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Applications of "[Embedded - Microcontrollers](#)"

Details

Product Status	Active
Core Processor	ARM® Cortex®-M0+
Core Size	32-Bit Single-Core
Speed	48MHz
Connectivity	I ² C, SPI, UART/USART, USB
Peripherals	DMA, I ² S, LVD, POR, PWM, WDT
Number of I/O	50
Program Memory Size	128KB (128K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	32K x 8
Voltage - Supply (Vcc/Vdd)	1.71V ~ 3.6V
Data Converters	A/D 16x16b; D/A 1x12b
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/mkl27z128vlh4r

1.4 Voltage and current operating ratings

Table 4. Voltage and current operating ratings

Symbol	Description	Min.	Max.	Unit
V_{DD}	Digital supply voltage	-0.3	3.8	V
I_{DD}	Digital supply current	—	120	mA
V_{IO}	IO pin input voltage	-0.3	$V_{DD} + 0.3$	V
I_D	Instantaneous maximum current single pin limit (applies to all port pins)	-25	25	mA
V_{DDA}	Analog supply voltage	$V_{DD} - 0.3$	$V_{DD} + 0.3$	V
V_{USB_DP}	USB_DP input voltage	-0.3	3.63	V
V_{USB_DM}	USB_DM input voltage	-0.3	3.63	V
V_{REGIN}	USB regulator input	-0.3	6.0	V

2 General

2.1 AC electrical characteristics

Unless otherwise specified, propagation delays are measured from the 50% to the 50% point, and rise and fall times are measured at the 20% and 80% points, as shown in the following figure.

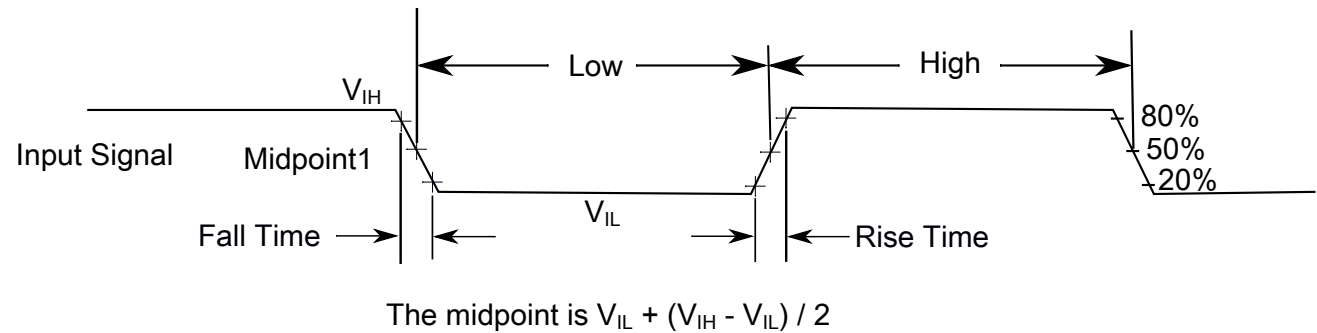


Figure 1. Input signal measurement reference

All digital I/O switching characteristics, unless otherwise specified, assume that the output pins have the following characteristics.

- $C_L=30$ pF loads
- Slew rate disabled
- Normal drive strength

2.2 Nonswitching electrical specifications

2.2.1 Voltage and current operating requirements

Table 5. Voltage and current operating requirements

Symbol	Description	Min.	Max.	Unit	Notes
V_{DD}	Supply voltage	1.71	3.6	V	
V_{DDA}	Analog supply voltage	1.71	3.6	V	
$V_{DD} - V_{DDA}$	V_{DD} -to- V_{DDA} differential voltage	-0.1	0.1	V	
$V_{SS} - V_{SSA}$	V_{SS} -to- V_{SSA} differential voltage	-0.1	0.1	V	
V_{IH}	Input high voltage • $2.7\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ • $1.7\text{ V} \leq V_{DD} \leq 2.7\text{ V}$	$0.7 \times V_{DD}$	—	V	
		$0.75 \times V_{DD}$	—	V	
V_{IL}	Input low voltage • $2.7\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ • $1.7\text{ V} \leq V_{DD} \leq 2.7\text{ V}$	—	$0.35 \times V_{DD}$	V	
		—	$0.3 \times V_{DD}$	V	
V_{HYS}	Input hysteresis	$0.06 \times V_{DD}$	—	V	
I_{ICIO}	IO pin negative DC injection current — single pin • $V_{IN} < V_{SS}-0.3\text{V}$	-3	—	mA	1
I_{ICcont}	Contiguous pin DC injection current —regional limit, includes sum of negative injection currents of 16 contiguous pins • Negative current injection	-25	—	mA	
V_{ODPU}	Open drain pullup voltage level	V_{DD}	V_{DD}	V	2
V_{RAM}	V_{DD} voltage required to retain RAM	1.2	—	V	

1. All I/O pins are internally clamped to V_{SS} through a ESD protection diode. There is no diode connection to V_{DD} . If V_{IN} greater than V_{IO_MIN} ($= V_{SS}-0.3\text{ V}$) is observed, then there is no need to provide current limiting resistors at the pads. If this limit cannot be observed then a current limiting resistor is required. The negative DC injection current limiting resistor is calculated as $R = (V_{IO_MIN} - V_{IN})/|I_{ICIO}|$.
2. Open drain outputs must be pulled to V_{DD} .

2.2.2 LVD and POR operating requirements

Table 6. V_{DD} supply LVD and POR operating requirements

Symbol	Description	Min.	Typ.	Max.	Unit	Notes
V_{POR}	Falling V_{DD} POR detect voltage	0.8	1.1	1.5	V	—

Table continues on the next page...

Table 8. Power mode transition operating behaviors (continued)

Symbol	Description	Min.	Typ.	Max.	Unit	Notes
	• LLS → RUN	—	7.5	8	μs	
	• VLPS → RUN	—	7.5	8	μs	
	• STOP → RUN	—	7.5	8	μs	

1. Normal boot (FTFA_FOPT[LPBOOT]=11)

2.2.5 Power consumption operating behaviors

The maximum values stated in the following table represent characterized results equivalent to the mean plus three times the standard deviation (mean + 3 sigma).

NOTE

The while (1) test is executed with flash cache enabled.

Table 9. Power consumption operating behaviors

Symbol	Description	Min.	Typ.	Max.	Unit	Notes
I _{DDA}	Analog supply current	—	—	See note	mA	1
I _{DD_RUNCO}	Running CoreMark in flash in compute operation mode—48M HIRC mode, 48 MHz core / 24 MHz flash, V _{DD} = 3.0 V - at 25 °C - at 105 °C	— —	5.76 6.04	6.40 6.68	mA	2
I _{DD_RUNCO}	Running While(1) loop in flash in compute operation mode—48M HIRC mode, 48 MHz core / 24 MHz flash, V _{DD} = 3.0 V - at 25 °C - at 105 °C	— —	3.21 3.49	3.85 4.13	mA	
I _{DD_RUN}	Run mode current—48M HIRC mode, running CoreMark in Flash all peripheral clock disable 48 MHz core/24 MHz flash, V _{DD} = 3.0 V - at 25 °C - at 105 °C	— —	6.45 6.75	7.09 7.39	mA	2
I _{DD_RUN}	Run mode current—48M HIRC mode, running CoreMark in flash all peripheral clock disable, 24 MHz core/12 MHz flash, V _{DD} = 3.0 V	— —	3.95 4.23	4.59 4.87	mA	2

Table continues on the next page...

Table 9. Power consumption operating behaviors (continued)

Symbol	Description	Min.	Typ.	Max.	Unit	Notes
	- at 25 °C - at 105 °C					
I_{DD_VLPRCO}	Very Low Power Run Core Mark in Flash in Compute Operation mode: Core@4MHz, Flash @1MHz, $V_{DD} = 3.0$ V at 25 °C	—	826	907	μA	
I_{DD_VLPRCO}	Very-low-power-run While(1) loop in SRAM in compute operation mode— 8 MHz LIRC mode, 4 MHz core / 1 MHz flash, $V_{DD} = 3.0$ V at 25 °C	—	405	486	μA	
I_{DD_VLPRCO}	Very-low-power run While(1) loop in SRAM in compute operation mode:—2 MHz LIRC mode, 2 MHz core / 0.5 MHz flash, $V_{DD} = 3.0$ V at 25 °C	—	154	235	μA	
I_{DD_VLPR}	Very-low-power run mode current— 2 MHz LIRC mode, While(1) loop in flash all peripheral clock disable, 2 MHz core / 0.5 MHz flash, $V_{DD} = 3.0$ V at 25 °C	—	108	189	μA	
I_{DD_VLPR}	Very-low-power run mode current— 2 MHz LIRC mode, While(1) loop in flash all peripheral clock disable, 125 kHz core / 31.25 kHz flash, $V_{DD} = 3.0$ V at 25 °C	—	39	120	μA	
I_{DD_VLPR}	Very-low-power run mode current— 8 MHz LIRC mode, While(1) loop in flash all peripheral clock disable, 4 MHz core / 1 MHz flash, $V_{DD} = 3.0$ V at 25 °C	—	249	330	μA	
I_{DD_VLPR}	Very-low-power run mode current— 8 MHz LIRC mode, While(1) loop in flash all peripheral clock enable, 4 MHz core / 1 MHz flash, $V_{DD} = 3.0$ V at 25 °C	—	337	418	μA	
I_{DD_VLPR}	Very-low-power run mode current— 8 MHz LIRC mode, While(1) loop in SRAM in all peripheral clock disable, 4 MHz core / 1 MHz flash, $V_{DD} = 3.0$ V at 25 °C	—	416	497	μA	
I_{DD_VLPR}	Very-low-power run mode current— 8 MHz LIRC mode, While(1) loop in SRAM all peripheral clock enable, 4 MHz core / 1 MHz flash, $V_{DD} = 3.0$ V at 25 °C	—	494	575	μA	
I_{DD_VLPR}	Very-low-power run mode current—2 MHz LIRC mode, While(1) loop in SRAM in all peripheral clock disable, 2 MHz core / 0.5 MHz flash, $V_{DD} = 3.0$ V at 25 °C	—	166	247	μA	
I_{DD_VLPR}	Very-low-power run mode current—2 MHz LIRC mode, While(1) loop in SRAM all peripheral clock					

Table continues on the next page...

Table 9. Power consumption operating behaviors (continued)

Symbol	Description	Min.	Typ.	Max.	Unit	Notes
	- at 50 °C - at 85 °C - at 105 °C	—	10.26	17.62	μA	
I _{DD_LLS}	Low-leakage stop mode current, all peripheral disable, at 3.0 V - at 25 °C and below - at 50 °C - at 70 °C - at 85 °C - at 105 °C	—	2.06	3.33	μA	
		—	4.72	6.85		
		—	8.13	13.30		
		—	13.34	24.70		
		—	41.08	52.43		
I _{DD_LLS}	Low-leakage stop mode current with RTC current, at 3.0 V - at 25 °C and below - at 50 °C - at 70 °C - at 85 °C - at 105 °C	—	2.46	3.73	μA	
		—	5.12	7.25		
		—	8.53	11.78		
		—	13.74	18.91		
		—	41.48	52.83		
I _{DD_LLS}	Low-leakage stop mode current with RTC current, at 1.8 V - at 25 °C and below - at 50 °C - at 70 °C - at 85 °C - at 105 °C	—	2.35	2.70	μA	3
		—	4.91	6.75		
		—	8.32	11.78		
		—	13.44	18.21		
		—	40.47	51.85		
I _{DD_VLLS3}	Very-low-leakage stop mode 3 current, all peripheral disable, at 3.0 V - at 25 °C and below - at 50 °C - at 70 °C - at 85 °C - at 105 °C	—	1.45	1.85	μA	
		—	3.37	4.39		
		—	5.76	8.48		
		—	9.72	14.30		
		—	30.41	37.50		
I _{DD_VLLS3}	Very-low-leakage stop mode 3 current with RTC current, at 3.0 V - at 25 °C and below - at 50 °C - at 70 °C - at 85 °C - at 105 °C	—	2.05	2.45	μA	3
		—	3.97	4.99		
		—	6.36	9.08		
		—	10.32	14.73		
		—	31.01	38.10		

Table continues on the next page...

Table 9. Power consumption operating behaviors

Symbol	Description	Min.	Typ.	Max.	Unit	Notes
	- at 25 °C and below - at 50 °C - at 70 °C - at 85 °C - at 105 °C	—	0.18	0.28	μA	
		—	1.09	1.31		
		—	2.25	2.94		
		—	4.25	5.10		
		—	15.95	19.10		

1. The analog supply current is the sum of the active or disabled current for each of the analog modules on the device. See each module's specification for its supply current.
2. MCG_Lite configured for HIRC mode. CoreMark benchmark compiled using IAR 7.10 with optimization level high, optimized for balanced.
3. RTC uses external 32 kHz crystal as clock source, and the current includes ERCLK32K power consumption.

Table 10. Low power mode peripheral adders — typical value

Symbol	Description	Temperature (°C)						Unit
		-40	25	50	70	85	105	
I _{IRC8MHz}	8 MHz internal reference clock (IRC) adder. Measured by entering STOP or VLPS mode with 8 MHz IRC enabled, MCG_SC[FCRDIV]=000b, MCG_MC[LIRC_DIV2]=000b.	93	93	93	93	93	93	μA
I _{IRC2MHz}	2 MHz internal reference clock (IRC) adder. Measured by entering STOP mode with the 2 MHz IRC enabled, MCG_SC[FCRDIV]=000b, MCG_MC[LIRC_DIV2]=000b.	29	29	29	29	29	29	μA
I _{EREFSTEN4MHz}	External 4 MHz crystal clock adder. Measured by entering STOP or VLPS mode with the crystal enabled.	206	224	230	238	245	253	μA
I _{EREFSTEN32KHz}	External 32 kHz crystal clock adder by means of the OSC0_CR[EREFSTEN and EREFSTEN] bits. Measured by entering all modes with the crystal enabled. - VLLS1 - VLLS3 - LLS - VLPS - STOP							nA
		440	490	540	560	570	580	
		440	490	540	560	570	580	
		490	490	540	560	570	680	
		510	560	560	560	610	680	
		510	560	560	560	610	680	
I _{LPTMR}	LPTMR peripheral adder measured by placing the device in VLLS1 mode with LPTMR enabled using LPO.	30	30	30	85	100	200	

Table continues on the next page...

Table 10. Low power mode peripheral adders — typical value (continued)

Symbol	Description	Temperature (°C)						Unit
		-40	25	50	70	85	105	
								nA
I_{CMP}	CMP peripheral adder measured by placing the device in VLLS1 mode with CMP enabled using the 6-bit DAC and a single external input for compare. Includes 6-bit DAC power consumption.	22	22	22	22	22	22	μA
I_{UART}	UART peripheral adder measured by placing the device in STOP or VLPS mode with selected clock source waiting for RX data at 115200 baud rate. Includes selected clock source power consumption. • IRC8M (8 MHz internal reference clock) • IRC2M (2 MHz internal reference clock)	114	114	114	114	114	114	μA
		34	34	34	34	34	34	
I_{TPM}	TPM peripheral adder measured by placing the device in STOP or VLPS mode with selected clock source configured for output compare generating 100 Hz clock signal. No load is placed on the I/O generating the clock signal. Includes selected clock source and I/O switching currents. • IRC8M (8 MHz internal reference clock) • IRC2M (2 MHz internal reference clock)	147	147	147	147	147	147	μA
		42	42	42	42	42	42	
I_{BG}	Bandgap adder when BGEN bit is set and device is placed in VLPx or VLLSx mode.	45	45	45	45	45	45	μA
I_{ADC}	ADC peripheral adder combining the measured values at V_{DD} and V_{DDA} by placing the device in STOP or VLPS mode. ADC is configured for low power mode using the internal clock and continuous conversions.	330	330	330	330	330	330	μA

2.2.5.1 Diagram: Typical $I_{\text{DD_RUN}}$ operating behavior

The following data was measured under these conditions:

- MCG-Lite in HIRC for run mode, and LIRC for VLPR mode
- USB regulator disabled
- No GPIOs toggled
- Code execution from flash
- For the ALLOFF curve, all peripheral clocks are disabled except FTFA

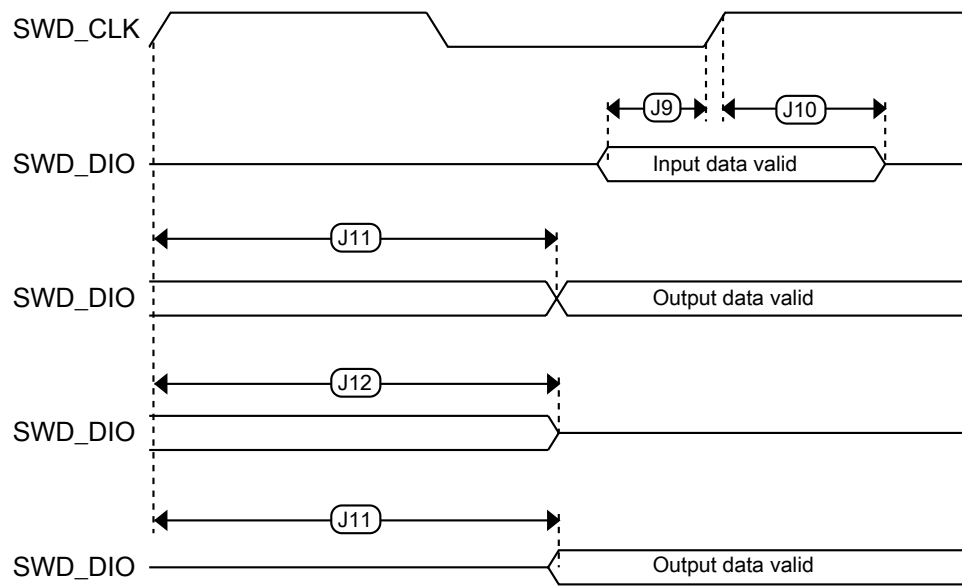


Figure 5. Serial wire data timing

3.2 System modules

There are no specifications necessary for the device's system modules.

3.3 Clock modules

3.3.1 MCG-Lite specifications

Table 18. IRC48M specification

Symbol	Description	Min.	Typ.	Max.	Unit	Notes
I_{DD}	Supply current	—	400	500	μA	—
f_{IRC}	Output frequency	—	48	—	MHz	—
$\Delta f_{irc48m_ol_lv}$	Open loop total deviation of IRC48M frequency at low voltage (VDD=1.71V-1.89V) over temperature	—	± 0.5	± 1.5	$\%f_{irc48m}$	1
$\Delta f_{irc48m_ol_hv}$	Open loop total deviation of IRC48M frequency at high voltage (VDD=1.89V-3.6V) over temperature	—	± 0.5	± 1.0	$\%f_{irc48m}$	1

Table continues on the next page...

3.4.1.1 Flash timing specifications — program and erase

The following specifications represent the amount of time the internal charge pumps are active and do not include command overhead.

Table 22. NVM program/erase timing specifications

Symbol	Description	Min.	Typ.	Max.	Unit	Notes
$t_{hvp\text{gm}4}$	Longword Program high-voltage time	—	7.5	18	μs	—
$t_{hversscr}$	Sector Erase high-voltage time	—	13	113	ms	1
$t_{hversblk128k}$	Erase Block high-voltage time for 128 KB	—	52	452	ms	1

1. Maximum time based on expectations at cycling end-of-life.

3.4.1.2 Flash timing specifications — commands

Table 23. Flash command timing specifications

Symbol	Description	Min.	Typ.	Max.	Unit	Notes
$t_{rd1blk128k}$	Read 1s Block execution time • 128 KB program flash	—	—	1.7	ms	1
$t_{rd1sec1k}$	Read 1s Section execution time (flash sector)	—	—	60	μs	1
t_{pgmchk}	Program Check execution time	—	—	45	μs	1
t_{rdrsr}	Read Resource execution time	—	—	30	μs	1
t_{pgm4}	Program Longword execution time	—	65	145	μs	—
$t_{ersblk128k}$	Erase Flash Block execution time • 128 KB program flash	—	88	600	ms	2
t_{ersscr}	Erase Flash Sector execution time	—	14	114	ms	2
t_{rd1all}	Read 1s All Blocks execution time	—	—	1.8	ms	1
t_{rdonce}	Read Once execution time	—	—	25	μs	1
$t_{pgmonce}$	Program Once execution time	—	65	—	μs	—
t_{ersall}	Erase All Blocks execution time	—	175	1300	ms	2
t_{vfykey}	Verify Backdoor Access Key execution time	—	—	30	μs	1
$t_{ersallu}$	Erase All Blocks Unsecure execution time	—	175	1300	ms	2

1. Assumes 25 MHz flash clock frequency.
2. Maximum times for erase parameters based on expectations at cycling end-of-life.

2. Typical values assume $V_{DDA} = 3.0\text{ V}$, $\text{Temp} = 25\text{ }^{\circ}\text{C}$, $f_{\text{ADCK}} = 2.0\text{ MHz}$ unless otherwise stated. Typical values are for reference only and are not tested in production.
3. The ADC supply current depends on the ADC conversion clock speed, conversion rate and ADC_CFG1[ADLPC] (low power). For lowest power operation, ADC_CFG1[ADLPC] must be set, the ADC_CFG2[ADHSC] bit must be clear with 1 MHz ADC conversion clock speed.
4. $1\text{ LSB} = (V_{\text{REFH}} - V_{\text{REFL}})/2^N$
5. ADC conversion clock < 16 MHz, Max hardware averaging (AVGE = %1, AVGS = %11)
6. Input data is 100 Hz sine wave. ADC conversion clock < 12 MHz.
7. Input data is 1 kHz sine wave. ADC conversion clock < 12 MHz.
8. ADC conversion clock < 3 MHz

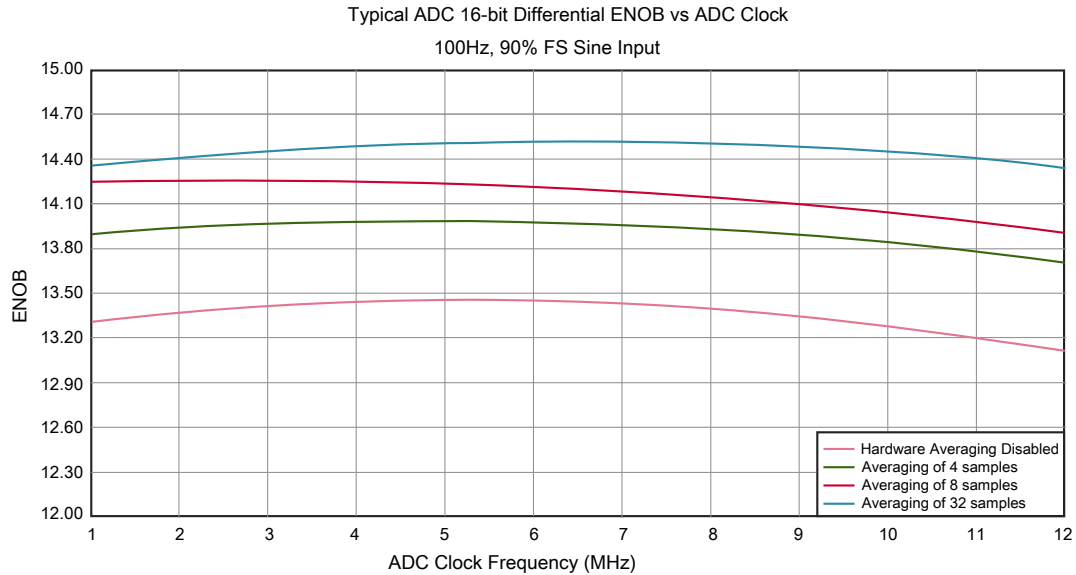


Figure 8. Typical ENOB vs. ADC_CLK for 16-bit differential mode

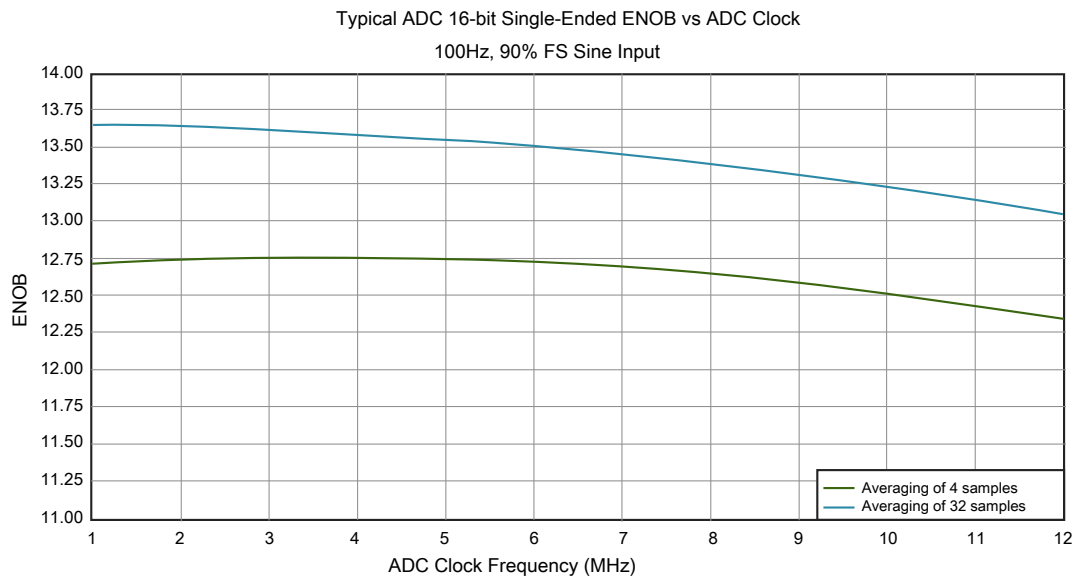


Figure 9. Typical ENOB vs. ADC_CLK for 16-bit single-ended mode

3.6.2 Voltage reference electrical specifications

Table 28. VREF full-range operating requirements

Symbol	Description	Min.	Max.	Unit	Notes
V_{DDA}	Supply voltage		3.6	V	—
T_A	Temperature	Operating temperature range of the device		°C	—
C_L	Output load capacitance	100		nF	1, 2

1. C_L must be connected to VREF_OUT if the VREF_OUT functionality is being used for either an internal or external reference.
2. The load capacitance should not exceed +/-25% of the nominal specified C_L value over the operating temperature range of the device.

Table 29 is tested under the condition of setting VREF_TRM[CHOPEN], VREF_SC[REGEN] and VREF_SC[ICOMPEN] bits to 1.

Table 29. VREF full-range operating behaviors

Symbol	Description	Min.	Typ.	Max.	Unit	Notes
V_{out}	Voltage reference output with factory trim at nominal V_{DDA} and temperature=25°C	1.1915	1.195	1.1977	V	1
V_{out}	Voltage reference output — factory trim	1.1584	—	1.2376	V	1
V_{out}	Voltage reference output — user trim	1.193	—	1.197	V	1
V_{step}	Voltage reference trim step	—	0.5	—	mV	1
V_{tdrift}	Temperature drift ($V_{max} - V_{min}$ across the full temperature range: 0 to 70°C)	—	—	50	mV	1
I_{bg}	Bandgap only current	—	—	80	μA	1
I_{lp}	Low-power buffer current	—	—	360	μA	1
I_{hp}	High-power buffer current	—	—	1	mA	1
ΔV_{LOAD}	Load regulation • current = ± 1.0 mA	—	200	—	μV	1, 2
T_{stup}	Buffer startup time	—	—	100	μs	—
$T_{chop_osc_st\ up}$	Internal bandgap start-up delay with chop oscillator enabled	—	—	35	ms	—
V_{vdrift}	Voltage drift ($V_{max} - V_{min}$ across the full voltage range)	—	2	—	mV	1

1. See the chip's Reference Manual for the appropriate settings of the VREF Status and Control register.
2. Load regulation voltage is the difference between the VREF_OUT voltage with no load vs. voltage with defined load

NOTE

The IRC48M do not meet the USB jitter specifications for certification for Host mode operation.

This device cannot support Host mode operation.

3.8.2 USB VREG electrical specifications

Table 35. USB VREG electrical specifications

Symbol	Description	Min.	Typ. ¹	Max.	Unit	Notes
VREGIN	Input supply voltage	2.7	—	5.5	V	
I _{DDon}	Quiescent current — Run mode, load current equal zero, input supply (VREGIN) > 3.6 V	—	125	186	μA	
I _{DDstby}	Quiescent current — Standby mode, load current equal zero	—	1.1	10	μA	
I _{DDoff}	Quiescent current — Shutdown mode - VREGIN = 5.0 V and temperature=25 °C - Across operating voltage and temperature	—	650	—	nA	
		—	—	4	μA	
I _{LOADrun}	Maximum load current — Run mode	—	—	120	mA	
I _{LOADstby}	Maximum load current — Standby mode	—	—	1	mA	
V _{Reg33out}	Regulator output voltage — Input supply (VREGIN) > 3.6 V - Run mode - Standby mode	3	3.3	3.6	V	
		2.1	2.8	3.6	V	
V _{Reg33out}	Regulator output voltage — Input supply (VREGIN) < 3.6 V, pass-through mode	2.1	—	3.6	V	2
C _{OUT}	External output capacitor	1.76	2.2	8.16	μF	
ESR	External output capacitor equivalent series resistance	1	—	100	mΩ	
I _{LIM}	Short circuit current	—	290	—	mA	

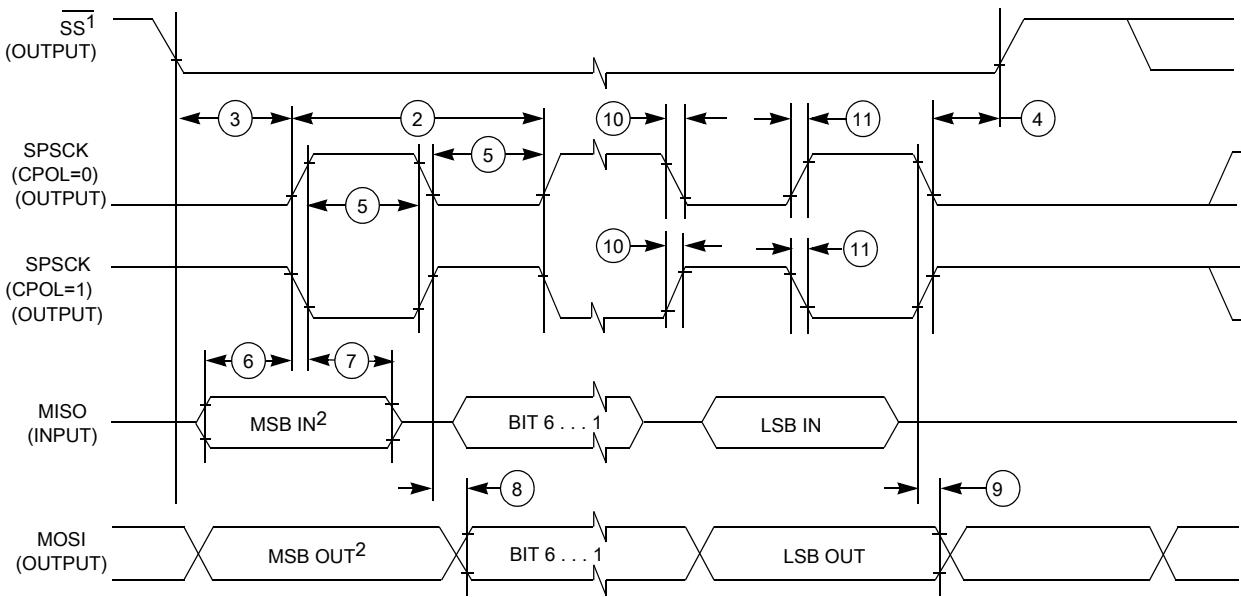
1. Typical values assume VREGIN = 5.0 V, Temp = 25 °C unless otherwise stated.

2. Operating in pass-through mode: regulator output voltage equal to the input voltage minus a drop proportional to I_{Load}.

Table 37. SPI master mode timing on slew rate enabled pads (continued)

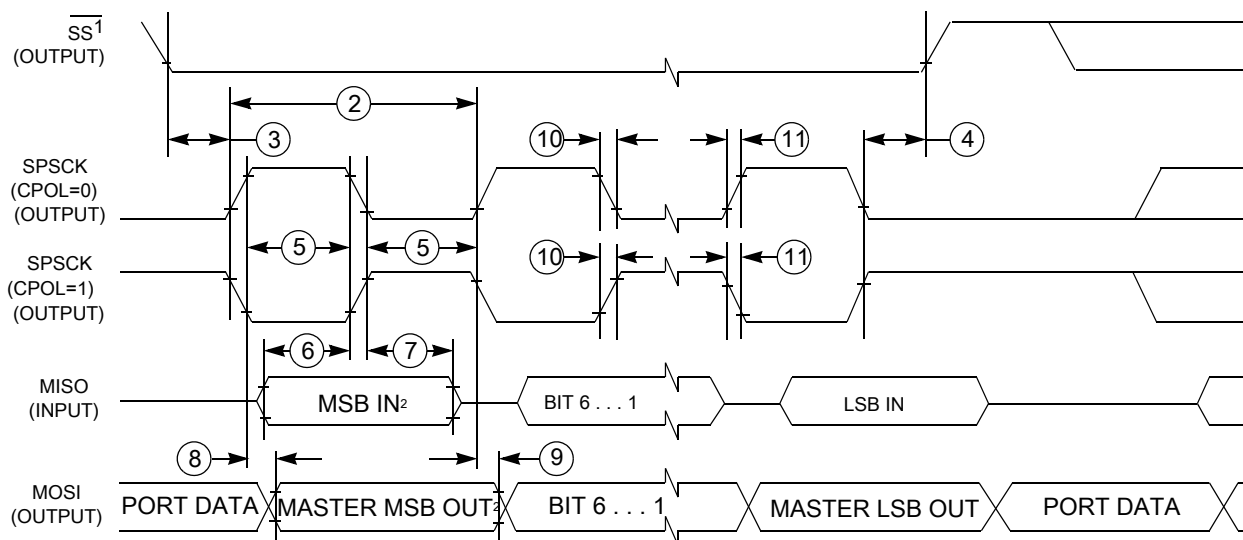
Num.	Symbol	Description	Min.	Max.	Unit	Note
8	t_v	Data valid (after SPSCCK edge)	—	52	ns	—
9	t_{HO}	Data hold time (outputs)	0	—	ns	—
10	t_{RI}	Rise time input	—	$t_{periph} - 25$	ns	—
	t_{FI}	Fall time input				
11	t_{RO}	Rise time output	—	36	ns	—
	t_{FO}	Fall time output				

1. For SPI0 f_{periph} is the bus clock (f_{BUS}). For SPI1 f_{periph} is the system clock (f_{SYS}).
2. $t_{periph} = 1/f_{periph}$



1. If configured as an output.
2. LSBF = 0. For LSBF = 1, bit order is LSB, bit 1, ..., bit 6, MSB.

Figure 14. SPI master mode timing (CPHA = 0)



1. If configured as output
2. LSBF = 0. For LSBF = 1, bit order is LSB, bit 1, ..., bit 6, MSB.

Figure 15. SPI master mode timing (CPHA = 1)

Table 38. SPI slave mode timing on slew rate disabled pads

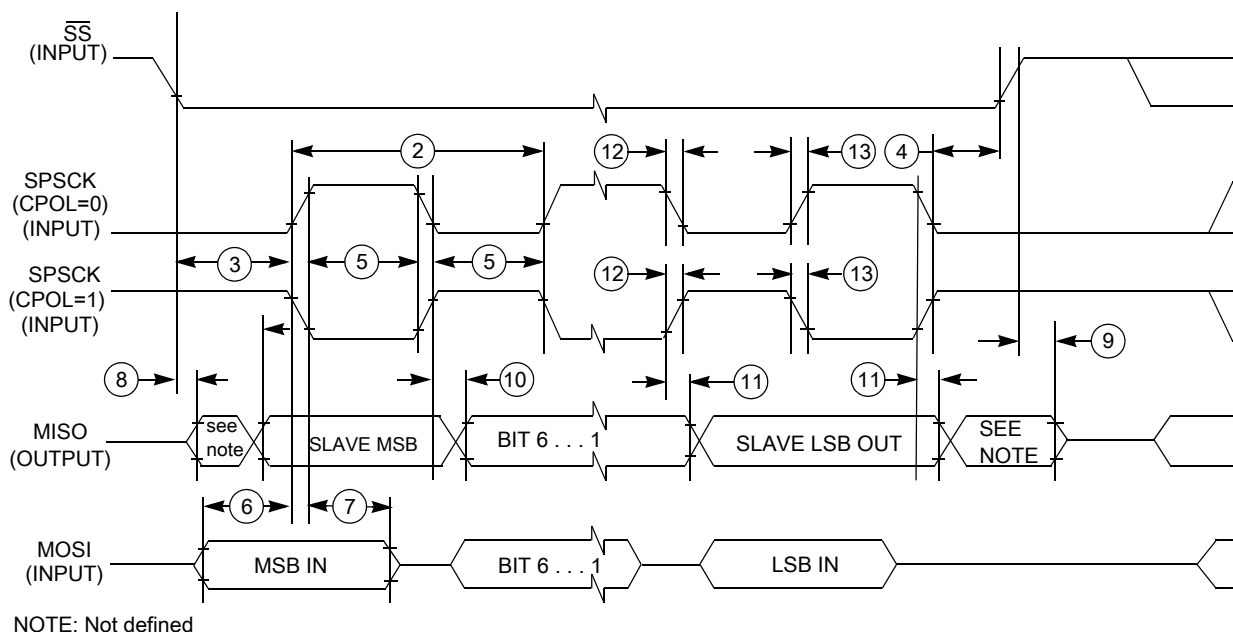
Num.	Symbol	Description	Min.	Max.	Unit	Note
1	f_{op}	Frequency of operation	0	$f_{periph}/4$	Hz	1
2	t_{SPSCCK}	SPSCCK period	$4 \times t_{periph}$	—	ns	2
3	t_{Lead}	Enable lead time	1	—	t_{periph}	—
4	t_{Lag}	Enable lag time	1	—	t_{periph}	—
5	$t_{WSPSCCK}$	Clock (SPSCCK) high or low time	$t_{periph} - 30$	—	ns	—
6	t_{SU}	Data setup time (inputs)	2.5	—	ns	—
7	t_{HI}	Data hold time (inputs)	3.5	—	ns	—
8	t_a	Slave access time	—	t_{periph}	ns	3
9	t_{dis}	Slave MISO disable time	—	t_{periph}	ns	4
10	t_v	Data valid (after SPSCCK edge)	—	31	ns	—
11	t_{HO}	Data hold time (outputs)	0	—	ns	—
12	t_{RI}	Rise time input	—	$t_{periph} - 25$	ns	—
	t_{FI}	Fall time input				
13	t_{RO}	Rise time output	—	25	ns	—
	t_{FO}	Fall time output				

1. For SPI0 f_{periph} is the bus clock (f_{BUS}). For SPI1 f_{periph} is the system clock (f_{SYS}).
2. $t_{periph} = 1/f_{periph}$
3. Time to data active from high-impedance state
4. Hold time to high-impedance state

Table 39. SPI slave mode timing on slew rate enabled pads

Num.	Symbol	Description	Min.	Max.	Unit	Note
1	f_{op}	Frequency of operation	0	$f_{periph}/4$	Hz	1
2	t_{SPSCK}	SPSCK period	$4 \times t_{periph}$	—	ns	2
3	t_{Lead}	Enable lead time	1	—	t_{periph}	—
4	t_{Lag}	Enable lag time	1	—	t_{periph}	—
5	t_{WSPSCK}	Clock (SPSCK) high or low time	$t_{periph} - 30$	—	ns	—
6	t_{SU}	Data setup time (inputs)	2	—	ns	—
7	t_{HI}	Data hold time (inputs)	7	—	ns	—
8	t_a	Slave access time	—	t_{periph}	ns	3
9	t_{dis}	Slave MISO disable time	—	t_{periph}	ns	4
10	t_v	Data valid (after SPSCK edge)	—	122	ns	—
11	t_{HO}	Data hold time (outputs)	0	—	ns	—
12	t_{RI}	Rise time input	—	$t_{periph} - 25$	ns	—
	t_{FI}	Fall time input	—	$t_{periph} - 25$	ns	—
13	t_{RO}	Rise time output	—	36	ns	—
	t_{FO}	Fall time output	—	36	ns	—

1. For SPI0 f_{periph} is the bus clock (f_{BUS}). For SPI1 f_{periph} is the system clock (f_{SYS}).
2. $t_{periph} = 1/f_{periph}$
3. Time to data active from high-impedance state
4. Hold time to high-impedance state


Figure 16. SPI slave mode timing (CPHA = 0)

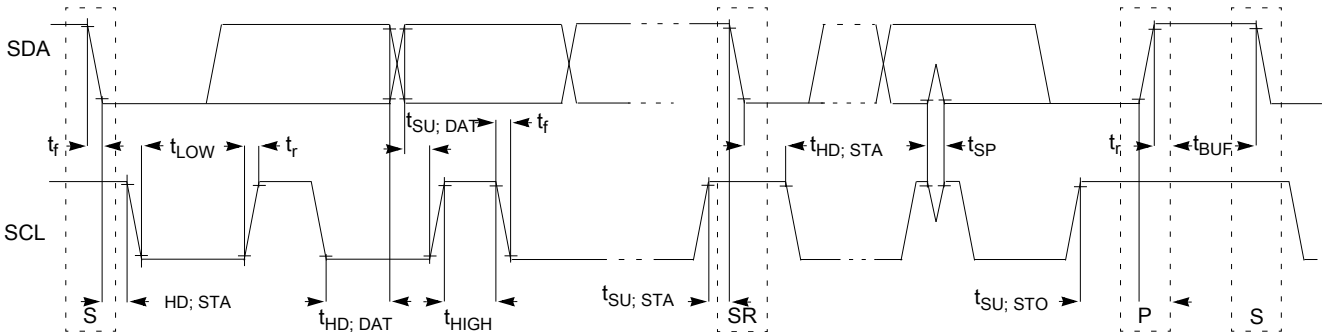


Figure 18. Timing definition for devices on the I²C bus

3.8.5 UART

See [General switching specifications](#).

3.8.6 I2S/SAI switching specifications

This section provides the AC timing for the I2S/SAI module in master mode (clocks are driven) and slave mode (clocks are input). All timing is given for noninverted serial clock polarity (TCR2[BCP] is 0, RCR2[BCP] is 0) and a noninverted frame sync (TCR4[FSP] is 0, RCR4[FSP] is 0). If the polarity of the clock and/or the frame sync have been inverted, all the timing remains valid by inverting the bit clock signal (BCLK) and/or the frame sync (FS) signal shown in the following figures.

3.8.6.1 Normal Run, Wait and Stop mode performance over the full operating voltage range

This section provides the operating performance over the full operating voltage for the device in Normal Run, Wait and Stop modes.

Table 42. I2S/SAI master mode timing

Num.	Characteristic	Min.	Max.	Unit
	Operating voltage	1.71	3.6	V
S1	I2S_MCLK cycle time	40	—	ns
S2	I2S_MCLK (as an input) pulse width high/low	45%	55%	MCLK period
S3	I2S_TX_BCLK/I2S_RX_BCLK cycle time (output)	80	—	ns
S4	I2S_TX_BCLK/I2S_RX_BCLK pulse width high/low	45%	55%	BCLK period
S5	I2S_TX_BCLK/I2S_RX_BCLK to I2S_TX_FS/I2S_RX_FS output valid	—	15.5	ns

Table continues on the next page...

Table 44. I2S/SAI master mode timing in VLPR, VLPW, and VLPS modes (full voltage range) (continued)

Num.	Characteristic	Min.	Max.	Unit
S8	I2S_TX_BCLK to I2S_TXD invalid	0	—	ns
S9	I2S_RXD/I2S_RX_FS input setup before I2S_RX_BCLK		—	ns
S10	I2S_RXD/I2S_RX_FS input hold after I2S_RX_BCLK	0	—	ns

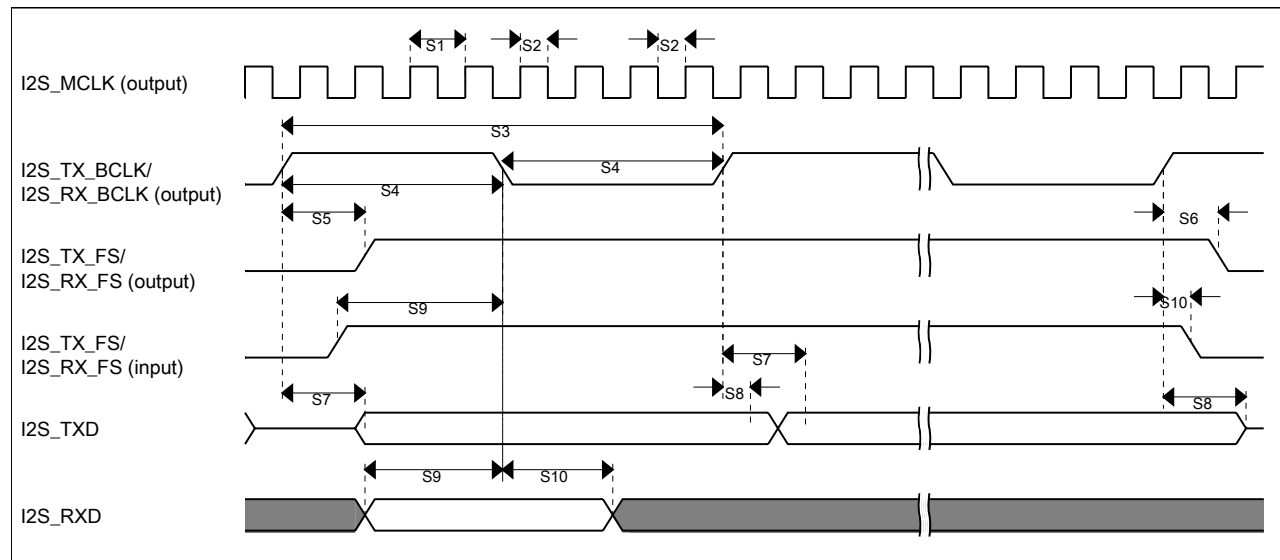


Figure 21. I2S/SAI timing — master modes

Table 45. I2S/SAI slave mode timing in VLPR, VLPW, and VLPS modes (full voltage range)

Num.	Characteristic	Min.	Max.	Unit
	Operating voltage	1.71	3.6	V
S11	I2S_TX_BCLK/I2S_RX_BCLK cycle time (input)	250	—	ns
S12	I2S_TX_BCLK/I2S_RX_BCLK pulse width high/low (input)	45%	55%	MCLK period
S13	I2S_TX_FS/I2S_RX_FS input setup before I2S_TX_BCLK/I2S_RX_BCLK	30	—	ns
S14	I2S_TX_FS/I2S_RX_FS input hold after I2S_TX_BCLK/I2S_RX_BCLK	2	—	ns
S15	I2S_TX_BCLK to I2S_TXD/I2S_TX_FS output valid	—	87	ns
S16	I2S_TX_BCLK to I2S_TXD/I2S_TX_FS output invalid	0	—	ns
S17	I2S_RXD setup before I2S_RX_BCLK	30	—	ns
S18	I2S_RXD hold after I2S_RX_BCLK	2	—	ns
S19	I2S_TX_FS input assertion to I2S_TXD output valid ¹	—	72	ns

Pinouts and Packaging

32 QFN	48 QFN	64 MAP BGA	64 LQFP	Pin Name	Default	ALT0	ALT1	ALT2	ALT3	ALT4	ALT5	ALT6	ALT7
—	31	E6	39	PTB16	DISABLED		PTB16	SPI1_MOSI	LPUART0_RX	TPM_CLKIN0	SPI1_MISO		
—	32	D7	40	PTB17	DISABLED		PTB17	SPI1_MISO	LPUART0_TX	TPM_CLKIN1	SPI1_MOSI		
—	—	D6	41	PTB18	DISABLED		PTB18		TPM2_CH0	I2S0_TX_BCLK			
—	—	C7	42	PTB19	DISABLED		PTB19		TPM2_CH1	I2S0_TX_FS			
—	33	D8	43	PTC0	ADC0_SE14	ADC0_SE14	PTC0		EXTRG_IN	audioUSB_SOF_OUT	CMP0_OUT	I2S0_TXD0	
—	—	E3	47	VSS	VSS	VSS							
—	—	E4	48	VDD	VDD	VDD							
—	—	A6	53	PTC8	CMP0_IN2	CMP0_IN2	PTC8	I2C0_SCL	TPM0_CH4	I2S0_MCLK			
—	—	B5	54	PTC9	CMP0_IN3	CMP0_IN3	PTC9	I2C0_SDA	TPM0_CH5	I2S0_RX_BCLK			
—	—	B4	55	PTC10	DISABLED		PTC10	I2C1_SCL		I2S0_RX_FS			
—	—	A5	56	PTC11	DISABLED		PTC11	I2C1_SDA		I2S0_RXD0			
—	41	C3	57	PTD0	DISABLED		PTD0	SPI0_SS		TPM0_CH0		FXIO0_D0	
—	42	A4	58	PTD1	ADC0_SE5b	ADC0_SE5b	PTD1	SPI0_SCK		TPM0_CH1		FXIO0_D1	
—	43	C2	59	PTD2	DISABLED		PTD2	SPI0_MOSI	UART2_RX	TPM0_CH2	SPI0_MISO	FXIO0_D2	
—	44	B3	60	PTD3	DISABLED		PTD3	SPI0_MISO	UART2_TX	TPM0_CH3	SPI0_MOSI	FXIO0_D3	
—	—	C5	—	NC	NC	NC							
1	—	A1	1	PTE0	DISABLED		PTE0/CLKOUT32K	SPI1_MISO	LPUART1_TX	RTC_CLKOUT	CMP0_OUT	I2C1_SDA	
2	2	C4	4	VSS	VSS	VSS							
3	3	E1	5	USB0_DP	USB0_DP	USB0_DP							
4	4	D1	6	USB0_DM	USB0_DM	USB0_DM							
5	5	E2	7	VOUT33	VOUT33	VOUT33							
6	6	D2	8	VREGIN	VREGIN	VREGIN							
7	9	F4	13	VDDA	VDDA	VDDA							
8	12	F3	16	VSSA	VSSA	VSSA							
9	14	H2	18	PTE30	DAC0_OUT/ ADC0_SE23/ CMP0_IN4	DAC0_OUT/ ADC0_SE23/ CMP0_IN4	PTE30		TPM0_CH3	TPM_CLKIN1	LPUART1_TX	LPTMR0_ALT1	
10	17	D3	22	PTA0	SWD_CLK		PTA0		TPM0_CH5				SWD_CLK
11	18	D4	23	PTA1	DISABLED		PTA1	LPUART0_RX	TPM2_CH0				
12	19	E5	24	PTA2	DISABLED		PTA2	LPUART0_TX	TPM2_CH1				
13	20	D5	25	PTA3	SWD_DIO		PTA3	I2C1_SCL	TPM0_CH0				SWD_DIO
14	21	G5	26	PTA4	NMI_b		PTA4	I2C1_SDA	TPM0_CH1				NMI_b
15	22	G7	30	VDD	VDD	VDD							
16	23	H7	31	VSS	VSS	VSS							

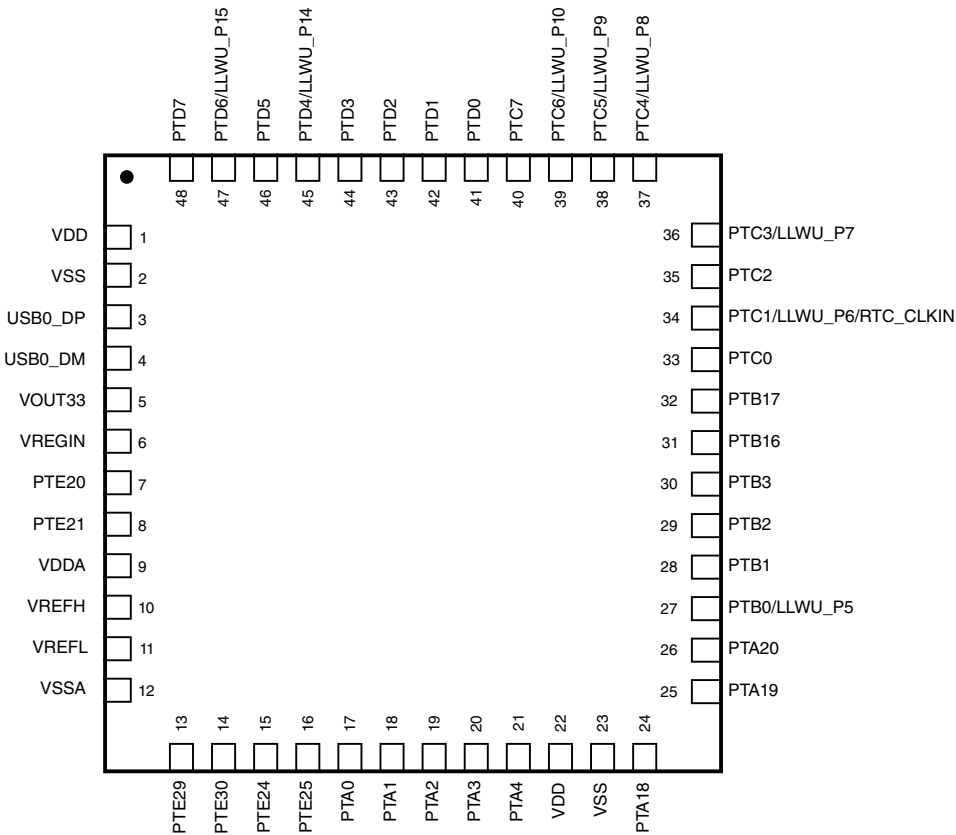


Figure 24. 48 QFN Pinout diagram

Figure below shows the 64 LQFP pinouts:

7.1 Description

Part numbers for the chip have fields that identify the specific part. You can use the values of these fields to determine the specific part you have received.

7.2 Format

Part numbers for this device have the following format:

Q KL## A FFF R T PP CC N

7.3 Fields

This table lists the possible values for each field in the part number (not all combinations are valid):

Table 46. Part number fields descriptions

Field	Description	Values
Q	Qualification status	- M = Fully qualified, general market flow - P = Prequalification
KL##	Kinetis family	KL27
A	Key attribute	Z = Cortex-M0+
FFF	Program flash memory size	
R	Silicon revision	(Blank) = Main - A = Revision after main
T	Temperature range (°C)	V = -40 to 105
PP	Package identifier	- FM = 32 QFN (5 mm x 5 mm) - FT = 48 QFN (7 mm x 7 mm) - LH = 64 LQFP (10 mm x 10 mm) - MP = 64 MAPBGA (5 mm x 5 mm)
CC	Maximum CPU frequency (MHz)	4 = 48 MHz
N	Packaging type	R = Tape and reel

7.4 Example

This is an example part number:

MKL27Z256VFT4