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What is "Embedded - Microcontrollers"?

"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	56800EX
Core Size	32-Bit Single-Core
Speed	100MHz
Connectivity	CANbus, I²C, SCI, SPI
Peripherals	DMA, POR, PWM, WDT
Number of I/O	54
Program Memory Size	64KB (32K x 16)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	4K x 16
Voltage - Supply (Vcc/Vdd)	2.7V ~ 3.6V
Data Converters	A/D 16x12b; D/A 2x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 105°C (TA)
Mounting Type	Surface Mount
Package / Case	64-LQFP
Supplier Device Package	64-LQFP (10x10)
Purchase URL	https://www.e-xfl.com/product-detail/nxp-semiconductors/mc56f82748vlh

Table 1. MC56F827xx Family (continued)

Feature	MC56F82											
Part Number[1]	748V LH	746V LF 746M LF	743V LC	743V FM	738V LH	736V LF	733V LC	733V FM 733M FM	728V LH	726V LF	723V LC	723V FM
Analog Comparators (CMP)	4	4	3	3	4	4	3	3	4	4	3	3
QSCI	2	2	1	1	2	2	1	1	2	2	1	1
QSPI	2	1	1	1	2	1	1	1	2	1	1	1
I2C/SMBus	1	1	1	1	1	1	1	1	1	1	1	1
MSCAN	1	1	0	0	1	1	0	0	1	1	0	0
GPIO	54	39	26	26	54	39	26	26	54	39	26	26
Package pin count	64 LQFP	48 LQFP	32 LQFP	32 QFN	64 LQFP	48 LQFP	32 LQFP	32 QFN	64 LQFP	48 LQFP	32 LQFP	32 QFN
AEC-Q100[3]	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No

1. Temperature options
   V: -40°C to 105°C
   M: -40°C to 125°C
2. Input capture shares the pin with cooresponding PWM channels.
3. Qualification aligned to AEC-Q100

1.2 56800EX 32-bit Digital Signal Controller (DSC) core

- Efficient 32-bit 56800EX Digital Signal Processor (DSP) engine with modified dual Harvard architecture:
  - Three internal address buses
  - Four internal data buses: two 32-bit primary buses, one 16-bit secondary data bus, and one 16-bit instruction bus
  - 32-bit data accesses
  - Supports concurrent instruction fetches in the same cycle, and dual data accesses in the same cycle
  - 20 addressing modes
- As many as 100 million instructions per second (MIPS) at 100 MHz core frequency
- 162 basic instructions
- Instruction set supports both fractional arithmetic and integer arithmetic
- 32-bit internal primary data buses support 8-bit, 16-bit, and 32-bit data movement, plus addition, subtraction, and logical operations
- Single-cycle 16 × 16-bit -> 32-bit and 32 x 32-bit -> 64-bit multiplier-accumulator (MAC) with dual parallel moves
- 32-bit arithmetic and logic multi-bit shifter
- Four 36-bit accumulators, including extension bits

- Automatic mode allows the DAC to automatically generate pre-programmed output waveforms, including square, triangle, and sawtooth waveforms (for applications like slope compensation)
- Programmable period, update rate, and range
- Output can be routed to an internal comparator, ADC, or optionally to an off-chip destination

1.6.7 Quad Timer

- Four 16-bit up/down counters, with a programmable prescaler for each counter
- Operation modes: edge count, gated count, signed count, capture, compare, PWM, signal shot, single pulse, pulse string, cascaded, quadrature decode
- Programmable input filter
- Counting start can be synchronized across counters
- Up to 100 MHz operation clock

1.6.8 Queued Serial Communications Interface (QSCI) modules

- Operating clock can be up to two times the CPU operating frequency
- Four-word-deep FIFOs available on both transmit and receive buffers
- Standard mark/space non-return-to-zero (NRZ) format
- 16-bit integer and 3-bit fractional baud rate selection
- Full-duplex or single-wire operation
- Programmable 8-bit or 9-bit data format
- Error detection capability
- Two receiver wakeup methods:
  - Idle line
  - Address mark
- 1/16 bit-time noise detection
- Up to 6.25 Mbit/s baud rate at 100 MHz operation clock

1.6.9 Queued Serial Peripheral Interface (QSPI) modules

- Maximum 12.5 Mbit/s baud rate
- Selectable baud rate clock sources for low baud rate communication
- Baud rate as low as Baudrate_Freq_in / 8192
- Full-duplex operation
- Master and slave modes
- Double-buffered operation with separate transmit and receive registers
- Four-word-deep FIFOs available on transmit and receive buffers

  - On-chip low-power 200 kHz oscillator
  - System bus (IPBus up to 50 MHz)
  - 8 MHz / 400 kHz ROSC
- Support for interrupt triggered when the counter reaches the timeout value

1.6.13 External Watchdog Monitor (EWM)

- Monitors external circuit as well as the software flow
- Programmable timeout period
- Interrupt capability prior to timeout
- Independent output (EWM_OUT_b) that places external circuit (but not CPU and peripheral) in a safe mode when EWM timeout occurs
- Selectable reference clock source in support of EN60730 and IEC61508
- Wait mode and Stop mode operation is not supported.
- Selectable clock sources:
  - External crystal oscillator/external clock source
  - On-chip low-power 200 kHz oscillator
  - System bus (IPBus up to 50 MHz)
  - 8 MHz / 400 kHz ROSC

1.6.14 Power supervisor

- Power-on reset (POR) to reset CPU, peripherals, and JTAG/EOnCE controllers (V_{DD} > 2.1 V)
- Brownout reset (V_{DD} < 1.9 V)
- Critical warn low-voltage interrupt (LVI2.0)
- Peripheral low-voltage interrupt (LVI2.7)

1.6.15 Phase-locked loop

- Wide programmable output frequency: 200 MHz to 400 MHz
- Input reference clock frequency: 8 MHz to 16 MHz
- Detection of loss of lock and loss of reference clock
- Ability to power down

1.6.16 Clock sources

1.6.16.1 On-chip oscillators

- Tunable 8 MHz relaxation oscillator with 400 kHz at standby mode (divide-by-two output)
- 200 kHz low frequency clock as secondary clock source for COP, EWM, PIT

1.6.16.2 Crystal oscillator

- Support for both high ESR crystal oscillator (ESR greater than 100 Ω) and ceramic resonator
- Operating frequency: 4–16 MHz

1.6.17 Cyclic Redundancy Check (CRC) Generator

- Hardware CRC generator circuit with 16-bit shift register
- High-speed hardware CRC calculation
- Programmable initial seed value
- CRC16-CCITT compliancy with $x^{16} + x^{12} + x^5 + 1$ polynomial
- Error detection for all single, double, odd, and most multibit errors
- Option to transpose input data or output data (CRC result) bitwise, which is required for certain CRC standards

1.6.18 General Purpose I/O (GPIO)

- 5 V tolerance (except RESETB pin)
- Individual control of peripheral mode or GPIO mode for each pin
- Programmable push-pull or open drain output
- Configurable pullup or pulldown on all input pins
- All pins (except JTAG and RESETB) default to be GPIO inputs
- 2 mA / 9 mA source/sink capability
- Controllable output slew rate

1.7 Block diagrams

The 56800EX core is based on a modified dual Harvard-style architecture, consisting of three execution units operating in parallel, and allowing as many as six operations per instruction cycle. The MCU-style programming model and optimized instruction set

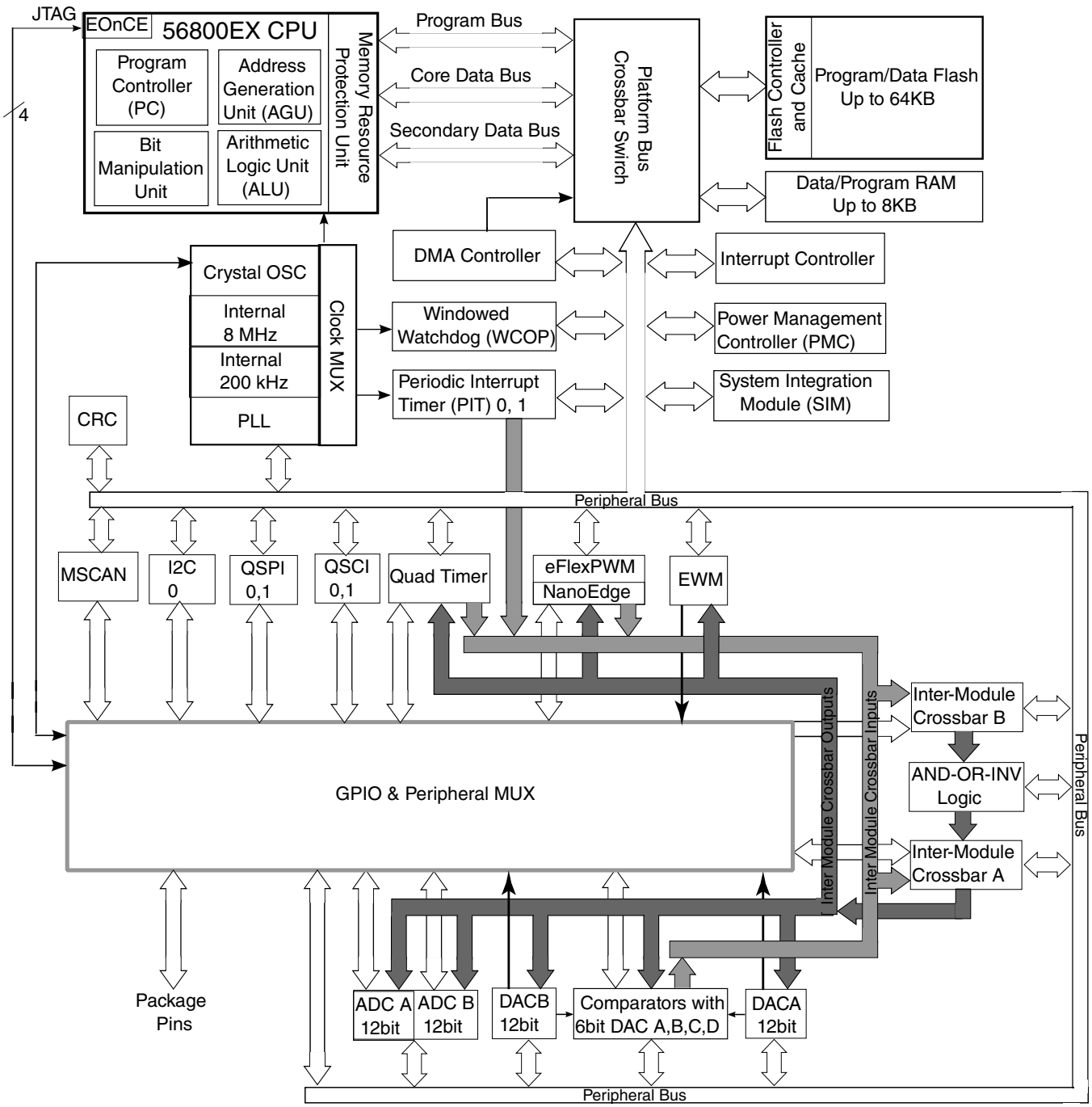


Figure 2. System diagram

2 MC56F827xx signal and pin descriptions

After reset, each pin is configured for its primary function (listed first). Any alternative functionality, shown in parentheses, must be programmed through the GPIO module peripheral enable registers (GPIOx_PER) and the SIM module GPIO peripheral select (GPSx) registers. All GPIO ports can be individually programmed as an input or output (using bit manipulation).

- PWMA_FAULT0, PWMA_FAULT1, and similar signals are inputs used to disable selected PWMA outputs, in cases where the fault conditions originate off-chip.

For the MC56F827xx products, which use 64-pin LQFP, 48-pin LQFP and 32-pin packages:

Table 2. Signal descriptions

Signal Name	64 LQFP	48 LQFP	32 LQFP	Type	State During Reset	Signal Description
V_{DD}	29	—	—	Supply	Supply	I/O Power — Supplies 3.3 V power to the chip I/O interface.
	44	32	—			
	60	44	28			
V_{SS}	30	22	14	Supply	Supply	I/O Ground — Provide ground for the device I/O interface.
	43	31	—			
	61	45	29			
V_{DDA}	22	15	9	Supply	Supply	Analog Power — Supplies 3.3 V power to the analog modules. It must be connected to a clean analog power supply.
V_{SSA}	23	16	10	Supply	Supply	Analog Ground — Supplies an analog ground to the analog modules. It must be connected to a clean power supply.
V_{CAP}	26	19	—	On-chip regulator output	On-chip regulator output	Connect a 2.2 µF or greater bypass capacitor between this pin and V_{SS} to stabilize the core voltage regulator output required for proper device operation.
	57	43	27			
TDI	64	48	32	Input	Input, internal pullup enabled	Test Data Input — It is sampled on the rising edge of TCK and has an internal pullup resistor. After reset, the default state is TDI.
(GPIOD0)				Input/Output		GPIO Port D0
TDO	62	46	30	Output	Output	Test Data Output — It is driven in the shift-IR and shift-DR controller states, and it changes on the falling edge of TCK. After reset, the default state is TDO
(GPIOD1)				Input/Output	Output	GPIO Port D1

Table continues on the next page...

Table 2. Signal descriptions (continued)

Signal Name	64 LQFP	48 LQFP	32 LQFP	Type	State During Reset	Signal Description
TCK	1	1	1	Input	Input, internal pullup enabled	Test Clock Input — The pin is connected internally to a pullup resistor. A Schmitt-trigger input is used for noise immunity. After reset, the default state is TCK
(GPIOD2)				Input/Output		GPIO Port D2
TMS	63	47	31	Input	Input, internal pullup enabled	Test Mode Select Input — It is sampled on the rising edge of TCK and has an internal pullup resistor. After reset, the default state is TMS. **NOTE:** Always tie the TMS pin to V_{DD} through a 2.2 kΩ resistor if need to keep on-board debug capability. Otherwise, directly tie to V_{DD}.
(GPIOD3)				Input/Output		GPIO Port D3
$\overline{\text{RESET}}$ or RESETB	2	2	2	Input	Input, internal pullup enabled	Reset — A direct hardware reset on the processor. When $\overline{\text{RESET}}$ is asserted low, the device is initialized and placed in the reset state. A Schmitt-trigger input is used for noise immunity. The internal reset signal is deasserted synchronous with the internal clocks after a fixed number of internal clocks. After reset, the default state is $\overline{\text{RESET}}$. Recommended a capacitor of up to 0.1 µF for filtering noise.
(GPIOD4)				Input/ Opendrain Output		GPIO Port D4 $\overline{\text{RESET}}$ functionality is disabled in this mode and the device can be reset only through POR, COP reset, or software reset.
GPIOA0	13	9	6	Input/Output	Input, internal pullup enabled	GPIO Port A0
(ANA0&CMPA_IN3)				Input		ANA0 is analog input to channel 0 of ADCA; CMPA_IN3 is positive input 3 of analog comparator A. After reset, the default state is GPIOA0.
(CMPC_O)				Output		Analog comparator C output
GPIOA1	14	10	7	Input/Output	Input, internal pullup enabled	GPIO Port A1: After reset, the default state is GPIOA1.
(ANA1&CMPA_IN0)				Input		ANA1 is analog input to channel 1 of ADCA; CMPA_IN0 is negative input 0 of analog comparator A. When used as an analog input, the signal goes to ANA1 and CMPA_IN0. The ADC control register configures this input as ANA1 or CMPA_IN0.
GPIOA2	15	11	8	Input/Output	Input, internal pullup enabled	GPIO Port A2: After reset, the default state is GPIOA2.
(ANA2&VREFHA &CMPA_IN1)				Input		ANA2 is analog input to channel 2 of ADCA; VREFHA is analog reference

Table continues on the next page...

Table 2. Signal descriptions (continued)

Signal Name	64 LQFP	48 LQFP	32 LQFP	Type	State During Reset	Signal Description
						oscillator output to an external crystal or ceramic resonator.
GPIOC2	5	5	3	Input/Output	Input, internal pullup enabled	GPIO Port C2: After reset, the default state is GPIOC2.
(TXD0)				Output		SCI0 transmit data output or transmit/ receive in single wire operation
(XB_OUT11)				Output		Crossbar module output 11
(XB_IN2)				Input		Crossbar module input 2
(CLKO0)				Output		Buffered clock output 0: the clock source is selected by clockout select (CLKOSEL) bits in the clock output select register (CLKOUT) of the SIM.
GPIOC3	7	6	4	Input/Output	Input, internal pullup enabled	GPIO Port C3: After reset, the default state is GPIOC3.
(TA0)				Input/Output		Quad timer module A channel 0 input/ output
(CMPA_O)				Output		Analog comparator A output
(RXD0)				Input		SCI0 receive data input
(CLKIN1)				Input		External clock input 1
GPIOC4	8	7	5	Input/Output	Input, internal pullup enabled	GPIO Port C4: After reset, the default state is GPIOC4.
(TA1)				Input/Output		Quad timer module A channel 1 input/ output
(CMPB_O)				Output		Analog comparator B output
(XB_IN6)				Input		Crossbar module input 6
(EWM_OUT_B)				Output		External Watchdog Module output
GPIOC5	18	13	—	Input/Output	Input, internal pullup enabled	GPIO Port C5: After reset, the default state is GPIOC5.
(DACA_O)				Analog Output		12-bit digital-to-analog output
(XB_IN7)				Input		Crossbar module input 7
GPIOC6	31	23	15	Input/Output	Input, internal pullup enabled	GPIO Port C6: After reset, the default state is GPIOC6.
(TA2)				Input/Output		Quad timer module A channel 2 input/ output
(XB_IN3)				Input		Crossbar module input 3
(CMP_REF)				Analog Input		Positive input 3 of analog comparator A and B and C.
($\overline{\text{SS0\_B}}$)				Input/Output		In slave mode, $\overline{\text{SS0\_B}}$ indicates to the SPI module 0 that the current transfer is to be received.
GPIOC7	32	24	—	Input/Output	Input, internal pullup enable	GPIO Port C7: After reset, the default state is GPIOC7.

Table continues on the next page...

Table 2. Signal descriptions (continued)

Signal Name	64 LQFP	48 LQFP	32 LQFP	Type	State During Reset	Signal Description
(TXD1)				Output		SCI1 transmit data output or transmit/ receive in single wire operation
GPIOC12	38	30	—	Input/Output	Input, internal pullup enabled	GPIO Port C12: After reset, the default state is GPIOC12.
(CANRX)				Input		CAN receive data input
(SDA0)				Input/Open-drain Output		I^2C0 serial data line
(RXD1)				Input		SCI1 receive data input
GPIOC13	49	37	—	Input/Output	Input, internal pullup enabled	GPIO Port C13: After reset, the default state is GPIOC13.
(TA3)				Input/Output		Quad timer module A channel 3 input/ output
(XB_IN6)				Input		Crossbar module input 6
(EWM_OUT_B)				Output		External Watchdog Module output
GPIOC14	55	41	—	Input/Output	Input, internal pullup enabled	GPIO Port C14: After reset, the default state is GPIOC14.
(SDA0)				Input/ Opendrain Output		I^2C0 serial data line
(XB_OUT4)				Output		Crossbar module output 4
(PWM_FAULT4)				Input		Disable PWMA output 4
GPIOC15	56	42	—	Input/Output	Input, internal pullup enabled	GPIO Port C15: After reset, the default state is GPIOC15.
(SCL0)				Input/Open-drain Output		I^2C0 serial clock
(XB_OUT5)				Output		Crossbar module output 5
(PWM_FAULT5)				Input		Disable PWMA output 5
GPIOE0	45	33	21	Input/Output	Input, internal pullup enabled	GPIO Port E0: After reset, the default state is GPIOE0.
(PWM_0B)				Input/Output		PWM module A (NanoEdge), submodule 0, output B or input capture B
GPIOE1	46	34	22	Input/Output	Input, internal pullup enabled	GPIO Port E1: After reset, the default state is GPIOE1.
(PWM_0A)				Input/Output		PWM module A (NanoEdge), submodule 0, output A or input capture A
GPIOE2	47	35	23	Input/Output	Input, internal pullup enabled	GPIO Port E2: After reset, the default state is GPIOE2.
(PWMA_1B)				Input/Output		PWM module A (NanoEdge), submodule 1, output B or input capture B
GPIOE3	48	36	24	Input/Output	Input, internal pullup enabled	GPIO Port E3: After reset, the default state is GPIOE3.
(PWMA_1A)				Input/Output		PWM module A (NanoEdge), submodule 1, output A or input capture A

Table continues on the next page...

5 Terminology and guidelines

5.1 Definition: Operating requirement

An *operating requirement* is a specified value or range of values for a technical characteristic that you must guarantee during operation to avoid incorrect operation and possibly decreasing the useful life of the chip.

5.1.1 Example

This is an example of an operating requirement:

Symbol	Description	Min.	Max.	Unit
V_{DD}	1.0 V core supply voltage	0.9	1.1	V

5.2 Definition: Operating behavior

Unless otherwise specified, an *operating behavior* is a specified value or range of values for a technical characteristic that are guaranteed during operation if you meet the operating requirements and any other specified conditions.

5.2.1 Example

This is an example of an operating behavior:

Symbol	Description	Min.	Max.	Unit
I_{WP}	Digital I/O weak pullup/ pulldown current	10	130	µA

5.3 Definition: Attribute

An *attribute* is a specified value or range of values for a technical characteristic that are guaranteed, regardless of whether you meet the operating requirements.

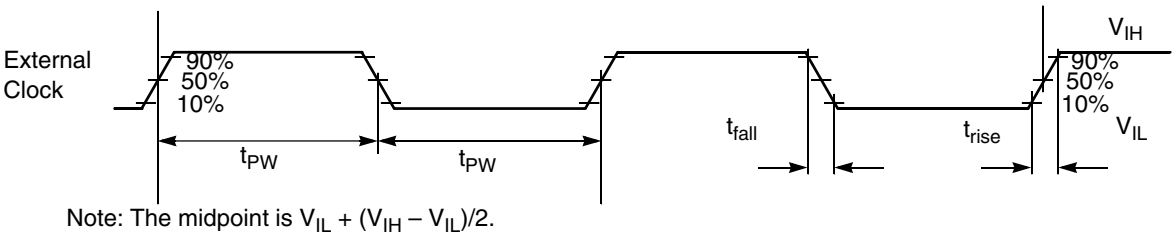
calculations, determine the difference between actual pin voltage and V_{SS} or V_{DD} and multiply by the pin current for each I/O pin. Except in cases of unusually high pin current (heavy loads), the difference between pin voltage and V_{SS} or V_{DD} is very small.

See Thermal design considerations for more detail on thermal design considerations.

Board type	Symbol	Description	32 QFN	32 LQFP	48 LQFP	64 LQFP	Unit	Notes
Single-layer (1s)	$R_{\theta JA}$	Thermal resistance, junction to ambient (natural convection)	96	83	70	64	°C/W	,
Four-layer (2s2p)	$R_{\theta JA}$	Thermal resistance, junction to ambient (natural convection)	33	55	46	46	°C/W	1,
Single-layer (1s)	$R_{\theta JMA}$	Thermal resistance, junction to ambient (200 ft./min. air speed)	80	70	57	52	°C/W	1,2
Four-layer (2s2p)	$R_{\theta JMA}$	Thermal resistance, junction to ambient (200 ft./min. air speed)	27	49	39	39	°C/W	1,2
—	$R_{\theta JB}$	Thermal resistance, junction to board	12	31	23	28	°C/W	
—	$R_{\theta JC}$	Thermal resistance, junction to case	1.8	22	17	15	°C/W	
—	Ψ_{JT}	Thermal characterization parameter, junction to package top outside center (natural convection)	6	5	3	3	°C/W	

1. Junction temperature is a function of die size, on-chip power dissipation, package thermal resistance, mounting site (board) temperature, ambient temperature, air flow, power dissipation of other components on the board, and board thermal resistance.

1. See Figure 1 for detail on using the recommended connection of an external clock driver.
2. The chip may not function if the high or low pulse width is smaller than 6.25 ns.
3. External clock input rise time is measured from 10% to 90%.
4. External clock input fall time is measured from 90% to 10%.



Note: The midpoint is $V_{IL} + (V_{IH} - V_{IL})/2$.

Figure 7. External clock timing

8.3.2 Phase-Locked Loop timing

Table 20. Phase-Locked Loop timing

Characteristic	Symbol	Min	Typ	Max	Unit
PLL input reference frequency[1]	f_{ref}	8	8	16	MHz
PLL output frequency[2]	f_{op}	200	—	400	MHz
PLL lock time[3]	t_{plls}	35.5		73.2	µs
Allowed Duty Cycle of input reference	t_{dc}	40	50	60	%

1. An externally supplied reference clock should be as free as possible from any phase jitter for the PLL to work correctly. The PLL is optimized for 8 MHz input.
2. The frequency of the core system clock cannot exceed 100 MHz. If the NanoEdge PWM is available, the PLL output must be set to 400 MHz.
3. This is the time required *after the PLL is enabled* to ensure reliable operation.

8.3.3 External crystal or resonator requirement

Table 21. Crystal or resonator requirement

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency of operation	f_{XOSC}	4	8	16	MHz

8.3.4 Relaxation Oscillator Timing

Table 22. Relaxation Oscillator Electrical Specifications

Characteristic		Symbol	Min	Typ	Max	Unit
8 MHz Output Frequency[1]						
Run Mode	0°C to 105°C		7.84	8	8.16	MHz

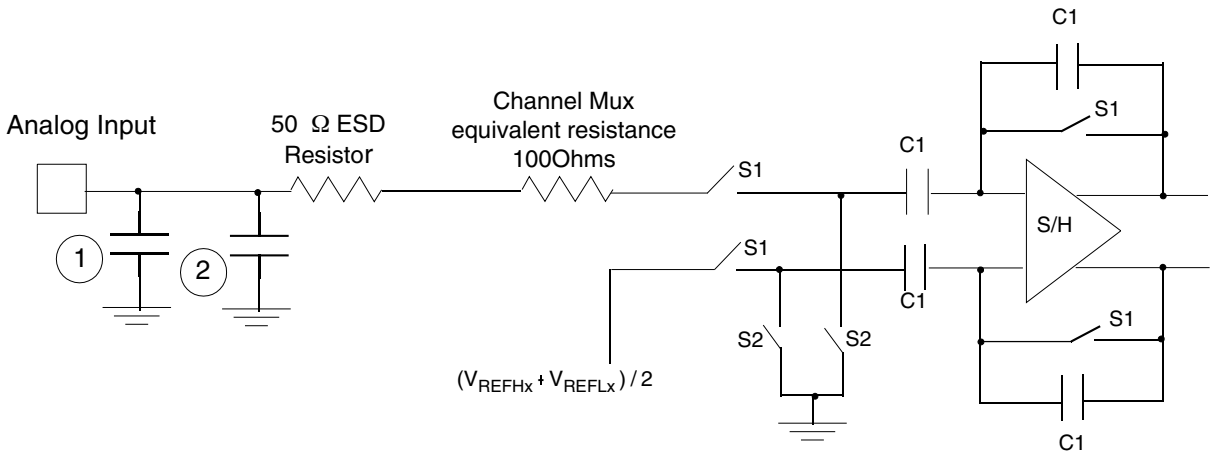
Table continues on the next page...

Table 22. Relaxation Oscillator Electrical Specifications (continued)

Characteristic		Symbol	Min	Typ	Max	Unit
	-40°C to 105°C		7.76	8	8.24	MHz
	-40°C to 125°C		7.60	8	8.32	MHz
Standby Mode (IRC trimmed @ 8 MHz)	-40°C to 105°C		248	405	562	kHz
	-40°C to 125°C		198	405	702	kHz
8 MHz Frequency Variation over 25°C						
RUN Mode	0°C to 105°C			+/-1.5	+/-2	%
	-40°C to 105°C			+/-1.5	+/-3	%
	-40°C to 125°C			+/-1.5	-5 to +4	%
200 kHz Output Frequency[1]						
RUN Mode	-40°C to 105°C		194	200	206	kHz
	-40°C to 125°C		192	200	208	kHz
200 kHz Output Frequency Variation over 25°C						
RUN Mode	0°C to 85°C			+/-1.5	+/-2	%
	-40°C to 105°C			+/-1.5	+/-3	%
	-40°C to 125°C			+/-1.5	+/-4	%
Stabilization Time	8 MHz output[2]	tstab		0.12		µs
	200 kHz output[3]			10		µs
Output Duty Cycle			48	50	52	%

1. Frequency after factory trim
2. Standby to run mode transition
3. Power down to run mode transition

$$\frac{1}{(\text{ADC ClockRate}) \times 4.8 \times 10^{-12}} + 100\ ohm + 50\ ohm$$



1. Parasitic capacitance due to package, pin-to-pin and pin-to-package base coupling = 1.8pF
2. Parasitic capacitance due to the chip bond pad, ESD protection devices and signal routing = 2.04pF
3. S1 and S2 switch phases are non-overlapping and depend on the ADC clock frequency

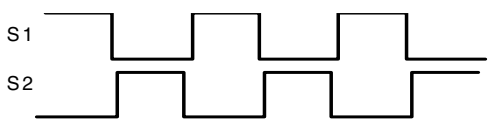


Figure 9. Equivalent circuit for A/D loading

8.5.2 12-bit Digital-to-Analog Converter (DAC) parameters

Table 28. DAC parameters

Parameter	Conditions/Comments	Symbol	Min	Typ	Max	Unit
DC Specifications						
Resolution			12	12	12	bits
Settling time[1]	At output load RLD = 3 kΩ CLD = 400 pF		—	1		µs
Power-up time	Time from release of PWRDWN signal until DACOUT signal is valid	t_{DAPU}	—	—	11	µs
Accuracy						
Integral non-linearity[2]	Range of input digital words:	INL	—	+/- 3	+/- 4	LSB[3]

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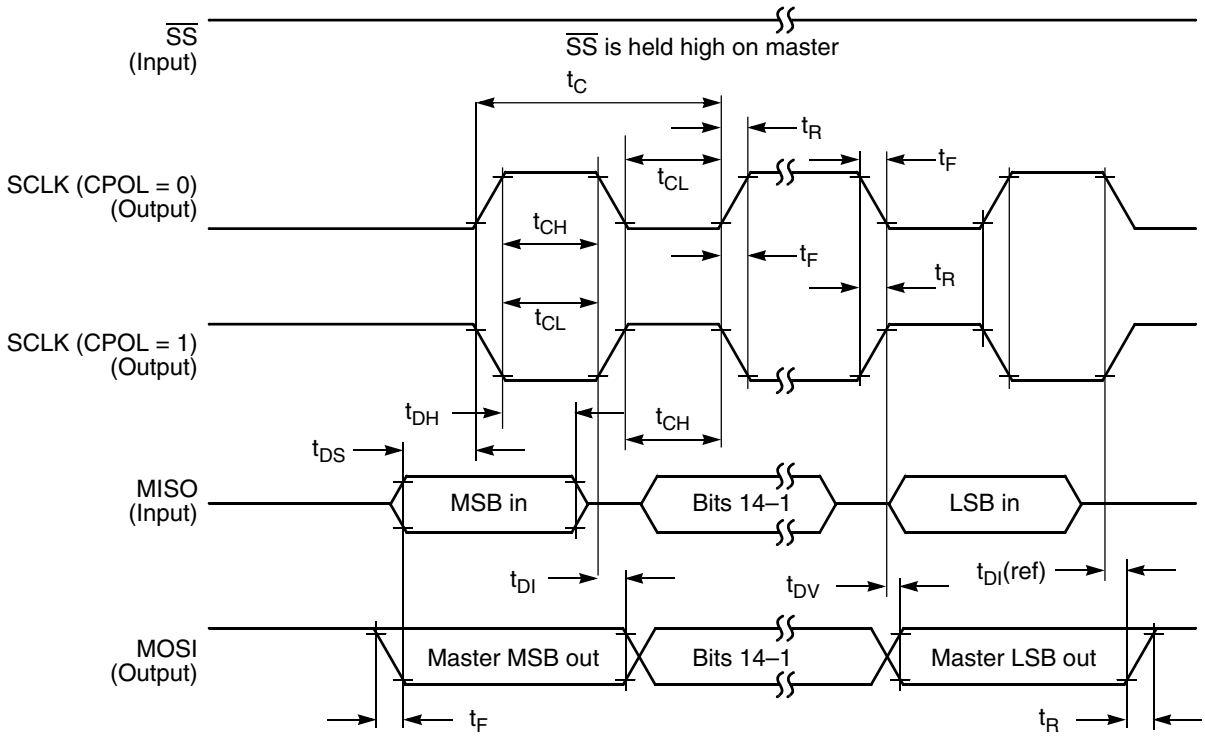

Figure 13. SPI master timing (CPHA = 0)

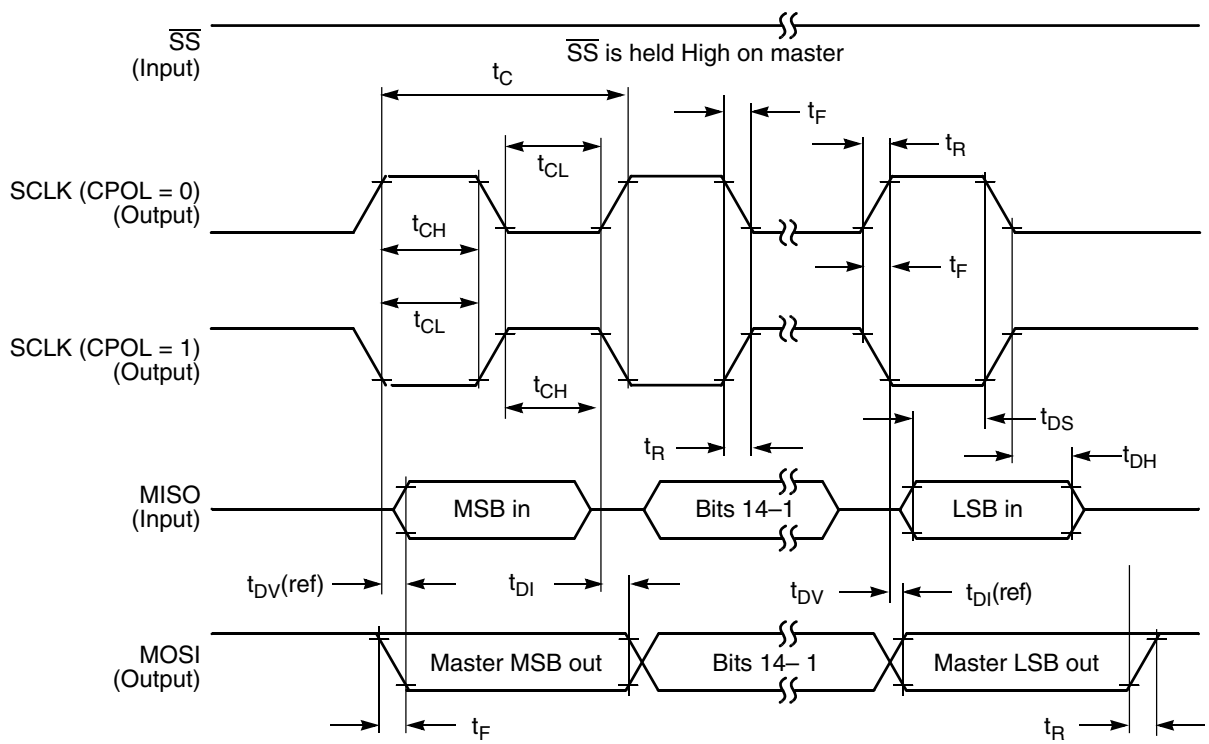

Figure 14. SPI master timing (CPHA = 1)

9.2 Electrical design considerations

CAUTION

This device contains protective circuitry to guard against damage due to high static voltage or electrical fields. However, take normal precautions to avoid application of any voltages higher than maximum-rated voltages to this high-impedance circuit. Reliability of operation is enhanced if unused inputs are tied to an appropriate voltage level.

Use the following list of considerations to assure correct operation of the device:

- Provide a low-impedance path from the board power supply to each V_{DD} pin on the device and from the board ground to each V_{SS} (GND) pin.
- The minimum bypass requirement is to place 0.01–0.1 µF capacitors positioned as near as possible to the package supply pins. The recommended bypass configuration is to place one bypass capacitor on each of the V_{DD}/V_{SS} pairs, including V_{DDA}/V_{SSA}. Ceramic and tantalum capacitors tend to provide better tolerances.
- Ensure that capacitor leads and associated printed circuit traces that connect to the chip V_{DD} and V_{SS} (GND) pins are as short as possible.
- Bypass the V_{DD} and V_{SS} with approximately 100 µF, plus the number of 0.1 µF ceramic capacitors.
- PCB trace lengths should be minimal for high-frequency signals.
- Consider all device loads as well as parasitic capacitance due to PCB traces when calculating capacitance. This is especially critical in systems with higher capacitive loads that could create higher transient currents in the V_{DD} and V_{SS} circuits.
- Take special care to minimize noise levels on the V_{REF}, V_{DDA}, and V_{SSA} pins.
- Using separate power planes for V_{DD} and V_{DDA} and separate ground planes for V_{SS} and V_{SSA} are recommended. Connect the separate analog and digital power and ground planes as near as possible to power supply outputs. If an analog circuit and digital circuit are powered by the same power supply, then connect a small inductor or ferrite bead in serial with V_{DDA}. Traces of V_{SS} and V_{SSA} should be shorted together.
- Physically separate analog components from noisy digital components by ground planes. Do not place an analog trace in parallel with digital traces. Place an analog ground trace around an analog signal trace to isolate it from digital traces.
- Because the flash memory is programmed through the JTAG/EOnCE port, SPI, SCI, or I^2C, the designer should provide an interface to this port if in-circuit flash programming is desired.
- If desired, connect an external RC circuit to the $\overline{\text{RESET}}$ pin. The resistor value should be in the range of 4.7 kΩ–10 kΩ; the capacitor value should be in the range of 0.22 µF–4.7 µF.

- Configuring the $\overline{\text{RESET}}$ pin to GPIO output in normal operation in a high-noise environment may help to improve the performance of noise transient immunity.
- Add a 2.2 kΩ external pullup on the TMS pin of the JTAG port to keep EOnCE in a restate during normal operation if JTAG converter is not present.
- During reset and after reset but before I/O initialization, all I/O pins are at tri-state.
- To eliminate PCB trace impedance effect, each ADC input should have a no less than 33 pF 10Ω RC filter.

9.3 Power-on Reset design considerations

9.3.1 Improper power-up sequence between VDD/VSS and VDDA/VSSA:

It is recommended that VDD be kept within 100 mV of VDDA at all times, including power ramp-up and ramp-down. Failure to keep VDDA within 100 mV of VDDA may cause a leakage current through the substrate, between the VDD and VDDA pad cells. This leakage current could prevent operation of the device after it powers up. The voltage difference between VDD and VDDA must be limited to below 0.3 V at all times, to avoid permanent damage to the part (See Table 5). Also see Table 6.

9.3.2 Improperly designed protection circuit:

In many circuit designs, it is a general practice to add external clamping diodes on each analog input pin; see diode D1 and D2 in Figure 21, to prevent the surge voltage from damaging the analog input. However, in some cases, these diodes can cause the DSC to fail to start at power-on. For example, in Figure 21, the entire system is directly powered from the power grid; high voltage is fed to 12V DC/DC converter Reg1, then 12V powers DC/DC converter Reg2 and Reg3 to provide 3.3V supply voltage to VDD and VDDA. Due to the startup time delay of DC/DC converters and per-charge the capacitors on 12V and 3.3V rail, VDDA can be charged to a less than 0.5V through a path of R6->R5->R4->R2->D1. If this low voltage duration is more than 1 ms without continuing ramp-up, then it can cause the device to fail to start up.

11 Pinout

11.1 Signal Multiplexing and Pin Assignments

The following table shows the signals available on each pin and the locations of these pins on the devices supported by this document. The SIM's GPS registers are responsible for selecting which ALT functionality is available on most pins.

NOTE

- The RESETB pin is a 3.3 V pin only.
- If the GPIOC1 pin is used as GPIO, the XOSC should be powered down.
- Not all CMPD pins are not available on 48 LQFP, 32 LQFP, and 32 QFN packages.
- QSPI signals—including MISO1, MOSI1, SCLK1, and SS0_B—are not available on the 48 LQFP, 32 LQFP, and 32 QFN packages.

64 LQFP	48 LQFP	32 LQFP	Pin Name	Default	ALT0	ALT1	ALT2	ALT3
1	1	1	TCK	TCK	GPIOD2			
2	2	2	RESETB	RESETB	GPIOD4			
3	3	—	GPIOC0	GPIOC0	EXTAL	CLKIN0		
4	4	—	GPIOC1	GPIOC1	XTAL			
5	5	3	GPIOC2	GPIOC2	TXD0	XB_OUT11	XB_IN2	CLKO0
6	—	—	GPIOF8	GPIOF8	RXD0	XB_OUT10	CMPD_O	PWM_2X
7	6	4	GPIOC3	GPIOC3	TA0	CMPA_O	RXD0	CLKIN1
8	7	5	GPIOC4	GPIOC4	TA1	CMPB_O	XB_IN6	EWM_OUT_B
9	—	—	GPIOA7	GPIOA7	ANA7&CMPD_IN3			
10	—	—	GPIOA6	GPIOA6	ANA6&CMPD_IN2			
11	—	—	GPIOA5	GPIOA5	ANA5&CMPD_IN1			
12	8	—	GPIOA4	GPIOA4	ANA4&CMPD_IN0			
13	9	6	GPIOA0	GPIOA0	ANA0&CMPA_IN3	CMPC_O		
14	10	7	GPIOA1	GPIOA1	ANA1&CMPA_IN0			
15	11	8	GPIOA2	GPIOA2	ANA2&VREFHA&CMPA_IN1			
16	12	—	GPIOA3	GPIOA3	ANA3&VREFLA&CMPA_IN2			
17	—	—	GPIOB7	GPIOB7	ANB7&CMPB_IN2			
18	13	—	GPIOC5	GPIOC5	DACA_O	XB_IN7		
19	—	—	GPIOB6	GPIOB6	ANB6&CMPB_IN1			

64 LQFP	48 LQFP	32 LQFP	Pin Name	Default	ALT0	ALT1	ALT2	ALT3
20	—	—	GPIOB5	GPIOB5	ANB5&CMPC_IN2			
21	14	—	GPIOB4	GPIOB4	ANB4&CMPC_IN1			
22	15	9	VDDA	VDDA				
23	16	10	VSSA	VSSA				
24	17	11	GPIOB0	GPIOB0	ANB0&CMPB_IN3			
25	18	12	GPIOB1	GPIOB1	ANB1&CMPB_IN0	DACB_O		
26	19	—	VCAP	VCAP				
27	20	13	GPIOB2	GPIOB2	ANB2&VERFHB&CMPC_IN3			
28	21	—	GPIOB3	GPIOB3	ANB3&VREFLB&CMPC_IN0			
29	—	—	VDD	VDD				
30	22	14	VSS	VSS				
31	23	15	GPIOC6	GPIOC6	TA2	XB_IN3	CMP_REF	SS0_B
32	24	—	GPIOC7	GPIOC7	SS0_B	TXD0	XB_IN8	
33	25	16	GPIOC8	GPIOC8	MISO0	RXD0	XB_IN9	XB_OUT6
34	26	17	GPIOC9	GPIOC9	SCLK0	XB_IN4	TXD0	XB_OUT8
35	27	18	GPIOC10	GPIOC10	MOSI0	XB_IN5	MISO0	XB_OUT9
36	28	—	GPIOF0	GPIOF0	XB_IN6		SCLK1	
37	29	—	GPIOC11	GPIOC11	CANTX	SCL0	TXD1	
38	30	—	GPIOC12	GPIOC12	CANRX	SDA0	RXD1	
39	—	19	GPIOF2	GPIOF2	SCL0	XB_OUT6	MISO1	
40	—	20	GPIOF3	GPIOF3	SDA0	XB_OUT7	MOSI1	
41	—	—	GPIOF4	GPIOF4	TXD1	XB_OUT8	PWM_0X	PWM_FAULT6
42	—	—	GPIOF5	GPIOF5	RXD1	XB_OUT9	PWM_1X	PWM_FAULT7
43	31	—	VSS	VSS				
44	32	—	VDD	VDD				
45	33	21	GPIOE0	GPIOE0	PWM_0B			
46	34	22	GPIOE1	GPIOE1	PWM_0A			
47	35	23	GPIOE2	GPIOE2	PWM_1B			
48	36	24	GPIOE3	GPIOE3	PWM_1A			
49	37	—	GPIOC13	GPIOC13	TA3	XB_IN6	EWM_OUT_B	
50	38	—	GPIOF1	GPIOF1	CLKO1	XB_IN7	CMPD_O	
51	39	25	GPIOE4	GPIOE4	PWM_2B	XB_IN2		
52	40	26	GPIOE5	GPIOE5	PWM_2A	XB_IN3		
53	—	—	GPIOE6	GPIOE6	PWM_3B	XB_IN4		
54	—	—	GPIOE7	GPIOE7	PWM_3A	XB_IN5		
55	41	—	GPIOC14	GPIOC14	SDA0	XB_OUT4	PWM_FAULT4	
56	42	—	GPIOC15	GPIOC15	SCL0	XB_OUT5	PWM_FAULT5	
57	43	27	VCAP	VCAP				
58	—	—	GPIOF6	GPIOF6		PWM_3X		XB_IN2
59	—	—	GPIOF7	GPIOF7		CMPC_O	SS1_B	XB_IN3

64 LQFP	48 LQFP	32 LQFP	Pin Name	Default	ALT0	ALT1	ALT2	ALT3
60	44	28	VDD	VDD				
61	45	29	VSS	VSS				
62	46	30	TDO	TDO	GPIOD1			
63	47	31	TMS	TMS	GPIOD3			
64	48	32	TDI	TDI	GPIOD0			

11.2 Pinout diagrams

The following diagrams show pinouts for the packages. For each pin, the diagrams show the default function. However, many signals may be multiplexed onto a single pin.

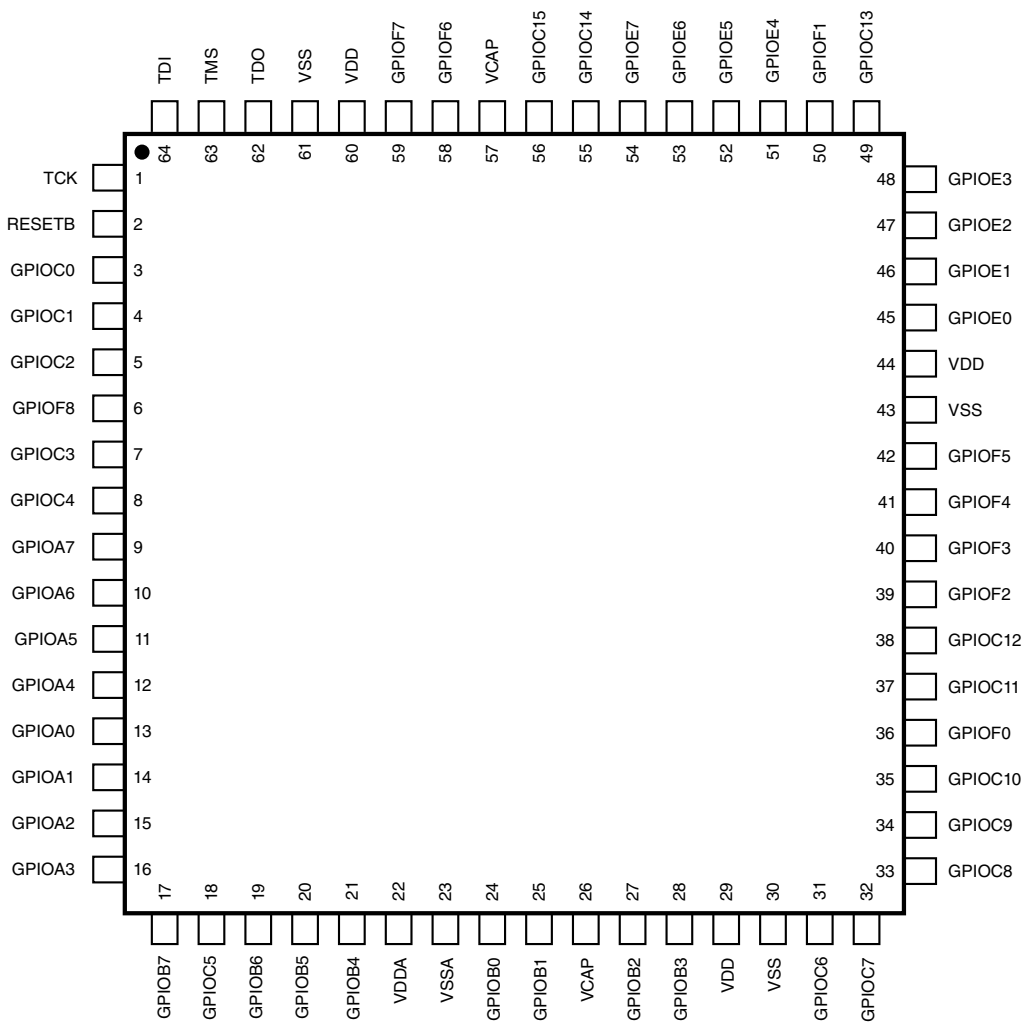

Figure 23. 64-pin LQFP

NOTE

The RESETB pin is a 3.3 V pin only.