



General Description

The MxL82404 is an 8-bit GPIO expander with an SPI interface. After power-up, the MxL82404 has internal 100K ohm pull-up resistors on each I/O pin that can be individually enabled.

In addition, the GPIOs on the MxL82404 can individually be controlled and configured. As outputs, the GPIOs can be outputs that are high, low, or in three-state mode. The three-state mode feature is useful for applications where the power is removed from the remote devices, but they may still be connected to the GPIO expander.

As inputs, the internal pull-up resistors can be enabled or disabled and the input polarity can be inverted. The interrupt can be programmed for different behaviors. The interrupts can be programmed to generate an interrupt on the rising edge, falling edge, or on both edges. The interrupt can be cleared if the input changes back to its original state or by reading the current state of the inputs.

The MxL82404 is available in 16-pin QFN and 16-pin TSSOP packages.

Applications

- Personal digital assistants (PDA)
- Cellular phones/Data devices
- Battery-Operated devices
- Global Positioning System (GPS)
- Bluetooth

Features

- 1.62V to 5.5V operating voltage
- Integrated level shifters
- 8 General purpose I/Os (GPIOs)
- Maximum stand-by current of 1 μ A at +1.8V
- SPI bus interface
 - SPI Clock frequency up to 26MHz
- Individually programmable inputs
 - Internal pull-up resistors
 - Polarity inversion
 - Individual interrupt enable
 - Rising edge and/or falling edge interrupt
 - Input filter
- Individually programmable outputs
 - Output level control
 - Output three-state control
- Open-drain active low interrupt output
- 3kV HBM ESD protection per *JESD22-A114F*
- 200mA latch-up performance per *JESD78B*

Revision History

Document No.	Release Date	Change Description
305DSR00	May 20, 2026	Initial preliminary release.

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Specifications

Absolute Maximum Ratings

Important: The stresses above what is listed under the following table may cause permanent damage to the device. This is a stress rating only—functional operation of the device above what is listed under the following table or any other conditions beyond what MaxLinear recommends is not implied. Exposure to conditions above the recommended extended periods of time may affect device reliability. Solder reflow profile is specified in the *IPC/JEDEC J-STD-020C* standard.

Table 1: Absolute Maximum Ratings

Parameter	Minimum	Maximum	Unit
Power Supply Voltage	-	6	V
Supply Current	-	160	mA
Ground Current	-	200	mA
External Current limit of each GPIO	-	25	mA
Total Current limit for GPIO[7:0]	-	100	mA
Total Supply Current sourced by all GPIOs	-	160	mA
Operating Temperature	-40	+85	°C
Storage Temperature	-65	+150	°C
Power Dissipation	-	200	mW

Electrical Characteristics

DC Electrical Characteristics

Unless otherwise noted, $T_A = -40^\circ$ to $+85^\circ\text{C}$, V_{CC} is from 1.62V to 5.5V.

Table 2: DC Electrical Characteristics

Symbol	Parameter	Limits $1.8\text{V} \pm 10\%$		Limits $2.5\text{V} \pm 10\%$		Limits $3.3\text{V} \pm 10\%$		Limits $5.0\text{V} \pm 10\%$		Units	Conditions
		Min	Max	Min	Max	Min	Max	Min	Max		
V_{IL}	Input Low Voltage	-0.3	0.2	-0.3	0.5	-0.3	0.8	-	$0.3 \times V_{CC}$	V	Note 1
V_{IH}	Input High Voltage	1.4	5.5	1.8	5.5	$0.7 \times V_{CC}$	5.5	$0.7 \times V_{CC}$	-	V	Note 1
V_{OL}	Output Low Voltage	-	0.4	-	0.4	-	0.4	-	0.4	V V V	$I_{OL} = 1.5\text{mA}$ $I_{OL} = 4\text{mA}$ $I_{OL} = 6\text{mA}$ Note 2 and Note 4
V_{OL}	Output Low Voltage	-	0.5	-	0.5	-	0.5	-	0.5	V	$I_{OL} = 8\text{mA}$ Note 3
V_{OH}	Output High Voltage	1.4	-	1.8	-	2.0	-	2.0	-	V V V	$I_{OL} = -0.2\text{mA}$ $I_{OL} = -2\text{mA}$ $I_{OL} = -4\text{mA}$ Note 2
V_{OH}	Output High Voltage	1.2	-	1.8	-	2.6	-	4.1	-	V	$I_{OH} = -8\text{mA}$ Note 3
I_{IL}	Input Low Leakage Current	-	± 10	-	± 10	-	± 10	-	± 10	μA	-
I_{IH}	Input High Leakage Current	-	± 10	-	± 10	-	± 10	-	± 10	μA	-
C_{IN}	Input Pin Capacitance	-	5	-	5	-	5	-	5	pF	-
I_{CC}	Power Supply Current	-	0.5	-	1.0	-	2.0	-	4	μA	Note 5
I_{CC}	Power Supply Current	-	0.6	-	1.2	-	2.4	-	5	μA	Note 6
I_{CCS}	Standby Current	-	1	-	2	-	5	-	7	μA	Note 7
R_{GPIO}	GPIO Pull-up Resistance	60	140	60	140	60	140	60	140	$\text{k}\Omega$	$100\text{k}\Omega \pm 40\%$
$R_{RESET\#}$	Reset# Pull-up Resistance	30	85	35	85	35	85	35	85	$\text{k}\Omega$	$60\text{k}\Omega \pm 40\%$

1. For SPI input signals (SI, SCK) AND GPIOs, A0, A1, and A2 signals.

2. For SPI output signal SO.

3. For GPIOs.

4. For IRQ# signal.

5. Test 1: SCL frequency is 10MHz with internal pull-ups disabled. All GPIOs are configured as inputs. All inputs are steady at VCC or GND. Outputs are floating or in the tri-state mode.

6. Test 2: SCL frequency is 10MHz with internal pull-ups enabled. All GPIOs are configured as inputs. All inputs are steady at VCC or GND. Outputs are floating or in the tri-state mode.

7. Test 3: All inputs are steady at VCC or GND to minimize standby current. If internal pull-up is enabled, input voltage level should be the same as VCC. SCL, and SI are at GND. CS# is at VCC. All GPIOs are configured as inputs. Outputs are left floating or in tri-state mode.

AC Electrical Characteristics

Unless otherwise noted, $T_A = -40^{\circ}$ to $+85^{\circ}\text{C}$, V_{CC} is from 1.62V to 5.5V.

Table 3: AC Electrical Characteristics

Symbol	Parameter	Limits 1.8V±10%			Limits 2.5V±10%			Limits 3.3V±10%			Limits 5V±10%			Unit	Conditions
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max		
f_{SCL}	Operating Frequency	-	-	15	-	-	26	-	-	26	-	-	26	MHz	
T_{CSS}	CS# to SCL Setup Time	20	-	-	20	-	-	20	-	-	20	-	-	ns	
T_{CSH}	CS# to SCL Hold Time	20	-	-	20	-	-	20	-	-	20	-	-	ns	
T_{DO}	SCL Fall to SO Valid Time	-	-	30	-	-	17	-	-	17	-	-	17	ns	$C_L = 30\text{ pF}$
T_{DS}	SI to SCL Setup Time	20	-	-	20	-	-	20	-	-	20	-	-	ns	
T_{DH}	SI to SCL Hold Time	20	-	-	20	-	-	20	-	-	20	-	-	ns	
T_{CP}	SCL Period	66	-	-	38	-	-	38	-	-	38	-	-	ns	$T_{CH} + T_{CL}$
T_{CH}	SCL HIGH Time	35	-	-	20	-	-	20	-	-	20	-	-	ns	
T_{CL}	SCL LOW Time	35	-	-	20	-	-	20	-	-	20	-	-	ns	
T_{CSW}	CS# HIGH Pulse Width	30	-	-	30	-	-	30	-	-	30	-	-	ns	
T_{D9}	SPI Output Data Valid Time	-	10	-	-	10	-	-	10	-	-	10	-	ns	
T_{D13}	SPI Input Pin Interrupt Clear	-	-	200	-	-	200	-	-	200	-	-	200	ns	

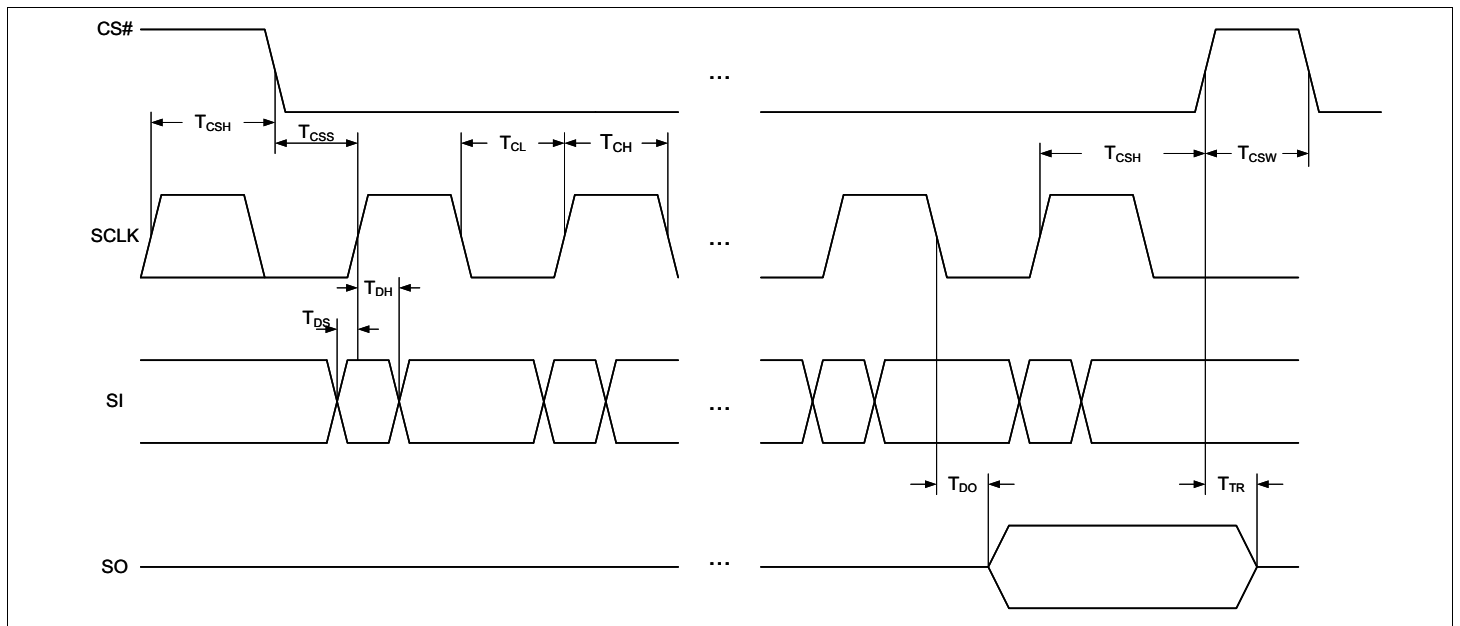


Figure 1: SPI-Bus Timing

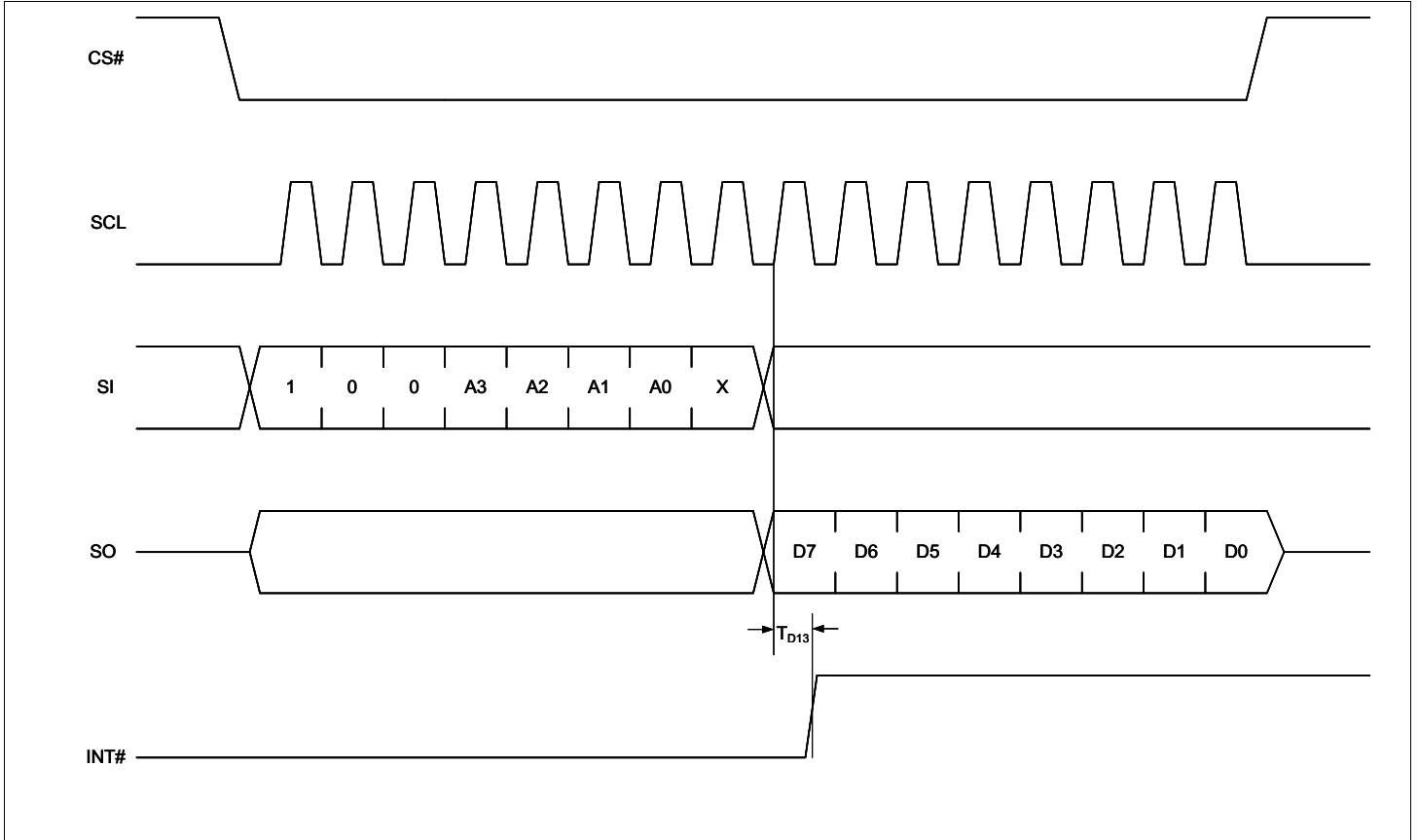


Figure 2: Read Input Port to Clear GPIO INT

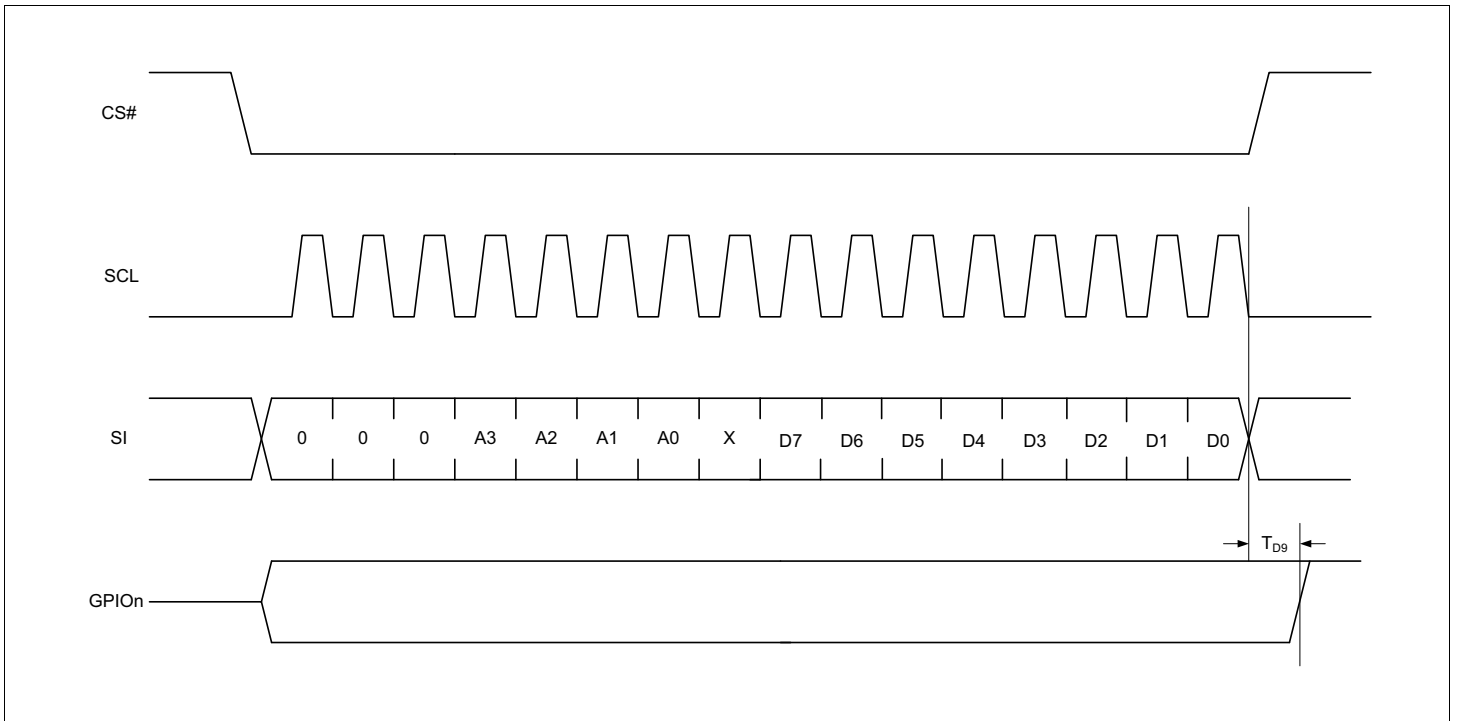


Figure 3: SPI Write out to GPIO Switch

Pin Configuration

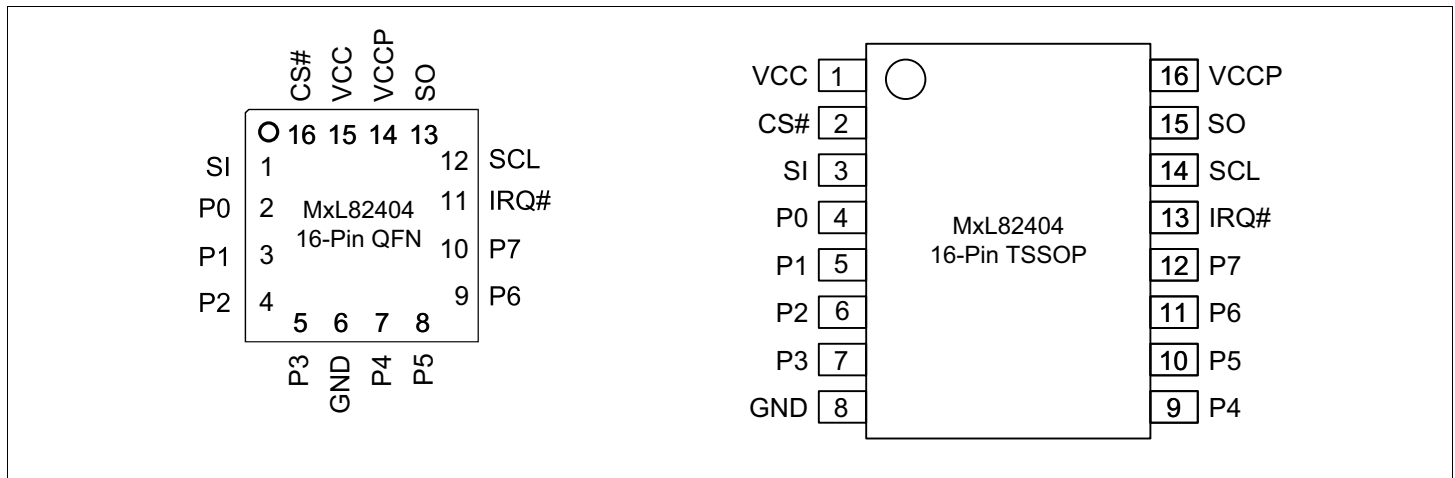


Figure 4: Pin Configuration (Top View)

Pin Description

Table 4: Pin Description

Name	QFN-16 Pin#	TSSOP-16 Pin#	Type	Description
SPI Interface				
SO	13	15	O	SPI serial data output.
SCL	12	14	I	SPI serial input clock.
IRQ#	11	13	OD	Interrupt output (open-drain, active LOW).
CS#	16	2	I	SPI bus chip select.
SI	1	3	I	SPI serial data input.
GPIOs				
P0	2	4	I/O	General purpose I/Os P0-P7. All GPIOs are configured as inputs upon power-up.
P1	3	5	I/O	
P2	4	6	I/O	
P3	5	7	I/O	
P4	7	9	I/O	
P5	8	10	I/O	
P6	9	11	I/O	
P7	10	12	I/O	
Ancillary Signals				
VCCP	14	16	Pwr	1.62V to 5.5V VCC supply voltage for GPIOs.
VCC	15	1	Pwr	1.62V to 5.5V VCC supply voltage for SPI bus interface.
GND	6	8	Pwr	Power supply common, ground.
GND	Center Pad	-	Pwr	The exposed pad at the bottom surface of the package is designed for thermal performance. Use of a center pad on the PCB is strongly recommended for thermal conductivity as well as to provide mechanical stability of the package on the PCB. The center pad is recommended to be solder masked defined with opening size less than or equal to the exposed thermal pad on the package bottom to prevent solder bridging to the outer leads of the device. Thermal vias must be connected to GND plane as the thermal pad of package is at GND potential.

Note: Pin type: I = Input, O = Output, I/O = Input/Output, OD = Output Open Drain.

Block Diagram

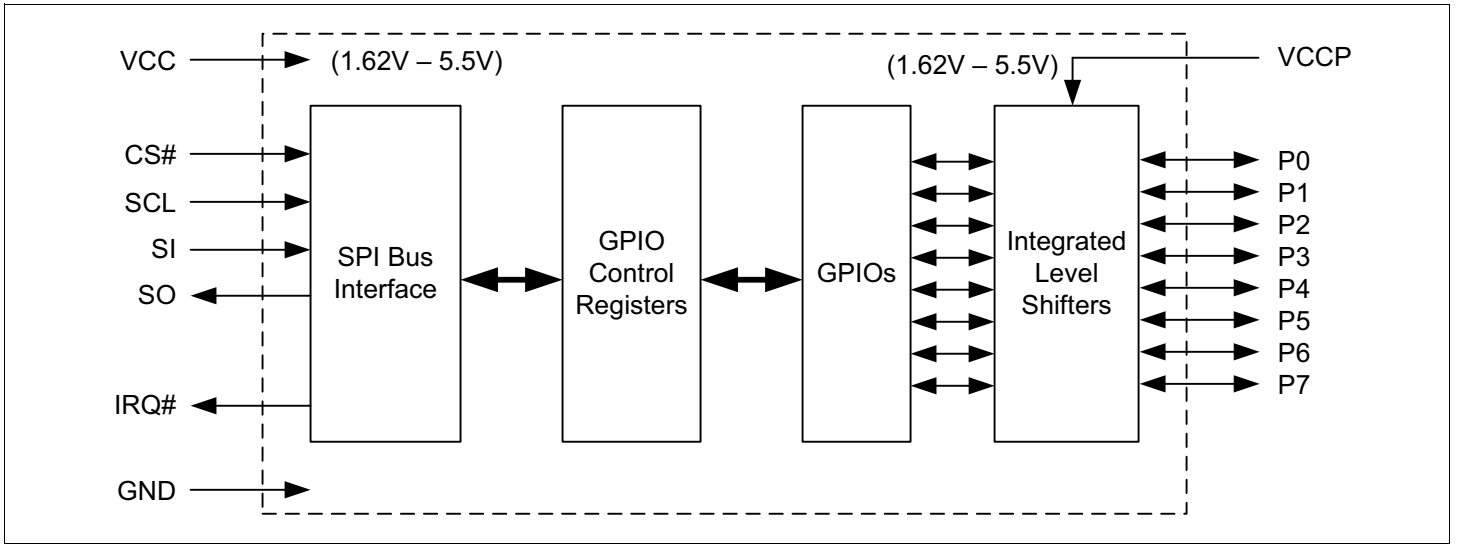


Figure 5: Functional Block Diagram

Functional Description

SPI-Bus Interface

The SPI interface consists of four lines: serial clock (SCL), chip select (CS#), slave output (SO), and slave input (SI). The serial clock, slave output and slave input can be as fast as 26MHz. To access the device in the SPI mode, the CS# signal is asserted by the SPI master, then the SPI master starts toggling the SCL signal with the appropriate transaction information. The first bit sent by the SPI master includes whether it is a read or write transaction and the register being accessed. See the following table.

Table 5: SPI Command Byte Format

Bit	Function
7	Read/Write# Logic 1 = Read Logic 0 = Write
6:1	Command Byte
0	Reserved

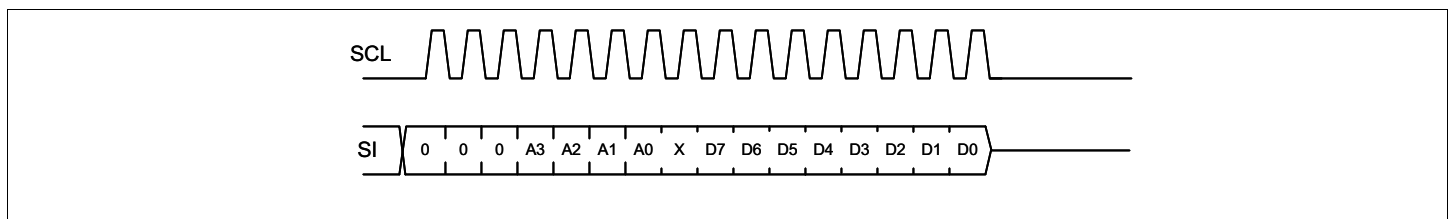


Figure 6: Master Writes To Slave

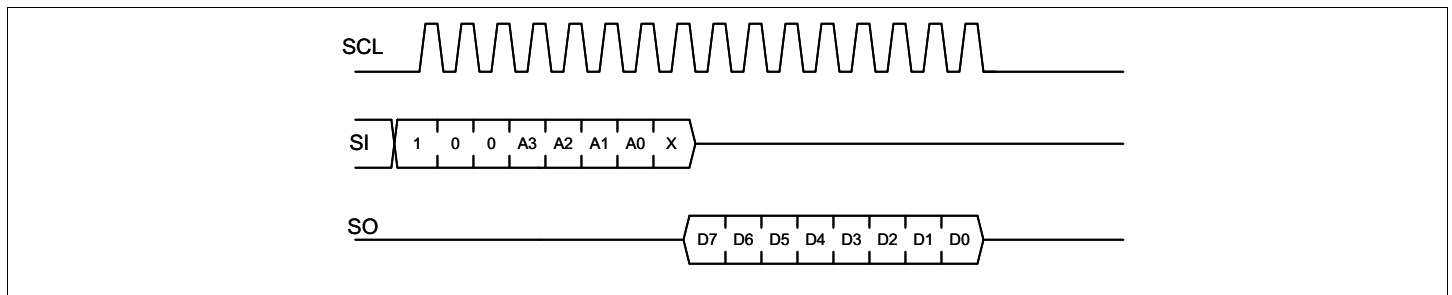


Figure 7: Master Reads From Slave

SPI Command Byte

An SPI command byte is sent by the SPI master following the slave address. The command byte indicates the address offset of the register that is accessed. The following table lists the command bytes for each register.

Table 6: SPI Command Byte (Register Address)

Command Byte	Register Name Description	Read/Write	Default Values
0x00	GSR - GPIO State	Read-Only	0xFF
0x01	OCR - Output Control	Read/Write	0xFF
0x02	PIR - Input Polarity Inversion	Read/Write	0x00
0x03	GCR - GPIO Configuration	Read/Write	0xFF
0x04	PUR - Input Internal Pull-up Resistor Enable/Disable	Read/Write	0x00
0x05	IER - Input Interrupt Enable	Read/Write	0x00
0x06	TSCR - Output Three-State Control	Read/Write	0x00
0x07	ISR - Input Interrupt Status	Read	0x00
0x08	REIR - Input Rising Edge Interrupt Enable	Read/Write	0x00
0x09	FEIR - Input Falling Edge Interrupt Enable	Read/Write	0x00
0x0A	IFR - Input Filter Enable/Disable	Read/Write	0xFF

Interrupts

The following table lists the interrupt behavior of the different register settings for the MxL82404 devices.

Table 7: Interrupt Generation and Clearing

GCR Bit	IER Bit	REIR Bit	FEIR Bit	IFR Bit	Interrupt Generated By:	Interrupt Cleared By:
1	0	X	X	X	No interrupts enabled (default).	N/A
1	1	0	0	0	A rising or falling edge on the input.	Reading the GSR register or if the input changes back to its previous state (state of input during last read to GSR).
				1	A rising or falling edge on the input and remains in the new state for more than 1075ns.	
1	1	1	0	0	A rising edge on the input.	Reading the GSR register.
				1	A rising edge on the input and remains high for more than 1075ns.	
1	1	0	1	0	A falling edge on the input.	Reading the GSR register.
				1	A falling edge on the input and remains low for more than 1075ns.	
1	1	1	1	0	A rising or falling edge on the input.	Reading the GSR register.
				1	A rising or falling edge on the input and remains in the new state for more than 1075ns.	
0	x	x	x	x	No interrupts in output mode.	N/A

Register Description

GPIO State Register (GSR)—Read-Only

The status of P7–P0 can be read via this register. A read shows the current state of these pins (or the inverted state of these pins if enabled via the PIR Register). Reading this register clears an input interrupt (for complete details, see [Table 7](#) on page 9). Reading this register also returns the last value written to the OCR register for any pins that are configured as outputs (that is, this is not the same as the state of the actual output pin since the output pin can be in three-state mode). A write to this register has no effect. The MSB of this register corresponds with P7 and the LSB of this register corresponds with P0.

Output Control Register (OCR)—Read/Write

When P7–P0 are defined as outputs, they can be controlled by writing to this register. Reading this register returns the last value written to it, however, this value may not be the actual state of the output pin since these pins can be in three-state mode. The MSB of this register corresponds with P7 and the LSB of this register corresponds with P0.

Input Polarity Inversion Register (PIR)—Read/Write

When P7–P0 are defined as inputs, this register inverts the polarity of the input value read from the Input Port Register. If the corresponding bit in this register is set to '1', the value of this bit in the GSR Register is the inverted value of the input pin. If the corresponding bit in this register is set to '0', the value of this bit in the GSR Register is the actual value of the input pin. The MSB of this register corresponds with P7 and the LSB of this register corresponds with P0.

GPIO Configuration Register (GCR)—Read/Write

This register configures the GPIOs as inputs or outputs. After power-up or after reset, the GPIOs are inputs. Setting these bits to '0' enables the GPIOs as outputs. Setting these bits to '1' enable the GPIOs as inputs. The MSB of this register corresponds with P7 and the LSB of this register corresponds with P0.

Input Internal Pull-up Enable/Disable Register (PUR)—Read/Write

After power-up or after reset, the internal pull-up resistors are enabled for the MxL82404. Writing a '0' to these bits disable the internal pull-up resistors. The MSB of this register corresponds with P7 and the LSB of this register corresponds with P0.

Input Interrupt Enable Register (IER)—Read/Write

This register enables/disables the interrupts for an input. After power-up or after reset, the interrupts are disabled. Writing a '1' to these bits enable the interrupt for the corresponding input pins. For complete details of the interrupt behavior for various register settings, see [Table 7](#) on page 9. No interrupts are generated for outputs when GCR bit is 0. The MSB of this register corresponds with P7 and the LSB of this register corresponds with P0.

Output Three-State Control Register (TSCR)—Read/Write

This register can enable/disable the three-state mode of an output. Writing a '1' to these bits enable the three-state mode for the corresponding output pins. The MSB of this register corresponds with P7 and the LSB of this register corresponds with P0.

Input Interrupt Status Register (ISR)—Read-Only

This register reports the input pins that have generated an interrupt. For complete details of the interrupt behavior for various register settings, see [Table 7](#) on page 9. The MSB of this register corresponds with P7 and the LSB of this register corresponds with P0.

Input Rising Edge Interrupt Enable Register (REIR)—Read/Write

Writing a '1' to these bits enable the corresponding input to generate an interrupt on the rising edge. For complete details of the interrupt behavior for various register settings, see [Table 7](#) on page 9. The MSB of this register corresponds with P7 and the LSB of this register corresponds with P0.

Input Falling Edge Interrupt Enable Register (FEIR)—Read/Write

Writing a '1' to these bits enable the corresponding input to generate an interrupt on the falling edge. Writing a '1' to these bits make that input generate an interrupt on the rising edge only. For complete details of the interrupt behavior for various register settings, see [Table 7](#) on page 9. The MSB of this register corresponds with P7 and the LSB of this register corresponds with P0.

Input Filter Enable Register (IFR)—Read/Write

By default, the input filters are enabled (IFR = 0xFF). When the input filters are enabled, any pulse that is greater than 1075ns generates an interrupt (if enabled). Pulses that are less than 225ns are filtered and do not generate an interrupt. Pulses in between this range may or may not generate an interrupt. Writing a '0' to these bits disable the input filter for the corresponding inputs. With the input filters disabled, any change on the inputs generates an interrupt (if enabled). For complete details of the interrupt behavior for various register settings, see [Table 7](#) on page 9. The MSB of this register corresponds with P7 and the LSB of this register corresponds with P0.

Mechanical Dimensions

16-Pin QFN

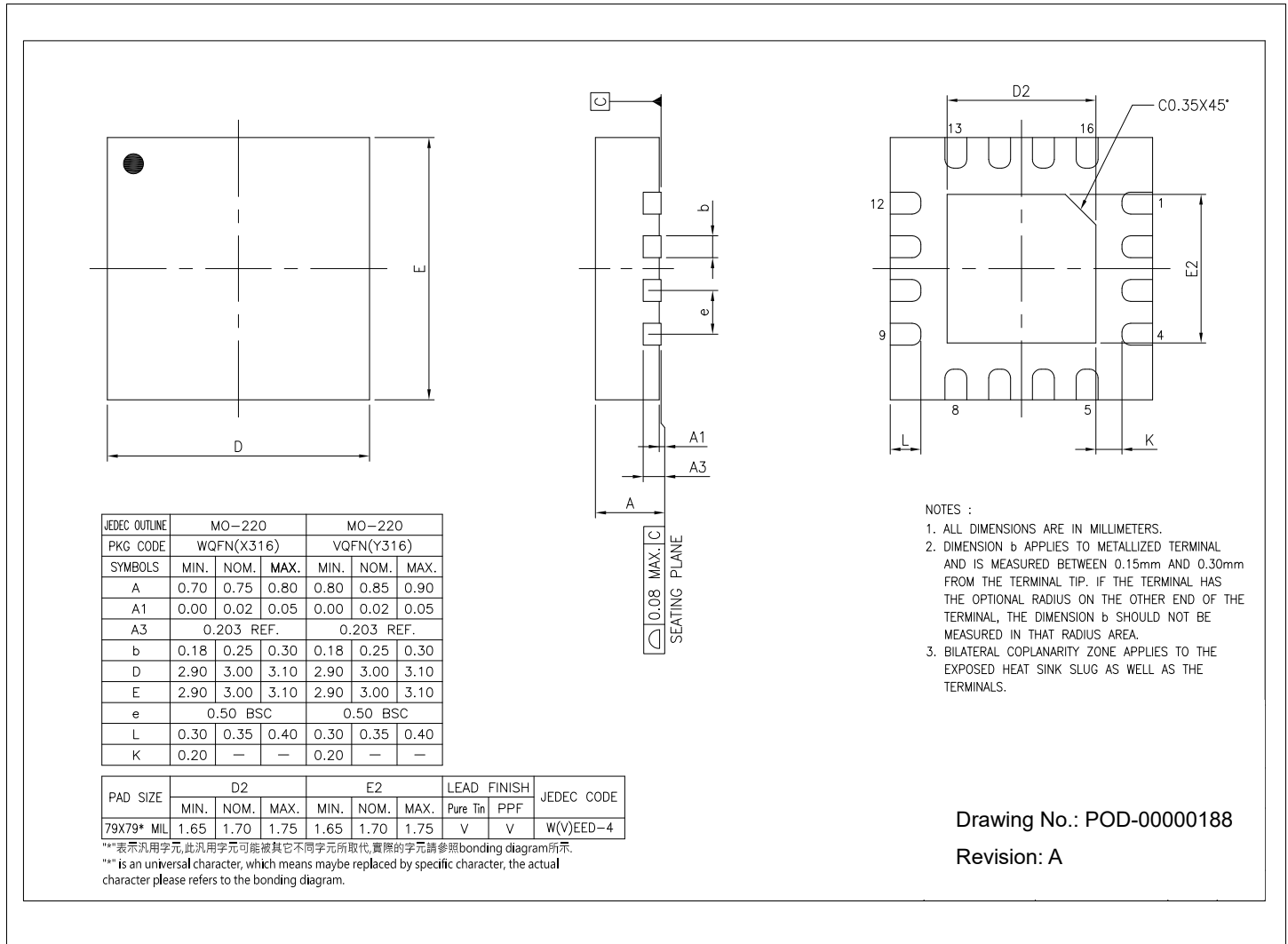
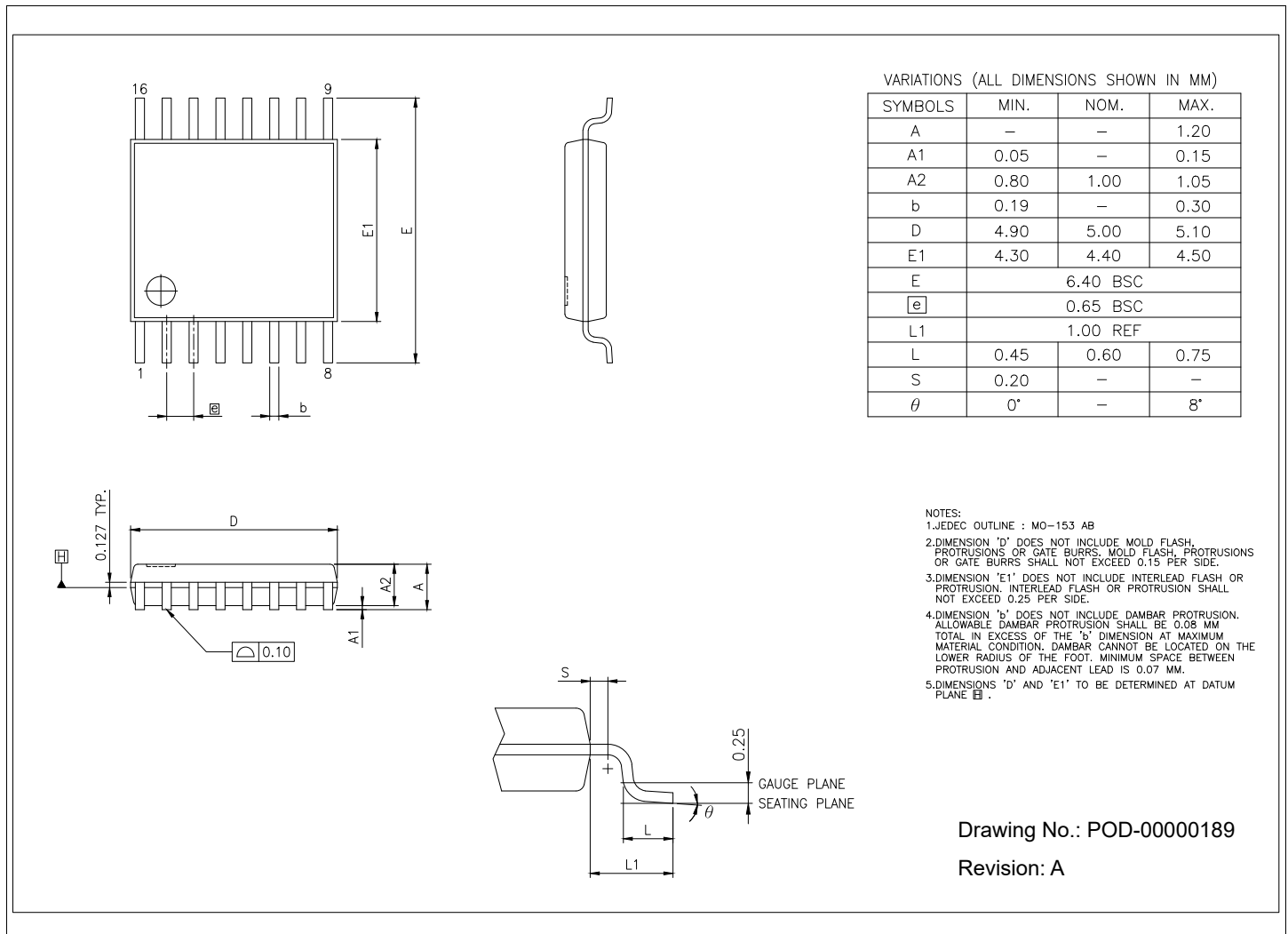


Figure 8: QFN-16 Mechanical Dimensions

16-Pin TSSOP



VARIATIONS (ALL DIMENSIONS SHOWN IN MM)

SYMBOLS	MIN.	NOM.	MAX.
A	—	—	1.20
A1	0.05	—	0.15
A2	0.80	1.00	1.05
b	0.19	—	0.30
D	4.90	5.00	5.10
E1	4.30	4.40	4.50
E	6.40 BSC		
e	0.65 BSC		
L1	1.00 REF		
L	0.45	0.60	0.75
S	0.20	—	—
θ	0°	—	8°

- NOTES:
1. JEDEC OUTLINE : MO-153 AB
 2. DIMENSION 'D' DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.15 PER SIDE.
 3. DIMENSION 'E1' DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 PER SIDE.
 4. DIMENSION 'b' DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 MM TOTAL IN EXCESS OF THE 'b' DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OF THE FOOT. MINIMUM SPACE BETWEEN PROTRUSION AND ADJACENT LEAD IS 0.07 MM.
 5. DIMENSIONS 'D' AND 'E1' TO BE DETERMINED AT DATUM PLANE \square .

Drawing No.: POD-00000189

Revision: A

Figure 9: TSSOP-16 Mechanical Dimensions

Ordering Information

Table 8: Ordering Information

Ordering Part Number	Package	Number of GPIOs	Operating Temperature Range	Packing Method	Lead-Free
MXL82404I-AGA-R	TSSOP-16	8	–40°C to 85°C	Tape and Reel	Yes
MXL82404I-AQB-R	QFN-16	8	–40°C to 85°C	Tape and Reel	Yes
MXL82404I-AGA-EVK	Evaluation Board for MxL82404				



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