

# LM8328 Mobile I/O Companion Supporting Keyscan, I/O Expansion, PWM, and ACCESS.bus Host Interface

Check for Samples: [LM8328](#)

## FEATURES

### • KEY FEATURES

- Internal RC Oscillator, No External Clock Required
- Internal PWM Clock Generation, No External Clock Required
- External Reset for System Control
- Programmable I<sup>2</sup>C-compatible ACCESS.bus Address (Default 0x88)
- Support for Keypad Matrices of up to of 8 x 12 Keys, Plus 8 Special Function (SF) Keys, for a Full 104 Key Support
- I<sup>2</sup>C-compatible ACCESS.bus Slave Interface at 100 kHz (Standard-Mode) and 400 kHz (Fast-Mode)
- Three Host-programmable PWM Outputs for Smooth LED Brightness Modulation
- Supports General-purpose I/O Expansion on Pins Not Otherwise Used for Keypad or PWM Output
- 15 byte Key Event Buffer
- Multiple Key Event Storage
- Key Events, Errors, and Dedicated Hardware Interrupts Request Host Service by Asserting an IRQ Output
- Automatic HALT Mode for Low Power Operation
- Wake-up from HALT Mode on Any Interface (Rising Edge, Falling Edge or Pulse)
- Three PWM Outputs with Dedicated Script Buffer for up to 32 Commands
- Register-based Command Interpreter with Auto Increment Address

### • HOST-CONTROLLED FEATURES

- Reset Input for System Control
- PWM Scripting for Three PWM Outputs
- Period of Inactivity that Triggers Entry into HALT Mode
- Debounce Time for Reliable Key Event Polling

- Configuration of General Purpose I/O Ports
- Various Initialization Options (Keypad Size, etc.)

### • KEY DEVICE FEATURES

- 1.8V ± 10% Single-supply Operation
- On-chip Power-on Reset (POR)
- Watchdog Timer
- –40°C to +85°C Temperature Range
- 25-pin DSBGA Package

## APPLICATIONS:

- Cordless Phones
- Smart Handheld Devices
- Keyboard Applications

## DESCRIPTION

The LM8328 GenI/O - Expander and Keypad Controller is a dedicated device to unburden a host processor from scanning a matrix-addressed keypad and to provide flexible and general purpose, host programmable input/output functions. Three independent PWM timer outputs are provided for dynamic LED brightness modulation.

It communicates with a host processor through an I<sup>2</sup>C-compatible ACCESS.bus serial interface. It can communicate in Standard (100 kHz) - and Fast-Mode (400 kHz) in slave Mode only.

All available input/output pins can alternately be used as an input or an output in a keypad matrix or as a host programmable general purpose input or output.

Any pin programmed as an input can also sense hardware interrupts. The interrupt polarity ("high to low" or "low to high" transition) is thereby programmable.

The LM8328 follows a predefined register based set of commands. Upon start-up (power - on) a configuration file must be sent from the host to setup the hardware of the device.



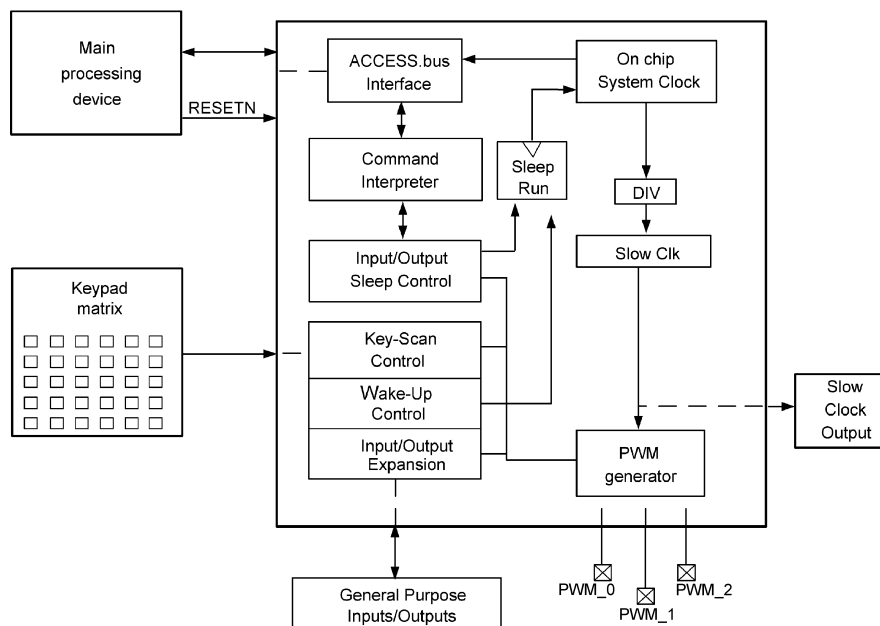
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## LM8328 FUNCTION BLOCKS



## PIN ASSIGNMENTS

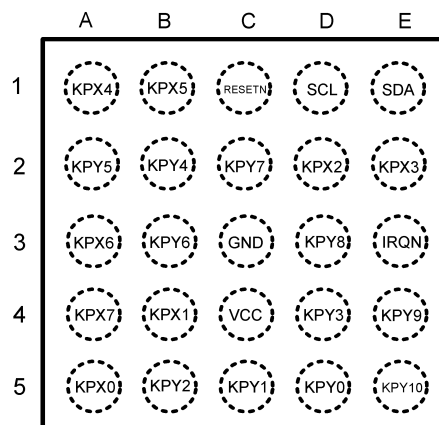


Figure 1. LM8328 Pinout - Top View (balls underneath): Y = Outputs; X = Inputs

## SIGNAL DESCRIPTIONS

### DEVICE PIN FUNCTIONS

#### KEY AND ALTERNATE FUNCTIONS OF ALL DEVICE PINS

| Ball | Function 0                   | Function 1     | Function 2 | Function 3 | Pin Count | Ball Name |
|------|------------------------------|----------------|------------|------------|-----------|-----------|
| C1   | Reset Active Low Input       |                |            |            | 1         | RESETN    |
| C4   | Supply Voltage               |                |            |            | 1         | VCC       |
| D1   | Main I <sup>2</sup> C - Clk  |                |            |            | 1         | SCL       |
| E1   | Main I <sup>2</sup> C - Data |                |            |            | 1         | SDA       |
| A5   | Keypad-I/O X0                | Genio0         |            |            | 1         | KPX0      |
| B4   | Keypad-I/O X1                | Genio1         |            |            | 1         | KPX1      |
| D2   | Keypad-I/O X2                | Genio2         |            |            | 1         | KPX2      |
| E2   | Keypad-I/O X3                | Genio3         |            |            | 1         | KPX3      |
| A1   | Keypad-I/O X4                | Genio4         |            |            | 1         | KPX4      |
| B1   | Keypad-I/O X5                | Genio5         |            |            | 1         | KPX5      |
| A3   | Keypad-I/O X6                | Genio6         |            |            | 1         | KPX6      |
| A4   | Keypad-I/O X7                | Genio7         |            |            | 1         | KPX7      |
| D5   | Keypad-I/O Y0                | Genio8         |            |            | 1         | KPY0      |
| C5   | Keypad-I/O Y1                | Genio9         |            |            | 1         | KPY1      |
| B5   | Keypad-I/O Y2                | Genio10        |            |            | 1         | KPY2      |
| D4   | Keypad-I/O Y3                | Genio11        |            |            | 1         | KPY3      |
| B2   | Keypad-I/O Y4                | Genio12        |            |            | 1         | KPY4      |
| A2   | Keypad-I/O Y5                | Genio13        |            |            | 1         | KPY5      |
| B3   | Keypad-I/O Y6                | Genio14        |            |            | 1         | KPY6      |
| C2   | Keypad-I/O Y7                | Genio15        |            |            | 1         | KPY7      |
| D3   | Keypad-I/O Y8                | Genio16        | ClockOut   | PWM2       | 1         | KPY8      |
|      |                              |                |            |            |           | PWM2      |
| E4   | Keypad-I/O Y9                | Genio17        |            | PWM1       | 1         | KPY9      |
|      |                              |                |            |            |           | PWM1      |
| E5   | Keypad-I/O Y10               | Genio18        |            | PWM0       | 1         | KPY10     |
|      |                              |                |            |            |           | PWM0      |
| E3   | Interrupt                    | Keypad-I/O Y11 | Genio19    | PWM2       | 1         | IRQN      |
|      |                              |                |            |            |           | KPY11     |
|      |                              |                |            |            |           | PWM2      |
| C3   | Ground                       |                |            |            | 1         | GND       |
|      | TOTAL                        |                |            |            | 25        |           |

### PIN CONFIGURATION AFTER RESET

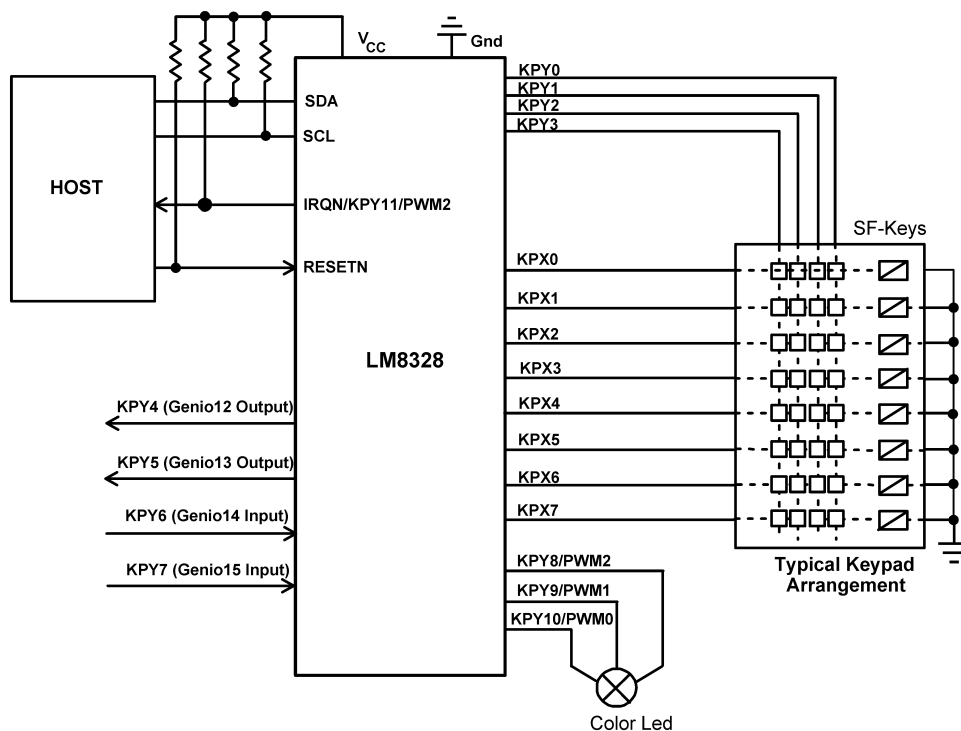
Upon power-up or RESET the LM8328 will have defined states on all pins. Pin configuration after reset provides a comprehensive overview on the states of all functional pins.

**PIN CONFIGURATION AFTER RESET**

| <b>Pins</b>                                                                                                          | <b>Pin States</b>                                                                |
|----------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| KPX0<br>KPX1<br>KPX2<br>KPX3<br>KPX4<br>KPX5<br>KPX6<br>KPX7                                                         | Full Buffer mode with an on-chip pull up resistor enabled.                       |
| KPY0<br>KPYP1<br>KPYP2<br>KPYP3<br>KPYP4<br>KPYP5<br>KPYP6<br>KPYP7<br>KPYP8 / PWM2<br>KPYP9 / PWM1<br>KPYP10 / PWM0 | Full Buffer mode with an on-chip pull down resistor enabled.                     |
| KPY11 / IRQN / PWM2                                                                                                  | Open Drain mode with no pull resistor enabled, driven low (IRQN). <sup>(1)</sup> |
| SCL<br>SDA                                                                                                           | Open Drain mode with no pull resistor enabled.                                   |

(1) The IRQN is driven low after Power-On Reset due to PORIRQ signal. The value 0x01 must be written to the RSTINTCLR register (0x84) to release the IRQN pin.

## TYPICAL APPLICATION SETUP



**Figure 2. LM8328 in a Typical Setup with Standard Handset Keypad**

## FEATURES

The following features are supported with the application example shown in example above:

### Hardware

#### Hardware

- 4 x 8 keys and 8 Special Function (SF) keys for 40 keys.
- ACCESS.bus interface for communication with a host device.
  - communication speeds supported are: 100 kHz and 400 kHz fast mode of operation.
- Interrupt signal (IRQN) to indicate any keypad or hardware interrupt events to the host.
- Sophisticated PWM function block with 3 independent channels to control color LED.
- External reset input for system control.
- Two host programmable dedicated general-purpose output pins (GPIOs) supporting IO-expansion capabilities for host device.
- Two host programmable dedicated general-purpose input pins with wake-up supporting IO-expansion capabilities for host device.

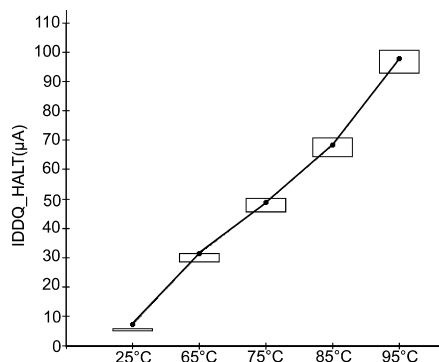
### Communication Layer

- Versatile register-based command integration supported from on-chip command interpreter.
- Keypad event storage.
- Individual PWM script file storage and execution control for 3 PWM channels.

## HALT MODE

### HALT MODE DESCRIPTION

The fully static architecture of the LM8328 allows stopping the internal RC clock in Halt mode, which reduces power consumption to the minimum level. Figure 3 shows the current in Halt mode at the maximum VCC (1.98V) from 25°C to +85°C.



**Figure 3. Halt Current vs. Temperature at 1.98V**

Halt mode is entered when no key-press event, key-release event, or ACCESS.bus activity is detected for a certain period of time (by default, 1020 milliseconds). The mechanism for entering Halt mode is always enabled in hardware, but the host can program the period of inactivity which triggers entry into Halt mode using the autosleep function. (See Table 47.)

### ACCESS.BUS ACTIVITY

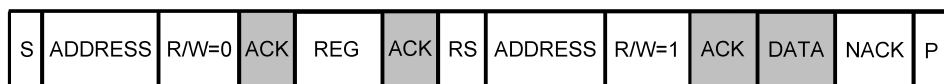
When the LM8328 is in Halt mode, only activity on the ACCESS.bus interface that matches its Slave Address will cause the LM8328 to exit from Halt mode. However, the LM8328 will not be able to acknowledge the first bus cycle immediately following wake-up from Halt mode. It will respond with a negative acknowledgement, and the host should then repeat the cycle. A peripheral that is continuously active can share the bus since this activity will not prevent the LM8328 from entering Halt mode.

## LM8328 PROGRAMMING INTERFACE

The LM8328 operation is controlled from a host device by a complete register set, accessed via the I<sup>2</sup>C-compatible ACCESS.bus interface. The ACCESS.bus communication is based on a READ/WRITE structure, following the I<sup>2</sup>C transmission protocol. All functions can be controlled by configuring one or multiple registers. Please refer to [LM8328 REGISTER SET](#) for the complete register set.

### ACCESS.BUS COMMUNICATION

Figure 4 shows a typical read cycle initiated by the host.)



**Figure 4. Master/Slave Serial Communication (Host to LM8328)**

**Table 1. Definition of Terms used in Serial Command Example**

| Term    | Bits | Description                                                                                                                                                                                                                     |
|---------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| S       |      | START Condition (always generated from the master device)                                                                                                                                                                       |
| ADDRESS | 7    | Slave address of LM8328 sent from the host                                                                                                                                                                                      |
| R/W     | 1    | This bit determines if the following data transfer is from master to slave (data write) or from slave to master (data read).<br>0: Write<br>1: Read                                                                             |
| ACK     | 1    | An acknowledge bit is mandatory and must be appended on each byte transfer. The Acknowledge status is actually provided from the slave and indicates to the master, that the byte transfer was successful.                      |
| REG     | 8    | The first byte after sending the slave address is the REGISTER byte which contains the physical address the host wants to read from or write to.                                                                                |
| RS      |      | Repeated START condition                                                                                                                                                                                                        |
| DATA    | 8    | The DATA field contains information to be stored into a register or information read from a register.                                                                                                                           |
| NACK    | 1    | Not Acknowledge Bit. The Not Acknowledge status is assigned from the Master receiving data from a slave. The NACK status will actually be assigned from the master in order to signal the end of a communication cycle transfer |
| P       |      | STOP condition (always generated from the master device)                                                                                                                                                                        |

All actions associated with the non-shaded boxes in [Figure 4](#) are controlled from the master (host) device.

All actions associated with the shaded boxes in [Figure 4](#) are controlled from the slave (LM8328) device.

The master device can send subsequent REGISTER addresses separated by Repeated START conditions. A STOP condition must be set from the master at the very end of a communication cycle.

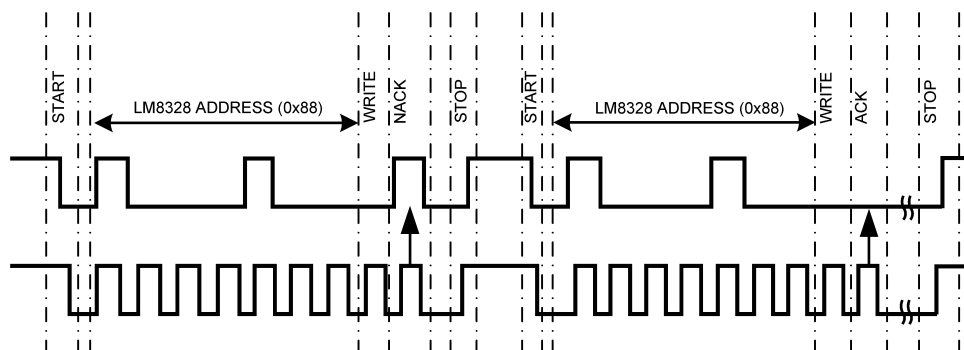
It is recommended to use Repeated START conditions in multi-Master systems when sending subsequent REGISTER addresses. This technique will make sure that the master device communicating with the LM8328 will not lose bus arbitration.

### Starting a Communication Cycle

There are two reasons for the host device to start communication to the LM8328:

1. The LM8328 device has set the IRQN line low in order to signal a key - event or any other condition which initializes a hardware interrupt from LM8328 to the host.
2. The host device wants to set a GENIO port, read from a GENIO port, configure a GENIO port, and read the status from a register or initialize any other function which is supported from the LM8328. In case a GENIO shall be read it will be most likely, that the LM8328 device will be residing in “sleep mode”. In this mode the system clock will be off to establish the lowest possible current consumption. If the host device starts the communication under this condition the LM8328 device will not be able to acknowledge the first attempt of sending the slave address. The LM8328 will wake up because of the START condition but it can't establish the internal timing to scan the first byte received. The master device must therefore apply a second attempt to start the communication with the LM8328 device.

### Communication Initialized from Host (Restart from Sleep Mode)


**Figure 5. Host Starts Communication While LM8328 is in Sleep Mode**

- In the timing diagram shown in [Figure 5](#) the LM8328 resides in sleep mode. Since the LM8328 device can't acknowledge the slave address the host must generate a STOP condition followed by a second START condition.
- On the second attempt the slave address is being acknowledged from the LM8328 device because it is in active mode now.
- The host can send different WRITE and/or READ commands subsequently after each other.
- The host must finally free the bus by generating a STOP condition.

### **ACCESS.bus Communication Flow**

The LM8328 will only be driven in slave mode. The maximum communication speed supported is Fast Mode (FS) which is 400 kHz. The device can be heavily loaded as it is processing different kind of events caused from the human interface and the host device. In such cases the LM8328 may temporarily be unable to accept new commands and data sent from the host device.

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#### **NOTE**

"It is a legitimate measure of the slave device to hold SCL line low in such cases in order to force the master device into a waiting state. It is therefore the obligation of the host device to detect such cases. Typically there is a control bit set in the master device indicating the Busy status of the bus. As soon as the SCL line is released the host can continue sending commands and data."

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### **Further Remarks:**

- In systems with multiple masters it is recommended to separate commands with Repeat START conditions rather than sending a STOP - and another START - condition to communicate with the LM8328 device.
- Delays enforced by the LM8328 during very busy phases of operation should typically not exceed a duration of 100 usec.
- Normally the LM8328 will clock stretch after the acknowledge bit is transmitted; however, there are some conditions where the LM8328 will clock stretch between the SDA Start bit and the first rising edge of SCL.

### **Auto Increment**

In order to improve multi-byte register access, the LM8328 supports the auto increment of the address pointer.

A typical protocol access sequence to the LM8328 starts with the I<sup>2</sup>C-compatible ACCESS.bus address, followed by REG, the register to access (see [Figure 4](#)). After a REPEATED START condition the host reads/writes a data byte from/to this address location. If more than one byte is transmitted, the LM8328 automatically increments the address pointer for each data byte by 1. The address pointer keeps the status until the STOP condition is received.

The LM8328 always uses auto increments unless otherwise noted.

Please refer to [Table 2](#) and [Table 3](#) for the typical ACCESS.bus flow of reading and writing multiple data bytes.

### **Reserved Registers and Bits**

The LM8328 includes reserved registers for future implementation options. Please use value 0 on a write to all reserved register bits.

### **Global Call Reset**

The LM8328 supports the Global Call Reset as defined in the I<sup>2</sup>C Specification, which can be used by the host to reset all devices connected to interface. The Global call reset is a single byte ACCESS.bus/I<sup>2</sup>C write of data byte 0x06 to slave address 0x00.

The Global Call Reset changes the I<sup>2</sup>C-compatible ACCESS.bus Slave address of the LM8328 back to its default value of 0x88.

**Table 2. Multi-Byte Write with Auto Increment**

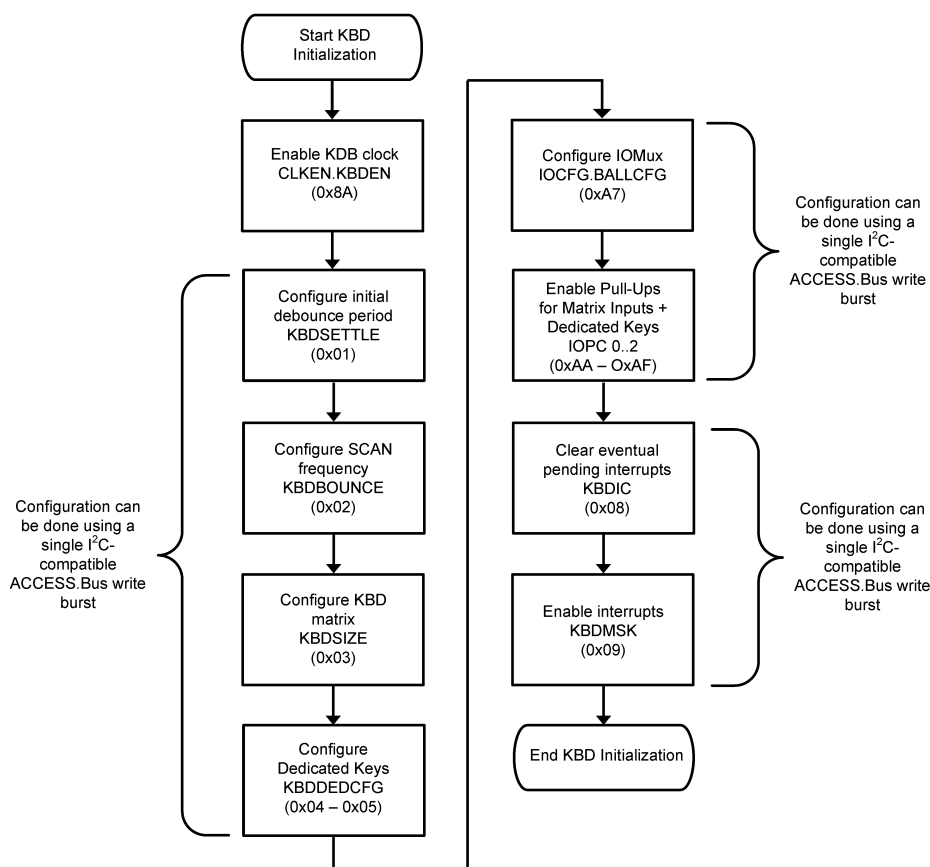
| Step | Master/Slave | I <sup>2</sup> C Com. | Value | Address Pointer | Comment                                        |
|------|--------------|-----------------------|-------|-----------------|------------------------------------------------|
| 1    | M            | S                     |       |                 | START condition                                |
| 2    | M            | ADDR.                 | 0x88  |                 | I <sup>2</sup> C-compatible ACCESS.bus Address |
| 3    | M            | R/W                   | 0     |                 | Write                                          |
| 4    | S            | ACK                   |       |                 | Acknowledge                                    |
| 5    | M            | REG                   | 0xAA  | 0xAA            | Register Address, used as Address Pointer      |
| 6    | S            | ACK                   |       | 0xAA            | Acknowledge                                    |
| 7    | M            | DATA                  | 0x01  | 0xAA            | Write Data to Address in Pointer               |
| 8    | S            | ACK                   | 0     | 0xAB            | Acknowledge, Address pointer incremented       |
| 9    | M            | DATA                  | 0x05  | 0xAB            | Write Data to address 0xAB                     |
| 10   | S            | ACK                   | 0     | 0xAC            | Acknowledge, Address pointer incremented       |
| 11   | M            | P                     |       |                 | STOP condition                                 |

**Table 3. Multi-Byte Read with Auto Increment**

| Step | Master/Slave | I <sup>2</sup> C Com. | Value | Address Pointer | Comment                                        |
|------|--------------|-----------------------|-------|-----------------|------------------------------------------------|
| 1    | M            | S                     |       |                 | START condition                                |
| 2    | M            | ADDR.                 | 0x88  |                 | I <sup>2</sup> C-compatible ACCESS.bus Address |
| 3    | M            | R/W                   | 0     |                 | Write                                          |
| 4    | S            | ACK                   |       |                 | Acknowledge                                    |
| 5    | M            | REG                   | 0xAA  | 0xAA            | Register Address, used as Address pointer      |
| 6    | S            | ACK                   |       | 0xAA            | Acknowledge                                    |
| 7    | M            | RS                    |       | 0xAA            | Repeated Start                                 |
| 8    | M            | ADDR.                 | 0x88  | 0xAA            | I <sup>2</sup> C-compatible ACCESS.bus Address |
| 9    | M            | R/W                   | 1     |                 | Read                                           |
| 10   | S            | ACK                   | 0     | 0xAA            | Acknowledge                                    |
| 11   | S            | DATA                  | 0x01  | 0xAA            | Read Data from Address in Pointer              |
| 12   | M            | ACK                   | 0     | 0xAB            | Acknowledge, Address Pointer incremented       |
| 13   | S            | DATA                  | 0x05  | 0xAB            | Read Data from Address in Pointer              |
| 14   | M            | NACK                  | 0     | 0xAC            | No Acknowledge, stops transmission             |
| 15   | M            | P                     |       |                 | STOP condition                                 |

## KEYSCAN OPERATION

### KEYSCAN INITIALIZATION



**Figure 6. Keyscan Initialization**

### KEYSCAN INITIALIZATION EXAMPLE

Table 4 shows all the LM8328 register configurations to initialize keyscan:

- Keypad matrix configuration is 8 rows x 8 columns.

**Table 4. Keyscan Initialization Example**

| Register name | adress | Access Type | Value  | Comment                                                   |
|---------------|--------|-------------|--------|-----------------------------------------------------------|
| CLKEN         | 0x8A   | byte        | 0x01   | enable keyscan clock                                      |
| KBDSETTLE     | 0x01   | byte        | 0x80   | set the keyscan settle time to 12 msec                    |
| KBDBOUNCE     | 0x02   | byte        | 0x80   | set the keyscan debounce time to 12 msec                  |
| KBDSIZE       | 0x03   | byte        | 0x88   | set the keyscan matrix size to 8 rows x 8 columns         |
| KBDEDCFG      | 0x04   | word        | 0xFC3F | configure KPX[7:2] and KPY[7:2] pins as keyboard matrix   |
| IOCFG         | 0xA7   | byte        | 0xF8   | write default value to enable all pins as keyboard matrix |
| IOPC0         | 0xAA   | word        | 0xAAAA | configure pull-up resistors for KPX[7:0]                  |
| IOPC1         | 0xAC   | word        | 0x5555 | configure pull-down resistors for KPY[7:0]                |
| KBDIC         | 0x08   | byte        | 0x03   | clear any pending interrupts                              |
| KBDMSK        | 0x09   | byte        | 0x03   | enable keyboard interrupts                                |

## KEYSCAN PROCESS

The LM8328 keyscan functionality is based on a specific scanning procedure performed in a 4ms interval. On each scan all assigned key matrix pins are evaluated for state changes.

In case a key event has been identified, the event is stored in the key event FIFO, accessible via the EVTCODE register. A key event can either be a key press or a key release. In addition, key presses are also stored in the KBDCODE[3:0] registers. As soon as the EVTCODE FIFO includes a event, the device sets the RAW keyboard event interrupt REVTINT. The RSINT interrupt is set anytime the keyboard status has changed.

Depending on the interrupt masking for the keyboard events (KBDMSK) and the masked interrupt handling (KBDNIS), the pin IRQN/KPY11/PWM2 will follow the IRQST.KBDIRQ status, which is set as soon as one interrupt in KBDRIS is set.

Figure 7 shows the basic flow of a scanning process and which registers are affected.

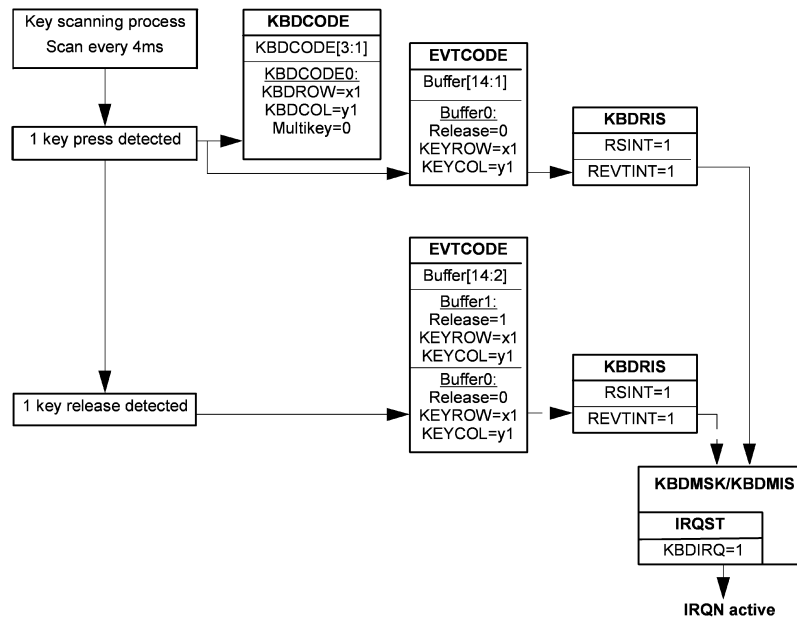


Figure 7. Example Keyscan Operation for 1 Key Press and Release

## READING KEYSKAN STATUS BY THE HOST

In order to keep track of the keyscan status, the host either needs to regularly poll the EVTCODE register or needs to react on the Interrupt signaled by the IRQN/KPY11/PWM2 pin, in case the ball is configured for interrupt functionality. (See [GPIO Feature Mapping](#)).

Figure 8 gives an example on which registers to read to get the keyboard events from the LM8328 and how they influence the interrupt event registers. The example is based on the assumption that the LM8328 has indicated the keyboard event by the IRQN/KPY11/PWM2 pin.

Since the interrupt pin has various sources, the host first checks the IRQST register for the interrupt source. If KBDIRQ is set, the host can check the KBDNIS register to define the exact interrupt source. KBDNIS contains the masked status of KBDRIS and reflects the source for raising the interrupt pin. The interrupt mask is defined by KBDMSK. The complete status of all pending keyboard interrupts is available in the raw interrupt register KBDRIS.

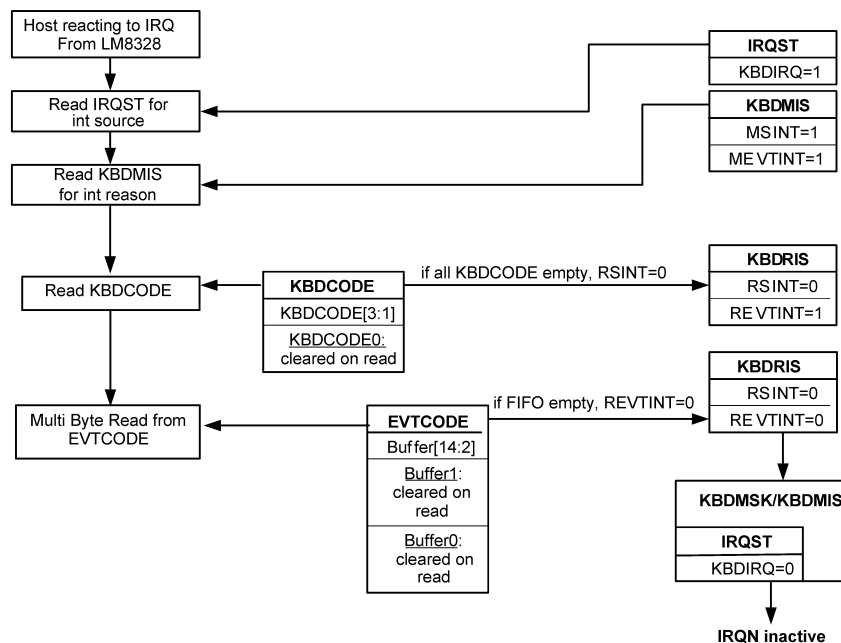
After evaluating the interrupt source the host starts reading the EVTCODE or KBDCODE register. In this example the host first reads the KBDCODE to get possible key press events and afterwards reads the complete event list by reading the EVTCODE register until all events are captured (0x7F indicates end of buffer).

Reading KBDCODE clears the RSINT interrupt bit if all keyboards events are emptied. In the same way, REVTINT is cleared in case the EVTCODE FIFO reaches its empty state on read.

The event buffer content and the REVTINT and RELINT (lost event) interrupt bits are also cleared if the KBDIC.EVTIC bit is set.

Interrupt bits in the masked interrupt register KBDMIS follow the masked KBDRIS status.

In order to support efficient Multi-byte reads from EVTCODE, the autoincrement feature is turned off for this register. Therefore the host can continuously read the complete EVTCODE buffer by sending one command.



**Figure 8. Example Host Reacting to Interrupt for Keypad Event**

## MULTIPLE KEY PRESSES

The LM8328 supports up to four simultaneous key presses. Any time a single key is pressed KBDCODE0 is set with the appropriate key code. If a second key is pressed, the key is stored in KBDCODE1 and the MULTIKEY flag of KBDCODE0 is set. Additional key presses are stored in KBDCODE2 and KBDCODE3 accordingly. The four registers signal the last multi key press events.

All events are stored in parallel in the EVTCODE register for the complete set of events.

All KBDCODE[3:0] registers are cleared on read.

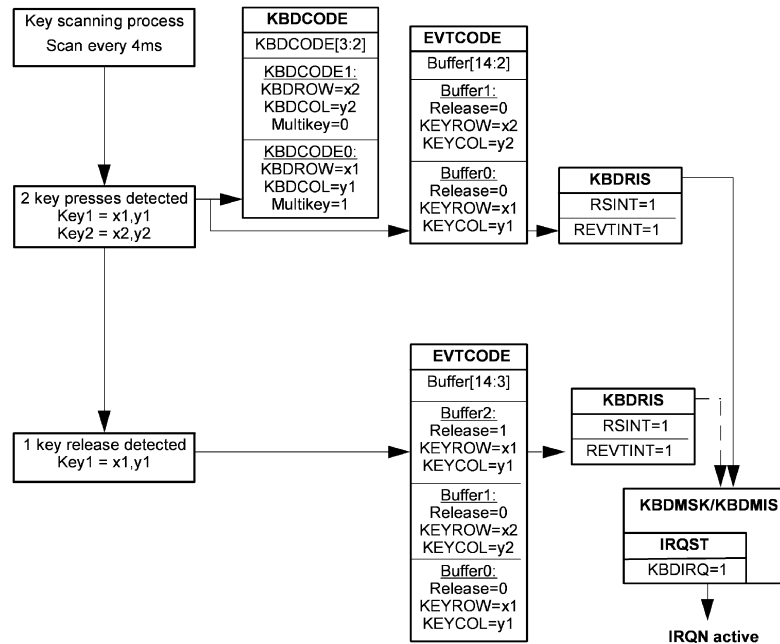


Figure 9. Example Keyscan Operation for 2 Key Press Events and 1 Key Release Event

## PWM TIMER

The LM8328 supports a timer module dedicated to smooth LED control techniques (lighting controls).

The PWM timer module consists of three independent timer units of which each can generate a PWM output with a fixed period and automatically incrementing or decrementing variable duty cycle. The timer units are all clocked with a slow (32.768 kHz) clock whereas the interface operates with the main system clock.

## OVERVIEW OF PWM FEATURES

- Each PWM can establish fixed — or variable — duty-cycle signal sequences on its output.
- Each PWM can trigger execution of any pre-programmed task on another PWM channel.
- The execution of any pre-programmed task is self-sustaining and does not require further interaction from the host.
- 64-byte script buffer for each PWM for up to 32 consecutive instructions.
- Direct addressing within script buffer to support multiple PWM tasks in one buffer.

## OVERVIEW ON PWM SCRIPT COMMANDS

The commands listed in [Table 5](#) are dedicated to the slow PWM timers.

### NOTE

The PWM Script commands are not part of the command set supported by the LM8328 command interpreter. These commands must be transferred from the host with help of the register-based command set.

**Table 5. PWM Script Commands**

| Command | 15 | 14       | 13       | 12          | 11  | 10 | 9 | 8 | 7           | 6          | 5 | 4 | 3 | 2 | 1 | 0 |  |
|---------|----|----------|----------|-------------|-----|----|---|---|-------------|------------|---|---|---|---|---|---|--|
| RAMP    | 0  | PRESCALE | STEPTIME |             |     |    |   |   | SIGN        | INCREMENT  |   |   |   |   |   |   |  |
| SET_PWM | 0  | 1        | 0        |             |     |    |   |   | PWMVALUE    |            |   |   |   |   |   |   |  |
| GO_TO_  | 0  |          |          |             |     |    |   |   |             |            |   |   |   |   |   |   |  |
| START   |    |          |          |             |     |    |   |   |             |            |   |   |   |   |   |   |  |
| BRANCH  | 1  | 0        | 1        | LOOPCOUNT   |     |    |   |   | ADDR        | STEPNUMBER |   |   |   |   |   |   |  |
| END     | 1  | 1        | 0        | 1           | INT | X  |   |   |             |            |   |   |   |   |   |   |  |
| TRIGGER | 1  | 1        | 1        | WAITTRIGGER |     |    |   |   | SENDTRIGGER |            |   |   |   |   |   | 0 |  |

**RAMP COMMAND**

A RAMP command will vary the duty cycle of a PWM output in either direction (up or down). The INCREMENT field specifies the amount of steps for the RAMP. The maximum amount of steps which can be executed with one RAMP Command is 126 which is equivalent to 50%. The SIGN bit field determines the direction of a RAMP (up or down). The STEPTIME field and the PRESCALE bit determine the duration of one step. Based on a 32.768 kHz clock, the minimum time resulting from these options would be 0.49 milliseconds and the maximum time for one step would be 1 second.

**Table 6. RAMP Command Bit and Building Fields**

| 15 | 14       | 13       | 12 | 11 | 10 | 9 | 8    | 7 | 6         | 5 | 4 | 3 | 2 | 1 | 0 |
|----|----------|----------|----|----|----|---|------|---|-----------|---|---|---|---|---|---|
| 0  | PRESCALE | STEPTIME |    |    |    |   | SIGN |   | INCREMENT |   |   |   |   |   |   |

**Table 7. Description of Bit and Building Fields of the RAMP Command**

| Bit or Field | Value   | Description                                                                                            |
|--------------|---------|--------------------------------------------------------------------------------------------------------|
| PRESCALE     | 0       | Divide the 32.768 kHz clock by 16                                                                      |
|              | 1       | Divide the 32.768 kHz clock by 512                                                                     |
| STEPTIME     | 1 - 63  | Number of prescaled clock cycles per step                                                              |
| SIGN         | 0       | Increment ramp counter                                                                                 |
|              | 1       | Decrement ramp counter                                                                                 |
| INCREMENT    | 0 - 126 | Number of steps executed by this instruction; a value of 0 functions as a WAIT determined by STEPTIME. |

**SET\_PWM COMMAND**

The SET\_PWM command will set the starting duty cycle MIN SCALE or FULL SCALE (0% or 100%). A RAMP command following the SET\_PWM command will finally establish the desired duty cycle on the PWM output.

**Table 8. SET\_PWM Command Bit and Building Fields**

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7         | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----|----|----|----|----|----|---|---|-----------|---|---|---|---|---|---|---|
| 0  | 1  | 0  | 0  | 0  | 0  | 0 | 0 | DUTYCYCLE |   |   |   |   |   |   |   |

**Table 9. Description of Bit and Building Fields of the SET\_PWM Command**

| Bit or Field | Value | Description         |
|--------------|-------|---------------------|
| DUTYCYCLE    | 0     | Duty cycle is 0%.   |
|              | 255   | Duty cycle is 100%. |

**GO\_TO\_START COMMAND**

The GO\_TO\_START command jumps to the first command in the script command file.

**Table 10. GO\_TO\_START Command Bit and Building Fields**

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|
| 0  |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   |

### BRANCH COMMAND

The BRANCH command jumps to the specified command in the script command file. The branch is executed with either absolute or relative addressing. In addition, the command gives the option of looping for a specified number of repetitions.

#### NOTE

Nested loops are not allowed.

**Table 11. BRANCH Command Bit and Building Fields**

| 15 | 14 | 13 | 12        | 11 | 10 | 9 | 8 | 7    | 6 | 5          | 4 | 3 | 2 | 1 | 0 |
|----|----|----|-----------|----|----|---|---|------|---|------------|---|---|---|---|---|
| 1  | 0  | 1  | LOOPCOUNT |    |    |   |   | ADDR |   | STEPNUMBER |   |   |   |   |   |

**Table 12. Description of Bit and Building Fields of the BRANCH Command**

| Bit or Field | Value  | Description                                                                       |
|--------------|--------|-----------------------------------------------------------------------------------|
| LOOPCOUNT    | 0      | Loop until a STOP PWM SCRIPT command is issued by the host.                       |
|              | 1 - 63 | Number of loops to perform.                                                       |
| ADDR         | 0      | Absolute addressing                                                               |
|              | 1      | Relative addressing                                                               |
| STEPNUMBER   | 0 - 63 | Depending on ADDR:<br>ADDR=0: Addr to jump to<br>ADDR=1: Number of backward steps |

### TRIGGER COMMAND

Triggers are used to synchronize operations between PWM channels. A TRIGGER command that sends a trigger takes sixteen 32.768 kHz clock cycles, and a command that waits for a trigger takes at least sixteen 32.768 kHz clock cycles.

A TRIGGER command that waits for a trigger (or triggers) will stall script execution until the trigger conditions are satisfied. On trigger it will clear the trigger(s) and continue to the next command.

When a trigger is sent, it is stored by the receiving channel and can only be cleared when the receiving channel executes a TRIGGER command that waits for the trigger.

**Table 13. TRIGGER Command Bit and Building Fields**

| 15 | 14 | 13 | 12          | 11 | 10 | 9 | 8 | 7           | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----|----|----|-------------|----|----|---|---|-------------|---|---|---|---|---|---|---|
| 1  | 1  | 1  | WAITTRIGGER |    |    |   |   | SENDTRIGGER |   |   |   |   |   | 0 |   |

**Table 14. Description of Bit and Building Fields**

| Field       | Value  | Description                     |
|-------------|--------|---------------------------------|
| WAITTRIGGER | 000xx1 | Wait for trigger from channel 0 |
|             | 000x1x | Wait for trigger from channel 1 |
|             | 0001xx | Wait for trigger from channel 2 |
| SENDTRIGGER | 000xx1 | Send trigger to channel 0       |
|             | 000x1x | Send trigger to channel 1       |
|             | 0001xx | Send trigger to channel 2       |

**END COMMAND**

The END command terminates script execution. It will only assert an interrupt to the host if the INT bit is set to "1".

When the END command is executed, the PWM output will be set to the level defined by PWMCFG.PWMPOL for this channel. Also, the script counter is reset back to the beginning of the script command buffer.

**NOTE**

If a PWM channel is waiting for the trigger (last executed command was "TRIGGER") and the script execution is halted then the "END" command can't be executed because the previous command is still pending. This is an exception - in this case the IRQ signal will not be asserted.

**Table 15. END Command Bit and Building Fields**

| 15 | 14 | 13 | 12 | 11  | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----|----|----|----|-----|----|---|---|---|---|---|---|---|---|---|---|
| 1  | 1  | 0  | 1  | INT |    |   |   |   |   | 0 |   |   |   |   |   |

**Table 16. Description of Bit and Building Fields of the END Command**

| Field | Value | Description                                                             |
|-------|-------|-------------------------------------------------------------------------|
| INT   | 0     | No interrupt will be sent.                                              |
|       | 1     | Set TIMRIS.CDIRQ for this PWM channel to notify that program has ended. |

**LM8328 REGISTER SET****KEYBOARD REGISTERS AND KEYBOARD CONTROL**

Keyboard selection and control registers are mapped in the address range from 0x01 to 0x10. This paragraph describes the functions of the associated registers down to the bit level.

**KBDSETTLE - Keypad Settle Time Register****Table 17. KBDSETTLE - Keypad Settle Time Register**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                                          |
|-----------------|---------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| KBDSETTLE       | 0x01    | R/W     | Initial time for keys to settle, before the key-scan process is started.                                                                                                                                                   |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                                               |
| WAIT[7:0]       | 7:0     | 0x80    | The default value 0x80 : 0xBF sets a time target of 12 msec<br>Further time targets are as follows:<br>0xC0 - 0xFF: 16 msec<br>0x80 - 0xBF: 12 msec<br>0x40 - 0x7F: 8 msec<br>0x01 - 0x3F: 4 msec<br>0x00 : no settle time |

**KBDBOUNCE - Debounce Time Register****Table 18. KBDBOUNCE - Debounce Time Register**

| Register - Name | Address | Type    | Register Function                                             |
|-----------------|---------|---------|---------------------------------------------------------------|
| KBDBOUNCE       | 0x02    | R/W     | Time between first detection of key and final sampling of key |
| Bit - Name      | Bit     | Default | Bit Function                                                  |

**Table 18. KBDBOUNCE - Debounce Time Register (continued)**

| Register - Name | Address | Type | Register Function                                                                                                                                                                                                                                            |
|-----------------|---------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| WAIT[7:0]       | 7:0     | 0x80 | <p>The default value 0x80 : 0xBF sets a time target of 12 msec</p> <p>Further time targets are as follows:</p> <p>0xC0 - 0xFF: 16 msec</p> <p>0x80 - 0xBF: 12 msec</p> <p>0x40 - 0x7F: 8 msec</p> <p>0x01 - 0x3F: 4 msec</p> <p>0x00: no debouncing time</p> |

**KBDSIZE - Set Keypad Size Register**
**Table 19. KBDSIZE - Set Keypad Size Register**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                                                                  |
|-----------------|---------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| KBDSIZE         | 0x03    | R/W     | Defines the physical keyboard matrix size                                                                                                                                                                                                          |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                                                                       |
| ROWSIZE[3:0]    | 7:4     | 0x2     | <p>Number of rows in the keyboard matrix</p> <p>0x0: free all rows to become GPIO, KPX[1:0] used as dedicated key inputs if scanning is enabled by CLKEN.KBEN</p> <p>0x1: (illegal value)</p> <p>0x2 - 0x8: Number of rows in the matrix</p>       |
| COLSIZE[3:0]    | 3:0     | 0x2     | <p>Number of columns in the keyboard matrix</p> <p>0x0: free all rows to become GPIO, KPY[1:0] used as dedicated key inputs if scanning is enabled by CLKEN.KBEN</p> <p>0x1: (illegal value)</p> <p>0x2 - 0xC: Number of columns in the matrix</p> |

**KBDEDCFG - Dedicated Key Register**
**Table 20. KBDEDCFG - Dedicated Key Register**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                                                                                                                       |
|-----------------|---------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| KBDEDCFG        | 0x04    | R/W     | Defines if a key is used as a standard keyboard/GPIO pin or whether it is used as dedicated key input.                                                                                                                                                                                                  |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                                                                                                                            |
| ROW[7:2]        | 15:10   | 0x3F    | <p>Each bit in ROW [7:2] corresponds to ball KPX7 : KPX2.</p> <p>Bit=0: the dedicated key function applies.</p> <p>Bit=1: no dedicated key function is selected. The standard GPIO functionality applies according to register IOCFG or defined keyboard matrix.</p>                                    |
| COL[11:10]      | 9:8     | 0x03    | <p>Each bit in COL [11:10] corresponds to ball KPY11 : KPY10.</p> <p>Bit=0: the dedicated key function applies.</p> <p>Bit=1: no dedicated key function is selected. The standard GPIO functionality applies according to register IOCFG or defined keyboard matrix.</p>                                |
| COL[9:2]        | 7:0     | 0xFF    | <p>Each bit in COL [9:2] corresponds to ball KPY9 : KPY2 and can be configured individually.</p> <p>Bit=0: the dedicated key function applies.</p> <p>Bit=1: no dedicated key function is selected. The standard GPIO functionality applies according to register IOCFG or defined keyboard matrix.</p> |

**KBDRIS - Keyboard Raw Interrupt Status Register****Table 21. KBDRIS - Keyboard Raw Interrupt Status Register**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                                      |
|-----------------|---------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| KBDRIS          | 0x06    | R       | Returns the status of stored keyboard interrupts.                                                                                                                                                                      |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                                           |
| (reserved)      | 7:4     |         | (reserved)                                                                                                                                                                                                             |
| RELINT          | 3       | 0x0     | Raw event lost interrupt.<br>More than 8 keyboard events have been detected and caused the event buffer to overflow. This bit is cleared by setting bit EVTIC of the KBDIC register.                                   |
| REVTINT         | 2       | 0x0     | Raw keyboard event interrupt.<br>At least one key press or key release is in the keyboard event buffer. Reading from EVTCODE until the buffer is empty will clear this interrupt.                                      |
| RKLINT          | 1       | 0x0     | Raw key lost interrupt indicates a lost key-code.<br>This interrupt is asserted when RSINT has not been cleared upon detection of a new key press or key release, or when more than 4 keys are pressed simultaneously. |
| RSINT           | 0       | 0x0     | Raw scan interrupt.<br>Interrupt generated after keyboard scan, if the keyboard status has changed.                                                                                                                    |

**KBDMIS - Keypad Masked Interrupt Status Register****Table 22. KBDMIS - Keypad Masked Interrupt Status Register**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                                          |
|-----------------|---------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| KBDMIS          | 0x07    | R       | Returns the status on masked keyboard interrupts after masking with the KBDMSK register.                                                                                                                                   |
| Bit - Name      | Bit     | Default | Bit Functions                                                                                                                                                                                                              |
| (reserved)      | 7:4     |         | (reserved)                                                                                                                                                                                                                 |
| MELINT          | 3       | 0x0     | Masked event lost interrupt.<br>More than 8 keyboard events have been detected and caused the event buffer to overflow. This bit is cleared by setting bit EVTIC of the KBDIC register.                                    |
| MEVTINT         | 2       | 0x0     | Masked keyboard event interrupt.<br>At least one key press or key release is in the keyboard event buffer. Reading from EVTCODE until the buffer is empty will clear this interrupt.                                       |
| MKLINT          | 1       | 0x0     | Masked key lost interrupt.<br>Indicates a lost key-code. This interrupt is asserted when RSINT has not been cleared upon detection of a new key press or key release, or when more than 4 keys are pressed simultaneously. |
| MSINT           | 0       | 0x0     | Masked scan interrupt.<br>Interrupt generated after keyboard scan, if the keyboard status has changed, after masking process.                                                                                              |

**KBDIC - Keypad Interrupt Clear Register****Table 23. KBDIC - Keypad Interrupt Clear Register**

| Register - Name | Address | Default | Register Function                                  |
|-----------------|---------|---------|----------------------------------------------------|
| KBDIC           | 0x08    | W       | Setting these bits clears Keypad active Interrupts |
| Bit - Name      | Bit     | Default | Bit Function                                       |

**Table 23. KBDIC - Keypad Interrupt Clear Register (continued)**

| Register - Name | Address | Default | Register Function                                                                                                                                                                                               |
|-----------------|---------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SFOFF           | 7       |         | Switches off scanning of special function (SF) keys, when keyboard has no special function layout.<br>0: keyboard layout and SF keys are scanned<br>1: only keyboard layout is scanned, SF keys are not scanned |
| (reserved)      | 6:2     |         | (reserved)                                                                                                                                                                                                      |
| EVTIC           | 1       |         | Clear event buffer and corresponding interrupts REVTINT and RELINT by writing a 1 to this bit position                                                                                                          |
| KBDIC           | 0       |         | Clear RSINT and RKLINT interrupt bits by writing a 1 to this bit position.                                                                                                                                      |

### ***KBDMSK - Keypad Interrupt Mask Register***

**Table 24. KBDMSK - Keypad Interrupt Mask Register**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------|---------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| KBDMSK          | 0x09    | R/W     | Configures masking of keyboard interrupts. Masked interrupts do not trigger an event on the interrupt output.<br><br>In case the interrupt processes registers KBDCODE[3:0], MSKELINT and MSKEINT should be set to 1. When the Event FIFO is processed, MSKLINT and MSKSINT should be set. For keyboard polling operations, all bits should be set and the polling operation consists of reading out the EVTCODE. |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                                                                                                                                                                                                                                      |
| (reserved)      | 7:4     |         | (reserved)                                                                                                                                                                                                                                                                                                                                                                                                        |
| MSKELINT        | 3       | 0x0     | 0: keyboard event lost interrupt RELINT triggers IRQ line<br>1: keyboard event lost interrupt RELINT is masked                                                                                                                                                                                                                                                                                                    |
| MSKEINT         | 2       | 0x0     | 0: keyboard event interrupt REVINT triggers IRQ line<br>1: keyboard event interrupt REVINT is masked                                                                                                                                                                                                                                                                                                              |
| MSKLINT         | 1       | 0x1     | 0: keyboard lost interrupt RKLINT triggers IRQ line<br>1: keyboard lost interrupt RKLINT is masked                                                                                                                                                                                                                                                                                                                |
| MSKSINT         | 0       | 0x1     | 0: keyboard status interrupt RSINT triggers IRQ line<br>1: keyboard status interrupt RSINT is masked                                                                                                                                                                                                                                                                                                              |

### ***KBDCODE0 - Keyboard Code Register 0***

The key code detected by the keyboard scan can be read from the registers KBDCODE0: KBDCODE3. Up to 4 keys can be detected simultaneously. Each KBDCODE register includes a bit (MULTIKEY) indicating if another key has been detected.

#### **NOTE**

Reading out all key code registers (KBDCODE0 to KBDCODE3) will automatically reset the keyboard scan interrupt RSINT the same way as an active write access into bit KBDIC of the interrupt clear register does. Reading 0x7F from the KBDCODE0 register means that no key was pressed.

**Table 25. KBDCODE0 - Keyboard Code Register 0**

| Register - Name | Address | Default | Register Function                                               |
|-----------------|---------|---------|-----------------------------------------------------------------|
| KBDCODE0        | 0x0B    | R       | Holds the row and column information of the first detected key  |
| Bit - Name      | Bit     | Default | Bit Function                                                    |
| MULTIKEY        | 7       | 0x0     | if this bit is 1 another key is available in KBDCODE1 register  |
| KEYROW[2:0]     | 6:4     | 0x7     | ROW index of detected key (0 to 7)                              |
| KEYCOL[3:0]     | 3:0     | 0xF     | Column index of detected (0 to 11, 12 for special function key. |

**KBDCODE1 - Keyboard Code Register 1****Table 26. KBDCODE1 - Keyboard Code Register 1**

| Register - Name | Address | Default | Register Function                                                    |
|-----------------|---------|---------|----------------------------------------------------------------------|
| KBDCODE1        | 0x0C    | R       | Holds the row and column information of the second detected key      |
| Bit - Name      | Bit     | Default | Bit Function                                                         |
| MULTIKEY        | 7       | 0x0     | if this bit is 1 another key is available in KBDCODE2 register       |
| KEYROW[2:0]     | 6:4     | 0x7     | ROW index of detected key (0 to 7)                                   |
| KEYCOL[3:0]     | 3:0     | 0xF     | Column index of detected key (0 to 11, 12 for special function key). |

**KBDCODE2 - Keyboard Code Register 2****Table 27. KBDCODE2 - Keyboard Code Register 2**

| Register - Name | Address | Default | Register Function                                                    |
|-----------------|---------|---------|----------------------------------------------------------------------|
| KBDCODE2        | 0x0D    | R       | Holds the row and column information of the third detected key       |
| Bit - Name      | Bit     | Default | Bit Function                                                         |
| MULTIKEY        | 7       | 0x0     | if this bit is 1 another key is available in KBDCODE3 register       |
| KEYROW[2:0]     | 6:4     | 0x7     | ROW index of detected key (0 to 7)                                   |
| KEYCOL[3:0]     | 3:0     | 0xF     | Column index of detected key (0 to 11, 12 for special function key). |

**KBDCODE3 - Keyboard Code Register 3****Table 28. KBDCODE3 - Keyboard Code Register 3**

| Register - Name | Address | Default | Register Function                                                           |
|-----------------|---------|---------|-----------------------------------------------------------------------------|
| KBDCODE3        | 0x0E    | R       | Holds the row and column information of the forth detected key              |
| Bit - Name      | Bit     | Default | Bit Function                                                                |
| MULTIKEY        | 7       | 0x0     | if this bit is set to "1" then more than 4 keys are pressed simultaneously. |
| KEYROW[2:0]     | 6:4     | 0x7     | ROW index of detected key (0 to 7)                                          |
| KEYCOL[3:0]     | 3:0     | 0xF     | Column index of detected key (0 to 11, 12 for special function key).        |

**EVTCODE - Key Event Code Register****Table 29. EVTCODE - Key Event Code Register**

| Register - Name | Address | Default | Bit Function                                                                                                                                                                                                                                                                                                 |
|-----------------|---------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| EVTCODE         | 0x10    | R       | With this register a FIFO buffer is addressed storing up to 15 consecutive events.<br>Reading the value 0x7F from this address means that the FIFO buffer is empty. See further details below.<br>NOTE: Auto increment is disabled on this register. Multi-byte read will always read from the same address. |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                                                                                                                                 |
| RELEASE         | 7       | 0x0     | This bit indicates, whether the keyboard event was a key press or a key release event.<br>0: key was pressed<br>1: key was released                                                                                                                                                                          |
| KEYROW[2:0]     | 6:4     | 0x7     | Row index of key that is pressed or released.                                                                                                                                                                                                                                                                |
| KEYCOL[3:0]     | 3:0     | 0xF     | Column index of key that is pressed (0...11, 12 for special function key) or released.                                                                                                                                                                                                                       |

## PWM TIMER CONTROL REGISTERS

The LM8328 provides three host-programmable PWM outputs useful for smooth LED brightness modulation. All PWM timer control registers are mapped in the range from 0x60 to 0x7F. This paragraph describes the functions of the associated registers down to the bit level.

### TIMCFGx - PWM Timer 0, 1 and 2 Configuration Registers

**Table 30. TIMCFGx - PWM Timer 0, 1 and 2 Configuration Registers**

| Register - Name               | Address | Type    | Register Function                                                                                                    |
|-------------------------------|---------|---------|----------------------------------------------------------------------------------------------------------------------|
| TIMCFG0                       | 0x60    | R/W     | This register configures interrupt masking and handles PWM start/stop control of the associated PWM channel.         |
| TIMCFG1                       | 0x68    |         |                                                                                                                      |
| TIMCFG2                       | 0x70    |         |                                                                                                                      |
| Bit - Name<br>(x = 0, 1 or 2) | Bit     | Default | Bit Function                                                                                                         |
| CYCIRQxMSK                    | 4       | 0x0     | Interrupt mask for PWM CYCIRQx (see register <a href="#">TIMRIS</a> )<br>0: interrupt enabled<br>1: interrupt masked |
| (reserved)                    | 3:0     | 0x0     | (reserved)                                                                                                           |

### PWMCFGx - PWM Timer 0, 1 and 2 Configuration Control Registers

**Table 31. PWMCFGx - PWM Timer 0, 1 and 2 Configuration Control Registers**

| Register - Name               | Address | Type    | Register Function                                                                                                                                                                                                                                                             |
|-------------------------------|---------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PWMCFG0                       | 0x61    | R/W     | This register defines interrupt masking and the output behavior for the associated PWM channel.<br><br>PGEx is used to start and stop the PWM script execution.<br><br>PWMENx sets the PWM output to either reflect the generated pattern or the value configured in PWMPOLx. |
| PWMCFG1                       | 0x69    |         |                                                                                                                                                                                                                                                                               |
| PWMCFG2                       | 0x71    |         |                                                                                                                                                                                                                                                                               |
| Bit - Name<br>(x = 0, 1 or 2) | Bit     | Default | Bit Function                                                                                                                                                                                                                                                                  |
| CDIRQxMSK                     | 3       | 0x0     | Mask for CDIRQx<br>0: CDIRQx enabled<br>1: CDIRQx disabled/masked                                                                                                                                                                                                             |
| PGEx                          | 2       | 0x0     | Pattern Generator Enable. Start/Stop PWM command processing for this channel. Script execution is started always from beginning.<br>0: Pattern Generator disabled<br>1: Pattern Generator enabled                                                                             |
| PWMENx                        | 1       | 0x0     | 0: PWM disabled. PWM timer output assumes value programmed in PWMPOL.<br>1: PWM enabled                                                                                                                                                                                       |
| PWMPOLx                       | 0       | 0x0     | Off-state of PWM output, when PWMEN=0.<br>0: PWM off-state is low<br>1: PWM off-state is high                                                                                                                                                                                 |

**TIMSWRES - PWM Timer Software Reset Registers****Table 32. TIMSWRES - PWM Timer Software Reset Registers**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                                                                                                                                                         |
|-----------------|---------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TIMSWRES        | 0x78    | W       | Reset control on all PWM timers<br>A reset forces the pattern generator to fetch the first pattern and stops it. Each reset stops all state-machines and timer.<br>Patterns stored in the pattern configuration register remain unaffected. Interrupts on each timer are not cleared, they need to be cleared writing into register TIMIC |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                                                                                                                                                              |
| (reserved)      | 7:3     |         | (reserved)                                                                                                                                                                                                                                                                                                                                |
| SWRES2          | 2       |         | Software reset of timer 2.<br>0: no action<br>1: Software reset on timer 2, needs not to be written back to 0.                                                                                                                                                                                                                            |
| SWRES1          | 1       |         | Software reset of timer 1.<br>0: no action<br>1: Software reset on timer 1, needs not to be written back to 0.                                                                                                                                                                                                                            |
| SWRES0          | 0       |         | Software reset of timer 0.<br>0: no action<br>1: software reset on timer 0, needs not to be written back to 0.                                                                                                                                                                                                                            |

**TIMRIS - PWM Timer Interrupt Status Register****Table 33. TIMRIS - PWM Timer Interrupt Status Register**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------|---------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TIMRIS          | 0x7A    | R       | This register returns the raw interrupt status from the PMW timers 0,1 and 2.<br>CYCIRQx - Interrupt from the timers when PWM cycle is complete (applies to the current PWM command residing in the active command register of a PWM block).<br>CDIRQx - Interrupt from the pattern generator when PWM pattern code is complete (applies to a completed task residing in the script buffer of a PWM block). |
| Bit - Name      | Bit     | Default | Bit Functions                                                                                                                                                                                                                                                                                                                                                                                               |
| (reserved)      | 7:6     |         | (reserved)                                                                                                                                                                                                                                                                                                                                                                                                  |
| CDIRQ2          | 5       | 0x0     | Raw interrupt status for CDIRQ timer2<br>0: no interrupt pending<br>1: unmasked interrupt generated                                                                                                                                                                                                                                                                                                         |
| CDIRQ1          | 4       | 0x0     | Raw interrupt status for CDIRQ timer1<br>0: no interrupt pending<br>1: unmasked interrupt generated                                                                                                                                                                                                                                                                                                         |
| CDIRQ0          | 3       | 0x0     | Raw interrupt status for CDIRQ timer0<br>0: no interrupt pending<br>1: unmasked interrupt generated                                                                                                                                                                                                                                                                                                         |
| CYCIRQ2         | 2       | 0x0     | Raw interrupt status for CYCIRQ timer2<br>0: no interrupt pending<br>1: unmasked interrupt generated                                                                                                                                                                                                                                                                                                        |
| CYCIRQ1         | 1       | 0x0     | Raw interrupt status for CYCIRQ timer1<br>0: no interrupt pending<br>1: unmasked interrupt generated                                                                                                                                                                                                                                                                                                        |

**Table 33. TIMRIS - PWM Timer Interrupt Status Register (continued)**

| Register - Name | Address | Type | Register Function                                                                                    |
|-----------------|---------|------|------------------------------------------------------------------------------------------------------|
| CYCIRQ0         | 0       | 0x0  | Raw interrupt status for CYCIRQ timer0<br>0: no interrupt pending<br>1: unmasked interrupt generated |

**TIMMIS - PWM Timer Masked Interrupt Status Register**
**Table 34. TIMMIS - PWM Timer Masked Interrupt Status Register**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------|---------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TIMMIS          | 0x7B    | R       | This register returns the masked interrupt status from the PMW timers 0,1 and 2. The raw interrupt status (TIMRIS) is masked with the associated TIMCFGx.CYCIRQxMSK and PWMCFGx.CDIRQxMSK bits to get the masked interrupt status of this register.<br><b>CYCIRQ</b> - Interrupt from the timers when PWM cycle is complete (applies to the current PWM command residing in the active command register of a PWM block)<br><b>CDIRQ</b> - Interrupt from the pattern generator when PWM pattern code is complete (applies to a completed task residing in the script buffer of a PWM block) |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| (reserved)      | 7:6     |         | (reserved)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| CDIRQ2          | 5       | 0x0     | Interrupt after masking, indicates active contribution to the interrupt ball, when set. Status for CDIRQ timer2.<br>0: no interrupt pending<br>1: interrupt generated                                                                                                                                                                                                                                                                                                                                                                                                                       |
| CDIRQ1          | 4       | 0x0     | Interrupt after masking, indicates active contribution to the interrupt ball, when set. Status for CDIRQ timer1.<br>0: no interrupt pending<br>1: interrupt generated                                                                                                                                                                                                                                                                                                                                                                                                                       |
| CDIRQ0          | 3       | 0x0     | Interrupt after masking, indicates active contribution to the interrupt ball, when set. Status for CDIRQ timer0.<br>0: no interrupt pending<br>1: interrupt generated                                                                                                                                                                                                                                                                                                                                                                                                                       |
| CYCIRQ2         | 2       | 0x0     | Interrupt after masking, indicates active contribution to the interrupt ball, when set. Status for CYCIRQ timer2.<br>0: no interrupt pending<br>1: interrupt generated                                                                                                                                                                                                                                                                                                                                                                                                                      |
| CYCIRQ1         | 1       | 0x0     | Interrupt after masking, indicates active contribution to the interrupt ball, when set. Status for CYCIRQ timer1.<br>0: no interrupt pending<br>1: interrupt generated                                                                                                                                                                                                                                                                                                                                                                                                                      |
| CYCIRQ0         | 0       | 0x0     | Interrupt after masking, indicates active contribution to the interrupt ball, when set. Status for CYCIRQ timer0.<br>0: no interrupt pending<br>1: interrupt generated                                                                                                                                                                                                                                                                                                                                                                                                                      |

**TIMIC - PWM Timer Interrupt Clear Register****Table 35. TIMIC - PWM Timer Interrupt Clear Register**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------|---------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TIMIC           | 0x7C    | W       | <p>This register clears timer and pattern interrupts.</p> <p>CYCIRQ - Interrupt from the timers when PWM cycle is complete (applies to the current PWM command residing in the active command register of a PWM block).</p> <p>CDIRQ - Interrupt from the pattern generator when PWM pattern code is complete (applies to a completed task residing in the script buffer of a PWM block)</p> |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                                                                                                                                                                                                                 |
| (reserved)      | 7:6     |         | (reserved)                                                                                                                                                                                                                                                                                                                                                                                   |
| CDIRQ2          | 5       |         | <p>Clears interrupt CDIRQ timer2.</p> <p>0: no effect</p> <p>1: interrupt is cleared. Does not need to be written back to 0</p>                                                                                                                                                                                                                                                              |
| CDIRQ1          | 4       |         | <p>Clears interrupt CDIRQ timer1.</p> <p>0: no effect</p> <p>1: interrupt is cleared. Does not need to be written back to 0</p>                                                                                                                                                                                                                                                              |
| CDIRQ0          | 3       |         | <p>Clears interrupt CDIRQ timer0.</p> <p>0: no effect</p> <p>1: interrupt is cleared. Does not need to be written back to 0</p>                                                                                                                                                                                                                                                              |
| CYCIRQ2         | 2       |         | <p>Clears interrupt CYCIRQ timer2.</p> <p>0: no effect</p> <p>1: interrupt is cleared. Does not need to be written back to 0</p>                                                                                                                                                                                                                                                             |
| CYCIRQ1         | 1       |         | <p>Clears interrupt CYCIRQ timer1.</p> <p>0: no effect</p> <p>1: interrupt is cleared. Does not need to be written back to 0</p>                                                                                                                                                                                                                                                             |
| CYCIRQ0         | 0       |         | <p>Clears interrupt CYCIRQ timer0.</p> <p>0: no effect</p> <p>1: interrupt is cleared. Does not need to be written back to 0</p>                                                                                                                                                                                                                                                             |

**PWMWP - PWM Timer Pattern Pointer Register****Table 36. PWMWP - PWM Timer Pattern Pointer Register**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                                                                                                                                           |
|-----------------|---------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PWMWP           | 0x7D    | R/W     | <p>Pointer to the pattern position inside the configuration register, which will be overwritten by the next write access to be PWMCFG register.</p> <p>NOTE: 1 pattern consist of 2 bytes and not the byte position (low or high). It is incremented by 1 every time a full PWMCFG register access (word) is performed.</p> |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                                                                                                                                                |
| (reserved)      | 7       | 0x0     | (reserved)                                                                                                                                                                                                                                                                                                                  |
| POINTER[6:0]    | 6:0     | 0x0     | <p>0 ≤ POINTER &lt; 32 : timer0 patterns 0 to 31</p> <p>32 ≤ POINTER &lt; 64 : timer1 patterns 0 to 31</p> <p>64 ≤ POINTER &lt; 96 : timer2 patterns 0 to 31</p> <p>96 ≤ POINTER &lt; 128: not valid</p>                                                                                                                    |

## PWMCFG - PWM Script Register

**Table 37. PWMCFG - PWM Script Register**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                                                                                                                                       |
|-----------------|---------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PWMCFG          | 0x7E    | W       | Two byte pattern storage register for a PWM script command indexed by PWMWP. PWMWP is automatically incremented.<br>To be applied by two consecutive parameter bytes in one I <sup>2</sup> C Write Transaction.<br>NOTE:<br>Autoincrement is disabled on this register. Address will stay at 0x7E for each word access. |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                                                                                                                                            |
| CMD[15:8]       | 15:8    |         | High byte portion of a PWM script command                                                                                                                                                                                                                                                                               |
| CMD[7:0]        | 7:0     |         | Low byte portion of a PWM script command                                                                                                                                                                                                                                                                                |

## INTERFACE CONTROL REGISTERS

The following section describes the functions of special control registers provided for the main controller.

The manufacturer code MFGCODE and the software revision number SWREV tell the main device which configuration file has to be used for this device.

### NOTE

I2CSA and MFGCODE use the same address. They just differentiate in the access type:

- Write - I2CSA
- Read - MFGCODE

## I2CSA - I<sup>2</sup>C-Compatible ACCESS.bus Slave Address Register

**Table 38. I2CSA - I<sup>2</sup>C-Compatible ACCESS.bus Slave Address Register**

| Register - Name | Address | Type    | Register Function                                                                                                                |
|-----------------|---------|---------|----------------------------------------------------------------------------------------------------------------------------------|
| I2CSA           | 0x80    | W       | I <sup>2</sup> C-compatible ACCESS.bus Slave Address.<br>The address is internally applied after the next I <sup>2</sup> C STOP. |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                     |
| SLAVEADDR[7:1]  | 7:1     | 0x44    | 7-bit address field for the I <sup>2</sup> C-compatible ACCESS.bus slave address.                                                |
| (reserved)      | 0       |         | (reserved)                                                                                                                       |

## MFGCODE - Manufacturer Code Register

**Table 39. MFGCODE - Manufacturer Code Register**

| Register - Name | Address | Type    | Register Function                              |
|-----------------|---------|---------|------------------------------------------------|
| MFGCODE         | 0x80    | R       | Manufacturer code of the LM8328                |
| Bit - Name      | Bit     | Default | Bit Function                                   |
| MFGBIT          | 7:0     | 0x00    | 8 - bit field containing the manufacturer code |

## SWREV - Software Revision Register

**Table 40. SWREV - Software Revision Register**

| Register - Name | Address | Type | Register Function                                                                                                                              |
|-----------------|---------|------|------------------------------------------------------------------------------------------------------------------------------------------------|
| SWREV           | 0x81    | R    | Software revision code of the LM8328.<br>NOTE: writing the SW revision with the inverted value triggers a reset (see <a href="#">SWRESET</a> ) |

**Table 40. SWREV - Software Revision Register (continued)**

| Register - Name | Address | Type    | Register Function                                |
|-----------------|---------|---------|--------------------------------------------------|
| Bit - Name      | Bit     | Default | Bit Function                                     |
| SWBIT           | 7:0     | 0x84    | 8 - bit field containing the SW Revision number. |

**SWRESET - Software Reset****Table 41. SWRESET - Software Reset Register**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                  |
|-----------------|---------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SWRESET         | 0x81    | W       | Software reset<br>NOTE: the reset is only applied if the supplied parameter has the inverted value as SWBIT.<br>Reading this register provides the software revision. (see <a href="#">SWREV</a> ) |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                       |
| SWBIT           | 7:0     |         | Reapply inverted value for software reset.                                                                                                                                                         |

**RSTCTRL - System Reset Register**

This register allows to reset specific blocks of the LM8328. For global reset of the IOExpander the I<sup>2</sup>C command 'General Call reset' is used (see [Global Call Reset](#)). This will reset the slave address back to 0x88. During an active reset of a module, the LM8328 blocks the access to the module registers. A read will return 0, write commands are ignored.

**Table 42. RSTCTRL - System Reset Register**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                                                         |
|-----------------|---------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RSTCTRL         | 0x82    | R/W     | Software reset of specific parts of the LM8328                                                                                                                                                                                            |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                                                              |
| (reserved)      | 7:5     |         | (reserved)                                                                                                                                                                                                                                |
| IRQRST          | 4       | 0x0     | Interrupt controller reset. Does not change status on IRQN ball. Only controls IRQ module register. Interrupt status read out is not possible when this bit is set.<br>0: interrupt controller not reset<br>1: interrupt controller reset |
| TIMRST          | 3       | 0x0     | Timer reset for Timers 0, 1, 2<br>0: timer not reset<br>1: timer is reset                                                                                                                                                                 |
| (reserved)      | 2       | 0x0     | (reserved)                                                                                                                                                                                                                                |
| KBDRST          | 1       | 0x0     | Keyboard interface reset<br>0: keyboard is not reset<br>1: keyboard is reset                                                                                                                                                              |
| GPIRST          | 0       | 0x0     | GENIO reset<br>0: GENIO not reset<br>1: GENIO is reset.                                                                                                                                                                                   |

**RSTINTCLR - Clear NO Init/Power-On Interrupt Register****Table 43. RSTINTCLR - Clear NO Init/Power-On Interrupt Register**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                              |
|-----------------|---------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RSTINTCLR       | 0x84    | W       | This register allows to de-assert the POR/No Init Interrupt set every time the device returns from RESET (either POR, HW or SW Reset), the IRQN line is assigned active (low) and the IRQST.PORIRQ bit is set. |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                                   |

**Table 43. RSTINTCLR - Clear NO Init/Power-On Interrupt Register (continued)**

| Register - Name | Address | Type | Register Function                                                            |
|-----------------|---------|------|------------------------------------------------------------------------------|
| reserved        | 7:1     |      | (reserved)                                                                   |
| IRQCLR          | 0       |      | 1: Clears the PORIRQ Interrupt signalled in IRQST register.<br>0: is ignored |

**CLKMODE - Clock Mode Register**
**Table 44. CLKMODE - Clock Mode Register**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                                                                       |
|-----------------|---------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CLKMODE         | 0x88    | R/W     | This register controls the current operating mode of the LM8328 device                                                                                                                                                                                  |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                                                                            |
| (reserved)      | 7:2     |         | (reserved)                                                                                                                                                                                                                                              |
| MODCTL[1:0]     | 1:0     | 0x01    | Writing to 00 forces the device to immediately enter sleep mode, regardless of any autosleep configuration. Reading this bit returns the current operating mode, which should always be 01.<br>00: SLEEP Mode<br>01: Operation Mode<br>1x: Future modes |

**CLKEN - Clock Enable Register**
**Table 45. CLKEN - Clock Enable Register**

| Register - Name | Address | Type    | Register Function                                                                                                              |
|-----------------|---------|---------|--------------------------------------------------------------------------------------------------------------------------------|
| CLKEN           | 0x8A    | R/W     | Controls the clock to different functional units. It shall be used to enable the functional blocks globally and independently. |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                   |
| (reserved)      | 7:3     |         | (reserved)                                                                                                                     |
| TIMEN           | 2       | 0x0     | PWM Timer 0, 1, 2 clock enable<br>0: Timer 0, 1, 2 clock disabled<br>1: Timer 0, 1, 2 clock enabled.                           |
| (reserved)      | 1       |         | (reserved)                                                                                                                     |
| KBDEN           | 0       | 0x0     | Keyboard clock enable (starts/stops key scan)<br>0: Keyboard clock disabled<br>1: Keyboard clock enabled                       |

**AUTOSLIP - Autosleep Enable Register**
**Table 46. AUTOSLIP - Autosleep Enable Register**

| Register - Name | Address | Type    | Register Function                                                                                                                                                        |
|-----------------|---------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AUTOSLP         | 0x8B    | R/W     | This register controls the Auto Sleep function of the LM8328 device                                                                                                      |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                             |
| (reserved)      | 7:1     |         | (reserved)                                                                                                                                                               |
| ENABLE          | 0       | 0x00    | Enables automatic sleep mode after a defined activity time stored in the AUTOSLPTI register<br>1: Enable entering auto sleep mode<br>0: Disable entering auto sleep mode |

**AUTOSLPTI - Auto Sleep Time Register****Table 47. AUTOSLPTI - Auto Sleep Time Register**

| Register - Name             | Address      | Type         | Register Function                                                                                                                                                                                                                 |
|-----------------------------|--------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AUTOSLPTIL<br>AUTOSLPTIH    | 0x8C<br>0x8D | R/W          | This register defines the activity time. If this time passes without any processing events then the device enters into sleep-mode, but only if AUTOSLP.ENABLE bit is set to 1.                                                    |
| Bit - Name                  | Bit          | Default      | Bit Function                                                                                                                                                                                                                      |
| (reserved)                  | 15:11        |              | (reserved)                                                                                                                                                                                                                        |
| UPTIME[10:8]<br>UPTIME[7:0] | 10:8<br>7:0  | 0x00<br>0xFF | Values of UPTIME[10:0] match to multiples of 4ms:<br>0x00: no autosleep, regardless if AUTOSLP.ENABLE is set<br>0x01: 4ms<br>0x02: 8ms<br>0x7A: 500 ms<br>0xFF: 1020 ms (default after reset)<br>0x100: 1024 ms<br>0x7FF: 8188 ms |

**IRQST - Global Interrupt Status Register****Table 48. IRQST - Global Interrupt Status Register**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                                                |
|-----------------|---------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IRQST           | 0x91    | R       | Returns the interrupt status from various on-chip function blocks. If any of the bits is set and an IRQN line is configured, the IRQN line is asserted active                                                                    |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                                                     |
| PORIRQ          | 7       | 0x1     | Supply failure on VCC.<br>Also power-on is considered as an initial supply failure. Therefore, after power-on, the bit is set.<br>0: no failure recorded<br>1: Failure, device was completely reset and requires re-programming. |
| KBDIRQ          | 6       | 0x0     | Keyboard interrupt (further key selection in keyboard module)<br>0: inactive<br>1: active                                                                                                                                        |
| (reserved)      | 5:4     |         | (reserved)                                                                                                                                                                                                                       |
| TIM2IRQ         | 3       | 0x0     | Timer2 expiry (CDIRQ or CYCIRQ)<br>0: inactive<br>1: active                                                                                                                                                                      |
| TIM1IRQ         | 2       | 0x0     | Timer1 expiry (CDIRQ or CYCIRQ)<br>0: inactive<br>1: active                                                                                                                                                                      |
| TIM0IRQ         | 1       | 0x0     | Timer0 expiry (CDIRQ or CYCIRQ)<br>0: inactive<br>1: active                                                                                                                                                                      |
| GPIOIRQ         | 0       | 0x0     | GPIO interrupt (further selection in GPIO module)<br>0: inactive<br>1: active                                                                                                                                                    |

**GPIO FEATURE CONFIGURATION****GPIO Feature Mapping**

The LM8328 has a flexible IO structure which allows to dynamically assign different functionality to each ball. The functionality of each ball is determined by the complete configuration of the balls.

In general the following priority is given:

- Keypad
- GPIO/PWM/Interrupt

With this, each ball will be available as GPIO, PWM or interrupt unless it is specified to be part of the keypad matrix. The configuration for keypad or PWM/interrupt usage is defined by the following registers:

- KBDSIZE and KBDEDCFG
  - Both registers define a ball as either part of the keypad matrix or as dedicated key input. These settings have highest priority and will overwrite settings made in other registers.
- IOCFG
  - This register is used to define the usage of KPY[11:8] if not configured to be part of the keymatrix, to be used as GPIO.

**Table 49. Ball Configuration Options**

| BALL            | Module connectivity       |            |                     |            |     |     |     |     |     |
|-----------------|---------------------------|------------|---------------------|------------|-----|-----|-----|-----|-----|
|                 | GPIOSEL                   | BALLCFG    |                     |            |     |     |     |     |     |
|                 |                           | 0x0        | 0x1                 | 0x2        | 0x3 | 0x4 | 0x5 | 0x6 | 0x7 |
| KPX[7:0]        | not used                  | GPIO[7:0]  |                     |            |     |     |     |     |     |
| KPY[7:0]        | not used                  | GPIO[15:8] |                     |            |     |     |     |     |     |
| KPY8/PWM2       | not used                  | GPIO16     | PWM2 <sup>(1)</sup> | (reserved) | -   | -   | -   | -   | -   |
| KPY9/PWM1       | not used                  | GPIO17     | PWM1                | -          | -   | -   | -   | -   | -   |
| KPY10/PWM0      | not used                  | GPIO18     | PWM0                | -          | -   | -   | -   | -   | -   |
| IRQN/KPY11/PWM2 | see <a href="#">IOCFG</a> | GPIO19     | PWM2 <sup>(1)</sup> | PWM2       | -   | -   | -   | -   | -   |

(1) **Note 1:** PWM2 functionality is mutually exclusive — one pin at a time only (KPX8 or KPY11) depending on interrupt enable Bit 4 of IOCFG.

### IOCGF - Input/Output Pin Mapping Configuration Register

**Table 50. IOCGF - Input/Output Pin Mapping Configuration Register**

| Register - Name | Address | Type    | Register Function                                                                                                                                          |
|-----------------|---------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IOCFG           | 0xA7    | W       | Configures usage of KPY[11:8] if not used for Keypad. On each write to this register, BALLCFG defines the column of <a href="#">Table 49</a> to configure. |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                               |
| GPIOSEL         | 7:4     |         | Configures the IRQN/KPY11/PWM2 ball<br>Bit 4: Interrupt enabled<br>Bit [7:5]: not used                                                                     |
| (reserved)      | 3       |         | (reserved)                                                                                                                                                 |
| BALLCFG         | 2:0     |         | Select column to configure, see <a href="#">Ball configuration options</a>                                                                                 |

### IOPC0 - Pull Resistor Configuration Register 0

**Table 51. IOPC0 - Pull Resistor Configuration Register 0**

| Register - Name | Address | Type    | Register Function                                                                                                                     |
|-----------------|---------|---------|---------------------------------------------------------------------------------------------------------------------------------------|
| IOPC0*          | 0xAA    | R/W     | Defines the pull resistor configuration for balls KPX[7:0]                                                                            |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                          |
| KPX7PR[1:0]     | 15:14   | 0x2     | Resistor enable for KPX7 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed |

**Table 51. IOPC0 - Pull Resistor Configuration Register 0 (continued)**

| Register - Name | Address | Type | Register Function                                                                                                                     |
|-----------------|---------|------|---------------------------------------------------------------------------------------------------------------------------------------|
| KPX6PR[1:0]     | 13:12   | 0x2  | Resistor enable for KPX6 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed |
| KPX5PR[1:0]     | 11:10   | 0x2  | Resistor enable for KPX5 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed |
| KPX4PR[1:0]     | 9:8     | 0x2  | Resistor enable for KPX4 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed |
| KPX3PR[1:0]     | 7:6     | 0x2  | Resistor enable for KPX3 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed |
| KPX2PR[1:0]     | 5:4     | 0x2  | Resistor enable for KPX2 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed |
| KPX1PR[1:0]     | 3:2     | 0x2  | Resistor enable for KPX1 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed |
| KPX0PR[1:0]     | 1:0     | 0x2  | Resistor enable for KPX0 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed |

**IOPC1 - Pull Resistor Configuration Register 1****Table 52. IOPC1 - Pull Resistor Configuration Register 1**

| Register - Name | Address | Type    | Register Function                                                                                                                     |
|-----------------|---------|---------|---------------------------------------------------------------------------------------------------------------------------------------|
| IOPC1**         | 0xAC    | R/W     | Defines the pull resistor configuration for balls KPY[7:0]                                                                            |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                          |
| KPY7PR[1:0]     | 15:14   | 0x1     | Resistor enable for KPY7 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed |
| KPY6PR[1:0]     | 13:12   | 0x1     | Resistor enable for KPY6 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed |
| KPY5PR[1:0]     | 11:10   | 0x1     | Resistor enable for KPY5 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed |

**Table 52. IOPC1 - Pull Resistor Configuration Register 1 (continued)**

| Register - Name | Address | Type | Register Function                                                                                                                     |
|-----------------|---------|------|---------------------------------------------------------------------------------------------------------------------------------------|
| KPY4PR[1:0]     | 9:8     | 0x1  | Resistor enable for KPY4 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed |
| KPY3PR[1:0]     | 7:6     | 0x1  | Resistor enable for KPY3 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed |
| KPY2PR[1:0]     | 5:4     | 0x1  | Resistor enable for KPY2 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed |
| KPY1PR[1:0]     | 3:2     | 0x1  | Resistor enable for KPY1 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed |
| KPY0PR[1:0]     | 1:0     | 0x1  | Resistor enable for KPY0 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed |

**IOPC2 - Pull Resistor Configuration Register 2**
**Table 53. IOPC2 - Pull Resistor Configuration Register 2**

| Register - Name | Address | Type    | Register Function                                                                                                                      |
|-----------------|---------|---------|----------------------------------------------------------------------------------------------------------------------------------------|
| IOPC2***        | 0xAE    | R/W     | Defines the pull resistor configuration for balls KPY[11:8]                                                                            |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                           |
| (reserved)      | 15:8    | 0x5A    | (reserved)                                                                                                                             |
| KPY11PR[1:0]    | 7:6     | 0x0     | Resistor enable for KPY11 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed |
| KPY10PR[1:0]    | 5:4     | 0x1     | Resistor enable for KPY10 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed |
| KPY9PR[1:0]     | 3:2     | 0x1     | Resistor enable for KPY9 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed  |
| KPY8PR[1:0]     | 1:0     | 0x1     | Resistor enable for KPY8 ball<br>00: no pull resistor at ball<br>01: pull down resistor programmed<br>1x: pull up resistor programmed  |

**GPIOOME0 - GPIO Open Drain Mode Enable Register 0****Table 54. GPIOOME0 - GPIO Open Drain Mode Enable Register 0**

| Register - Name | Address | Type    | Register Function                                                                                                           |
|-----------------|---------|---------|-----------------------------------------------------------------------------------------------------------------------------|
| GPIOOME0        | 0xE0    | R/W     | Configures KPX[7:0] for Open Drain or standard output functionality. The Open Drain drive source is configured by GPIOOMS0. |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                |
| KPX[7:0]ODE     | 7:0     | 0x0     | Open Drain Enable on KPX[7:0]<br>0: full buffer<br>1: open drain functionality                                              |

**GPIOOMS0 - GPIO Open Drain Mode Select Register 0****Table 55. GPIOOMS0 - GPIO Open Drain Mode Select Register 0**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                              |
|-----------------|---------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GPIOOMS0        | 0xE1    | R/W     | Configures the Open Drain drive source on KPX[7:0] if selected by GPIOOME0.                                                                                                                    |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                   |
| KPX[7:0]ODM     | 7:0     | 0x0     | 0: Only nmos transistor is active in output driver stage. Output can be driven to gnd or Hi-Z<br>1: Only pmos transistor is active in output driver stage. Output can be driven to VCC or Hi-Z |

**GPIOOME1 - GPIO Open Drain Mode Enable Register 1****Table 56. GPIOOME1 - GPIO Open Drain Mode Enable Register 1**

| Register - Name | Address | Type    | Register Function                                                                                                           |
|-----------------|---------|---------|-----------------------------------------------------------------------------------------------------------------------------|
| GPIOOME1        | 0xE2    | R/W     | Configures KPY[7:0] for Open Drain or standard output functionality. The Open Drain drive source is configured by GPIOOMS1. |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                |
| KPY[7:0]ODE     | 7:0     | 0x0     | Open Drain Enable on KPY[7:0]<br>0: full buffer<br>1: open drain functionality                                              |

**GPIOOMS1 - GPIO Open Drain Mode Select Register 1****Table 57. GPIOOMS1 - GPIO Open Drain Mode Select Register 1**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                              |
|-----------------|---------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GPIOOMS1        | 0xE3    | R/W     | Configures the Open Drain drive source on KPY[7:0] if selected by GPIOOME1.                                                                                                                    |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                   |
| KPY[7:0]ODM     | 7:0     | 0x0     | 0: Only nmos transistor is active in output driver stage. Output can be driven to gnd or Hi-Z<br>1: Only pmos transistor is active in output driver stage. Output can be driven to VCC or Hi-Z |

**GPIOOME2 - GPIO Open Drain Mode Enable Register 2****Table 58. GPIOOME2 - GPIO Open Drain Mode Enable Register 2**

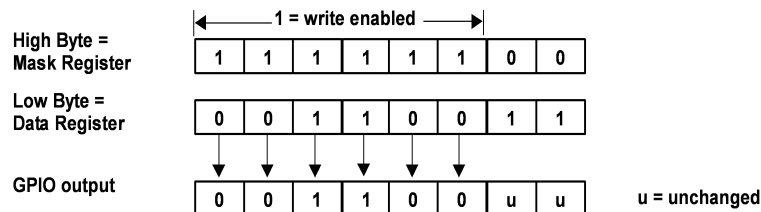
| Register - Name | Address | Type | Register Function                                                                                                            |
|-----------------|---------|------|------------------------------------------------------------------------------------------------------------------------------|
| GPIOOME2        | 0xE4    | R/W  | Configures KPY[11:8] for Open Drain or standard output functionality. The Open Drain drive source is configured by GPIOOMS2. |

**Table 58. GPIOOME2 - GPIO Open Drain Mode Enable Register 2 (continued)**

| Register - Name | Address | Type    | Register Function                                                                                                                                               |
|-----------------|---------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                    |
| (reserved)      | 7:4     | 0x0     | (reserved)                                                                                                                                                      |
| KPY[11:8]ODE    | 3:0     | 0x8     | Open Drain Enable on KPY[11:8]<br>0: full buffer<br>1: open drain functionality<br><b>Note:</b> KPY11/IRQN ball defaults to Open Drain Mode Enable after reset. |

**GPIOOMS2 - GPIO Open Drain Mode Select Register 2**
**Table 59. GPIOOMS2 - GPIO Open Drain Mode Select Register 2**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                              |
|-----------------|---------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GPIOOMS2        | 0xE5    | R/W     | Configures the Open Drain drive source on KPY[11:8] if selected by GPIOOME2.                                                                                                                   |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                   |
| (reserved)      | 7:4     |         | (reserved)                                                                                                                                                                                     |
| KPY[11:8]ODM    | 3:0     | 0x0     | 0: Only nmos transistor is active in output driver stage. Output can be driven to gnd or Hi-Z<br>1: Only pmos transistor is active in output driver stage. Output can be driven to VCC or Hi-Z |

**GPIO DATA INPUT/OUTPUT**

**GPIODATA0 - GPIO Data Register 0**
**Table 60. GPIODATA0 - GPIO Data Register 0**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------|---------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GPIODATA0       | 0xC0    | R/W     | This register is used for data input/output of KPX[7:0]. Every data I/O is masked with the associated MASK register.<br>If one of the I/Os is defined as output (see <a href="#">Table 63</a> ) values written to this register are masked with MASK and then applied to the associated pin.<br>If one of the I/Os is defined as input (see <a href="#">Table 63</a> ) values read from this register hold the masked input value of the associated pin. |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| MASK7           | 15      | 0x0     | Mask Status for KPX7 when enabled as GPIO<br>1: KPX7 enabled<br>0: KPX7 disabled                                                                                                                                                                                                                                                                                                                                                                         |
| MASK6           | 14      | 0x0     | Mask Status for KPX6 when enabled as GPIO<br>1: KPX6 enabled<br>0: KPX6 disabled                                                                                                                                                                                                                                                                                                                                                                         |
| MASK5           | 13      | 0x0     | Mask Status for KPX5 when enabled as GPIO<br>1: KPX5 enabled<br>0: KPX5 disabled                                                                                                                                                                                                                                                                                                                                                                         |

**Table 60. GPIOPDATA0 - GPIO Data Register 0 (continued)**

| Register - Name | Address | Type | Register Function                                                                |
|-----------------|---------|------|----------------------------------------------------------------------------------|
| MASK4           | 12      | 0x0  | Mask Status for KPX4 when enabled as GPIO<br>1: KPX4 enabled<br>0: KPX4 disabled |
| MASK3           | 11      | 0x0  | Mask Status for KPX3 when enabled as GPIO<br>1: KPX3 enabled<br>0: KPX3 disabled |
| MASK2           | 10      | 0x0  | Mask Status for KPX2 when enabled as GPIO<br>1: KPX2 enabled<br>0: KPX2 disabled |
| MASK1           | 9       | 0x0  | Mask Status for KPX1 when enabled as GPIO<br>1: KPX1 enabled<br>0: KPX1 disabled |
| MASK0           | 8       | 0x0  | Mask Status for KPX0 when enabled as GPIO<br>1: KPX0 enabled<br>0: KPX0 disabled |
| DATA7           | 7       | 0x0  | Pin Status for KPX7 when enabled as GPIO                                         |
| DATA6           | 6       | 0x0  | Pin Status for KPX6 when enabled as GPIO                                         |
| DATA5           | 5       | 0x0  | Pin Status for KPX5 when enabled as GPIO                                         |
| DATA4           | 4       | 0x0  | Pin Status for KPX4 when enabled as GPIO                                         |
| DATA3           | 3       | 0x0  | Pin Status for KPX3 when enabled as GPIO                                         |
| DATA2           | 2       | 0x0  | Pin Status for KPX2 when enabled as GPIO                                         |
| DATA1           | 1       | 0x0  | Pin Status for KPX1 when enabled as GPIO                                         |
| DATA0           | 0       | 0x0  | Pin Status for KPX0 when enabled as GPIO                                         |

**GPIOPDATA1 - GPIO Data Register 1****Table 61. GPIOPDATA1 - GPIO Data Register 1**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------|---------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GPIODATA1       | 0xC2    | R/W     | This register is used for data input/output of KPY[7:0]. Every data I/O is masked with the associated MASK register.<br>If one of the I/Os is defined as output (see <a href="#">Table 64</a> ) values written to this register are masked with MASK and then applied to the associated pin.<br>If one of the I/Os is defined as input (see <a href="#">Table 64</a> ) values read from this register hold the masked input value of the associated pin. |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| MASK15          | 15      | 0x0     | Mask Status for KPY7 when enabled as GPIO<br>1: KPY7 enabled<br>0: KPY7 disabled                                                                                                                                                                                                                                                                                                                                                                         |
| MASK14          | 14      | 0x0     | Mask Status for KPY6 when enabled as GPIO<br>1: KPY6 enabled<br>0: KPY6 disabled                                                                                                                                                                                                                                                                                                                                                                         |
| MASK13          | 13      | 0x0     | Mask Status for KPY5 when enabled as GPIO<br>1: KPY5 enabled<br>0: KPY5 disabled                                                                                                                                                                                                                                                                                                                                                                         |
| MASK12          | 12      | 0x0     | Mask Status for KPY4 when enabled as GPIO<br>1: KPY4 enabled<br>0: KPY4 disabled                                                                                                                                                                                                                                                                                                                                                                         |

**Table 61. GPIOPDATA1 - GPIO Data Register 1 (continued)**

| Register - Name | Address | Type | Register Function                                                                |
|-----------------|---------|------|----------------------------------------------------------------------------------|
| MASK11          | 11      | 0x0  | Mask Status for KPY3 when enabled as GPIO<br>1: KPY3 enabled<br>0: KPY3 disabled |
| MASK10          | 10      | 0x0  | Mask Status for KPY2 when enabled as GPIO<br>1: KPY2 enabled<br>0: KPY2 disabled |
| MASK9           | 9       | 0x0  | Mask Status for KPY1 when enabled as GPIO<br>1: KPY1 enabled<br>0: KPY1 disabled |
| MASK8           | 8       | 0x0  | Mask Status for KPY0 when enabled as GPIO<br>1: KPY0 enabled<br>0: KPY0 disabled |
| DATA15          | 7       | 0x0  | Pin Status for KPY7 when enabled as GPIO                                         |
| DATA14          | 6       | 0x0  | Pin Status for KPY6 when enabled as GPIO                                         |
| DATA13          | 5       | 0x0  | Pin Status for KPY5 when enabled as GPIO                                         |
| DATA12          | 4       | 0x0  | Pin Status for KPY4 when enabled as GPIO                                         |
| DATA11          | 3       | 0x0  | Pin Status for KPY3 when enabled as GPIO                                         |
| DATA10          | 2       | 0x0  | Pin Status for KPY2 when enabled as GPIO                                         |
| DATA9           | 1       | 0x0  | Pin Status for KPY1 when enabled as GPIO                                         |
| DATA8           | 0       | 0x0  | Pin Status for KPY0 when enabled as GPIO                                         |

**GPIOPDATA2 - GPIO Data Register 2**
**Table 62. GPIOPDATA2 - GPIO Data Register 2**

| Register - Name | Address | Type    | Register Function                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------|---------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GPIOPDATA2      | 0xC4    | R/W     | This register is used for data input/output of KPY[11:8]. Every data I/O is masked with the associated MASK register.<br>If one of the I/Os is defined as output (see <a href="#">Table 65</a> ) values written to this register are masked with MASK and then applied to the associated pin.<br>If one of the I/Os is defined as input (see <a href="#">Table 65</a> ) values read from this register hold the masked input value of the associated pin. |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| (reserved)      | 15:12   | 0x0     | (reserved)                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| MASK19          | 11      | 0x0     | Mask Status for KPY11 when enabled as GPIO<br>1: KPY11 enabled<br>0: KPY11 disabled                                                                                                                                                                                                                                                                                                                                                                       |
| MASK18          | 10      | 0x0     | Mask Status for KPY10 when enabled as GPIO<br>1: KPY10 enabled<br>0: KPY10 disabled                                                                                                                                                                                                                                                                                                                                                                       |
| MASK17          | 9       | 0x0     | Mask Status for KPY9 when enabled as GPIO<br>1: KPY9 enabled<br>0: KPY9 disabled                                                                                                                                                                                                                                                                                                                                                                          |
| MASK16          | 8       | 0x0     | Mask Status for KPY8 when enabled as GPIO<br>1: KPY8 enabled<br>0: KPY8 disabled                                                                                                                                                                                                                                                                                                                                                                          |
| reserved        | 7:4     | 0x0     | (reserved)                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| DATA19          | 3       | 0x0     | Pin Status for KPY11 when enabled as GPIO                                                                                                                                                                                                                                                                                                                                                                                                                 |
| DATA18          | 2       | 0x0     | Pin Status for KPY10 when enabled as GPIO                                                                                                                                                                                                                                                                                                                                                                                                                 |

**Table 62. GPIOPDATA2 - GPIO Data Register 2 (continued)**

| Register - Name | Address | Type | Register Function                        |
|-----------------|---------|------|------------------------------------------|
| DATA17          | 1       | 0x0  | Pin Status for KPY9 when enabled as GPIO |
| DATA16          | 0       | 0x0  | Pin Status for KPY8 when enabled as GPIO |

***GPIOPDIR0 - GPIO Port Direction Register 0*****Table 63. GPIOPDIR0 - GPIO Port Direction Register 0**

| Register - Name | Address | Type    | Register Function                                              |
|-----------------|---------|---------|----------------------------------------------------------------|
| GPIODIR0        | 0xC6    | R/W     | Port direction for KPX[7:0]                                    |
| Bit - Name      | Bit     | Default | Bit Function                                                   |
| KPX[7:0]DIR     | 7:0     | 0x00    | Direction bits for KPX[7:0]<br>0: input mode<br>1: output mode |

***GPIOPDIR1 - GPIO Port Direction Register 1*****Table 64. GPIOPDIR1 - GPIO Port Direction Register 1**

| Register - Name | Address | Type    | Register Function                                              |
|-----------------|---------|---------|----------------------------------------------------------------|
| GPIODIR1        | 0xC7    | R/W     | Port direction for KPY[7:0]                                    |
| Bit - Name      | Bit     | Default | Bit Function                                                   |
| KPY[7:0]DIR     | 7:0     | 0x00    | Direction bits for KPY[7:0]<br>0: input mode<br>1: output mode |

***GPIOPDIR2 - GPIO Port Direction Register 2*****Table 65. GPIOPDIR2 - GPIO Port Direction Register 2**

| Register - Name | Address | Type    | Register Function                                               |
|-----------------|---------|---------|-----------------------------------------------------------------|
| GPIODIR2        | 0xC8    | R/W     | Port direction for KPY[11:8]                                    |
| Bit - Name      | Bit     | Default | Bit Function                                                    |
| (reserved)      | 7:4     |         | (reserved)                                                      |
| KPY[11:8]DIR    | 3:0     | 0x08    | Direction bits for KPY[11:8]<br>0: input mode<br>1: output mode |

**GPIO INTERRUPT CONTROL*****GPIOIS0 - Interrupt Sense Configuration Register 0*****Table 66. GPIOIS0 - Interrupt Sense Configuration Register 0**

| Register - Name | Address | Type    | Register Function                                                                               |
|-----------------|---------|---------|-------------------------------------------------------------------------------------------------|
| GPIOIS0         | 0xC9    | R/W     | Interrupt type on KPX[7:0]                                                                      |
| Bit - Name      | Bit     | Default | Bit Function                                                                                    |
| KPX[7:0]IS      | 7:0     | 0x0     | Interrupt type bits for KPX[7:0]<br>0: edge sensitive interrupt<br>1: level sensitive interrupt |

***GPIOIS1 - Interrupt Sense Configuration Register 1***
**Table 67. GPIOIS1 - Interrupt Sense Configuration Register 1**

| Register - Name | Address | Type    | Register Function                                                                               |
|-----------------|---------|---------|-------------------------------------------------------------------------------------------------|
| GPIOIS1         | 0xCA    | R/W     | Interrupt type on KPY[7:0]                                                                      |
| Bit - Name      | Bit     | Default | Bit Function                                                                                    |
| KPY[7:0]IS      | 7:0     | 0x0     | Interrupt type bits for KPY[7:0]<br>0: edge sensitive interrupt<br>1: level sensitive interrupt |

***GPIOIS2 - Interrupt Sense Configuration Register 2***
**Table 68. GPIOIS2 - Interrupt Sense Configuration Register 2**

| Register - Name | Address | Type    | Register Function                                                                                |
|-----------------|---------|---------|--------------------------------------------------------------------------------------------------|
| GPIOIS2         | 0xCB    | R/W     | Interrupt type on KPY[11:8]                                                                      |
| Bit - Name      | Bit     | Default | Bit Function                                                                                     |
| (reserved)      | 7:4     |         | (reserved)                                                                                       |
| KPY[11:8]IS     | 3:0     | 0x0     | Interrupt type bits for KPY[11:8]<br>0: edge sensitive interrupt<br>1: level sensitive interrupt |

***GPIOIBE0 - GPIO Interrupt Edge Configuration Register 0***
**Table 69. GPIOIBE0 - GPIO Interrupt Edge Configuration Register 0**

| Register - Name | Address | Type    | Register Function                                                                                                                                 |
|-----------------|---------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| GPIOIBE0        | 0xCC    | R/W     | Defines whether an interrupt on KPX[7:0] is triggered on both edges or on a single edge. See <a href="#">Table 72</a> for the edge configuration. |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                      |
| KPX[7:0]IBE     | 7:0     | 0x0     | Interrupt both edges bits for KPX[7:0]<br>0: interrupt generated at the active edge<br>1: interrupt generated after both edges                    |

***GPIOIBE1 - GPIO Interrupt Edge Configuration Register 1***
**Table 70. GPIOIBE1 - GPIO Interrupt Edge Configuration Register 1**

| Register - Name | Address | Type    | Register Function                                                                                                                                 |
|-----------------|---------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| GPIOIBE1        | 0xCD    | R/W     | Defines whether an interrupt on KPY[7:0] is triggered on both edges or on a single edge. See <a href="#">Table 73</a> for the edge configuration. |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                      |
| KPY[7:0]IBE     | 7:0     | 0x0     | Interrupt both edges bits for KPY[7:0]<br>0: interrupt generated at the configured edge<br>1: interrupt generated after both edges                |

***GPIOIBE2 - GPIO Interrupt Edge Configuration Register 2***
**Table 71. GPIOIBE2 - GPIO Interrupt Edge Configuration Register 2**

| Register - Name | Address | Type    | Register Function                                                                                                                                  |
|-----------------|---------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| GPIOIBE2        | 0xCE    | R/W     | Defines whether an interrupt on KPY[11:8] is triggered on both edges or on a single edge. See <a href="#">Table 74</a> for the edge configuration. |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                       |

**Table 71. GPIOIBE2 - GPIO Interrupt Edge Configuration Register 2 (continued)**

| Register - Name | Address | Type | Register Function                                                                                                               |
|-----------------|---------|------|---------------------------------------------------------------------------------------------------------------------------------|
| (reserved)      | 7:4     |      | (reserved)                                                                                                                      |
| KPY[11:8]IBE    | 3:0     | 0x0  | Interrupt both edges bits for KPY[11:8]<br>0: interrupt generated at the active edge<br>1: interrupt generated after both edges |

**GPIOIEV0 - GPIO Interrupt Edge Select Register 0****Table 72. GPIOIEV0 - GPIO Interrupt Edge Select Register 0**

| Register - Name | Address | Type    | Register Function                                                                                                             |
|-----------------|---------|---------|-------------------------------------------------------------------------------------------------------------------------------|
| GPIOIEV0        | 0xCF    | R/W     | Select Interrupt edge for KPX[7:0].                                                                                           |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                  |
| KPX[7:0]EV      | 7:0     | 0xFF    | Interrupt edge select from KPX[7:0]<br>0: interrupt at low level or falling edge<br>1: interrupt at high level or rising edge |

**GPIOIEV1 - GPIO Interrupt Edge Select Register 1****Table 73. GPIOIEV1 - GPIO Interrupt Edge Select Register 1**

| Register - Name | Address | Type    | Register Function                                                                                                             |
|-----------------|---------|---------|-------------------------------------------------------------------------------------------------------------------------------|
| GPIOIEV1        | 0xD0    | R/W     | Select Interrupt edge for KPY[7:0].                                                                                           |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                  |
| KPY[7:0]EV      | 7:0     | 0xFF    | Interrupt edge select from KPY[7:0]<br>0: interrupt at low level or falling edge<br>1: interrupt at high level or rising edge |

**GPIOIEV2 - GPIO Interrupt Edge Select Register 2****Table 74. GPIOIEV2 - GPIO Interrupt Edge Select Register 2**

| Register - Name | Address | Type    | Register Function                                                                                                              |
|-----------------|---------|---------|--------------------------------------------------------------------------------------------------------------------------------|
| GPIOIEV2        | 0xD1    | R/W     | Select Interrupt edge for KPY[11:8].                                                                                           |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                   |
| (reserved)      | 7:4     |         | (reserved)                                                                                                                     |
| KPY[11:8]EV     | 3:0     | 0xFF    | Interrupt edge select from KPY[11:8]<br>0: interrupt at low level or falling edge<br>1: interrupt at high level or rising edge |

**GPIOIE0 - GPIO Interrupt Enable Register 0****Table 75. GPIOIE0 - GPIO Interrupt Enable Register 0**

| Register - Name | Address | Type    | Register Function                                                           |
|-----------------|---------|---------|-----------------------------------------------------------------------------|
| GPIOIE0         | 0xD2    | R/W     | Enable/disable interrupts on KPX[7:0]                                       |
| Bit - Name      | Bit     | Default | Bit Function                                                                |
| KPX[7:0]IE      | 7:0     | 0x0     | Interrupt enable on KPX[7:0]<br>0: disable interrupt<br>1: enable interrupt |

**GPIOIE1 - GPIO Interrupt Enable Register 1**
**Table 76. GPIOIE1 - GPIO Interrupt Enable Register 1**

| Register - Name | Address | Type    | Register Function                                                           |
|-----------------|---------|---------|-----------------------------------------------------------------------------|
| GPIOIE1         | 0xD3    | R/W     | Enable/disable interrupts on KPY[7:0]                                       |
| Bit - Name      | Bit     | Default | Bit Function                                                                |
| KPY[7:0]IE      | 7:0     | 0x0     | Interrupt enable on KPY[7:0]<br>0: disable interrupt<br>1: enable interrupt |

**GPIOIE2 - GPIO Interrupt Enable Register 2**
**Table 77. GPIOIE2 - GPIO Interrupt Enable Register 2**

| Register - Name | Address | Type    | Register Function                                                            |
|-----------------|---------|---------|------------------------------------------------------------------------------|
| GPIOIE2         | 0xD4    | R/W     | Enable/disable interrupts on KPY[11:8]                                       |
| Bit - Name      | Bit     | Default | Bit Function                                                                 |
| (reserved)      | 7:4     |         | (reserved)                                                                   |
| KPY[11:8]IE     | 3:0     | 0x0     | Interrupt enable on KPY[11:8]<br>0: disable interrupt<br>1: enable interrupt |

**GPIOIC0 - GPIO Clear Interrupt Register 0**
**Table 78. GPIOIC0 - GPIO Clear Interrupt Register 0**

| Register - Name | Address | Type    | Register Function                                                               |
|-----------------|---------|---------|---------------------------------------------------------------------------------|
| GPIOIC0         | 0xDC    | W       | Clears the interrupt on KPX[7:0]                                                |
| Bit - Name      | Bit     | Default | Bit Function                                                                    |
| KPX[7:0]IC      | 7:0     |         | Clear Interrupt on KPX[7:0]<br>0: no effect<br>1: Clear corresponding interrupt |

**GPIOIC1 - GPIO Clear Interrupt Register 1**
**Table 79. GPIOIC1 - GPIO Clear Interrupt Register 1**

| Register - Name | Address | Type    | Register Function                                                               |
|-----------------|---------|---------|---------------------------------------------------------------------------------|
| GPIOIC1         | 0xDD    | W       | Clears the interrupt on KPY[7:0]                                                |
| Bit - Name      | Bit     | Default | Bit Function                                                                    |
| KPY[7:0]IC      | 7:0     |         | Clear Interrupt on KPY[7:0]<br>0: no effect<br>1: Clear corresponding interrupt |

**GPIOIC2 - GPIO Clear Interrupt Register 2**
**Table 80. GPIOIC2 - GPIO Clear Interrupt Register 2**

| Register - Name | Address | Type    | Register Function                 |
|-----------------|---------|---------|-----------------------------------|
| GPIOIC2         | 0xDE    | W       | Clears the interrupt on KPY[11:8] |
| Bit - Name      | Bit     | Default | Bit Function                      |
| (reserved)      | 7:4     |         | (reserved)                        |

**Table 80. GPIOIC2 - GPIO Clear Interrupt Register 2 (continued)**

| Register - Name | Address | Type | Register Function                                                                |
|-----------------|---------|------|----------------------------------------------------------------------------------|
| KPY[11:8]IC     | 3:0     |      | Clear Interrupt on KPY[11:8]<br>0: no effect<br>1: Clear corresponding interrupt |

**GPIO INTERRUPT STATUS*****GPORIS0 - Raw Interrupt Status Register 0*****Table 81. GPORIS0 - Raw Interrupt Status Register 0**

| Register - Name | Address | Type    | Register Function                                                                                            |
|-----------------|---------|---------|--------------------------------------------------------------------------------------------------------------|
| GPORIS0         | 0xD6    | R       | Raw interrupt status on KPX[7:0]                                                                             |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                 |
| KPX[7:0]RIS     | 7:0     | 0x0     | Raw Interrupt status data on KPX[7:0]<br>0: no interrupt condition at GPIO<br>1: interrupt condition at GPIO |

***GPORIS1 - Raw Interrupt Status Register 1*****Table 82. GPORIS1 - Raw Interrupt Status Register 1**

| Register - Name | Address | Type    | Register Function                                                                                            |
|-----------------|---------|---------|--------------------------------------------------------------------------------------------------------------|
| GPORIS1         | 0xD7    | R       | Raw interrupt status on KPY[7:0]                                                                             |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                 |
| KPY[7:0]RIS     | 7:0     | 0x0     | Raw Interrupt status data on KPY[7:0]<br>0: no interrupt condition at GPIO<br>1: interrupt condition at GPIO |

***GPORIS2 - Raw Interrupt Status Register 2*****Table 83. GPORIS2 - Raw Interrupt Status Register 2**

| Register - Name | Address | Type    | Register Function                                                                                             |
|-----------------|---------|---------|---------------------------------------------------------------------------------------------------------------|
| GPORIS2         | 0xD8    | R       | Raw interrupt status on KPY[11:8]                                                                             |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                  |
| (reserved)      | 7:4     |         | (reserved)                                                                                                    |
| KPY[11:8]RIS    | 3:0     | 0x0     | Raw Interrupt status data on KPY[11:8]<br>0: no interrupt condition at GPIO<br>1: interrupt condition at GPIO |

***GPOMIS0 - Masked Interrupt Status Register 0*****Table 84. GPOMIS0 - Masked Interrupt Status Register 0**

| Register - Name | Address | Type    | Register Function                                                                                                 |
|-----------------|---------|---------|-------------------------------------------------------------------------------------------------------------------|
| GPOMIS0         | 0xD9    | R       | Masked interrupt status on KPX[7:0]                                                                               |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                      |
| KPX[7:0]MIS     | 7:0     | 0x0     | Masked Interrupt status data on KPX[7:0]<br>0: no interrupt contribution from GPIO<br>1: interrupt GPIO is active |

**GPIOMIS1 - Masked Interrupt Status Register 1**
**Table 85. GPIOMIS1 - Masked Interrupt Status Register 1**

| Register - Name | Address | Type    | Register Function                                                                                                 |
|-----------------|---------|---------|-------------------------------------------------------------------------------------------------------------------|
| GPIOMIS1        | 0xDA    | R       | Masked interrupt status on KPY[7:0]                                                                               |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                      |
| KPY[7:0]MIS     | 7:0     | 0x0     | Masked Interrupt status data on KPY[7:0]<br>0: no interrupt contribution from GPIO<br>1: interrupt GPIO is active |

**GPIOMIS2 - Masked Interrupt Status Register 2**
**Table 86. GPIOMIS2 - Masked Interrupt Status Register 2**

| Register - Name | Address | Type    | Register Function                                                                                                  |
|-----------------|---------|---------|--------------------------------------------------------------------------------------------------------------------|
| GPIOMIS2        | 0xDB    | R       | Masked interrupt status on KPY[11:8]                                                                               |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                       |
| (reserved)      | 7:4     |         | (reserved)                                                                                                         |
| KPY[11:8]MIS    | 3:0     | 0x0     | Masked Interrupt status data on KPY[11:8]<br>0: no interrupt contribution from GPIO<br>1: interrupt GPIO is active |

**GPIO WAKE-UP CONTROL**
**GPIOWAKE0 - GPIO Wake-Up Register 0**
**Table 87. GPIOWAKE0 - GPIO Wake-Up Register 0**

| Register - Name | Address | Type    | Register Function                                                                                                                                              |
|-----------------|---------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GPIOWAKE0       | 0xE9    | R/W     | Configures wake-up conditions for KPX[7:0]<br>Each bit corresponds to a ball. When bit set, the corresponding ball contributes to wakeup from auto sleep mode. |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                   |
| KPX[7:0]WAKE    | 7:0     | 0x0     | Bit 7: KPX7<br>...<br>Bit 0: KPX0                                                                                                                              |

**GPIOWAKE1 - GPIO Wake-Up Register 1**
**Table 88. GPIOWAKE1 - GPIO Wake-Up Register 1**

| Register - Name | Address | Type    | Register Function                                                                                                                                              |
|-----------------|---------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GPIOWAKE1       | 0xEA    | R/W     | Configures wake-up conditions for KPY[7:0]<br>Each bit corresponds to a ball. When bit set, the corresponding ball contributes to wakeup from auto sleep mode. |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                   |
| KPY[7:0]WAKE    | 7:00    | 0x0     | Bit 7: KPY7<br>...<br>Bit 0: KPY0                                                                                                                              |

**GPIOWAKE2 - GPIO Wake-Up Register 2****Table 89. GPIOWAKE2 - GPIO Wake-Up Register 2**

| Register - Name | Address | Type    | Register Function                                                                                                                                               |
|-----------------|---------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GPIOWAKE2       | 0xEB    | R/W     | Configures wake-up conditions for KPY[11:8]<br>Each bit corresponds to a ball. When bit set, the corresponding ball contributes to wakeup from auto sleep mode. |
| Bit - Name      | Bit     | Default | Bit Function                                                                                                                                                    |
| (reserved)      | 7:4     |         | (reserved)                                                                                                                                                      |
| KPY[11:8]WAKE   | 3:0     | 0x0     | Bit 3: KPY11<br>...<br>Bit 0: KPY8                                                                                                                              |



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

**ABSOLUTE MAXIMUM RATINGS <sup>(1)(2)</sup>**

|                                          |                       |                          |
|------------------------------------------|-----------------------|--------------------------|
| Supply Voltage ( $V_{CC}$ )              |                       | -0.3V to 2.2V            |
| Voltage at Generic IOs                   |                       | -0.2V to $V_{CC} + 0.2V$ |
| Voltage at Backdrive/Overvoltage IOs     |                       | -0.3V to +4.25V          |
| Maximum Input Current Without Latchup    |                       | ±100 mA                  |
| ESD Protection Level                     | (Human Body Model)    | 2kV                      |
|                                          | (Machine Model)       | 200V                     |
|                                          | (Charge Device Model) | 750V                     |
| Total Current into $V_{CC}$ Pin (Source) |                       | 100 mA                   |
| Total Current out of GND Pin (Sink)      |                       | 100 mA                   |
| Storage Temperature Range                |                       | -65°C to +140°C          |

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not ensured. For ensured specifications and test conditions, see the Electrical Characteristics tables.
- (2) If Military/Aerospace specified devices are required, please contact the TI Sales Office/ Distributors for availability and specifications.

**DC ELECTRICAL CHARACTERISTICS**

Datasheet min/max specification limits are specified by design, test, or statistical analysis.

(Temperature: -40°C ≤  $T_A$  ≤ +85°C, unless otherwise specified)

| Parameter                                             | Conditions                                                                                                                                 | Min  | Typ | Max  | Units |
|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|------|-----|------|-------|
| Operating Voltage ( $V_{CC}$ )                        | Core Supply Voltage                                                                                                                        | 1.62 |     | 1.98 | V     |
| Maximum Input voltage for Backdrive/Overvoltage IOs   |                                                                                                                                            |      |     | 3.60 | V     |
| Supply Current ( $I_{DD}$ ) <sup>(1)</sup>            | No loads on pins; Internal Clock = ON, all internal functional blocks running<br>$V_{CC} = 1.8V$ , $T_C = 0.5 \mu s$<br>$T_A = 25^\circ C$ |      | 1.9 | 3.0  | mA    |
| Sleep Mode HALT Current ( $I_{HALT}$ ) <sup>(2)</sup> | $V_{CC} = 1.8V$ , $T_A = 25^\circ C$ ; Internal Clock = OFF, no internal functional blocks running                                         |      | <9  | 40   | μA    |
| IDLE Current                                          | Internal Clock = ON, no internal functional blocks running                                                                                 |      | 1   |      | mA    |

- (1) Supply and IDLE current is measured with inputs connected to  $V_{CC}$  and outputs driven low but not connected to a load.
- (2) In sleep mode, the internal clock is switched off. Supply current in sleep mode is measured with inputs connected to  $V_{CC}$  and outputs driven low but not connected to a load.

## AC ELECTRICAL CHARACTERISTICS

(Temperature:  $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ )

Data sheet specification limits are specified by design, test, or statistical analysis.

| Parameter                                                                   | Conditions                                   | Min | Typ | Max     | Units         |
|-----------------------------------------------------------------------------|----------------------------------------------|-----|-----|---------|---------------|
| System Clock Frequency                                                      | Internal RC                                  |     | 21  |         | MHz           |
| System Clock Period (mclk)                                                  | $1.62\text{V} \leq V_{CC} \leq 1.98\text{V}$ |     | 48  |         | ns            |
| Internal RC Oscillator ( $t_C$ )                                            | $1.62\text{V} \leq V_{CC} \leq 1.98\text{V}$ |     | 0.5 |         | $\mu\text{s}$ |
| Internal RC Oscillator Frequency Variation                                  |                                              |     |     | $\pm 7$ | %             |
| ACCESS.bus Input Signals                                                    |                                              |     |     |         |               |
| Bus Free Time Between Stop and Start Condition ( $t_{BUF}$ ) <sup>(1)</sup> |                                              | 16  |     |         |               |
| SCL Setup Time ( $t_{CSTOSi}$ ) <sup>(1)</sup>                              | Before Stop Condition                        | 8   |     |         | mclk          |
| SCL Hold Time ( $t_{CSTRhi}$ ) <sup>(1)</sup>                               | After Start Condition                        | 8   |     |         |               |
| SCL Setup Time ( $t_{CSTRsi}$ ) <sup>(1)</sup>                              | Before Start Condition                       | 8   |     |         |               |
| Data High Setup Time ( $t_{DHCsi}$ ) <sup>(1)(2)</sup>                      | Before SCL Rising Edge (RE)                  | 2   |     |         |               |
| Data Low Setup Time ( $t_{DLCsi}$ ) <sup>(1)(2)</sup>                       | Before SCL RE                                | 2   |     |         |               |
| SCL Low Time ( $t_{SCLlowi}$ ) <sup>(1)</sup>                               | After SCL Falling Edge (FE)                  | 12  |     |         |               |
| SCL High Time ( $t_{SCLhighi}$ ) <sup>(1)(2)</sup>                          | After SCL FE                                 | 12  |     |         |               |
| SDA Hold Time ( $t_{SDAhi}$ ) <sup>(1)</sup>                                | After SCL FE                                 | 0   |     |         |               |
| SDA Setup Time ( $t_{SDAsi}$ ) <sup>(1)(2)</sup>                            | Before SCL RE                                | 2   |     |         |               |
| ACCESS.bus Output Signals                                                   |                                              |     |     |         |               |
| SDA Hold Time ( $t_{SDAho}$ ) <sup>(1)</sup>                                | After SCL Falling Edge                       | 2   |     |         | mclk          |

(1) Specified by design, not tested.

(2) The ACCESS.bus interface implements and meets the timings necessary for interface to the I<sup>2</sup>C and SMBus protocols at logic levels. The bus drivers have open-drain outputs for bidirectional operation. Due to Internal RC Oscillator Frequency Variation, this specification may not meet the AC timing and current/voltage drive requirements of the full-bus specifications.

## GENERAL GPIO CHARACTERISTICS

Characteristics for all pins except IRQN/KPY11/PWM2, SDA, and SCL in GPIO mode.

| Parameter                                                 | Conditions                                        | Min                 | Typ | Max                 | Units         |
|-----------------------------------------------------------|---------------------------------------------------|---------------------|-----|---------------------|---------------|
| $V_{IH}$ (Min. Input High Voltage)                        |                                                   | $0.7 \times V_{CC}$ |     |                     | V             |
| $V_{IL}$ (Max. Input Low Voltage)                         |                                                   |                     |     | $0.3 \times V_{CC}$ | V             |
| $I_{Source}$                                              | $V_{CC} = 1.62$<br>$V_{OH} = 0.7 \times V_{CC}$   |                     |     | -16                 | mA            |
| $I_{Sink}$                                                | $V_{CC} = 1.62$<br>$V_{OL} = 0.3 \times V_{CC}$   | 16                  |     |                     | mA            |
| Allowable Sink current per pin <sup>(1)</sup>             |                                                   |                     |     | 16                  | mA            |
| $I_{PU}$ (Weak Pull-UP Current) <sup>(2)</sup>            | $V_{OUT} = 0\text{V}$                             | -30                 |     | -160                | $\mu\text{A}$ |
| $I_{PD}$ (Weak Pull-Down Current) <sup>(2)</sup>          | $V_{OUT} = V_{CC}$                                | 30                  |     | 160                 |               |
| $I_{OZ}$ (Input Leakage Current)                          | GPIO output disabled<br>$V_{pin} = 0$ to $V_{CC}$ |                     |     | $\pm 2$             |               |
| $t_{Rise/Fall}$ (Max. Rise and Fall times) <sup>(3)</sup> | $C_{LOAD} = 50\text{ pF}$                         |                     |     | 15                  | ns            |

(1) The sum of all I/O sink/source current must not exceed the maximum total current into  $V_{CC}$  and out of GND as specified in the absolute maximum ratings.

(2) This is the internal weak pull-up (pull-down) current when driver output is disabled. If enabled, during receiving mode, this is the current required to switch the input from one state to another.

(3) Specified by design, not tested.

## BACKDRIVE/OVERVOLTAGE I/O DC CHARACTERISTICS

Characteristics for pins IRQN/KPY11/PWM2, SDA and SCL

| Parameter                                        | Conditions                                                                                                       | Min                 | Typ | Max                 | Units   |
|--------------------------------------------------|------------------------------------------------------------------------------------------------------------------|---------------------|-----|---------------------|---------|
| $V_{IH}$ (Min. Input High Voltage)               |                                                                                                                  | $0.7 \times V_{CC}$ |     |                     | V       |
| $V_{IL}$ (Max. Input Low Voltage)                |                                                                                                                  |                     |     | $0.3 \times V_{CC}$ |         |
| $I_{Source}$                                     | $V_{CC} = 1.62V$<br>$V_{OH} = 1.5V$                                                                              |                     |     | -6                  | mA      |
| $I_{Sink1}$ (as GPIO)                            | $V_{CC} = 1.62V$<br>$V_{OL} = 0.4V$                                                                              | 12                  |     |                     | mA      |
| $I_{Sink2}$ (as ACCESS.bus)                      | $V_{CC} = 1.62V$<br>$V_{OL} = 0.4V$                                                                              | 3                   |     |                     | mA      |
| $I_{Sink3}$ (as ACCESS.bus)                      | $V_{CC} = 1.62V$<br>$V_{OL} = 0.6V$                                                                              | 4                   |     |                     | mA      |
| Allowable Sink current per pin <sup>(1)</sup>    |                                                                                                                  |                     |     | 12                  | mA      |
| $I_{PU}$ (Weak Pull-UP Current) <sup>(2)</sup>   | $V_{OUT} = 0V$                                                                                                   | -7                  |     | -40                 | $\mu A$ |
| $I_{PD}$ (Weak Pull-Down Current) <sup>(2)</sup> | $V_{OUT} = V_{CC}$                                                                                               | 7                   |     | 40                  |         |
| $I_{OZ1}$ (Input Leakage Current)                | GPIO output disabled<br>$V_{CC} = 1.62V$ to $1.98V$<br>$V_{pin} = 0$ to $V_{CC}$<br>$V_{pin} = V_{CC}$ to $3.6V$ |                     |     | $\pm 2$<br>$\pm 10$ |         |
| $I_{OZ2}$ (Input Backdrive Leakage Current)      | $0 \leq V_{CC} \leq 0.5V$<br>$V_{pin} = 0$ to $3.6V$                                                             |                     |     | $\pm 10$            | $\mu A$ |

- (1) The sum of all I/O sink/source current must not exceed the maximum total current into  $V_{CC}$  and out of GND as specified in the absolute maximum ratings.
- (2) This is the internal weak pull-up (pull-down) current when driver output is disabled. If enabled, during receiving mode, this is the current required to switch the input from one state to another.

## BACKDRIVE/OVERVOLTAGE I/O AC CHARACTERISTICS

Characteristics for pins IRQN/KPY11/PWM2, SDA and SCL

| Parameter                                                                | Conditions                                                 | Min | Typ | Max | Units |
|--------------------------------------------------------------------------|------------------------------------------------------------|-----|-----|-----|-------|
| $t_{Rise/Fall}$ (Max. Rise and Fall time) <sup>(1)</sup>                 | $C_{LOAD} = 50$ pF @ 1MHz                                  |     |     | 70  | ns    |
| $t_{Fall}$ (Max. Fall time) as ACCESS.bus (SDA, SCL only) <sup>(1)</sup> | $C_{LOAD} = 10$ pF to 100 pF<br>$V_{IHmin}$ to $V_{ILmax}$ | 10  |     | 120 |       |

- (1) Specified by design, not tested.

## REGISTERS

### REGISTER MAPPING

#### KEYBOARD REGISTERS

shows the register map for keyboard functionality. In addition to Global Call Reset (see [GLOBAL INTERRUPT REGISTERS](#)) or Software Reset using SWRESET (see [Table 41](#)), these registers are reset to 0x00 values by a module reset using RSTCTRL.KBDRST and should be rewritten for desired settings (see [Table 42](#)).

**Register Map for Keyboard Functionality**

| Register Name | Description                    | Register File Address | Register Type | ACCESS Size | Default value | Next RF Address |
|---------------|--------------------------------|-----------------------|---------------|-------------|---------------|-----------------|
| KBDSETTLE     | Keypad Settle Time             | 0x01                  | R/W           | byte        | 0x80          | 0x02            |
| KBDBOUNCE     | Keypad Debounce Time           | 0x02                  | R/W           | byte        | 0x80          | 0x03            |
| KBDSIZE       | Keypad Size Configuration      | 0x03                  | R/W           | byte        | 0x22          | 0x04            |
| KBDEDCFG0     | Keypad Dedicated Key 0         | 0x04                  | R/W           | byte        | 0xFF          | 0x05            |
| KBDEDCFG1     | Keypad Dedicated Key 1         | 0x05                  | R/W           | byte        | 0xFF          | 0x06            |
| KBDRIS        | Keypad Raw Interrupt Status    | 0x06                  | R             | byte        | 0x00          | 0x07            |
| KBDMIS        | Keypad Masked Interrupt Status | 0x07                  | R             | byte        | 0x00          | 0x08            |
| KBDIC         | Keypad Interrupt Clear         | 0x08                  | W             | byte        |               | 0x09            |
| KBDMSK        | Keypad Interrupt Mask          | 0x09                  | R/W           | byte        | 0xF3          | 0x0A            |
| KBDCODE0      | Keypad Code 0                  | 0x0B                  | R             | byte        | 0x7F          | 0x0C            |
| KBDCODE1      | Keypad Code 1                  | 0x0C                  | R             | byte        | 0x7F          | 0x0D            |
| KBDCODE2      | Keypad Code 2                  | 0x0D                  | R             | byte        | 0x7F          | 0x0E            |
| KBDCODE3      | Keypad Code 3                  | 0x0E                  | R             | byte        | 0x7F          | 0x0F            |
| EVTCODE       | Key Event Code                 | 0x10                  | R             | byte        | 0x7F          | 0x10            |

#### PWM TIMER REGISTERS

shows the register map for PWM Timer functionality. In addition to Global Call Reset (see [Global Call Reset](#)) or Software Reset using SWRESET (see [Table 41](#)), these registers are reset to default values by a module reset using RSTCTRL.TIMRST (see [Table 42](#)).

**Register Map for PWM Timer Functionality**

| Register Name | Description               | Register File Address | Register Type | ACCESS Size | Default value | Next RF Address |
|---------------|---------------------------|-----------------------|---------------|-------------|---------------|-----------------|
| TIMCFG0       | PWM Timer Configuration 0 | 0x60                  | R/W           | byte        | 0x00          | 0x61            |
| PWMCFG0       | PWM Configuration 0       | 0x61                  | R/W           | byte        | 0x00          | 0x62            |
| TIMCFG1       | PWM Timer Configuration 1 | 0x68                  | R/W           | byte        | 0x00          | 0x69            |
| PWMCFG1       | PWM Configuration 1       | 0x69                  | R/W           | byte        | 0x00          | 0x6A            |
| TIMCFG2       | PWM Timer Configuration 2 | 0x70                  | R/W           | byte        | 0x00          | 0x71            |
| PWMCFG2       | PWM Configuration 2       | 0x71                  | R/W           | byte        | 0x00          | 0x72            |

### Register Map for PWM Timer Functionality (continued)

| Register Name | Description                  | Register File Address | Register Type | ACCESS Size | Default value | Next RF Address |
|---------------|------------------------------|-----------------------|---------------|-------------|---------------|-----------------|
| TIMSWRES      | PWM Timer SW Reset           | 0x78                  | W             | byte        |               | 0x79            |
| TIMRIS        | PWM Timer Interrupt Status   | 0x7A                  | R             | byte        | 0x00          | 0x7B            |
| TIMMIS        | PWM Timer Masked Int. Status | 0x7B                  | R             | byte        | 0x00          | 0x7C            |
| TIMIC         | Timer Interrupt Clear        | 0x7C                  | W             | byte        |               | 0x7D            |
| PWMWP         | PWM Command Write Pointer    | 0x7D                  | R/W           | byte        | 0x00          | 0x7E            |
| PWMCFG        | PWM Command Script           | 0x7E                  | W             | word        |               | 0x7F            |

## SYSTEM REGISTERS

shows the register map for general system registers. These registers are not affected by any of the module resets addressed by RSTCTRL (see [Table 42](#)). These registers can only be reset to default values by a Global Call Reset (see [Global Call Reset](#)) or by a complete Software Reset using SWRESET (see [Table 41](#)).

### Register Map for System Control Functionality

| Register Name | Description                                          | Register File Address | Register Type | ACCESS Size | Default value | Next RF Address |
|---------------|------------------------------------------------------|-----------------------|---------------|-------------|---------------|-----------------|
| I2CSA         | I <sup>2</sup> C-compatible ACCESS.bus Slave Address | 0x80                  | W             | byte        | 0x88          | 0x81            |
| MFGCODE       | Manufacturer Code                                    | 0x80                  | R             | byte        | 0x00          | 0x81            |
| SWREV         | SW Revision                                          | 0x81                  | R             | byte        | 0x83          | 0x82            |
| SWRESET       | SW Reset                                             | 0x81                  | W             | byte        |               | 0x82            |
| RSTCTRL       | System Reset                                         | 0x82                  | R/W           | byte        | 0x00          | 0x83            |
| RSTINTCLR     | Clear No Init/Power On Interrupt                     | 0x84                  | W             | byte        |               | 0x85            |
| CLKMODE       | Clock Mode                                           | 0x88                  | R/W           | byte        | 0x01          | 0x89            |
| CLKEN         | Clock Enable                                         | 0x8A                  | R/W           | byte        | 0x00          | 0x8B            |
| AUTOSLP       | Auto Sleep Enable                                    | 0x8B                  | R/W           | byte        | 0x00          | 0x8C            |
| AUTOSLPTI     | Auto Sleep Time                                      | 0x8C                  | R/W           | word        | 0x00FF        | 0x8D            |

## GLOBAL INTERRUPT REGISTERS

[Table 90](#) shows the register map for global interrupt functionality. In addition to Global Call Reset (see [Global Call Reset](#)) or Software Reset using SWRESET (see [Table 41](#)), these registers are reset to default values by a module reset using RSTCTRL.IRQRST (see [Table 42](#)).

**Table 90. Register Map for Global Interrupt Functionality**

| Register Name | Description             | Register File Address | Register Type | ACCESS Size | Default value | Next RF Address |
|---------------|-------------------------|-----------------------|---------------|-------------|---------------|-----------------|
| IRQRST        | Global Interrupt Status | 0x91                  | R             | byte        | 0x80          | 0x92            |

## GPIO REGISTERS

shows the register map for GPIO functionality. In addition to Global Call Reset (see [Global Call Reset](#)) or Software Reset using SWRESET (see [Table 41](#)), these registers are reset to 0x00 values by a module reset using RSTCTRL.GPIRST and should be rewritten for desired settings (see [Table 42](#)).

**Register Map for GPIO Functionality**

| Register Name | Description                   | Register File Address | Register Type | ACCESS Size | Default value | Next RF Address |
|---------------|-------------------------------|-----------------------|---------------|-------------|---------------|-----------------|
| IOCFG         | I/O Pin Mapping Configuration | 0xA7                  | W             | byte        |               | 0xA8            |
| IOPC0         | Pull Resistor Configuration 0 | 0xAA                  | R/W           | word        | 0xAAAA        | 0xAB            |
| IOPC1         | Pull Resistor Configuration 1 | 0xAC                  | R/W           | word        | 0x5555        | 0xAD            |
| IOPC2         | Pull Resistor Configuration 2 | 0xAE                  | R/W           | word        | 0x5A15        | 0xAF            |
| GPIODATA0     | GPIO I/O Data 0               | 0xC0                  | R/W           | byte        | 0x00          | 0xC1            |
| GPIONMASK0    | GPIO I/O Mask 0               | 0xC1                  | W             | byte        |               | 0xC2            |
| GPIODATA1     | GPIO I/O Data 1               | 0xC2                  | R/W           | byte        | 0x00          | 0xC3            |
| GPIONMASK1    | GPIO I/O Mask 1               | 0xC3                  | W             | byte        |               | 0xC4            |
| GPIODATA2     | GPIO I/O Data 2               | 0xC4                  | R/W           | byte        | 0x00          | 0xC5            |
| GPIONMASK2    | GPIO I/O Mask 2               | 0xC5                  | W             | byte        |               | 0xC6            |
| GPIODIR0      | GPIO I/O Direction 0          | 0xC6                  | R/W           | byte        | 0x00          | 0xC7            |
| GPIODIR1      | GPIO I/O Direction 1          | 0xC7                  | R/W           | byte        | 0x00          | 0xC8            |
| GPIODIR2      | GPIO I/O Direction 2          | 0xC8                  | R/W           | byte        | 0x08          | 0xC9            |
| GPIOIS0       | GPIO Int Sense Config 0       | 0xC9                  | R/W           | byte        | 0x00          | 0xCA            |
| GPIOIS1       | GPIO Int Sense Config 1       | 0xCA                  | R/W           | byte        | 0x00          | 0xCB            |
| GPIOIS2       | GPIO Int Sense Config 2       | 0xCB                  | R/W           | byte        | 0x00          | 0xCC            |
| GPIOIBE0      | GPIO Int Both Edges Config 0  | 0xCC                  | R/W           | byte        | 0x00          | 0xCD            |
| GPIOIBE1      | GPIO Int Both Edges Config 1  | 0xCD                  | R/W           | byte        | 0x00          | 0xCE            |
| GPIOIBE2      | GPIO Int Both Edges Config 2  | 0xCE                  | R/W           | byte        | 0x00          | 0xCF            |
| GPIOIEV0      | GPIO Int Edge Select 0        | 0xCF                  | R/W           | byte        | 0xFF          | 0xD0            |
| GPIOIEV1      | GPIO Int Edge Select 1        | 0xD0                  | R/W           | byte        | 0xFF          | 0xD1            |
| GPIOIEV2      | GPIO Int Edge Select 2        | 0xD1                  | R/W           | byte        | 0xFF          | 0xD2            |
| GPIOIE0       | GPIO Interrupt Enable 0       | 0xD2                  | R/W           | byte        | 0x00          | 0xD3            |
| GPIOIE1       | GPIO Interrupt Enable 1       | 0xD3                  | R/W           | byte        | 0x00          | 0xD4            |
| GPIOIE2       | GPIO Interrupt Enable 2       | 0xD4                  | R/W           | byte        | 0x00          | 0xD5            |
| GPORIS0       | GPIO Raw Int Status 0         | 0xD6                  | R             | byte        | 0x00          | 0xD7            |
| GPORIS1       | GPIO Raw Int Status 1         | 0xD7                  | R             | byte        | 0x00          | 0xD8            |
| GPORIS2       | GPIO Raw Int Status 2         | 0xD8                  | R             | byte        | 0x00          | 0xD9            |
| GPOMIS0       | GPIO Masked Int Status 0      | 0xD9                  | R             | byte        | 0x00          | 0xDA            |
| GPOMIS1       | GPIO Masked Int Status 1      | 0xDA                  | R             | byte        | 0x00          | 0xDB            |

**Register Map for GPIO Functionality (continued)**

| Register Name | Description                   | Register File Address | Register Type | ACCESS Size | Default value | Next RF Address |
|---------------|-------------------------------|-----------------------|---------------|-------------|---------------|-----------------|
| GPIOMIS2      | GPIO Masked Int Status 2      | 0xDB                  | R             | byte        | 0x00          | 0xDC            |
| GPIOIC0       | GPIO Interrupt Clear 0        | 0xDC                  | W             | byte        |               | 0xDD            |
| GPIOIC1       | GPIO Interrupt Clear 1        | 0xDD                  | W             | byte        |               | 0xDE            |
| GPIOIC2       | GPIO Interrupt Clear 2        | 0xDE                  | W             | byte        |               | 0xDF            |
| GPIOOME0      | GPIO Open Drain Mode Enable 0 | 0xE0                  | R/W           | byte        | 0x00          | 0xE1            |
| GPIOOMS0      | GPIO Open Drain Mode Select 0 | 0xE1                  | R/W           | byte        | 0x00          | 0xE2            |
| GPIOOME1      | GPIO Open Drain Mode Enable 1 | 0xE2                  | R/W           | byte        | 0x00          | 0xE3            |
| GPIOOMS1      | GPIO Open Drain Mode Select 1 | 0xE3                  | R/W           | byte        | 0x00          | 0xE4            |
| GPIOOME2      | GPIO Open Drain Mode Enable 2 | 0xE4                  | R/W           | byte        | 0x08          | 0xE5            |
| GPIOOMS2      | GPIO Open Drain Mode Select 2 | 0xE5                  | R/W           | byte        | 0x00          | 0xE6            |
| GPIOWAKE0     | GPIO Wakeup Enable 0          | 0xE9                  | R/W           | byte        | 0x00          | 0xEA            |
| GPIOWAKE1     | GPIO Wakeup Enable 1          | 0xEA                  | R/W           | byte        | 0x00          | 0xEB            |
| GPIOWAKE2     | GPIO Wakeup Enable 2          | 0xEB                  | R/W           | byte        | 0x00          | 0xEC            |

**REGISTER LAYOUT - Control Bits in LM8328 Registers**

| Register   | Addr. | BIT 7     | BIT 6     | BIT 5     | BIT 4        | BIT 3       | BIT 2     | BIT 1     | BIT 0     |
|------------|-------|-----------|-----------|-----------|--------------|-------------|-----------|-----------|-----------|
| KBDSETTLE  | 0x01  | Wait[7:0] |           |           |              |             |           |           |           |
| KBDBOUNCE  | 0x02  | Wait[7:0] |           |           |              |             |           |           |           |
| KBDSIZE    | 0x03  | ROW-SIZE3 | ROW-SIZE2 | ROW-SIZE1 | ROW-SIZE0    | COL-SIZE3   | COL-SIZE2 | COL-SIZE1 | COL-SIZE0 |
| KBDDCDCFG0 | 0x04  | COL9      | COL8      | COL7      | COL6         | COL5        | COL4      | COL3      | COL2      |
| KBDDCDCFG1 | 0x05  | ROW7      | ROW6      | ROW5      | ROW4         | ROW3        | ROW2      | COL11     | COL10     |
| KBDRIS     | 0x06  |           |           |           |              | RELINT      | REVTINT   | RKLINT    | RSINT     |
| KBDMIS     | 0x07  |           |           |           |              | MELINT      | MEVTINT   | MKLINT    | MSINT     |
| KBDIC      | 0x08  | SFOFF     |           |           |              |             |           | EVTIC     | KBDIC     |
| KBDMASK    | 0x09  |           |           |           |              | MSKELINT    | MSKEINT   | MSKLINT   | MSKSINT   |
| KBDCODE0   | 0x0B  | MULTIKEY  | KEYROW2   | KEYROW1   | KEYROW0      | KEYCOL3     | KEYCOL2   | KEYCOL1   | KEYCOL0   |
| KBDCODE1   | 0x0C  | MULTIKEY  | KEYROW2   | KEYROW1   | KEYROW0      | KEYCOL3     | KEYCOL2   | KEYCOL1   | KEYCOL0   |
| KBDCODE2   | 0x0D  | MULTIKEY  | KEYROW2   | KEYROW1   | KEYROW0      | KEYCOL3     | KEYCOL2   | KEYCOL1   | KEYCOL0   |
| KBDCODE3   | 0x0E  | MULTIKEY  | KEYROW2   | KEYROW1   | KEYROW0      | KEYCOL3     | KEYCOL2   | KEYCOL1   | KEYCOL0   |
| EVTCODE    | 0x10  | RELEASE   | KEYROW2   | KEYROW1   | KEYROW0      | KEYCOL3     | KEYCOL2   | KEYCOL1   | KEYCOL0   |
| TIMCFG0    | 0x60  |           |           |           | CICIRQ0-MASK |             |           |           | START     |
| PWMCFG0    | 0x61  |           |           |           |              | CDIRQ0-MASK | PGE       | PWMEN     | PWMPOL    |
| TIMCFG1    | 0x68  |           |           |           | CYIRQ1-MASK  |             |           |           | START     |

**REGISTER LAYOUT - Control Bits in LM8328 Registers (continued)**

| Register         | Addr. | BIT 7          | BIT 6      | BIT 5        | BIT 4   | BIT 3       | BIT 2          | BIT 1        | BIT 0   |
|------------------|-------|----------------|------------|--------------|---------|-------------|----------------|--------------|---------|
| PWMCFG1          | 0x69  |                |            |              |         | CDIRQ1-MASK | PGE            | PWMEN        | PWMPOL  |
| TIMCFG2          | 0x70  |                |            |              | IRQMASK |             |                |              | START   |
| PWMCFG2          | 0x71  |                |            |              |         | CDIRQ2-MASK | PGE            | PWMEN        | PWMPOL  |
| TIMSWRES         | 0x78  |                |            |              |         |             | SWRES2         | SWRES1       | SWRES0  |
| TIMRIS           | 0x7A  |                |            | CDIRQ2       | CDIRQ1  | CDIRQ0      | CICIRQ2        | CICIRQ1      | CICIRQ0 |
| TIMMIS           | 0x7B  |                |            | CDIRQ2       | CDIRQ1  | CDIRQ0      | CICIRQ2        | CICIRQ1      | CICIRQ0 |
| TIMIC            | 0x7C  |                |            | CDIRQ2       | CDIRQ1  | CDIRQ0      | CICIRQ2        | CICIRQ1      | CICIRQ0 |
| PWMWP            | 0x7D  | 0              | PWMWP[6:0] |              |         |             |                |              |         |
| PWMCFG (Low)     | 0x7E  | CMD[7:0]       |            |              |         |             |                |              |         |
| PWMCFG (High)    | 0x7F  | CMD[15:8]      |            |              |         |             |                |              |         |
| I2CSA            | 0x80  | SLAVEADDR[7:1] |            |              |         |             |                |              | 0       |
| MFGCODE          | 0x80  | MFGBIT[7:0]    |            |              |         |             |                |              |         |
| SWREV            | 0x81  | SWBIT[7:0]     |            |              |         |             |                |              |         |
| SWRESET          | 0x81  | SWBIT[7:0]     |            |              |         |             |                |              |         |
| RSTCTRL          | 0x82  |                |            |              | IRQRST  | TIMRST      |                | KBDRST       | GPIRST  |
| RSTINTCLR        | 0x84  |                |            |              |         |             |                |              | IRQCLR  |
| CLKMODE          | 0x88  |                |            |              |         |             |                | MOD-CTL[1:0] |         |
| CLKEN            | 0x8A  | CLKOUTEN[1:0]  |            |              |         |             | TIMEN          |              | KB DEN  |
| AUTOSLP          | 0x8B  |                |            |              |         |             |                |              | ENABLE  |
| AUTOSLPTI (Low)  | 0x8C  | UP-TIME [7:0]  |            |              |         |             |                |              |         |
| AUTOSLPTI (High) | 0x8D  |                |            |              |         |             | UP-TIME [10:8] |              |         |
| IRQST            | 0x91  | PORIRQ         | KBD1RQ     |              |         | TIM2IRQ     | TIM1IRQ        | TIM01RQ      | GPIIRQ  |
| IOCFG            | 0xA7  | IOCFGPM [7:0]  |            |              |         |             |                |              |         |
| IOPC0 (Low)      | 0xAA  | KPX3PR[1:0]    |            | KPX2PR[1:0]  |         | KPX1PR[1:0] |                | KPX0PR[1:0]  |         |
| IOPC0 (High)     | 0xAB  | KPX7PR[1:0]    |            | KPX6PR[1:0]  |         | KPX5PR[1:0] |                | KPX4PR[1:0]  |         |
| IOPC1 (Low)      | 0xAC  | KPY3PR[1:0]    |            | KPY2PR[1:0]  |         | KPY1PR[1:0] |                | KPY0PR[1:0]  |         |
| IOPC1 (High)     | 0xAD  | KPY7PR[1:0]    |            | KPY6PR[1:0]  |         | KPY5PR[1:0] |                | KPY4PR[1:0]  |         |
| IOPC2 (Low)      | 0xAE  | KPY11PR[1:0]   |            | KPY10PR[1:0] |         | KPY9PR[1:0] |                | KPY8PR[1:0]  |         |
| IOPC2 (High)     | 0xAF  |                |            |              |         |             |                |              |         |
| GPIODATA0        | 0xC0  | DATA7          | DATA6      | DATA5        | DATA4   | DATA3       | DATA2          | DATA1        | DATA0   |
| GPIOMASK0        | 0xC1  | MASK7          | MASK6      | MASK5        | MASK4   | MASK3       | MASK2          | MASK1        | MASK0   |
| GPIODATA1        | 0xC2  | DATA15         | DATA14     | DATA13       | DATA12  | DATA11      | DATA10         | DATA9        | DATA8   |
| GPIOMASK1        | 0xC3  | MASK15         | MASK14     | MASK13       | MASK12  | MASK11      | DATA10         | DATA9        | DATA8   |
| GPIODATA2        | 0xC4  |                |            |              |         | DATA19      | DATA18         | DATA17       | DATA16  |
| GPIOMASK2        | 0xC5  |                |            |              |         | MASK19      | MASK18         | MASK17       | MASK16  |
| GPIODIR0         | 0xC6  | KPX7DIR        | KPX6DIR    | KPX5DIR      | KPX4DIR | KPX3DIR     | KPX2DIR        | KPX1DIR      | KPX0DIR |
| GPIODIR1         | 0xC7  | KPY7DIR        | KPY6DIR    | KPY5DIR      | KPY4DIR | KPY3DIR     | KPY2DIR        | KPY1DIR      | KPY0DIR |
| GPIODIR2         | 0xC8  |                |            |              |         | KP11DIR     | KPY10DIR       | KPY9DIR      | KPY8DIR |
| GPIOIS0          | 0xC9  | KPX7IS         | KPX6IS     | KPX5IS       | KPX4IS  | KPX3IS      | KPX2IS         | KPX1IS       | KPX0IS  |
| GPIOIS1          | 0xCA  | KPY7IS         | KPY6IS     | KPY5IS       | KPY4IS  | KPY3IS      | KPY2IS         | KPY1IS       | KPY0IS  |
| GPIOIS2          | 0xCB  |                |            |              |         | KPY11IS     | KPY10IS        | KPY9IS       | KPY8IS  |
| GPIOIBE0         | 0xCC  | KPX7IBE        | KPX6IBE    | KPX5IBE      | KPX4IBE | KPX3IBE     | KPX2IBE        | KPX1IBE      | KPX0IBE |
| GPIOIBE1         | 0xCD  | KPY7IBE        | KPY6IBE    | KPY5IBE      | KPY4IBE | KPY3IBE     | KPY2IBE        | KPY1IBE      | KPY0IBE |

**REGISTER LAYOUT - Control Bits in LM8328 Registers (continued)**

| Register  | Addr. | BIT 7     | BIT 6     | BIT 5     | BIT 4     | BIT 3      | BIT 2      | BIT 1     | BIT 0     |
|-----------|-------|-----------|-----------|-----------|-----------|------------|------------|-----------|-----------|
| GPIOIBE2  | 0xCE  |           |           |           |           | KPY11IBE   | KPY10IBE   | KPY9IBE   | KPY8IBE   |
| GPIOIEV0  | 0xCF  | KPX7EV    | KPX6EV    | KPX5EV    | KPX4EV    | KPX3EV     | KPX2EV     | KPX1EV    | KPX0EV    |
| GPIOIEV1  | 0xD0  | KPY7EV    | KPY6EV    | KPY5EV    | KPY4EV    | KPY3EV     | KPY2EV     | KPY1EV    | KPY0EV    |
| GPIOIEV2  | 0xD1  |           |           |           |           | KPY11IEV   | KPY10IEV   | KPY9IEV   | KPY8IEV   |
| GPIOIE0   | 0xD2  | KPX7IE    | KPX6IE    | KPX5IE    | KPX4IE    | KPX3IE     | KPX2IE     | KPX1IE    | KPX0IE    |
| GPIOIE1   | 0xD3  | KPY7IE    | KPY6IE    | KPY5IE    | KPY4IE    | KPY3IE     | KPY2IE     | KPY1IE    | KPY0IE    |
| GPIOIE2   | 0xD4  |           |           |           |           | KPY11IE    | KPY10IE    | KPY9IE    | KPY8IE    |
| GPORIS0   | 0xD6  | KPX7RIS   | KPX6RIS   | KPX5RIS   | KPX4RIS   | KPX3RIS    | KPX2RIS    | KPX1RIS   | KPX0RIS   |
| GPORIS1   | 0xD7  | KPY7RIS   | KPY6RIS   | KPY5RIS   | KPY4RIS   | KPY3RIS    | KPY2RIS    | KPY1RIS   | KPY0RIS   |
| GPORIS2   | 0xD8  |           |           |           |           | KPY11RIS   | KPY10RIS   | KPY9RIS   | KPY8RIS   |
| GPIOMIS0  | 0xD9  | KPX7MIS   | KPX6MIS   | KPX5MIS   | KPX4MIS   | KPX3MIS    | KPX2MIS    | KPX1MIS   | KPX0MIS   |
| GPIOMIS1  | 0xDA  | KPY7MIS   | KPY6MIS   | KPY5MIS   | KPY4MIS   | KPY3MIS    | KPY2MIS    | KPY1MIS   | KPY0MIS   |
| GPIOMIS2  | 0xDB  |           |           |           |           | KPY11MIS   | KPY10MIS   | KPY9MIS   | KPY8MIS   |
| GPIOIC0   | 0xDC  | KPX7IC    | KPX6IC    | KPX5IC    | KPX4IC    | KPX3IC     | KPX2IC     | KPX1IC    | KPX0IC    |
| GPIOIC1   | 0xDD  | KPY7IC    | KPY6IC    | KPY5IC    | KPY4IC    | KPY3IC     | KPY2IC     | KPY1IC    | KPY0IC    |
| GPIOIC2   | 0xDE  |           |           |           |           | KPY11IC    | KPY10IC    | KPY9IC    | KPY8IC    |
| GPIOOME0  | 0xE0  | KPX7ODE   | KPX6ODE   | KPX5ODE   | KPX4ODE   | KPX3ODE    | KPX2ODE    | KPX1ODE   | KPX0ODE   |
| GPIOOMS0  | 0xE1  | KPX7ODM   | KPX6ODM   | KPX5ODM   | KPX4ODM   | KPX3ODM    | KPX2ODM    | KPX1ODM   | KPX0ODM   |
| GPIOOME1  | 0xE2  | KPY7ODE   | KPY6ODE   | KPY5ODE   | KPY4ODE   | KPY3ODE    | KPY2ODE    | KPY1ODE   | KPY0ODE   |
| GPIOOMS1  | 0xE3  | KPY7ODM   | KPY6ODM   | KPY5ODM   | KPY4ODM   | KPY3ODM    | KPY2ODM    | KPY1ODM   | KPY0ODM   |
| GPIOOME2  | 0xE4  |           |           |           |           | KPY11ODE   | KPY10ODE   | KPY9ODE   | KPY8ODE   |
| GPIOOMS2  | 0xE5  |           |           |           |           | KPY11ODM   | KPY10ODM   | KPY9ODM   | KPY8ODM   |
| GPIOWAKE0 | 0xE9  | KPX7 WAKE | KPX6 WAKE | KPX5 WAKE | KPX4 WAKE | KPX3 WAKE  | KPX2 WAKE  | KPX1 WAKE | KPX0 WAKE |
| GPIOWAKE1 | 0xEA  | KPY7 WAKE | KPY6 WAKE | KPY5 WAKE | KPY4 WAKE | KPY3 WAKE  | KPY2 WAKE  | KPY1 WAKE | KPY0 WAKE |
| GPIOWAKE2 | 0xEB  |           |           |           |           | KPY11 WAKE | KPY10 WAKE | KPY9 WAKE | KPY8 WAKE |

## REVISION HISTORY

| Changes from Original (March 2013) to Revision A           | Page               |
|------------------------------------------------------------|--------------------|
| • Changed layout of National Data Sheet to TI format ..... | <a href="#">48</a> |

## PACKAGING INFORMATION

| Orderable part number          | Status<br>(1) | Material type<br>(2) | Package   Pins   | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|--------------------------------|---------------|----------------------|------------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| <a href="#">LM8328TME/NOPB</a> | Active        | Production           | DSBGA (YFQ)   25 | 250   SMALL T&R       | Yes         | SNAGCU                               | Level-1-260C-UNLIM                | -40 to 85    | 2731                |
| LM8328TME/NOPB.A               | Active        | Production           | DSBGA (YFQ)   25 | 250   SMALL T&R       | Yes         | SNAGCU                               | Level-1-260C-UNLIM                | -40 to 85    | 2731                |
| LM8328TMX/NOPB                 | Active        | Production           | DSBGA (YFQ)   25 | 3000   LARGE T&R      | Yes         | SNAGCU                               | Level-1-260C-UNLIM                | -40 to 85    | 2731                |
| LM8328TMX/NOPB.A               | Active        | Production           | DSBGA (YFQ)   25 | 3000   LARGE T&R      | Yes         | SNAGCU                               | Level-1-260C-UNLIM                | -40 to 85    | 2731                |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

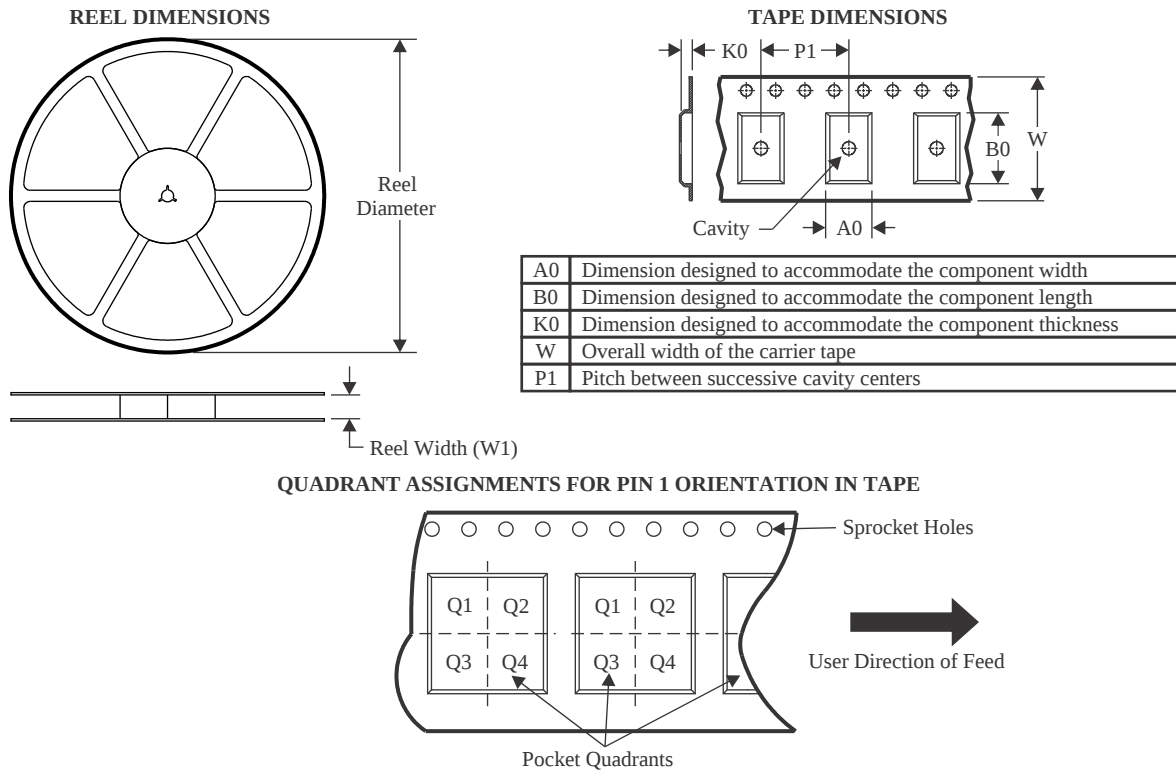
<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "-" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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## TAPE AND REEL INFORMATION



\*All dimensions are nominal

| Device         | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| LM8328TME/NOPB | DSBGA        | YFQ             | 25   | 250  | 178.0              | 8.4                | 2.08    | 2.08    | 0.76    | 4.0     | 8.0    | Q1            |
| LM8328TMX/NOPB | DSBGA        | YFQ             | 25   | 3000 | 178.0              | 8.4                | 2.08    | 2.08    | 0.76    | 4.0     | 8.0    | Q1            |

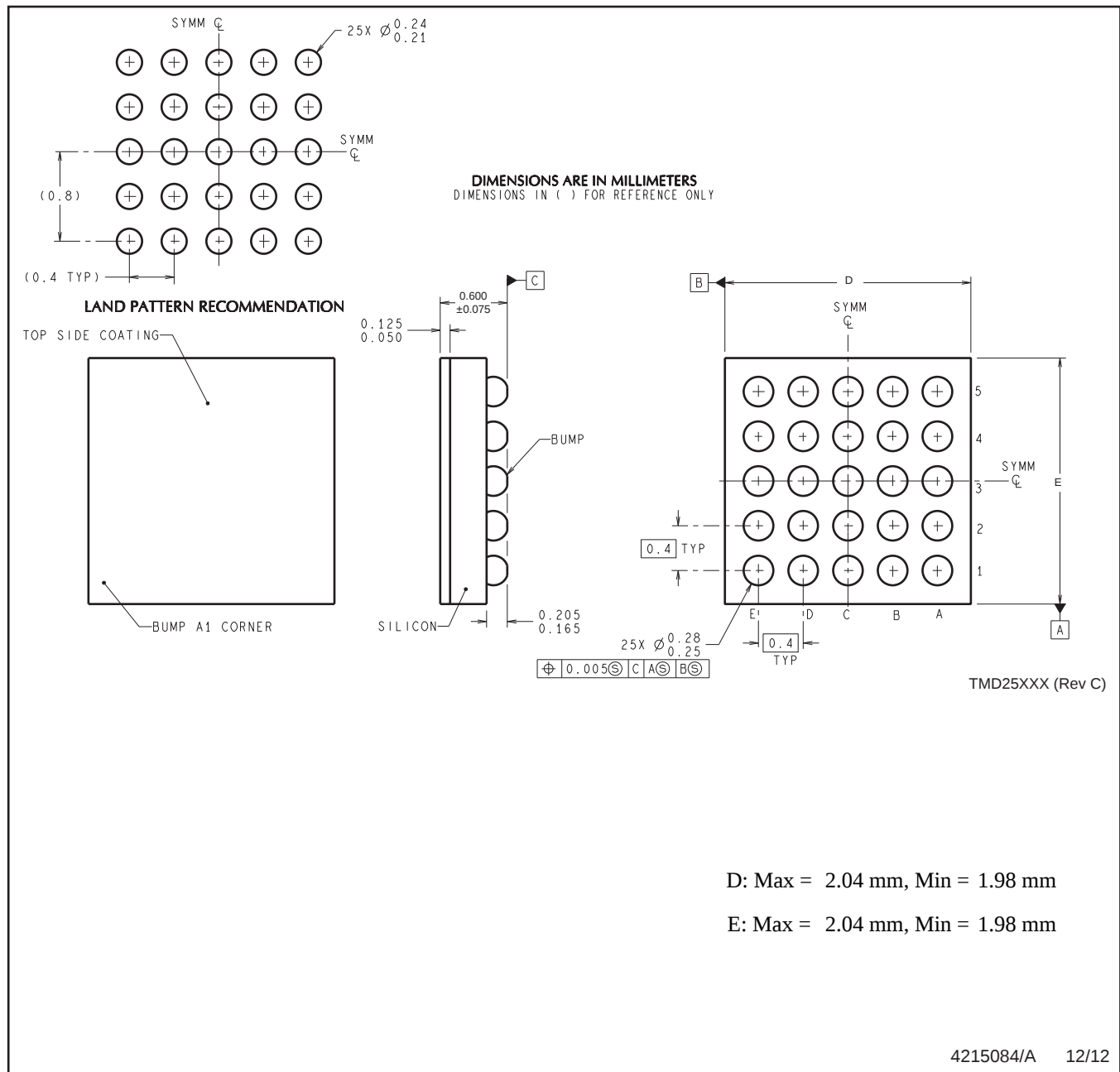
## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device         | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| LM8328TME/NOPB | DSBGA        | YFQ             | 25   | 250  | 208.0       | 191.0      | 35.0        |
| LM8328TMX/NOPB | DSBGA        | YFQ             | 25   | 3000 | 208.0       | 191.0      | 35.0        |

YFQ0025



NOTES: A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.  
B. This drawing is subject to change without notice.

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