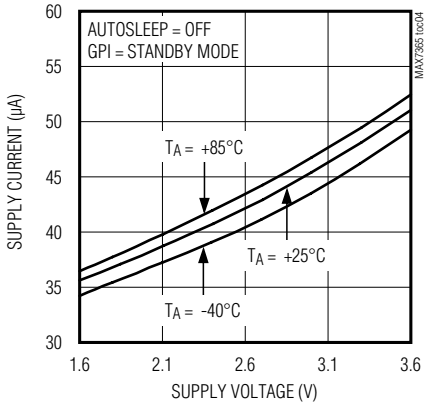
GPO OUTPUT LOW VOLTAGE vs. SINK CURRENT (GPIO4–GPIO0)



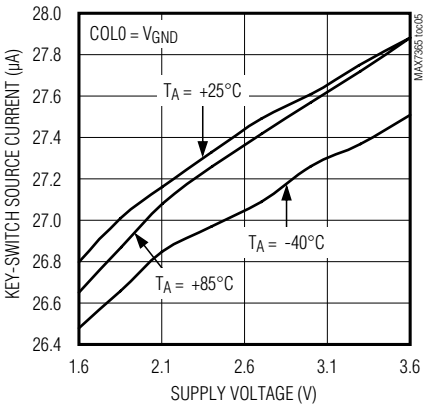
GPO OUTPUT LOW VOLTAGE vs. SINK CURRENT (GPIO4–GPIO0)



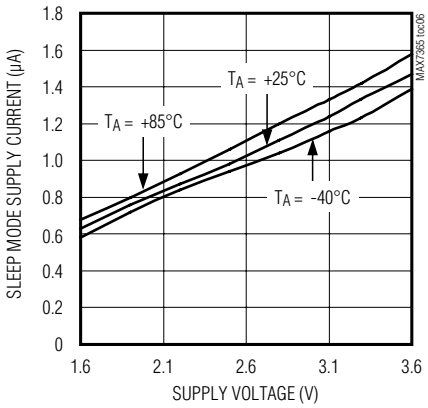
SUPPLY CURRENT vs. SUPPLY VOLTAGE



KEY-SWITCH SOURCE CURRENT vs. SUPPLY VOLTAGE

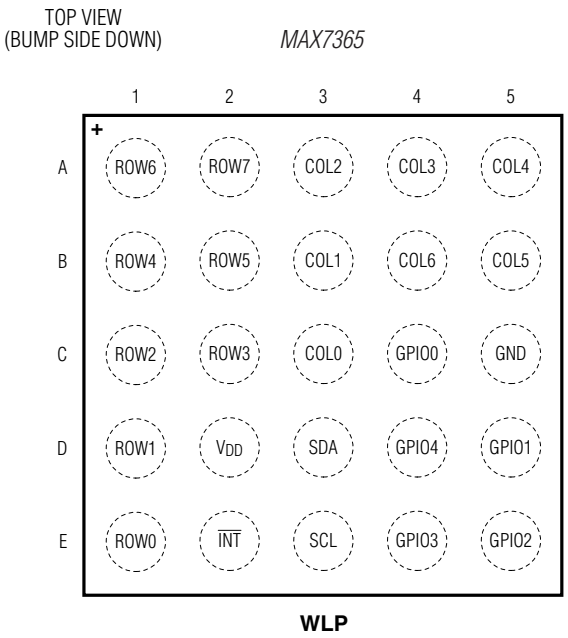


SLEEP MODE SUPPLY CURRENT vs. SUPPLY VOLTAGE



1MHz I2C-Interfaced 8 x 7 Key-Switch Controller with GPIO Ports

Pin Configuration



WLP

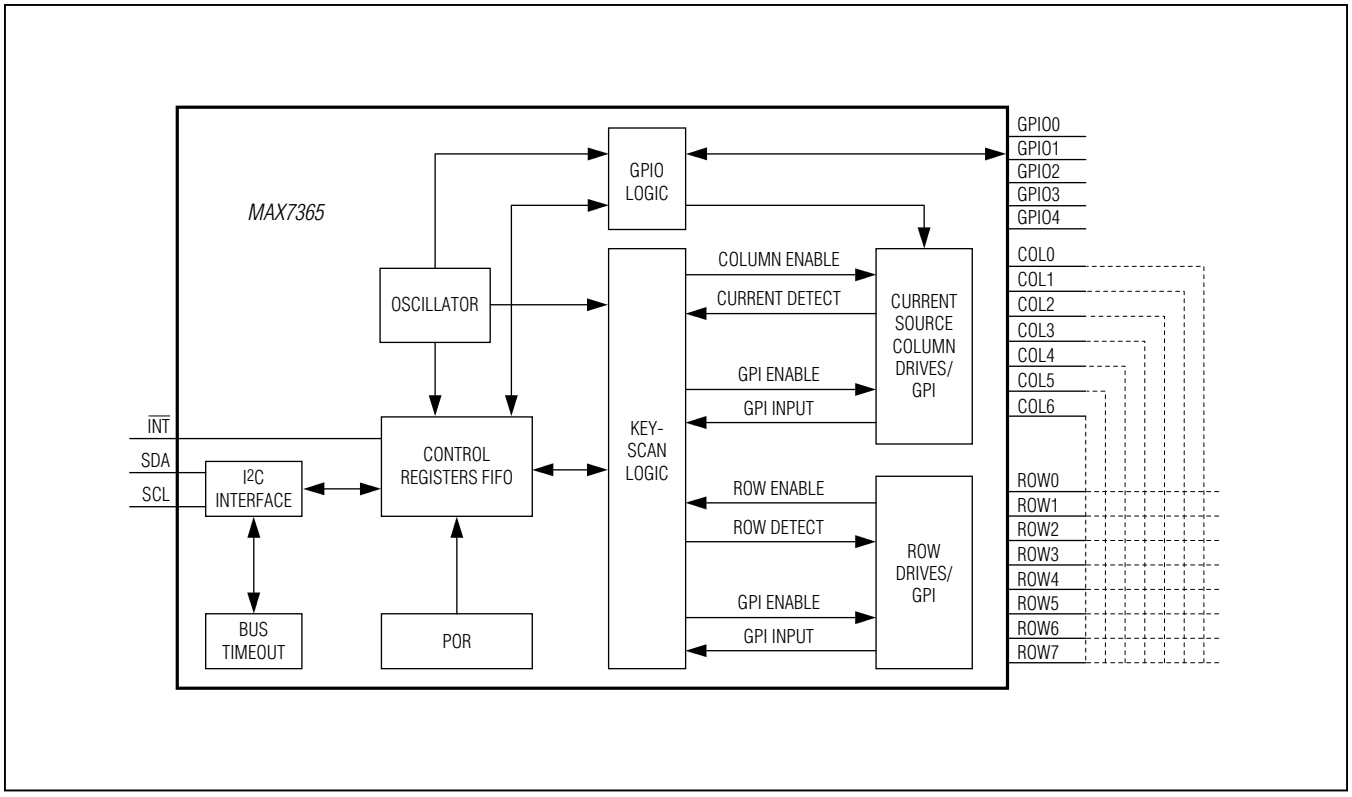
Pin Description

BUMP	NAME	FUNCTION
A1	ROW6	Row 6 Input from Key Matrix or General-Purpose Input
A2	ROW7	Row 7 Input from Key Matrix or General-Purpose Input
A3	COL2	Column 2 Input from Key Matrix or General-Purpose Input
A4	COL3	Column 3 Input from Key Matrix or General-Purpose Input
A5	COL4	Column 4 Input from Key Matrix or General-Purpose Input
B1	ROW4	Row 4 Input from Key Matrix or General-Purpose Input
B2	ROW5	Row 5 Input from Key Matrix or General-Purpose Input
B3	COL1	Column 1 Input from Key Matrix or General-Purpose Input
B4	COL6	Column 6 Input from Key Matrix or General-Purpose Input
B5	COL5	Column 5 Input from Key Matrix or General-Purpose Input
C1	ROW2	Row 2 Input from Key Matrix or General-Purpose Input
C2	ROW3	Row 3 Input from Key Matrix or General-Purpose Input
C3	COL0	Column 0 Input from Key Matrix or General-Purpose Input
C4	GPIO0	General-Purpose Input/Output Port 0

Pin Description (continued)

BUMP	NAME	FUNCTION
C5	GND	Ground
D1	ROW1	Row 1 Input from Key Matrix or General-Purpose Input
D2	V_{DD}	Positive Supply Voltage. Bypass to GND with a 0.1µF capacitor as close as possible to the device.
D3	SDA	I²C-Compatible Serial-Data Input/Output
D4	GPIO4	General-Purpose Input/Output Port 4
D5	GPIO1	General-Purpose Input/Output Port 1
E1	ROW0	Row 0 Input from Key Matrix or General-Purpose Input
E2	$\overline{INT}$	Active-Low Key-Switch Interrupt Output. $\overline{INT}$ is open drain and requires a pullup resistor.
E3	SCL	I²C-Compatible Serial-Clock Input
E4	GPIO3	General-Purpose Input/Output Port 3
E5	GPIO2	General-Purpose Input/Output Port 2

Functional Diagram



Detailed Description

The MAX7365 is a microprocessor peripheral low-noise, key-switch controller that monitors up to 56 key switches with optional autorepeat. Key events are presented in a 16-byte FIFO. Key-switch functionality can be traded to provide up to 16 logic inputs. The device features an additional five GPIOs. Outputs configured as open drain feature an optional on-chip 100kΩ pullup/pulldown resistor.

The device features an automatic sleep mode and automatic wakeup that further reduce supply current consumption. The device can be configured to enter sleep mode after a programmable time following a key event. The FIFO content is maintained during sleep mode and can be read in sleep mode. When a key is held down, the device cannot enter autosleep. The autowake feature takes the device out of sleep mode following a keypress event. Autosleep and autowake can be disabled.

Interrupt requests can be configured to be issued on a programmable number of FIFO entries or can be set to a period of time to prevent overloading the microprocessor with too many interrupts. The key-switch status can be checked at any time by reading the key-switch FIFO. A 1-byte read access returns both the next key-event in the FIFO, if there is one, and the FIFO status. Interrupts are configurable per each input port with edge detection.

Register Description

On power-up, all control registers are set to power-up values (Table 1), and the device is in sleep mode.

Table 1. Register Address Map and Power-Up Condition

ADDRESS CODE (hex)	READ/ WRITE	POWER-UP VALUE (hex)	REGISTER FUNCTION	DESCRIPTION
0x00	Read only	0x3F	Keys FIFO	Read FIFO keyscan data out
0x01	R/$\overline{W}$	0x0B	Configuration	Power-down, interrupt clearing mode, key-release enable, autowake, and I²C timeout enable
0x02	R/$\overline{W}$	0xFF	Key-Switch Debounce	Key debounce time setting
0x03	R/$\overline{W}$	0x00	Key-Switch Interrupt	Key-switch interrupt and $\overline{INT}$ frequency setting
0x05	R/$\overline{W}$	0x00	Key-Switch Autorepeat	Delay and frequency for key repeat
0x06	R/$\overline{W}$	0x07	Autosleep	Idle time to autosleep
0x30	R/$\overline{W}$	0xF7	Key-Switch Array Size	Keyscan switch array size
0x31	R/$\overline{W}$	0x00	GPIO Direction	Select GPIO port as input mode or output mode
0x32	R/$\overline{W}$	0x00	GPO Output Mode	GPO open-drain/push-pull output setting for GPIO port
0x33	Read only	0xFF	GPIs LSB Value	GPI[7:0] (ROW0, COL[6:0]) port input values
0x34	Read only	0x7F	GPIs MSB Value	GPI[14:8] (ROW[7:1]) port input values
0x35	R/$\overline{W}$	0x1F	GPIO Value	Debounced input or output values for GPIO port
0x36	R/$\overline{W}$	0x1F	GPIs Interrupt Mask	GPIO port interrupt mask for inputs
0x37	R/$\overline{W}$	0xFF	GPIs LSB Interrupt Mask	GPI[7:0] (ROW0, COL[6:0]) port interrupt mask for inputs
0x38	R/$\overline{W}$	0x7F	GPIs MSB Interrupt Mask	GPI[14:8] (ROW[7:1]) port interrupt mask for inputs
0x39	R/$\overline{W}$	0x00	GPIs Interrupt Trigger	GPIO edge-triggered interrupt setting
0x3A	R/$\overline{W}$	0x00	GPIs LSB Interrupt Trigger Mode	GPI[7:0] (ROW0, COL[6:0]) edge-triggered interrupt setting
0x3B	R/$\overline{W}$	0x00	GPIs MSB Interrupt Trigger Mode	GPI[14:8] (ROW[7:1]) edge-triggered interrupt setting
0x3C	R/$\overline{W}$	0x00	GPO High-Side Open-Drain Enable	GPIO port output mode high-side open-drain setting

Table 1. Register Address Map and Power-Up Condition (continued)

ADDRESS CODE (hex)	READ/ WRITE	POWER-UP VALUE (hex)	REGISTER FUNCTION	DESCRIPTION
0x3D	R/$\overline{W}$	0x00	GPO Pullup/Pulldown Resistor Enable	GPIO port open-drain output mode pullup/pulldown resistor setting
0x40	R/$\overline{W}$	0x00	GPIO Global Configuration	GPI autowake enable, I²C timeout interrupt enable, operating mode
0x42	R/$\overline{W}$	0x00	GPI Debounce Setting	GPIO port inputs debounce time setting
0x48	R/$\overline{W}$	0x00	I²C Timeout Flag	I²C timeout since last POR

Table 2. Key-Switch Mapping

PIN	COL0	COL1	COL2	COL3	COL4	COL5	COL6
ROW0	KEY 0	KEY 8	KEY 16	KEY 24	KEY 32	KEY 40	KEY 48
ROW1	KEY 1	KEY 9	KEY 17	KEY 25	KEY 33	KEY 41	KEY 49
ROW2	KEY 2	KEY 10	KEY 18	KEY 26	KEY 34	KEY 42	KEY 50
ROW3	KEY 3	KEY 11	KEY 19	KEY 27	KEY 35	KEY 43	KEY 51
ROW4	KEY 4	KEY 12	KEY 20	KEY 28	KEY 36	KEY 44	KEY 52
ROW5	KEY 5	KEY 13	KEY 21	KEY 29	KEY 37	KEY 45	KEY 53
ROW6	KEY 6	KEY 14	KEY 22	KEY 30	KEY 38	KEY 46	KEY 54
ROW7	KEY 7	KEY 15	KEY 23	KEY 31	KEY 39	KEY 47	KEY 55

Keyscan Controller

Key inputs are scanned statically, not dynamically, to ensure low-EMI operation. Since inputs only toggle in response to switch changes, the key matrix can be routed closer to sensitive circuit nodes.

The keyscan controller debounces and maintains a FIFO buffer of keypress and release events (including auto-repeated keypresses, if autorepeat is enabled). Table 2 shows the key-switch order. The user-programmable key-switch debounce time and autosleep timer are derived from the clock, which in turn is derived from the internal oscillator. Time delay for autorepeat and key-switch interrupt is based on the key-switch debounce time. There is no limitation for the number of keys pressed simultaneously as long as no ghost keys are generated. If the application requires fewer keys to be scanned, the unused key-switch ports can be configured as GPIs.

Keys FIFO Register (0x00)

The Keys FIFO register contains the information pertaining to the status of the keys FIFO, as well as the key events that have been debounced (Table 6). Bits D[5:0] denote which of the 56 keys have been debounced, and the keys are numbered as shown in Table 2.

Special codes are key repeat (0x1E/0x3E), FIFO empty (0x3F), and FIFO overflow (0x7F). Bit D7 indicates if there is more data in the FIFO, except when a special key code occurs. D6 indicates if a keypress or release event has occurred.

Reading the keyscan FIFO clears the interrupt ($\overline{INT}$), depending on the setting of bit D5 in the configuration register (0x01).

Configuration Register (0x01)

The Configuration register controls the I²C bus timeout feature, enables the key-release indicator, enables autowake, and determines how $\overline{INT}$ is deasserted. Write to bit D7 to put the device into sleep or operating mode. Autosleep and autowake, when enabled, also change the status of D7 (Table 7).

Key-Switch Debounce Register (0x02)

The Key-Switch Debounce register sets the keypress and key-release time for each debounce cycle. Bits D[3:0] set the debounce time for keypresses, while bits D[7:4] set the debounce time for key releases. Both debounce times are configured in increments of 2ms starting at 1ms and ending at 31ms (Table 8).

Key-Switch Interrupt Register (0x03)

The Key-Switch Interrupt register contains information related to the settings of the interrupt request function, as well as the status of the $\overline{INT}$ output. If bits D[7:0] are set to 0x00, $\overline{INT}$ is disabled. There are two types of interrupts, the FIFO-based interrupt and the time-based interrupt. Set bits D[4:0] to assert interrupts at the end of the selected number of debounce cycles following a key event (Table 9). This number ranges from 1–31 debounce cycles. Setting bits D[7:5] sets the FIFO-based interrupt when there are 2–14 key events stored in the FIFO. Both interrupts can be configured simultaneously, and $\overline{INT}$ asserts depending on which condition is met first. $\overline{INT}$ deasserts depending on the status of bit D5 in the Configuration register.

Key-Switch Autorepeat Register (0x05)

The device's autorepeat feature notifies the host that at least one key has been pressed for a continuous period. The Autorepeat register enables or disables this feature, sets the time delay after the last key event before the key repeat code (0x7E) is entered into the FIFO, and sets the frequency at which the key-repeat code is entered into the FIFO thereafter. The autorepeat code continues to be entered in the FIFO at the frequency set by bits D[3:0] until another key event is recorded. The key being pressed is not entered again into the FIFO. Following the key-release event, if any keys are still pressed, the device restarts the autorepeat sequence. Bit D7 specifies whether the autorepeat function is enabled with 0 denoting autorepeat disabled, and 1 denoting autorepeat enabled. Bits D[3:0] specify the autorepeat delay in terms of debounce cycles, ranging from 8–128 debounce cycles (Table 10). Bits D[6:4] specify the autorepeat rate or frequency ranging from 4–32 debounce cycles.

Autosleep Register (0x06)

Autosleep puts the device in sleep mode to draw minimal current. When enabled, the device enters sleep mode if no keys are pressed for the autoshutdown time (Table 11).

Key-Switch Array Size Register (0x30)

Bits D[7:4] set the row size of the key-switch array, and bits D[3:0] set the column size of the key-switch array (see Table 12). Set the bits to 0 if no key switches are used. The key-switch array should be connected beginning at ROW0 and COL0. If not used as a key-switch-matrix pin, the pin can function as a GPI port, if enabled.

Key-Switch Autosleep Mode

In sleep mode, the device draws minimal current. Switch-matrix current sources are turned off and become high. When autosleep is enabled, key-switch inactivity for a period longer than the autosleep time puts the part into sleep mode (FIFO data is maintained). Writing a 1 to D7 in the Configuration register (0x01) or a keypress can take the device out of sleep mode. Bit D7 in the Configuration register gives the sleep-mode status and can be read at any time.

To place the device in sleep mode, clear bit D7 in the Configuration register. The device is in sleep mode after power-on reset (POR). In sleep mode, the keyscan controller is disabled and the device draws minimal current. No additional supply current is drawn if no keys are pressed. All switch-matrix current sources are turned off, and the row outputs (ROW7–ROW0) are low and the column outputs (COL6–COL0) become high.

To take the device out of sleep mode and into operating mode, cause a low-to-high transition in bit D7 by setting it to a 1 in the Configuration register. The keyscan controller FIFO buffers are cleared and key monitoring starts. Note that rewriting the Configuration register bit D7 to a 1, when bit D7 is already a 1, does not clear the FIFOs. The FIFOs are only cleared when the device is changing state from shutdown to operating mode.

In sleep mode, the internal oscillator is disabled and the I²C timeout features are disabled.

Key-Switch Autowake

Keypresses initiate autowake and the device goes into operating mode. Keypresses that autowake the device are not lost. When a key is pressed while the device is in sleep mode, all analog circuitry, including switch-matrix current sources, turn on in 2ms. The initial key needs to be pressed for 2ms plus the debounce time to be stored in the FIFO. Write a 0 to bit D1 in the Configuration register (0x01) to disable autowake.

FIFO Overflow

The FIFO overflow status occurs when the FIFO is full (16 bytes) and additional events occur. If key release is disabled, then the FIFO overflow status occurs when the FIFO is full and not upon additional key events. When the FIFO is overflowed, the first byte read from the FIFO buffer is the overflow byte (0x7F). The order of the original 16 bytes of event data is preserved, but further events could be lost. When the FIFO is full, if the 18th key event is a key release, then the FIFO overflow status is removed.

GPIO Ports

The device has five GPIO ports. The ports can be used as logic inputs or logic outputs. Each GPIO port features pullup/pulldown resistors when configured as open-drain outputs. Also, the port is configurable with a high-side open-drain output.

The COLs (GPI[6:0]) and ROWs (GPI[14:7]) are also configurable as GPIs when not used for the key-switch matrix. When the device is configured with C columns and R rows for the key-switch matrix, assuming N is the larger number between R and C, then COL[6:N+1] and ROW[7:N+1] are configured as GPI ports. As an example, for a 4 x 4 matrix, COL6/COL5 and ROW7, ROW6, and ROW5 are configured as GPIs, as shown in Table 3. Unused GPIs and pins configured neither as key-switch nor GPI should be connected to GND. Table 4, configured as a 3 x 4 matrix, shows ROW4 and ROW3 connected to GND, since they cannot be configured as GPI.

GPIO Direction Register (0x31)

This register configures the pins as an input or an output port. GPIO Direction register bits D[4:0] correspond with GPIO4–GPIO0 (Table 13). Set the corresponding bit to 0 to configure it as an input and 1 to configure it as an output.

When the port is initially programmed as an input, there is a delay of one debounce period prior to detecting a transition on the input port. This is to prevent a false interrupt from occurring when changing a port from an output to an input.

GPO Output Mode Register (0x32)

This register configures the pin as an open-drain or push-pull output. GPO Output Mode register bits D[4:0] correspond with GPIO4–GPIO0 (Table 14). Set the corresponding bit to 0 to configure the output mode as open drain and 1 to configure the output mode as push-pull.

GPIs LSB, MSB Port Value Registers (0x33, 0x34) (Read Only)

The GPIs LSB and MSB Port Value registers contain the debounced input data for all the GPIOs for GPI[7:0] and GPI[14:8], respectively (Table 15 and Table 16). There is one debounce period delay prior to detecting a transition on the input port. This prevents a false interrupt from occurring when changing a port from an output to an input. These registers report the state of all input ports, regardless of any interrupt mask settings.

Table 3. 4 x 4 Keyboard Matrix Configuration with GPI

ROWS	COLUMNS						
	0	1	2	3	4	5	6
0	4 x 4 keyboard matrix				GND	GPI	GPI
1							
2							
3							
4	GND				—	—	—
5	GPI				—	—	—
6	GPI				—	—	—
7	GPI				—	—	—

Table 4. 3 x 4 Keyboard Matrix Configuration with GPI

ROWS	COLUMNS						
	0	1	2	3	4	5	6
0	3 x 4 keyboard matrix				GND	GPI	GPI
1							
2							
3	GND				—	—	—
4	GND				—	—	—
5	GPI				—	—	—
6	GPI				—	—	—
7	GPI				—	—	—

GPIO Value Register (0x35)

The GPIO Value register consists of a read and write mode for the GPIO4–GPIO0 pins (Table 17). When read, this register reports the debounced input values for ports configured as a GPI. There is one debounce period delay prior to detecting a transition on the input port. This prevents a false interrupt from occurring when changing a port from an output to an input. This register reports the state of all input ports, regardless of any interrupt mask settings.

When written, this register sets the output as logic-low when written logic 0, or as logic-high when written logic 1 for ports configured as GPO.

GPIs, LSB, MSB Interrupt Mask Registers (0x36, 0x37, 0x38)

The GPIs, LSB, and MSB Interrupt Mask registers control which ports trigger an interrupt (Table 18 for GPIO4–GPIO0, Table 19 for GPI[7:0], and Table 20 for GPI[14:8]). Set the bit to logic 0 to enable the interrupt. Set the bit to logic 1 to mask the interrupt.

If the port that generated the interrupt is not masked, then the interrupt causes the $\overline{INT}$ signal to assert. A read of the port value registers (0x33 to 0x35) is required to deassert the $\overline{INT}$ pin. Note that transitions that occur while $\overline{INT}$ is asserted, but before the read of the port value registers, set the appropriate bit of the port value registers only, but have no affect on the $\overline{INT}$ pin as it is already asserted.

However, transitions that occur when the I²C is active cannot be latched into the port values registers until after the read has taken place. If there are transitions that cause the $\overline{INT}$ signal to assert during the time of an I²C read, they cause the $\overline{INT}$ signal to reassert once the read transaction has taken place. Note that the interrupt configurations only apply when a port is configured as an input.

GPIs, LSB, MSB Interrupt Trigger Registers (0x39, 0x3A, 0x3B)

The GPIs, LSB, and MSB Interrupt Trigger registers control how an interrupt is triggered (Table 21 for GPIO4–GPIO0, Table 22 for GPI[7:0], and Table 23 for GPI[14:8]). Set the bit to logic 0 for rising edge-triggered interrupts. Set the bit to logic 1 for both rising and falling edge-trigged interrupts.

GPO High-Side Open-Drain Enable Register (0x3C)

This register allows for high-side open-drain mode for GPIO4–GPIO0 (see Table 24). Set the bit to logic 0 for low-side open-drain mode. Set the bit to logic 1 to enable high-side open-drain mode.

GPO Pullup/Pulldown Resister Enable Register (0x3D)

This register enables the GPO 100kΩ pullup resistor in low-side open-drain mode or pulldown resistor in high-side open-drain mode for GPIO4–GPIO0 (Table 25). Set the bit to logic 0 to disable the internal pullup. Set the bit to logic 1 to enable the internal pullup.

GPIO Global Configuration Register (0x40)

The GPIO Global Configuration register controls the main settings for the GPIO ports (Table 26). Bit D5 enables interrupt generation for I²C timeouts. Bit D4 is the enable bit for the GPIs. Set bit D4 to logic 1 for normal GPIO operation for GPIO_, and ROW_ and COL_ configured as GPIs. GPIO_ configured as GPOs are automatically enabled.

GPI Debounce Setting Register (0x42)

The GPI Debounce Setting register sets the amount of time an input must be held in order for the device to register a logic transition (Table 27). The GPIO debounce setting is independent of the key-switch debounce setting. Bits D[4:0] set the 32 possible debounce times from 9ms up to 40ms.

I²C Timeout Flag Register (0x48) (Read Only)

The I²C Timeout Flag register contains a single bit (D0) that indicates if an I²C timeout has occurred (Table 28). Read this register to clear an I²C timeout-initiated interrupt.

Interrupts

Three possible sources generate $\overline{INT}$: key-switch FIFO level/debounce cycle settings, I²C timeout, and GPIOs configured as inputs (registers 0x01 or 0x40, 0x39–0x3A). Read the respective data/status registers for each type of interrupt to clear $\overline{INT}$. If multiple sources generate the interrupt, all the related status registers must be read to clear $\overline{INT}$.

Serial Interface

The device operates as a slave that sends and receives data through an I²C-compatible two-wire interface. The interface uses a serial-data line (SDA) and a serial-clock line (SCL) to achieve bidirectional communication between master(s) and slave(s). A master (typically a microcontroller) initiates all data transfers to and from the device and generates the SCL clock that synchronizes the data transfer. Figure 1 shows the two-wire serial interface timing details.

The device's SDA line operates as both an input and an open-drain output. A pullup resistor, typically 4.7kΩ, is required on SDA. The device's SCL line operates only as an input. A pullup resistor is required on SCL if there are multiple masters on the two-wire interface, or if the master in a single-master system has an open-drain SCL output.

Each transmission consists of a START (S) condition (Figure 2) sent by a master, followed by the device's 7-bit slave address plus R/$\overline{W}$ bit, a register address byte, one or more data bytes, and finally, a STOP (P) condition.

START and STOP Condition

Both SCL and SDA remain high when the interface is not busy. A master signals the beginning of a transmission with a START condition by transitioning SDA from high to low while SCL is high. When the master has finished communicating with the slave, it issues a STOP condition by transitioning SDA from low to high while SCL is high. The bus is then free for another transmission.

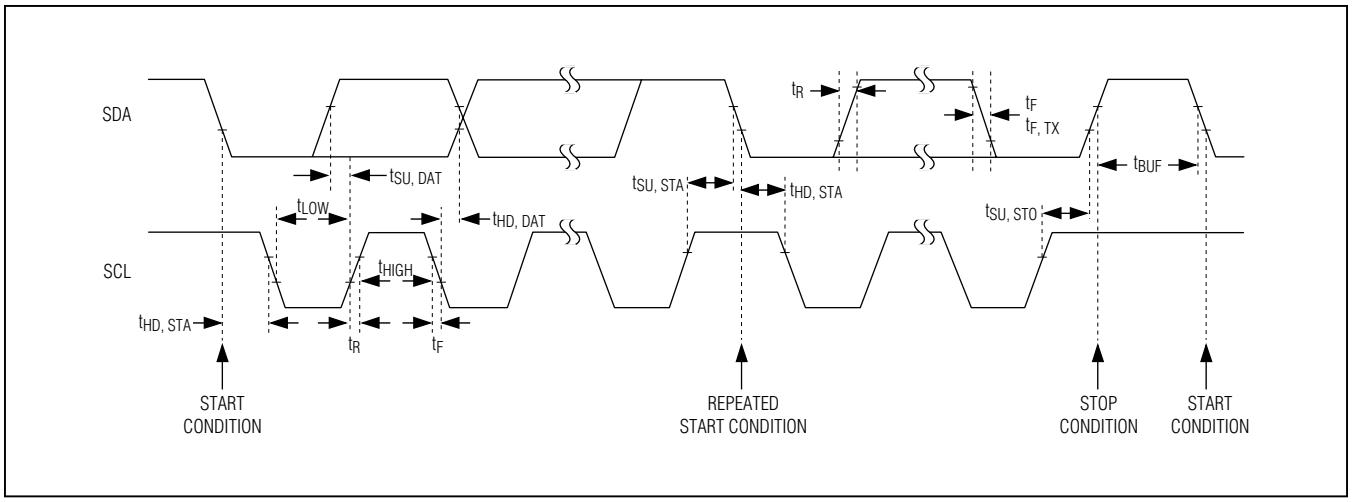


Figure 1. Two-Wire Serial Interface Timing Details

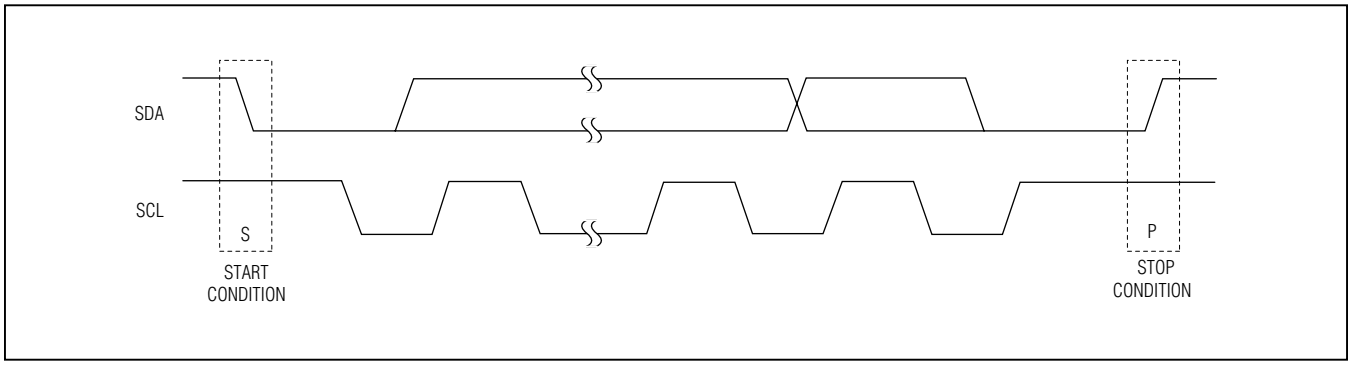


Figure 2. START and STOP Conditions

Bit Transfer

One data bit is transferred during each clock pulse (Figure 3). The data on SDA must remain stable while SCL is high.

Acknowledge

The acknowledge bit is a clocked 9th bit (Figure 4), which the recipient uses to handshake receipt of each byte of data. Thus, each byte transferred effectively requires 9 bits. The master generates the 9th clock pulse, and the recipient pulls down SDA during the acknowledge clock pulse; therefore, the SDA line is stable low during the high period of the clock pulse. When the master is transmitting to the device, the device generates the acknowledge bit because the device is the recipient. When the device is transmitting to the master, the master generates the acknowledge bit because the master is the recipient.

Slave Addresses

The device has a 7-bit long slave address of 0x70, 0x72, 0x74, or 0x76 as determined by the suffix of the complete part number. The bit following a 7-bit slave address is the R/$\overline{W}$ bit, which is low for a write command and high for a read command.

The device monitors the bus continuously waiting for a START condition, followed by its slave address. When the device recognizes its slave address, it acknowledges and is then ready for continued communication.

Bus Timeout

The device features a 20ms (min) bus timeout on the two-wire serial interface, largely to prevent the device from holding the SDA I/O low during a read transaction should the SCL lock up for any reason before a serial transaction is completed. Bus timeout operates by causing the device to internally terminate a serial transaction (either read or write) if the time between adjacent edges on SCL exceeds 20ms. After a bus timeout, the device waits for a valid START condition before responding to a consecutive transmission. This feature can be enabled or disabled under user control by writing to the Configuration register. In sleep mode, the internal oscillator is disabled, thus the bus timeout feature is not active.

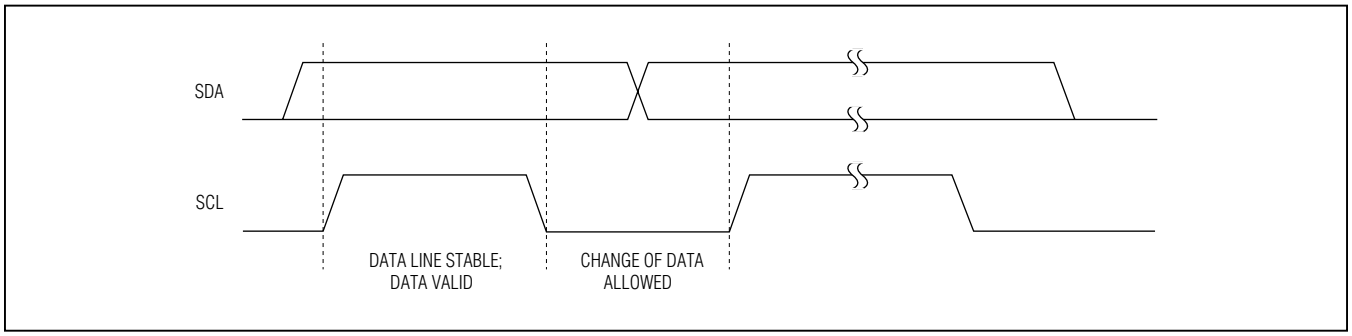


Figure 3. Bit Transfer

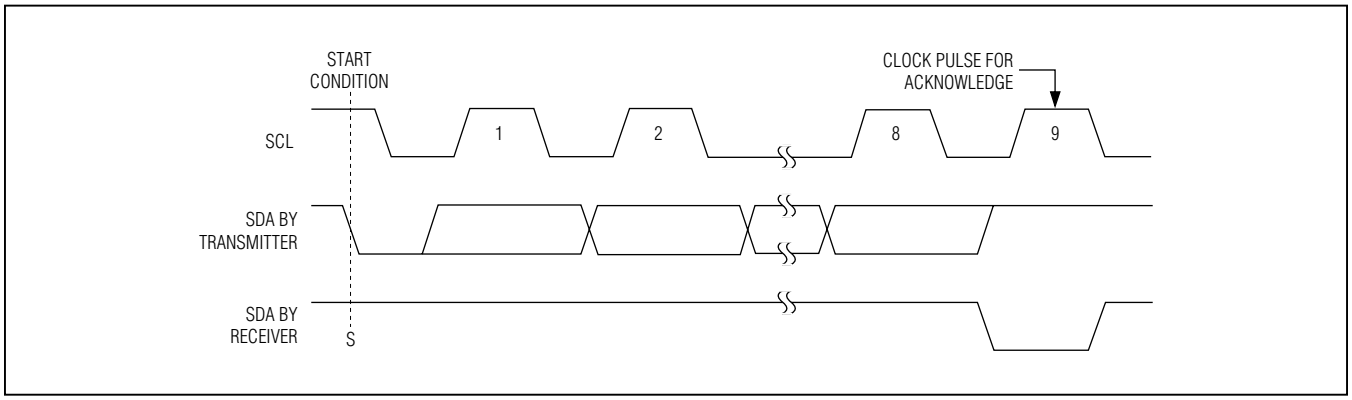


Figure 4. Acknowledge

Message Format for Writing the Keyscan Controller

A write to the device comprises the transmission of the slave address with the R/$\overline{W}$ bit set to zero, followed by at least 1 byte of information. The first byte of information is the command byte. The command byte determines which register of the device is to be written by the next byte, if received. If a STOP condition is detected after the command byte is received, the device takes no further action (Figure 5) beyond storing the command byte.

Any bytes received after the command byte are data bytes. The first data byte goes into the internal register of the device selected by the command byte (Figure 6).

If multiple data bytes are transmitted before a STOP condition is detected, these bytes are generally stored insubsequent internal registers of the device because the command-byte address generally autoincrements (Table 5).

Message Format for Reading the Keyscan Controller

The device is read using the internally stored command byte as an address pointer, the same way the stored command byte is used as an address pointer for a write. The pointer generally autoincrements after each data byte is read using the same rules as for a write (Table 5). Thus, a read is initiated by first configuring the device's command byte by performing a write (Figure 5). The master can now read N consecutive bytes from the device, with the first data byte being read from the register addressed by the initialized command byte. When performing read-after-write verification, remember to reset the command byte's address because the stored command byte address is generally autoincremented after the write (Figure 7, Table 5).

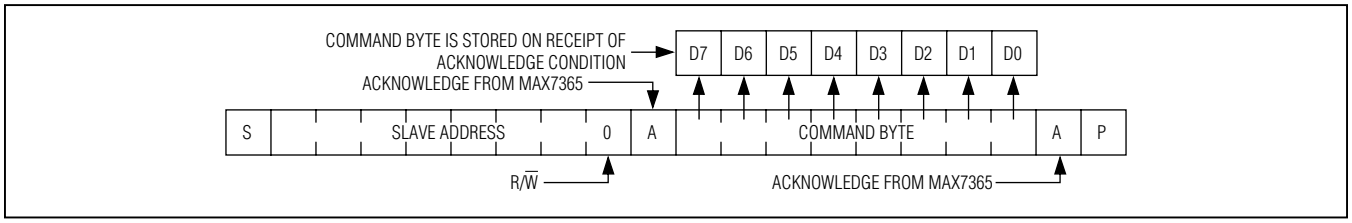


Figure 5. Command Byte Received

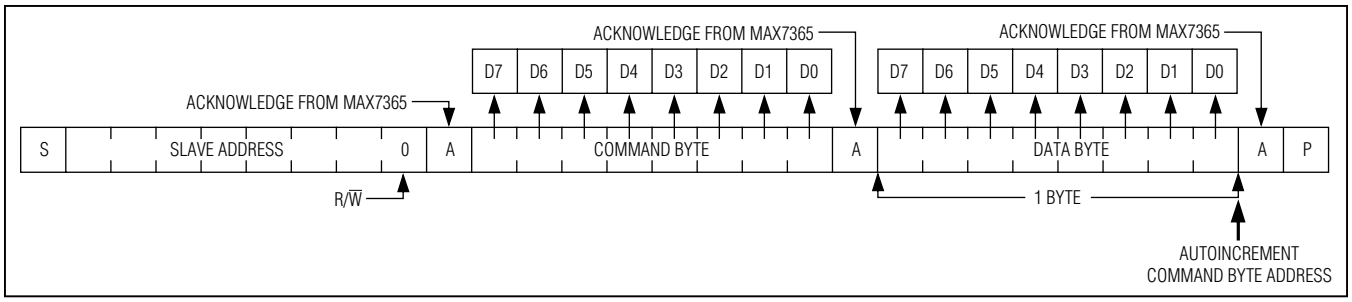


Figure 6. Command and Single Data Byte Received

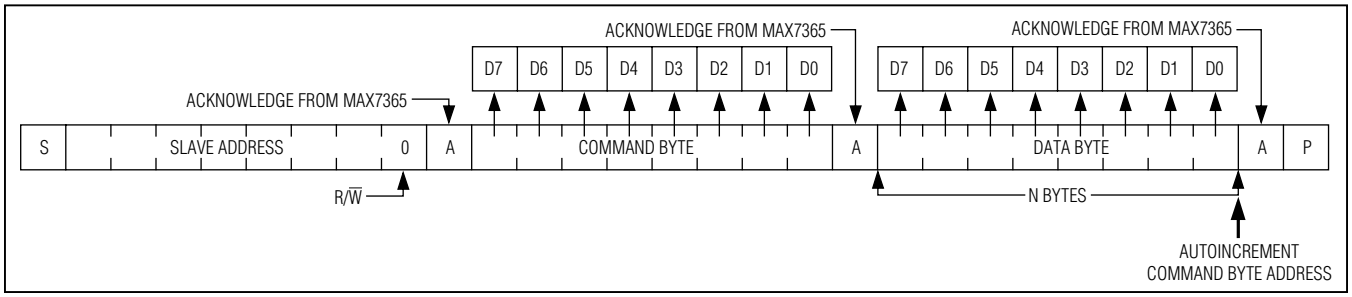


Figure 7. N Data Bytes Received

Operation with Multiple Masters

When the device is operated on a two-wire interface with multiple masters, a master reading the device uses a repeated START between the write that sets the device's address pointer and the read(s) that takes the data from the location(s). This is because it is possible for master 2 to take over the bus after master 1 has set up the device's address pointer, but before master 1 has read the data. If master 2 subsequently resets the device's address pointer, master 1's read can be from an unexpected location.

Command Address Autoincrementing

Address autoincrementing allows the device to be configured with fewer transmissions by minimizing the number of times the command address needs to be sent. The command address stored in the device generally increments after each data byte is written or read (Table 5). Autoincrement only functions when doing a multiburst read or write.

Applications Information

Reset from I²C

After a catastrophic event such as ESD discharge or microcontroller reset, use bit D7 of the Configuration register (0x01) as a software reset for the key switches. Use bit D4 of the GPIO Global Configuration register (0x40) as a software reset for the GPIOs.

Ghost-Key Elimination

Ghost keys are a phenomenon inherent with key-switch matrices. When three switches located at the corners of a matrix rectangle are pressed simultaneously, the switch that is located at the last corner of the rectangle (the ghost key) also appears to be pressed. This occurs because the potentials at the two sides of the ghost-key switch are identical due to the other three connections—the switch is electrically shorted by the combination of the other three switches (Figure 8). Because the key appears to be pressed electrically, it is impossible to detect which of the four keys is the ghost key.

The device employs a proprietary scheme that detects any three-key combination that generates a fourth ghost key, and does not report the third key that causes a ghost-key event. This means that although ghost keys are never reported, many combinations of three keys are effectively ignored when pressed at the same time. Applications requiring three-key combinations (such as <Ctrl><Alt><Del>) must ensure that the three keys are not wired in positions that define the vertices of a rectangle (Figure 9). There is no limit on the number of keys that can be pressed simultaneously, as long as the keys do not generate ghost-key events and the FIFO is not full.

Table 5. Autoincrement Rules

REGISTER FUNCTION	ADDRESS CODE (hex)	AUTOINCREMENT ADDRESS (hex)
Keys FIFO	0x00	0x00
Autosleep	0x06	0x00
All other key	0x01 to 0x05	Addr + 0x01
All other GPIOs	0x30 to 0x48	Addr + 0x01

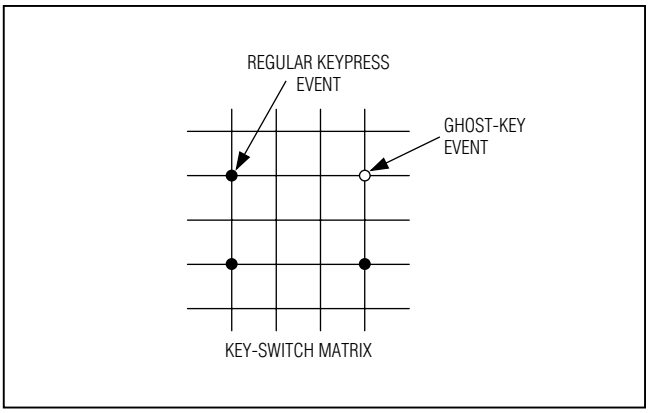


Figure 8. Ghost-Key Phenomenon

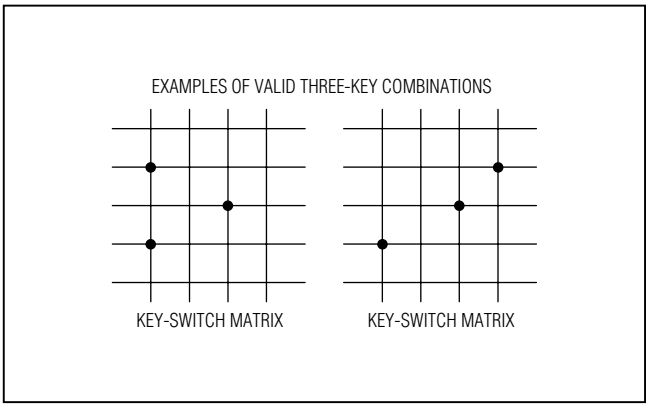


Figure 9. Valid Three-Key Combinations

Low-EMI Operation

The device uses two techniques to minimize EMI radiating from the key-switch wiring. First, the voltage across the switch matrix never exceeds 0.5V if not in sleep mode, independent of supply voltage V_{DD}. This reduces the voltage swing at any node when a switch is pressed to 0.5V (max). Second, the keys are not dynamically scanned, which would cause the key-switch wiring to continuously radiate interference. Instead, the keys are monitored for current draw (only occurs when pressed), and debounce circuitry only operates when one or more keys are actually pressed.

Switch On-Resistance

The device is designed to be insensitive to resistance, either in the key switches, or the switch routing to and from the appropriate COL_ and ROW_ up to 5kΩ (max). These controllers are therefore compatible with low-cost membrane and conductive carbon switches.

Hot Insertion

The $\overline{INT}$, SCL, and SDA remain high impedance with up to 3.6V asserted on them when the device powers down (V_{DD} = 0V). I/O ports remain high impedance with up to 4V asserted on them when not powered. The device can be used in hot-swap applications.

Power-Supply Considerations

The device operates with a 1.62V to 3.6V power-supply voltage. Bypass the power supply (V_{DD}) to GND with a 0.1µF or higher ceramic capacitor as close as possible to the device.

Register Tables

Table 6. Keys FIFO Register (0x00)

SPECIAL FUNCTION	KEYS FIFO REGISTER DATA							
	D7	D6	D5	D4	D3	D2	D1	D0
General bit description	FIFO not-empty flag	Key-release flag	Key number/Key event					
Key number indicated by D[5:0] is a keypress. Last data in the FIFO.	0	0	X	X	X	X	X	X
Key number indicated by D[5:0] is a keypress. More data in the FIFO.	1	0	X	X	X	X	X	X
Key number indicated by D[5:0] is a key release. Last data in the FIFO.	0	1	X	X	X	X	X	X
Key number indicated by D[5:0] is a key release. More data in the FIFO.	1	1	X	X	X	X	X	X
FIFO is empty.	0	0	1	1	1	1	1	1
FIFO is overflowed. Continued to read data in the FIFO.	0	1	1	1	1	1	1	1
Key repeat. Indicates the last data in the FIFO.	0	0	1	1	1	1	1	0
Key repeat. Indicates more data in the FIFO.	0	1	1	1	1	1	1	0

Table 7. Configuration Register (0x01)

REGISTER BIT	DESCRIPTION	VALUE	FUNCTION		DEFAULT VALUE
D7	Sleep	X (when 0x40 D4 = 1)	Key-switch operating mode. Key switches always remain active when GPI (bit 4 of register 0x40) is high, regardless of autosleep, autowake, or an I²C write to this bit.		0
		0 (when 0x40 D4 = 0)	Key-switch sleep mode. The entire chip is shut down.	I²C write, autosleep, and autowake can all change this bit. This bit can be read back by I²C any time for current status.	
		1 (when 0x40 D4 = 0)	Key-switch operating mode.		
D6	Reserved	0	—		0
D5	Interrupt	0	$\overline{INT}$ cleared when the FIFO is empty.		0
		1	$\overline{INT}$ cleared after host read. In this mode, I²C should read the FIFO until interrupt condition is removed or further $\overline{INT}$ could be lost.		
D4	Reserved	0	—		0
D3	Key-release enable	0	Disable key releases.		1
		1	Enable key releases.		
D2	Reserved	0	—		0
D1	Autowake enable	0	Disable keypress wakeup.		1
		1	Enable keypress wakeup.		
D0	Timeout disable	0	I²C timeout enabled.		1
		1	I²C timeout disabled.		

X = Don't care.

Table 8. Key-Switch Debounce Register (0x02)

REGISTER DESCRIPTION	REGISTER DATA							
	D7	D6	D5	D4	D3	D2	D1	D0
DEBOUNCE TIME (ms)	**RELEASE DEBOUNCE TIME**				**PRESS DEBOUNCE TIME**			
1	X				0	0	0	0
3					0	0	0	1
5					0	0	1	0
7					0	0	1	1
9					0	1	0	0
11					0	1	0	1
⋮					⋮			
25	X				1	1	0	0
27					1	1	0	1
29					1	1	1	0
31					1	1	1	1
1	0	0	0	0	X			
3	0	0	0	1				
5	0	0	1	0				
7	0	0	1	1				
9	0	1	0	0				
11	0	1	0	1				
⋮	⋮							
25	1	1	0	0	X			
27	1	1	0	1				
29	1	1	1	0				
31	1	1	1	1				
Power-on default (31)	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

X = Don't care.

Table 9. Key-Switch Interrupt Register (0x03)

REGISTER DESCRIPTION	REGISTER DATA							
	D7	D6	D5	D4	D3	D2	D1	D0
	FIFO-BASED $\overline{INT}$			TIME-BASED $\overline{INT}$				
Power-up default setting All $\overline{INT}$ disabled	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Time-based $\overline{INT}$ disabled	X			0	0	0	0	0
$\overline{INT}$ asserts every debounce cycle				0	0	0	0	1
$\overline{INT}$ asserts every 2 debounce cycles				0	0	0	1	0
⋮							⋮	
$\overline{INT}$ asserts every 29 debounce cycles	X			1	1	1	0	1
$\overline{INT}$ asserts every 30 debounce cycles				1	1	1	1	0
$\overline{INT}$ asserts every 31 debounce cycles				1	1	1	1	1
FIFO-based $\overline{INT}$ disabled	0	0	0	X				
$\overline{INT}$ asserts when the FIFO has 2 key events	0	0	1					
$\overline{INT}$ asserts when the FIFO has 4 key events	0	1	0					
⋮		⋮						
$\overline{INT}$ asserts when the FIFO has 10 key events	1	0	1	X				
$\overline{INT}$ asserts when the FIFO has 12 key events	1	1	0					
$\overline{INT}$ asserts when the FIFO has 14 key events	1	1	1					
Both time-based and FIFO-based interrupts active	Not all zero			Not all zero				

X = Don't care.

Table 10. Key-Switch Autorepeat Register (0x05)

REGISTER DESCRIPTION	REGISTER DATA							
	D7	D6	D5	D4	D3	D2	D1	D0
	ENABLE	AUTOREPEAT RATE			AUTOREPEAT DELAY			
Autorepeat is disabled	0	X	X	X	X	X	X	X
Autorepeat is enabled	1	Autorepeat rate			Autorepeat delay			
Autorepeat delay is 8 debounce cycles	1	X			0	0	0	0
Autorepeat delay is 16 debounce cycles	1				0	0	0	1
Autorepeat delay is 24 debounce cycles	1				0	0	1	0
⋮						⋮		
Autorepeat delay is 112 debounce cycles	1	X			1	1	0	1
Autorepeat delay is 120 debounce cycles	1				1	1	1	0
Autorepeat delay is 128 debounce cycles	1				1	1	1	1
Autorepeat frequency is 4 debounce cycles	1	0	0	0	X			
Autorepeat frequency is 8 debounce cycles	1	0	0	1				
Autorepeat frequency is 12 debounce cycles	1	0	1	0				
⋮		⋮						
Autorepeat frequency is 24 debounce cycles	1	1	0	1	X			
Autorepeat frequency is 28 debounce cycles	1	1	1	0				
Autorepeat frequency is 32 debounce cycles	1	1	1	1				
Power-on default setting	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

X = Don't care.

Table 11. Autosleep Register (0x06)

REGISTER DESCRIPTION	REGISTER DATA							
	RESERVED				AUTOSHUTDOWN TIME			
AUTOSLEEP (ms)	D7	D6	D5	D4	D3	D2	D1	D0
Disabled	0	0	0	0	0	0	0	0
8192	0	0	0	0	0	0	0	1
4096	0	0	0	0	0	0	1	0
2048	0	0	0	0	0	0	1	1
1024	0	0	0	0	0	1	0	0
512	0	0	0	0	0	1	0	1
256	0	0	0	0	0	1	1	0
256	0	0	0	0	0	1	1	1
Power-up default settings	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**

Table 12. Key-Switch Array Size Register (0x30)

REGISTER DESCRIPTION	REGISTER DATA							
	D7	D6	D5	D4	D3	D2	D1	D0
	ROWS				COLUMNS			
No rows are key switches	0	0	0	0	X			
ROW0 is a key switch	0	0	0	1				
ROW0 to ROW1 are key switches	0	0	1	0				
ROW0 to ROW2 are key switches	0	0	1	1				
ROW0 to ROW3 are key switches	0	1	0	0				
ROW0 to ROW4 are key switches	0	1	0	1				
ROW0 to ROW5 are key switches	0	1	1	0				
ROW0 to ROW6 are key switches	0	1	1	1				
ROW0 to ROW7 are key switches	1	X	X	X				
No columns are key switches	X				0	0	0	0
COL0 is a key switch					0	0	0	1
COL0 to COL1 are key switches					0	0	1	0
COL0 to COL2 are key switches					0	0	1	1
COL0 to COL3 are key switches					0	1	0	0
COL0 to COL4 are key switches					0	1	0	1
COL0 to COL5 are key switches					0	1	1	0
COL0 to COL6 are key switches					0	1	1	1
Power-up default setting	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**1**

X = Don't care.

Table 13. GPIO Direction Register (0x31)

REGISTER BIT	DESCRIPTION	VALUE	FUNCTION	DEFAULT VALUE
D[7:5]	Reserved	000	—	000
D4	GPIO4	0	Set as input pin	0
		1	Set as output pin	
D3	GPIO3	0	Set as input pin	0
		1	Set as output pin	
D2	GPIO2	0	Set as input pin	0
		1	Set as output pin	
D1	GPIO1	0	Set as input pin	0
		1	Set as output pin	
D0	GPIO0	0	Set as input pin	0
		1	Set as output pin	

Table 14. GPO Output Mode Register (0x32)

REGISTER BIT	DESCRIPTION	VALUE	FUNCTION	DEFAULT VALUE
D[7:5]	Reserved	000	—	000
D4	GPIO4	0	Port is an open-drain output	0
		1	Port is a push-pull output	
D3	GPIO3	0	Port is an open-drain output	0
		1	Port is a push-pull output	
D2	GPIO2	0	Port is an open-drain output	0
		1	Port is a push-pull output	
D1	GPIO1	0	Port is an open-drain output	0
		1	Port is a push-pull output	
D0	GPIO0	0	Port is an open-drain output	0
		1	Port is a push-pull output	

Table 15. GPIs LSB Value Register (0x33) (Read Only)

REGISTER BIT	DESCRIPTION	VALUE	FUNCTION	DEFAULT VALUE
D7	ROW0	0	Input value is low	1
		1	Input value is high	
D6	COL6	0	Input value is low	1
		1	Input value is high	
D5	COL5	0	Input value is low	1
		1	Input value is high	
D4	COL4	0	Input value is low	1
		1	Input value is high	
D3	COL3	0	Input value is low	1
		1	Input value is high	
D2	COL2	0	Input value is low	1
		1	Input value is high	
D1	COL1	0	Input value is low	1
		1	Input value is high	
D0	COL0	0	Input value is low	1
		1	Input value is high	

Table 16. GPIs MSB Value Register (0x34) (Read Only)

REGISTER BIT	DESCRIPTION	VALUE	FUNCTION	DEFAULT VALUE
D7	Reserved	—	—	0
D6	ROW7	0	Input value is low	1
		1	Input value is high	
D5	ROW6	0	Input value is low	1
		1	Input value is high	
D4	ROW5	0	Input value is low	1
		1	Input value is high	
D3	ROW4	0	Input value is low	1
		1	Input value is high	
D2	ROW3	0	Input value is low	1
		1	Input value is high	
D1	ROW2	0	Input value is low	1
		1	Input value is high	
D0	ROW1	0	Input value is low	1
		1	Input value is high	

Table 17. GPIO Value Register (0x35)

REGISTER BIT	DESCRIPTION	R/W	VALUE	FUNCTION	DEFAULT VALUE
D[7:5]	—	—	000	Reserved	000
D4	GPIO4	R	0	Input value is low	0
			1	Input value is high	
D3	GPIO3	R	0	Input value is low	0
			1	Input value is high	
D2	GPIO2	R	0	Input value is low	0
			1	Input value is high	
D1	GPIO1	R	0	Input value is low	0
			1	Input value is high	
D0	GPIO0	R	0	Input value is low	0
			1	Input value is high	
D4	GPIO4	W	0	Set output logic-low	—
			1	Set output logic-high	
D3	GPIO3	W	0	Set output logic-low	—
			1	Set output logic-high	
D2	GPIO2	W	0	Set output logic-low	—
			1	Set output logic-high	
D1	GPIO1	W	0	Set output logic-low	—
			1	Set output logic-high	
D0	GPIO0	W	0	Set output logic-low	—
			1	Set output logic-high	

Table 18. GPIs Interrupt Mask Register (0x36)

REGISTER BIT	DESCRIPTION	VALUE	FUNCTION	DEFAULT VALUE
D[7:5]	Reserved	000	—	000
D4	GPIO4	0	Interrupt is unmasked	1
		1	Interrupt is masked	
D3	GPIO3	0	Interrupt is unmasked	1
		1	Interrupt is masked	
D2	GPIO2	0	Interrupt is unmasked	1
		1	Interrupt is masked	
D1	GPIO1	0	Interrupt is unmasked	1
		1	Interrupt is masked	
D0	GPIO0	0	Interrupt is unmasked	1
		1	Interrupt is masked	

Table 19. GPIs LSB Interrupt Mask Register (0x37)

REGISTER BIT	DESCRIPTION	VALUE	FUNCTION	DEFAULT VALUE
D7	ROW0	0	Interrupt is unmasked	1
		1	Interrupt is masked	
D6	COL6	0	Interrupt is unmasked	1
		1	Interrupt is masked	
D5	COL5	0	Interrupt is unmasked	1
		1	Interrupt is masked	
D4	COL4	0	Interrupt is unmasked	1
		1	Interrupt is masked	
D3	COL3	0	Interrupt is unmasked	1
		1	Interrupt is masked	
D2	COL2	0	Interrupt is unmasked	1
		1	Interrupt is masked	
D1	COL1	0	Interrupt is unmasked	1
		1	Interrupt is masked	
D0	COL0	0	Interrupt is unmasked	1
		1	Interrupt is masked	

Table 20. GPIs MSB Interrupt Mask Register (0x38)

REGISTER BIT	DESCRIPTION	VALUE	FUNCTION	DEFAULT VALUE
D7	Reversed	—	—	0
D6	ROW7	0	Interrupt is unmasked	1
		1	Interrupt is masked	
D5	ROW6	0	Interrupt is unmasked	1
		1	Interrupt is masked	
D4	ROW5	0	Interrupt is unmasked	1
		1	Interrupt is masked	
D3	ROW4	0	Interrupt is unmasked	1
		1	Interrupt is masked	
D2	ROW3	0	Interrupt is unmasked	1
		1	Interrupt is masked	
D1	ROW2	0	Interrupt is unmasked	1
		1	Interrupt is masked	
D0	ROW1	0	Interrupt is unmasked	1
		1	Interrupt is masked	

Table 21. GPIs Interrupt Trigger Mode Register (0x39)

REGISTER BIT	DESCRIPTION	VALUE	FUNCTION	DEFAULT VALUE
D[7:5]	Reserved	000	—	000
D4	GPIO4	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	
D3	GPIO3	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	
D2	GPIO2	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	
D1	GPIO1	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	
D0	GPIO0	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	

Table 22. GPIs LSB Interrupt Trigger Mode Register (0x3A)

REGISTER BIT	DESCRIPTION	VALUE	FUNCTION	DEFAULT VALUE
D7	ROW0	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	
D6	COL6	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	
D5	COL5	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	
D4	COL4	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	
D3	COL3	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	
D2	COL2	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	
D1	COL1	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	
D0	COL0	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	

Table 23. GPIs MSB Input Interrupt Trigger Mode Register (0x3B)

REGISTER BIT	DESCRIPTION	VALUE	FUNCTION	DEFAULT VALUE
D7	—	X	Don't care	0
D6	ROW7	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	
D5	ROW6	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	
D4	ROW5	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	
D3	ROW4	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	
D2	ROW3	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	
D1	ROW2	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	
D0	ROW1	0	Rising edge-triggered interrupts	0
		1	Rising and falling edge-triggered interrupts	

Table 24. GPO High-Side Open-Drain Enable Register (0x3C)

REGISTER BIT	DESCRIPTION	VALUE	FUNCTION	DEFAULT VALUE
D[7:5]	Reserved	000	—	000
D4	GPIO4	0	Set low-side open-drain mode	0
		1	Set high-side open-drain mode	
D3	GPIO3	0	Set low-side open-drain mode	0
		1	Set high-side open-drain mode	
D2	GPIO2	0	Set low-side open-drain mode	0
		1	Set high-side open-drain mode	
D1	GPIO1	0	Set low-side open-drain mode	0
		1	Set high-side open-drain mode	
D0	GPIO0	0	Set low-side open-drain mode	0
		1	Set high-side open-drain mode	

Table 25. GPO Pullup/Pulldown Resistor Enable Register (0x3D)

REGISTER BIT	DESCRIPTION	VALUE	FUNCTION	DEFAULT VALUE
D[7:5]	Reserved	000	—	000
D4	GPIO4	0	Disable internal pullup/pulldown	0
		1	Enable internal pullup/pulldown for open-drain output	
D3	GPIO3	0	Disable internal pullup/pulldown	0
		1	Enable internal pullup/pulldown for open-drain output	
D2	GPIO2	0	Disable internal pullup/pulldown	0
		1	Enable internal pullup/pulldown for open-drain output	
D1	GPIO1	0	Disable internal pullup/pulldown	0
		1	Enable internal pullup/pulldown for open-drain output	
D0	GPIO0	0	Disable internal pullup/pulldown	0
		1	Enable internal pullup/pulldown for open-drain output	

Table 26. GPIO Global Configuration Register (0x40)

REGISTER BIT	DESCRIPTION	VALUE	FUNCTION	DEFAULT VALUE
D[7:6]	Reserved	00	—	00
D5	I²C Interrupt Timeout Enable	0	Disable I²C timeout interrupt	0
		1	Enable I²C timeout interrupt. $\overline{INT}$ is deasserted when a read is performed on the I²C timeout flag register (0x48)	
D4	Operating Mode	0	Standby mode	0
		1	Normal mode	
D[3:0]	Reserved	—	—	0000

Table 27. GPI Debounce Setting Register (0x42)

REGISTER DESCRIPTION	REGISTER DATA							
	D7	D6	D5	D4	D3	D2	D1	D0
	RESERVED				DEBOUNCE TIME			
Power-up default setting Debounce time is 9ms	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Debounce time is 10ms	0	0	0	0	0	0	0	1
Debounce time is 11ms	0	0	0	0	0	0	1	0
Debounce time is 12ms	0	0	0	0	0	0	1	1
	⋮							
Debounce time is 37ms	0	0	0	1	1	1	0	0
Debounce time is 38ms	0	0	0	1	1	1	0	1
Debounce time is 39ms	0	0	0	1	1	1	1	0
Debounce time is 40ms	0	0	0	1	1	1	1	1

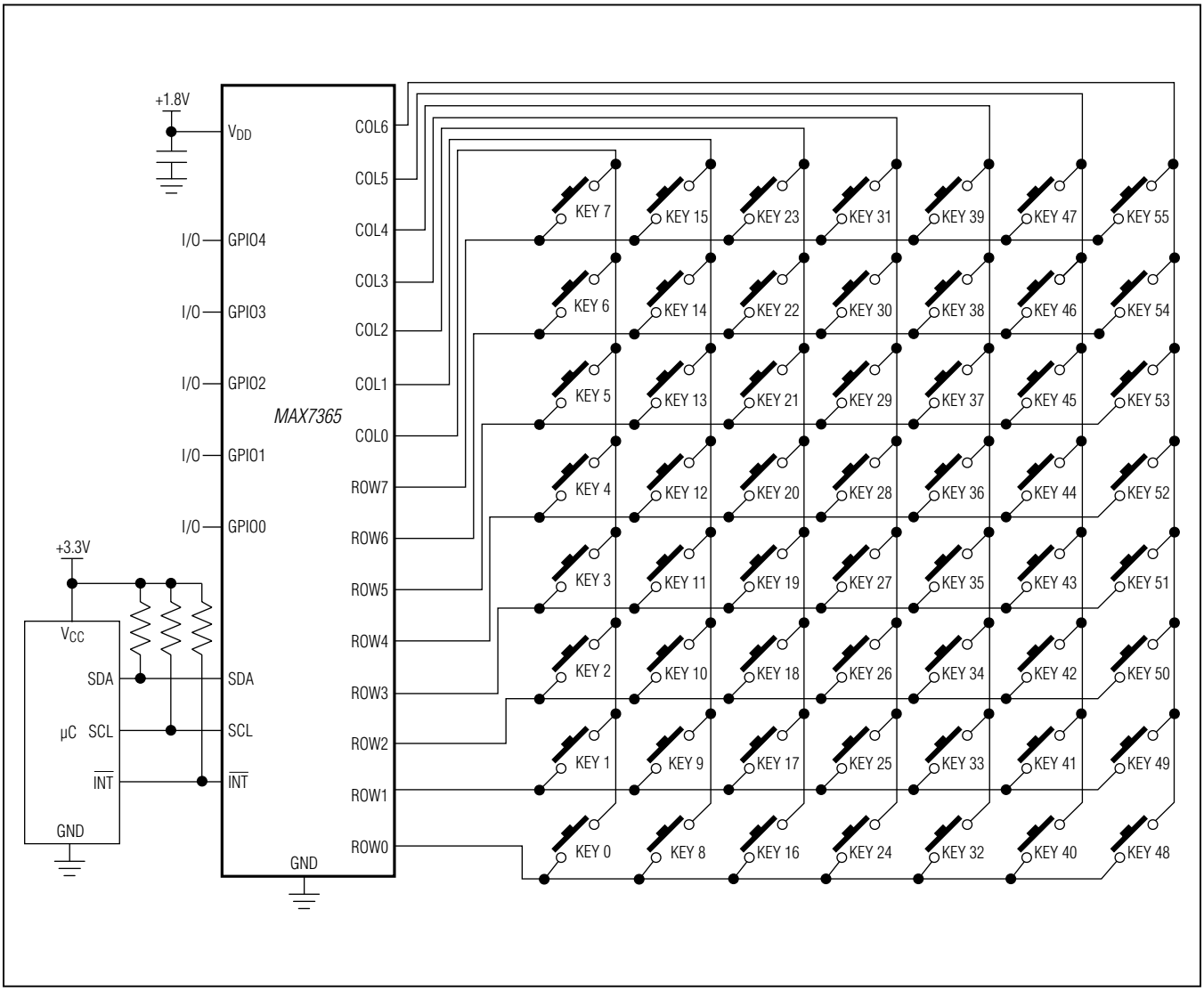
Table 28. I²C Timeout Flag Register (0x48) (Read Only)

REGISTER BIT	DESCRIPTION	VALUE	FUNCTION	DEFAULT VALUE
D[7:1]	Reserved	0000000	—	0000000
D0	I²C Timeout Flag	0	No I²C timeout has occurred since last read or POR.	0
		1	I²C timeout has occurred since last read or POR. This bit is reset to zero when a read is performed on this register. I²C timeouts must be enabled for this function to work (Table 26).	

Wafer-Level Packaging (WLP) Applications Information

For the latest application details on WLP construction, dimensions, tape-carrier information, PCB techniques, bump-pad layout, and recommended reflow temperature profile, as well as the latest information on reliability testing results, refer to Application Note 1891: *Wafer-Level Packaging (WLP) and Its Applications*, available at www.maximintegrated.com/an1891.

Typical Application Circuit



Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	I²C ADDRESS (hex)
MAX7365EWA70+	-40°C to +85°C	25 WLP	70
MAX7365EWA72+	-40°C to +85°C	25 WLP	72
MAX7365EWA74+	-40°C to +85°C	25 WLP	74
MAX7365EWA76+	-40°C to +85°C	25 WLP	76

+Denotes a lead(Pb)-free/RoHS-compliant package.

Chip Information

PROCESS: BiCMOS

Package Information

For the latest package outline information and land patterns (footprints), go to **www.maximintegrated.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

PACKAGE TYPE	PACKAGE CODE	OUTLINE NO.	LAND PATTERN NO.
25 WLP	W252B2+1	21-0180	Refer to Application Note 1891

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	9/11	Initial release	—

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