PEDL66517-03

OKI Semiconductor

This version: Nov. 1999
Previous version: Aug. 1999

ML66517 Family

Preliminary

16-Bit Microcontroller

GENERAL DESCRIPTION

The ML66517 family of highly functional CMOS 16-bit single chip microcontrollers utilizes the nX-8/500S, Oki's proprietary CPU core.

Each device includes capture input with an internal digital filter, 10-bit A/D converter, a number of timers, and dedicated 3-phase PWM (6 outputs) function capable of generating and controlling of AC/DC motor driving waveforms.

By means of the internal dedicated function for motor control, this general-purpose microcontroller is optimally suited for DC and AC motor control applications for energy saving. And the internal hardware multiplier allows high-speed arithmetic operations to be executed. And also the internal clock multiplication circuit can reduce the source frequency noise so that high-speed operations can be performed.

The flash ROM versions (ML66Q517 and ML66Q515) programmable with a single 5V power supply are also included in the family. These versions are easily adaptable to quick specification changes and to new product versions.

APPLICATIONS

Air conditioner or inverter control
Motor control for FA equipment

ORDERING INFORMATION

Order Code or Product Name	Package	Remark
ML66514-RB	80-pin plastic QFP (QFP 80-P-1420-0.80-BK)	5 V mask ROM version
ML66Q515-RB		5 V flash ROM version
ML66517-GA	64-pin plastic SDIP (SDIP 64-P-750-1.778)	5 V mask ROM version
ML66Q517-GA		MSM66517 flash ROM version

FEATURES

Name	ML66514	ML66517
Operating temperature	–40°C to 85°C	
Power supply voltage/ Maximum frequency	V_{DD} = 4.5 to 5.5 V/f = 25 MHz	
Minimum instruction execution time	80 nsec @25 MHz	
Internal ROM size (max. external)	32 KB (64 KB)	64 KB (128 KB)
Internal RAM size (max. external)	1 KB (64 KB)	2 KB (64 KB)
I/O ports	46 I/O pins (with pull-up resistors, programmable at the bit level), 4 input pins	56 I/O pins (with pull-up resistors, programmable at the bit level), 8 input pins
Timers	16-bit free-running counter × 1ch	
	Compare output/capture input × 2ch	
	16-bit timer (auto-reload/timer out) × 1ch	
	8-bit auto reload timer × 2ch	8-bit auto reload timer × 4ch (can also be used as 16-bit auto reload timer × 1ch and 8-bit auto reload timer × 2ch)
	Capture × 2ch	
	8-bit auto reload timer × 2ch (also functions as serial communication baud rate generators)	
	8-bit auto reload timer × 1ch (also functions as a watchdog timer)	
	8-bit PWM × 2ch (can also be used as 16-bit PWM × 1ch)	8-bit PWM × 4ch (can also be used as 16-bit PWM × 2ch)
Serial port	Synchronous/UART × 2ch	
A/D converter	10-bit × 4ch	10-bit × 8ch
3-phase PWM (AC motor control)	Available	
3-phase PWM (DC motor control)	Available	
External interrupt	Non-Maskable × 1ch Maskable × 2ch	Non-Maskable × 1ch Maskable × 4ch
Interrupt priority	3 levels	
Others	Multiplexed address and data buses	
	Multiplication calculator	
Flash ROM version	ML66Q515 (ROM = 64 KB, RAM = 2 KB)	ML66Q517

SPECIAL FEATURES

1. High-performance CPU
The family includes the high-performance CPU, powerful bit manipulation instruction set, full symmetrical addressing mode, and ROM WINDOW function, and also provides the best optimized C compiler support.

2. 3-phase PWM circuit for generating motor drive waveforms
The device includes a 16-bit three-phase PWM (six outputs) circuit designed specifically for generating AC three-phase motor or DC three-phase brushless motor drive waveforms. PWM and level outputs can be switched by compare and match circuitry and software, and the compare and match circuitry can switch the outputs in real time.
The device has circuitry to fix the three-phase outputs at an inactive level by inputting malfunction signals from a motor at the specific pin.

3. Capture inputs with digital filter filters
The device has two channels of capture inputs with 3/4 digital filters. The device is best suited to event interval measurement, pulse width measurement, etc. in a high noise environment such as motor control. An optimum filter can be selected according to noise width since a sampling interval of an input signal can be selected. A digital filter OFF mode can also be selected.

4. High-speed multiplier
The device includes a dedicated high-speed multiplier.
The calculation time, 16 bits × 16 bits = 32 bits, is 200 ns (f = 25 MHz).

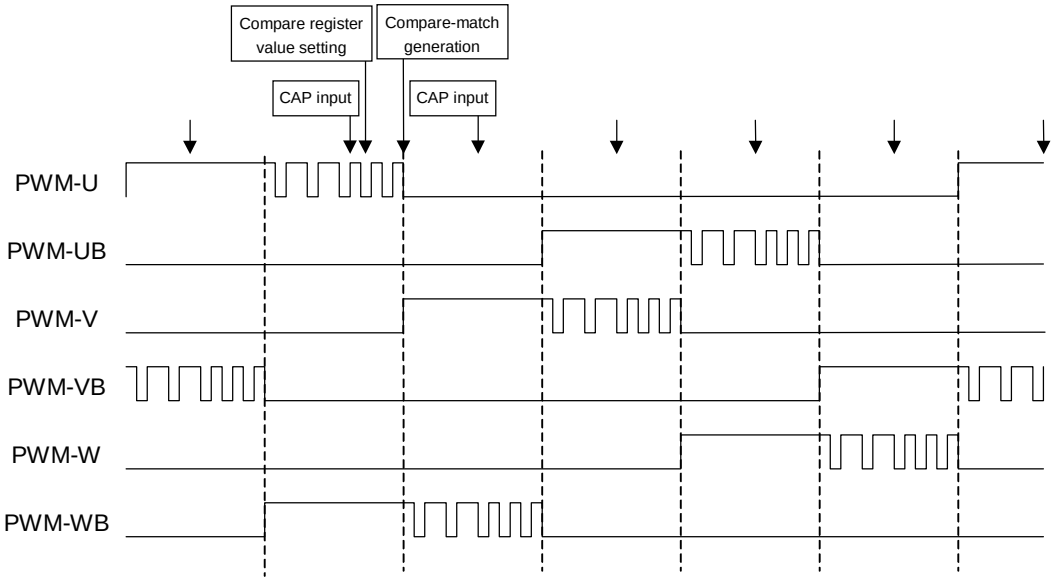
5. Clock multiplication circuit
The device includes a clock multiplication circuit in which the clock can be selected as a source clock (PLL OFF), 1 × clock, 2 × clock, or 4 × clock.
Therefore, the use of a low frequency oscillator (external clock) allows the device to internally operate at a high speed, which achieves noise reduction and lower power consumption.

6. Flash memory version programmable with a single power supply
In addition to the mask ROM versions, the family includes the versions (ML66Q517 and ML66Q515) with 64 KB flash memory that can be programmed with a single 5 V supply.

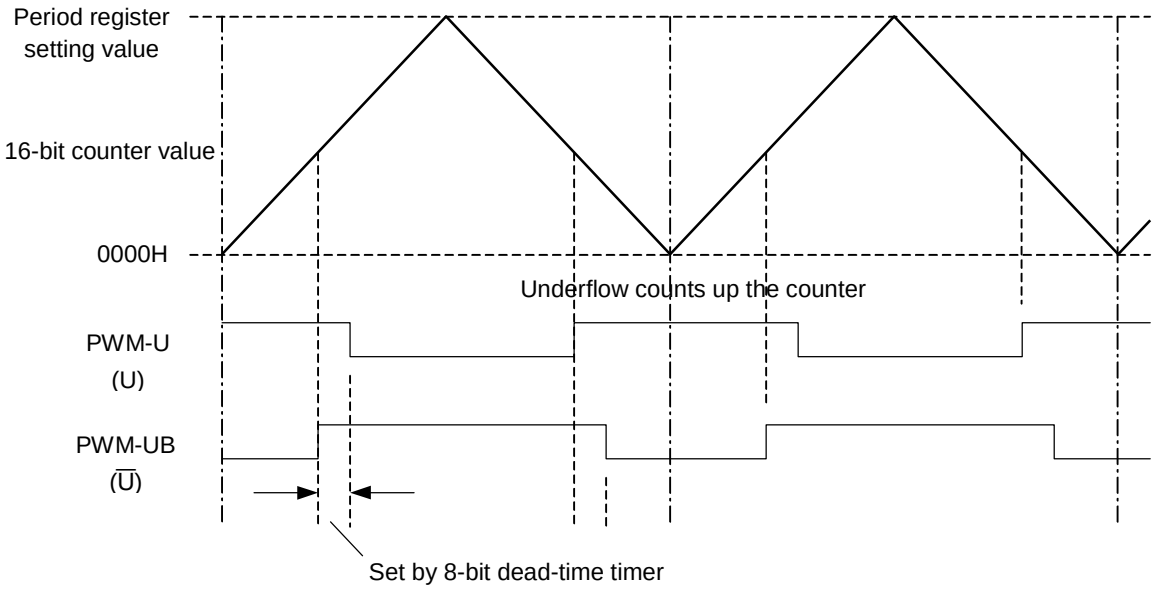
7. A high-precision A/D converter
The device has a high precision 10-bit A/D converter with eight channels.
An independent result register for each channel provides easy accessibility by software.
The A/D converter is activated in a channel select mode, and automatic conversion is also implemented in a scan mode which scans from any designated channel to the last channel (ch 7).

8. Programmable pull-up resistors
Building the pull-up resistors into the chip contributes to overall design compactness. Making them programmable on a per-bit basis allows complete flexibility in circuit board layout and system design. These programmable pull-up resistors are available for all I/O pins not already assigned specific functions (such as the oscillator connection pins).

PWM output switching every 60° of motor turn using the compare-out timer



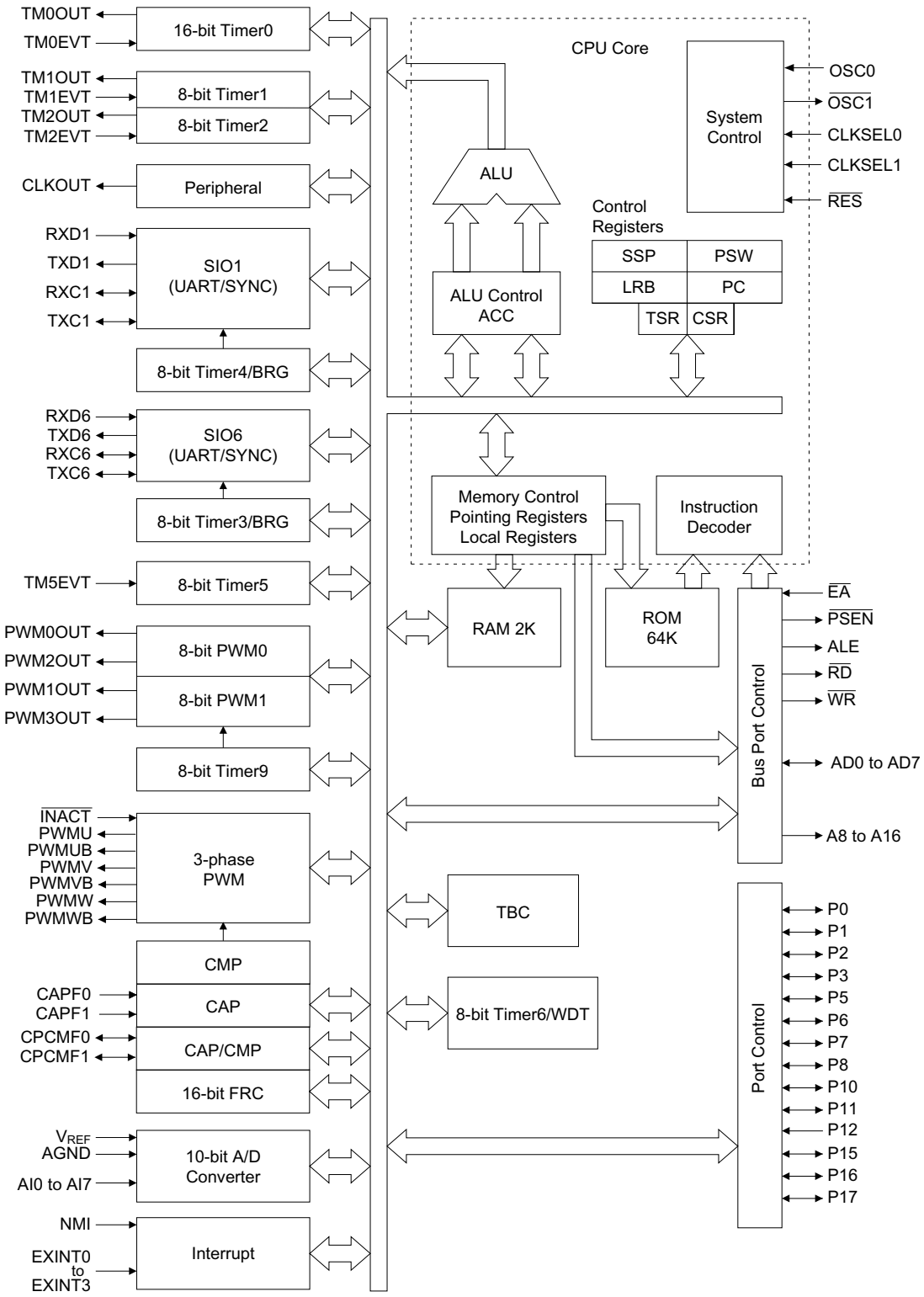
PWM Output Timing (DC Motor Control)



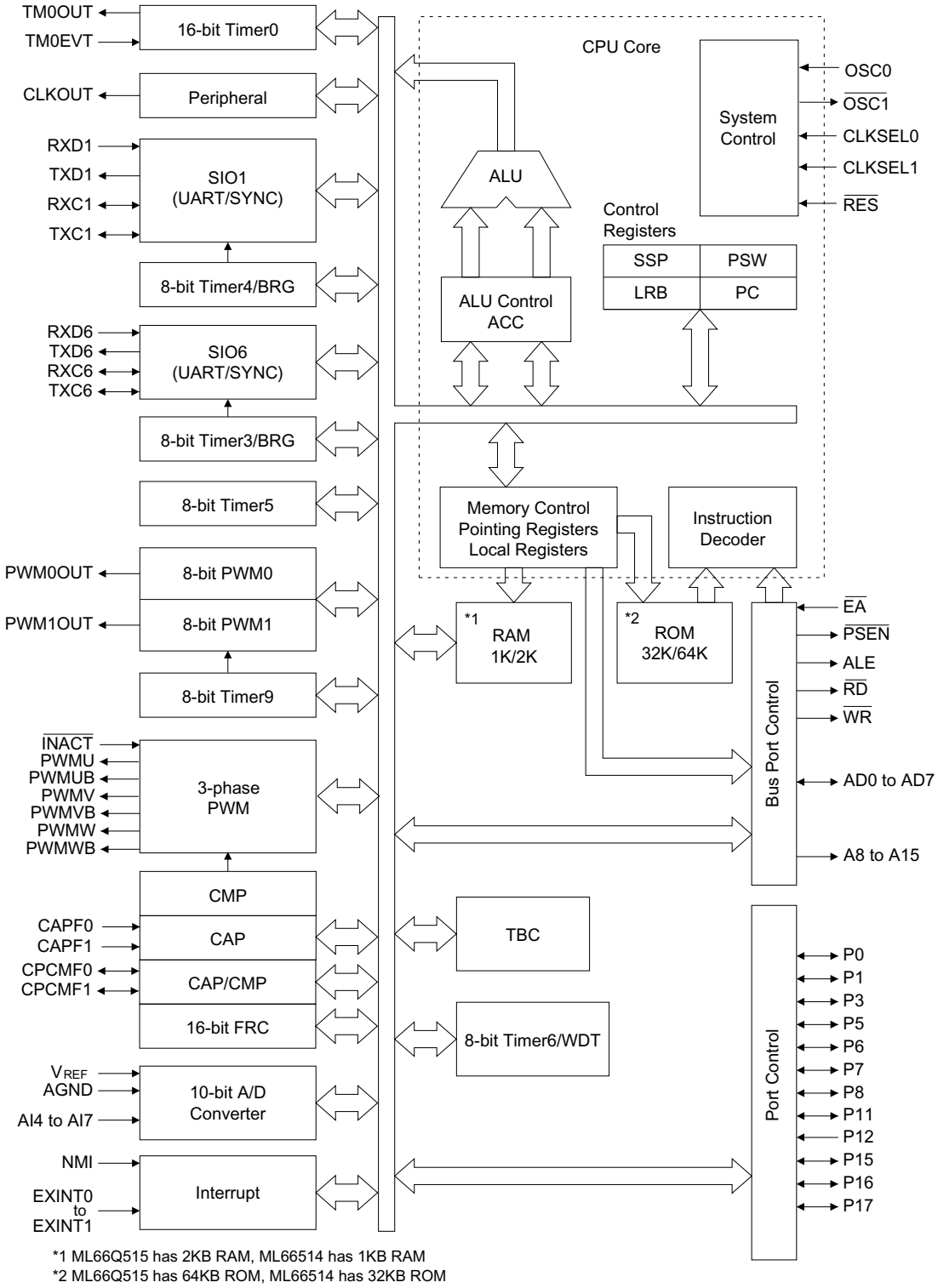
(Only U and Ū output signals are indicated above)

PWM Output Timing (AC Motor Control)

BLOCK DIAGRAM



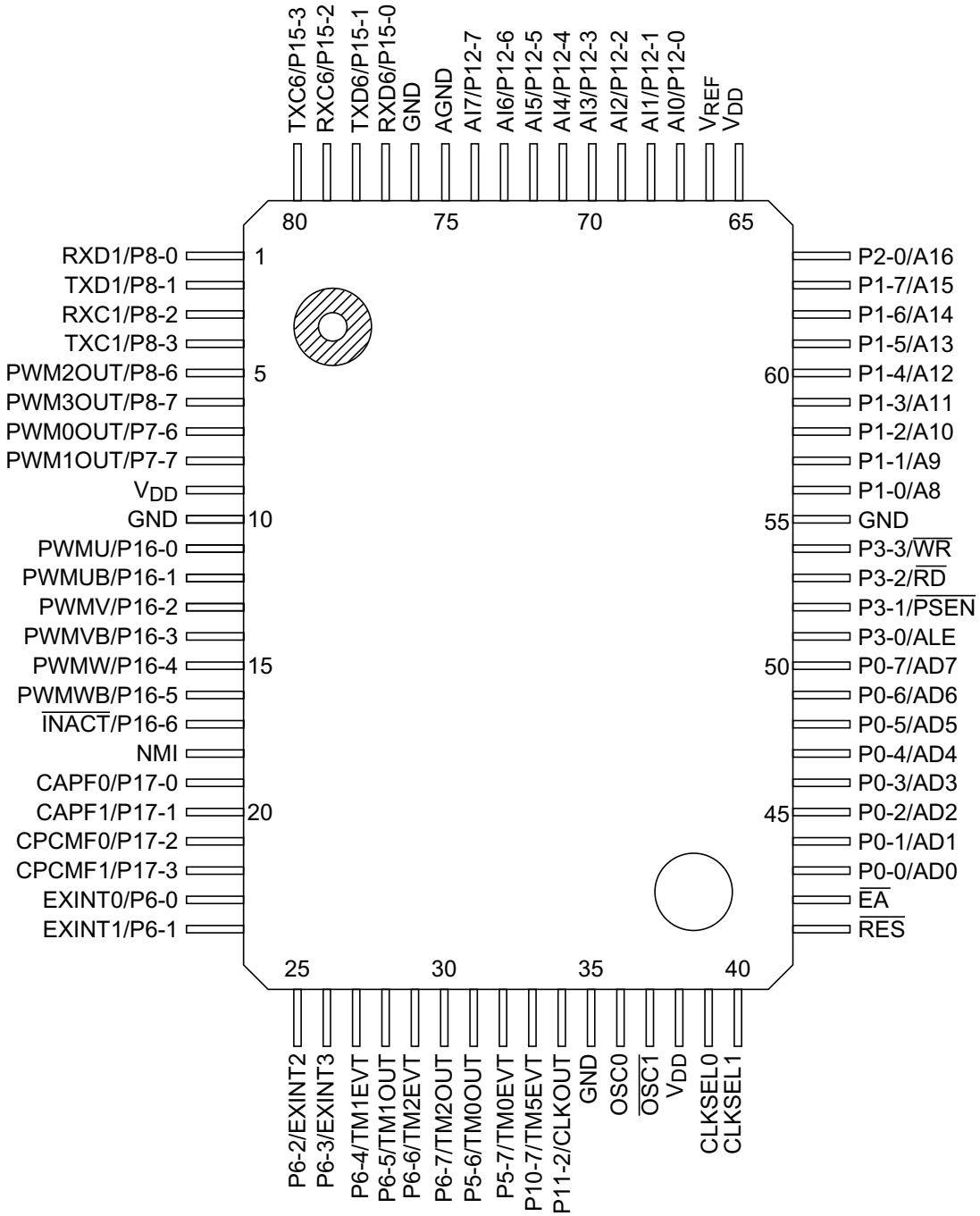
ML66517/ML66Q517 Block Diagram



*1 ML66Q515 has 2KB RAM, ML66514 has 1KB RAM
*2 ML66Q515 has 64KB ROM, ML66514 has 32KB ROM

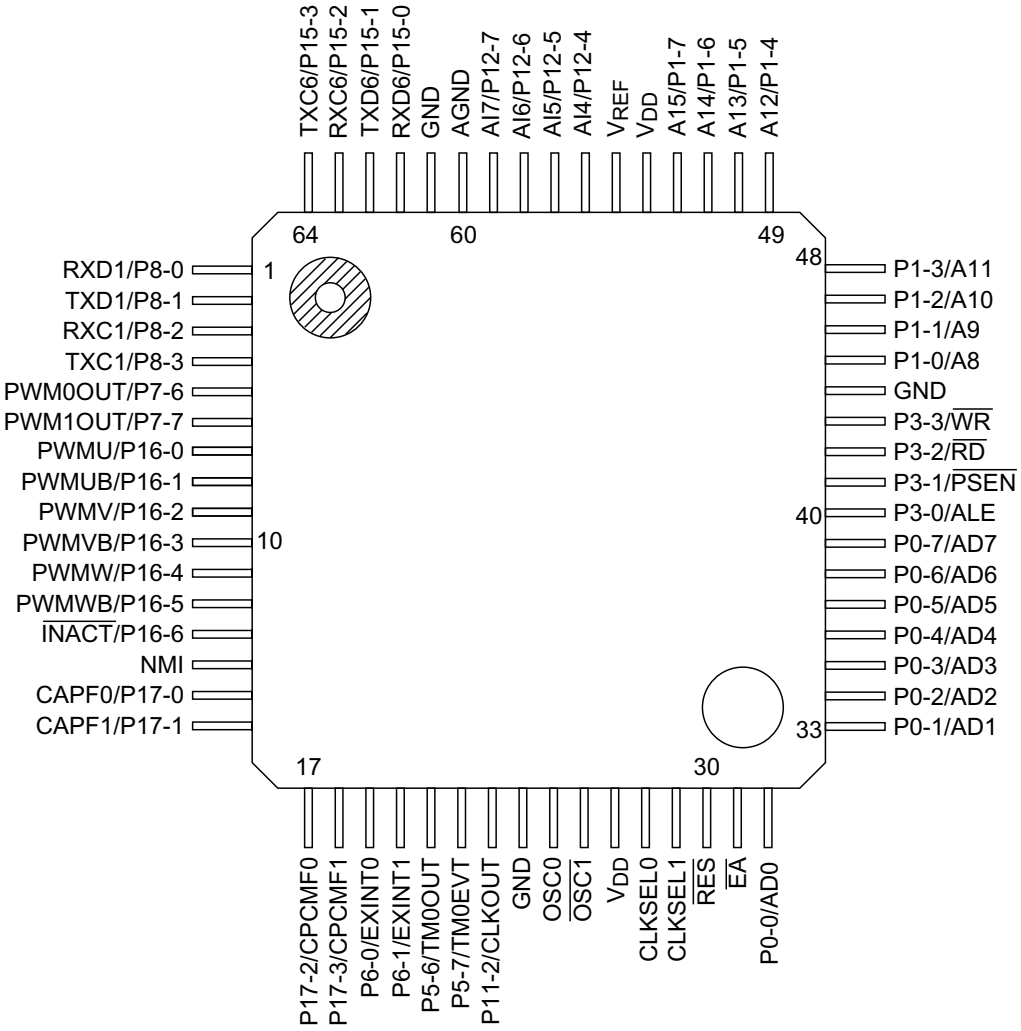
ML66Q515/ML66514 Block Diagram

PIN CONFIGURATION (TOP VIEW)



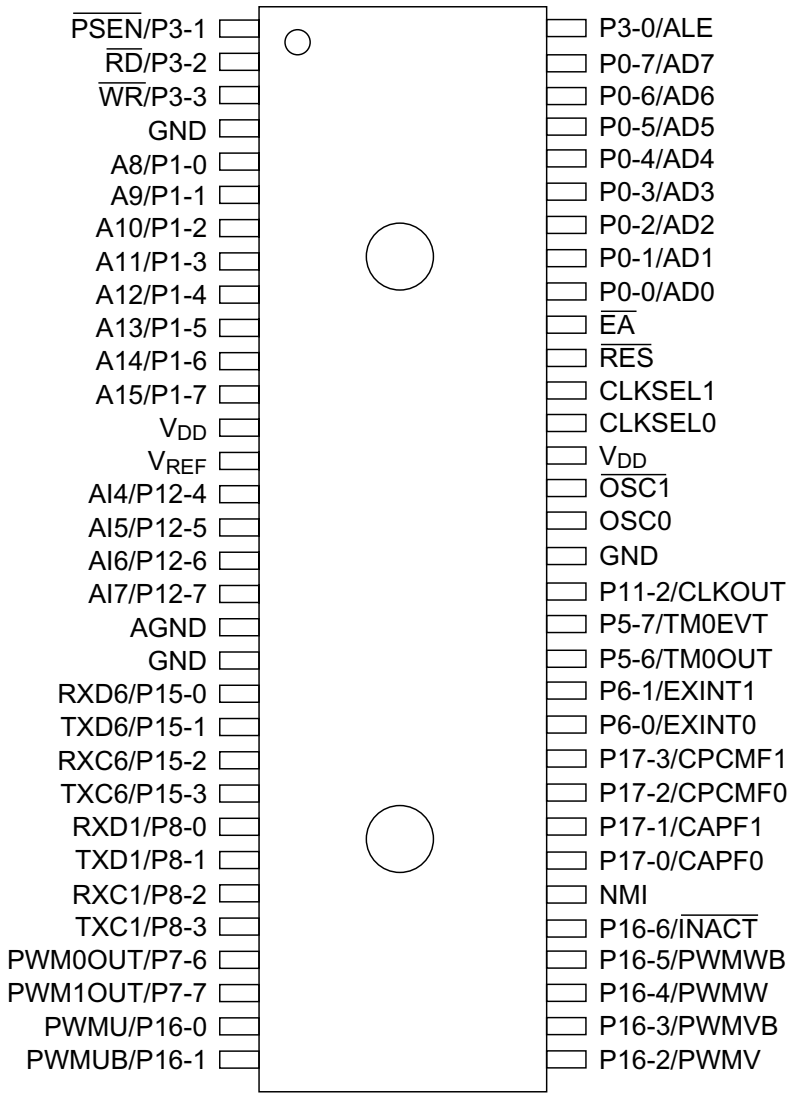
80-Pin Plastic QFP

ML66517/ML66Q517 Pin Configuration



64-Pin Plastic QFP

ML66Q515/ML66514 Pin Configuration



64-Pin Plastic SDIP

ML66Q515/ML66514 Pin Configuration

PIN DESCRIPTIONS

In the Type column, "I" indicates an input pin, "O" indicates an output pin, and "I/O" indicates an I/O pin.

ML66517/ML66Q517 Pin Descriptions

Function	Symbol	Description			
		Primary function		Secondary function	
		Type		Type	
Port	P0_0/AD0 to P0_7/AD7	I/O	8-bit I/O port Pull-up resistors can be specified for each individual bit	I/O	External memory access Address output/data I/O port
	P1_0/A8 to P1_7/A15	I/O	8-bit I/O port Pull-up resistors can be specified for each individual bit	O	External memory access Address output port
	P2_0/A16	I/O	1-bit I/O port Pull-up resistors can be specified for each individual bit	O	External memory access Address output port
	P3_0/ALE	I/O	4-bit I/O port 10 mA sink capability Pull-up resistors can be specified for each individual bit	O	External memory access Address latch enable signal output pin
	P3_1/$\overline{\text{PSEN}}$			O	External program memory access Read strobe output pin
	P3_2/$\overline{\text{RD}}$			O	External memory access Read strobe output pin
	P3_3/$\overline{\text{WR}}$			O	External memory access Write strobe output pin
	P5_6/TM0OUT	I/O	2-bit I/O port Pull-up resistors can be specified for each individual bit	O	Timer 0 timer output pin
	P5_7/TM0EVT			I	Timer 0 external event input pin
	P6_0/EXINT0	I/O	8-bit I/O port Pull-up resistors can be specified for each individual bit	I	External interrupt 0 input pin
	P6_1/EXINT1			I	External interrupt 1 input pin
	P6_2/EXINT2			I	External interrupt 2 input pin
	P6_3/EXINT3			I	External interrupt 3 input pin
	P6_4/TM1EVT			I	Timer 1 external event input pin
	P6_5/TM1OUT			O	Timer 1 timer output pin
	P6_6/TM2EVT			I	Timer 2 external event input pin
	P6_7/TM2OUT			O	Timer 2 timer output pin
	P7_6/PWM0OUT	I/O	2-bit I/O port Pull-up resistors can be specified for each individual bit	O	PWM0 output pin
	P7_7PWM1OUT			O	PWM1 output pin

ML66517/ML66Q517 Pin Descriptions (Continued)

Function	Symbol	Description			
		Primary function		Secondary function	
		Type		Type	
Port	P8_0/RXD1	I/O	6-bit I/O port Pull-up resistors can be specified for each individual bit	I	SIO1 receive data input pin
	P8_1/TXD1			O	SIO1 transmit data output pin
	P8_2/RXC1			I/O	SIO1 receive clock I/O pin
	P8_3/TXC1			I/O	SIO1 transmit clock I/O pin
	P8_6/PWM2OUT			O	PWM2 output pin
	P8_7PWM3OUT			O	PWM3 output pin
	P10_7/TM5EVT	I/O	1-bit I/O port Pull-up resistors can be specified	I	Timer 5 external event input pin
	P11_2/CLKOUT	I/O	1-bit I/O port Pull-up resistors can be specified	O	Main clock pulse output pin
	P12_0/AI0 to P12_7/AI7	I	8-bit input port	I	A/D converter analog input port
	P15_0/RXD6	I/O	4-bit I/O port Pull-up resistors can be specified for each individual bit	I	SIO6 receive data input pin
	P15_1/TXD6			O	SIO6 transmit data output pin
	P15_2/RXC6			I/O	SIO6 receive clock I/O pin
	P15_3/TXC6			I/O	SIO6 transmit clock I/O pin
	P16_0/PWMU	I/O	7-bit I/O port Pull-up resistors can be specified for each individual bit	O	3-phase PWMU output pin
	P16_1/PWMUB			O	3-phase PWMUB output pin
	P16_2/PWMV			O	3-phase PWMV output pin
	P16_3/PWMVB			O	3-phase PWMVB output pin
	P16_4/PWMW			O	3-phase PWMW output pin
	P16_5/PWMWB			O	3-phase PWMWB output pin
	P16_6/$\overline{\text{INACT}}$			I	Abnormality detect input pin
	P17_0/CAPF0	I/O	4-bit I/O port Pull-up resistors can be specified for each individual bit	I	Capture 0 input pin
	P17_1/CAPF1			I	Capture 1 input pin
	P17_2/CPCMF0			I/O	Capture 0 input/compare 0 output pin
	P17_3/CPCMF1			I/O	Capture 1 input/compare 1 output pin

ML66517/ML66Q517 Pin Descriptions (Continued)

Function	Symbol	Type	Description
Power supply	V_{DD}	I	Power supply pin Connect all V_{DD} pins to the power supply.*
	GND	I	GND pin Connect all GND pins to GND.*
	V_{REF}	I	Analog reference voltage pin
	AGND	I	Analog GND pin
Oscillation	OSC0	I	Main clock oscillation input pin Connect to a crystal or ceramic oscillator. Or, input an external clock.
	$\overline{OSC1}$	O	Main clock oscillation output pin Connect to a crystal or ceramic oscillator. The clock output is opposite in phase to OSC0. Leave this pin unconnected when an external clock is used.
	CLKSEL0	I	Clock multiplication factor select pin Clock multiplication factor is selected from source oscillation (PLL OFF), source oscillation × 2, or source oscillation × 4
	CLKSEL1	I	
Reset	$\overline{RES}$	I	Reset input pin
Others	NMI	I	Non-maskable interrupt input pin
	$\overline{EA}$	I	External program memory access input pin If the $\overline{EA}$ pin is enabled (low level), the internal program memory is masked and the CPU executes the program code in external program memory all address space.

* Each of the family devices has unique pattern routes for the internal power and ground. Connect the power supply voltage to all V_{DD} pins and the ground potential to all GND pins. If a device may have one or more V_{DD} or GND pins to which the power supply voltage or the ground potential is not connected, it can not be guaranteed for normal operation.

ML66Q515/ML66514 Pin Descriptions

Function	Symbol	Description			
		Primary function		Secondary function	
		Type		Type	
Port	P0_0/AD0 to P0_7/AD7	I/O	8-bit I/O port Pull-up resistors can be specified for each individual bit	I/O	External memory access Address output/Data I/O port
	P1_0/A8 to P1_7/A15	I/O	8-bit I/O port Pull-up resistors can be specified for each individual bit	O	External memory access Address output port
	P3_0/ALE	I/O	4-bit I/O port 10mA sink capability Pull-up resistors can be specified for each individual bit	O	External memory access Address latch enable signal output pin
	P3_1/$\overline{\text{PSEN}}$			O	External program memory access Read strobe output pin
	P3_2/$\overline{\text{RD}}$			O	External memory access Read strobe output pin
	P3_3/$\overline{\text{WR}}$			O	External memory access Write strobe output pin
	P5_6/TIM0OUT	I/O	2-bit I/O port Pull-up resistors can be specified for each individual bit	O	Timer 0 timer output pin
	P5_7/TIM0EVT			I	Timer 0 external event input pin
	P6_0/EXINT0	I/O	2-bit I/O port Pull-up resistors can be specified for each individual bit	I	External interrupt 0 input pin
	P6_1/EXINT1			I	External interrupt 1 input pin
	P7_6/PWM0OUT	I/O	2-bit I/O port Pull-up resistors can be specified for each individual bit	O	PWM0 output pin
	P7_7/PWM1OUT			O	PWM1 output pin
	P8_0/RXD1	I/O	4-bit I/O port Pull-up resistors can be specified for each individual bit	I	SIO1 receive data input pin
	P8_1/TXD1			O	SIO1 transmit data output pin
	P8_2/RXC1			I/O	SIO1 receive clock I/O pin
	P8_3/TXC1			I/O	SIO1 transmit clock I/O pin
	P11_2/CLKOUT	I/O	1-bit I/O port Pull-up resistors can be specified	O	Main clock pulse output pin
	P12_4/AI4 to P12_7/AI7	I	4-bit input port	I	A/D converter analog input port
	P15_0/RXD6	I/O	4-bit I/O port Pull-up resistors can be specified for each individual bit	I	SIO6 receive data input pin
	P15_1/TXD6			O	SIO6 transmit data output pin
	P15_2/RXC6			I/O	SIO6 receive clock I/O pin
	P15_3/TXC6			I/O	SIO6 transmit clock I/O pin

ML66Q515/ML66514 Pin Descriptions (Continued)

Function	Symbol	Description			
		Primary function		Secondary function	
		Type		Type	
Port	P16_0/PWMU	I/O	7-bit I/O port Pull-up resistors can be specified for each individual bit	O	3-phase PWMU output pin
	P16_1/PWMUB			O	3-phase PWMUB output pin
	P16_2/PWMV			O	3-phase PWMV output pin
	P16_3/PWMVB			O	3-phase PWMVB output pin
	P16_4/PWMW			O	3-phase PWMW output pin
	P16_5/PWMWB			O	3-phase PWMWB output pin
	P16_6/$\overline{\text{INACT}}$			I	Abnormality detect input pin
	P17_0/CAPF0	I/O	4-bit I/O port Pull-up resistors can be specified for each individual bit	I	Capture 0 input pin
	P17_1/CAPF1			I	Capture 1 input pin
	P17_2/CPCMF0			I/O	Capture 0 input/compare 0 output pin
	P17_3/CPCMF1			I/O	Capture 1 input/compare 1 output pin

ML66Q515/ML66514 Pin Descriptions (Continued)

Function	Symbol	Type	Description
Power supply	V_{DD}	I	Power supply pin Connect all V_{DD} pins to the power supply.*
	GND	I	GND pin Connect all GND pins to GND.*
	V_{REF}	I	Analog reference voltage pin
	AGND	I	Analog GND pin
Oscillation	OSC0	I	Main clock oscillation input pin Connect to a crystal or ceramic oscillator. Or, input an external clock.
	$\overline{OSC1}$	O	Main clock oscillation output pin Connect to a crystal or ceramic oscillator. The clock output is opposite in phase to OSC0. Leave this pin unconnected when an external clock is used.
	CLKSEL0	I	Clock multiplication factor select pin Clock multiplication factor is selected from source oscillation (PLL OFF), source oscillation × 2, or source oscillation × 4
	CLKSEL1	I	
Reset	$\overline{RES}$	I	Reset input pin
Others	NMI	I	Non-maskable interrupt input pin
	$\overline{EA}$	I	External program memory access input pin If the $\overline{EA}$ pin is enabled (low level), the internal program memory is masked and the CPU executes the program code in external program memory all address space.

* Each of the family devices has unique pattern routes for the internal power and ground. Connect the power supply voltage to all V_{DD} pins and the ground potential to all GND pins. If a device may have one or more V_{DD} or GND pins to which the power supply voltage or the ground potential is not connected, it can not be guaranteed for normal operation.

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Condition		Rating	Unit
Digital power supply voltage	V_{DD}	GND = AGND = 0 V Ta = 25°C		–0.3 to +7.0	V
Input voltage	V_I			–0.3 to V_{DD} +0.3	V
Output voltage	V_O			–0.3 to V_{DD} +0.3	V
Analog reference voltage	V_{REF}			–0.3 to V_{DD} +0.3	V
Analog input voltage	V_{AI}			–0.3 to V_{REF}	V
Power dissipation	P_D	Ta = 85°C per package	80-pin QFP	600	mW
			64-pin QFP	520	
			64-pin SDIP	1280	
Storage temperature	T_{STG}	—		–50 to +150	°C

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Condition		Range	Unit
Digital power supply voltage	V_{DD}	$f_{OSC} \leq 25$ MHz		4.5 to 5.5	V
Analog reference voltage	V_{REF}	—		V_{DD} – 0.3 to V_{DD}	V
Analog input voltage	V_{AI}	—		AGND to V_{REF}	V
Memory hold voltage	V_{DDH}	f_{OSC} = 0 Hz		2.0 to 5.5	V
Internal operating frequency	f_{OSC}	PLL (multiplier) OFF		2 to 25	MHz
		PLL (multiplier) ON		20 to 25	
Ambient temperature	Ta	—		–40 to +85	°C
Fan out	N	MOS load		20	—
		TTL load	P3	6	—
			P0, P16	2	
			P1, P2, P5 to P8, P10, P11, P15, P17	1	

ALLOWABLE OUTPUT CURRENT

(1) ML66517/ML66Q517 (80-pin QFP)

(V_{DD} = 4.5 to 5.5 V, Ta = –40 to +85°C)

Parameter	Pin	Symbol	Min.	Typ.	Max.	Unit
"H" output pin (1 pin)	All input pins	I_{OH}	—	—	–2	mA
"H" output pins (sum total)	Sum total of all output pins	Σ_{IOH}	—	—	–50	
"L" output pin (1 pin)	P3	I_{OL}	—	—	10	
	Other ports		—	—	5	
"L" output pins (sum total)	Sum total of P0, P3	Σ_{IOL}	—	—	60	
	Sum total of P1, P2				50	
	Sum total of P7, P8, P15					
	Sum total of P5, P6, P10, P11, P16, P17					
	Sum total of all output pins				100	

(2) ML66Q515/ML66514 (64-pin QFP/SDIP)

(V_{DD} = 4.5 to 5.5 V, Ta = –40 to +85°C)

Parameter	Pin	Symbol	Min.	Typ.	Max.	Unit
"H" output pin (1 pin)	All input pins	I_{OH}	—	—	–2	mA
"H" output pins (sum total)	Sum total of all output pins	Σ_{IOH}	—	—	–20	
"L" output pin (1 pin)	P3	I_{OL}	—	—	10	
	Other ports		—	—	5	
"L" output pins (sum total)	Sum total of P0, P3	Σ_{IOL}	—	—	50	
	P1				30	
	Sum total of P5 to P8, P11, P15, P17					
	Sum total of all output pins				60	

Note: Each of the family devices has unique pattern routes for the internal power and ground. Connect the power supply voltage to all V_{DD} pins and the ground potential to all GND pins. If a device may have one or more V_{DD} or GND pins to which the power supply voltage or the ground potential is not connected, it can not be guaranteed for normal operation.

ELECTRICAL CHARACTERISTICS

DC Characteristics

(V_{DD} = 4.5 to 5.5 V, Ta = –40 to +80°C)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
"H" input voltage *1	V_{IH}	—	0.44 V_{DD}	—	V_{DD} + 0.3	V
"H" input voltage *2 to *8			0.80 V_{DD}	—	V_{DD} + 0.3	
"L" input voltage *1	V_{IL}	—	–0.3	—	0.16 V_{DD}	
"L" input voltage *2 to *8			–0.3	—	0.2 V_{DD}	
"H" output voltage *1, *4, *5	V_{OH}	I_O = –400 µA	V_{DD} – 0.4		—	
		I_O = –2.0 mA	V_{DD} – 0.6	—	—	
"H" output voltage *2		I_O = –200 µA	V_{DD} – 0.4	—	—	
		I_O = –2.0 mA	V_{DD} – 0.6	—	—	
"L" output voltage *1, *5	V_{OL}	I_O = 3.2 mA	—	—	0.4	
		I_O = 5.0 mA	—	—	0.8	
"L" output voltage *4		I_O = 3.2 mA	—	—	0.4	
		I_O = 10.0 mA	—	—	1.0	
"L" output voltage *2		I_O = 1.6 mA	—	—	0.4	
		I_O = 5.0 mA	—	—	0.8	
Input leakage current *3, *7	I_{IH}/I_{IL}	V_I = V_{DD}/0 V	—	—	1/–1	µA
Input current *6			—	—	1/–250	
Input current *8			—	—	15/–15	
Output leakage current *1, *2, *4, *5	I_{LO}	V_O = V_{DD}/0 V	—	—	± 10	µA
Pull-up resistance	R_{pull}	V_I = 0 V	25	50	100	kΩ
Input capacitance	C_I	f = 1 MHz, Ta = 25°C	—	5	—	pF
Output capacitance	C_O		—	7	—	
Analog reference supply current	I_{REF}	During A/D operation	—	—	4	mA
		When A/D is stopped	—	—	10	µA
Supply current (STOP mode)	I_{DDS}	ML66Q517/Q515 *9	—	20	900	µA
		ML66517/514 *9		1	50	
Supply current (HALT mode)	I_{DDH}	f = 25 MHz, No load	—	30	40	mA
Supply current	I_{DD}		—	40	60	

*1: Applicable to P0
*2: Applicable to P1, P2, P6, P7, P8, P10, P11, P15, P17
*3: Applicable to P12
*4: Applicable to P3
*5: Applicable to P16
*6: Applicable to $\overline{RES}$
*7: Applicable to $\overline{EA}$, NMI, CLKSEL0, CLKSEL1
*8: Applicable to OSC0
*9: Ports used as inputs are at V_{DD} or 0 V. Other ports are unloaded.

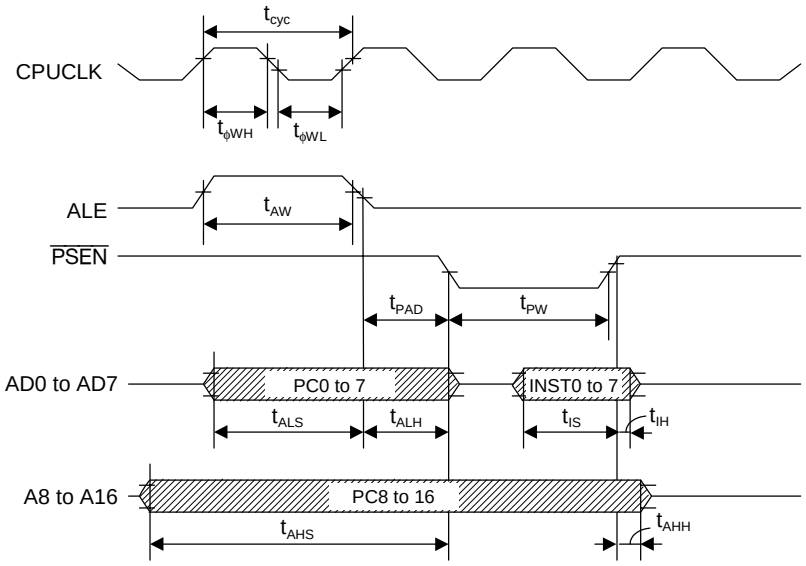
AC Characteristics

(1) External program memory control

(V_{DD} = 4.5 to 5.5 V, Ta = –40 to +85°C)

Parameter	Symbol	Condition	Min.	Max.	Unit
Cycle time	t_{cyc}	f_{OSC} = 25 MHz	40	—	ns
Clock pulse width (HIGH level)	$t_{\phi WH}$	C_L = 50 pF	13	—	
Clock pulse width (LOW level)	$t_{\phi WL}$		13	—	
ALE pulse width	t_{AW}		2tϕ – 10	—	
$\overline{PSEN}$ pulse width	t_{PW}		2tϕ – 18	—	
$\overline{PSEN}$ pulse delay time	t_{PAD}		tϕ – 5	—	
Low address setup time	t_{ALS}		2tϕ – 15	—	
Low address hold time	t_{ALH}		tϕ – 13	—	
High address setup time	t_{AHS}		3tϕ – 30	—	
High address hold time	t_{AHH}		–8	—	
Instruction setup time	t_{IS}		30	—	
Instruction hold time	t_{IH}		–8	tϕ – 3	

Note: tϕ = t_{cyc}/2



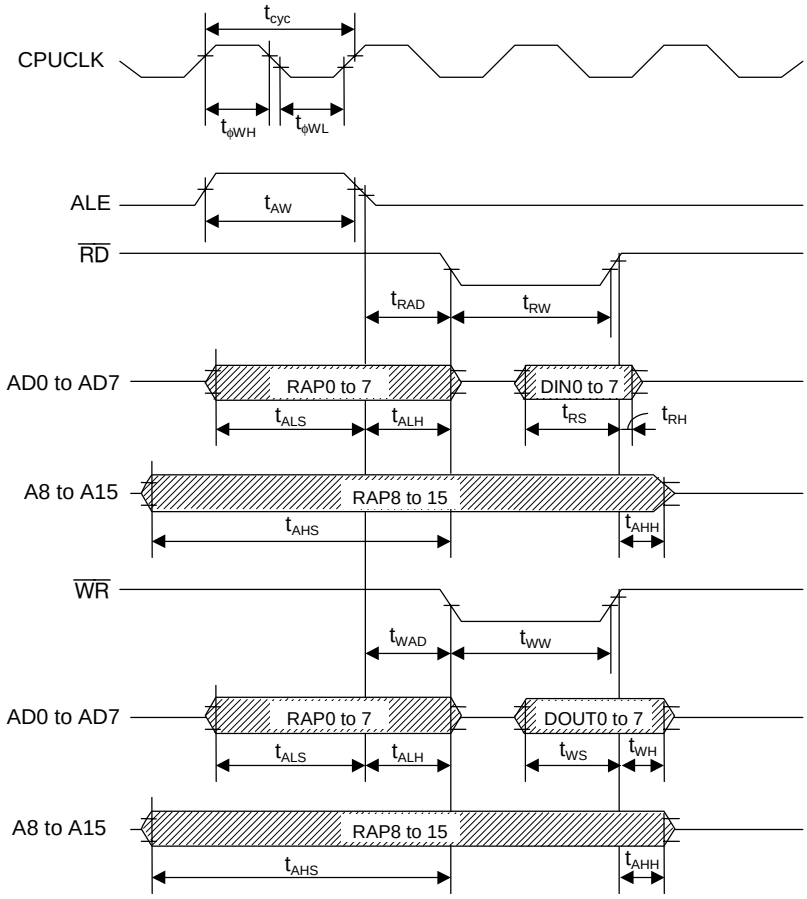
Bus timing during no wait cycle time

(2) External data memory control

(V_{DD} = 4.5 to 5.5 V, Ta = –40 to +85°C)

Parameter	Symbol	Condition	Min.	Max.	Unit
Cycle time	t_{cyc}	f_{OSC} = 25 MHz	40	—	ns
Clock pulse width (HIGH level)	$t_{\phi WH}$	C_L = 50 pF	13	—	
Clock pulse width (LOW level)	$t_{\phi WL}$		13	—	
ALE pulse width	t_{AW}		2tϕ – 10	—	
$\overline{RD}$ pulse width	t_{RW}		2tϕ – 18	—	
$\overline{WR}$ pulse width	t_{WW}		2tϕ – 18	—	
$\overline{RD}$ pulse delay time	t_{RAD}		tϕ – 5	—	
$\overline{WR}$ pulse delay time	t_{WAD}		tϕ – 5	—	
Low address setup time	t_{ALS}		2tϕ – 15	—	
Low address hold time	t_{ALH}		tϕ – 13	—	
High address setup time	t_{AHS}		3tϕ – 30	—	
High address hold time	t_{AHH}		tϕ – 3	—	
Read data setup time	t_{RS}		30	—	
Read data hold time	t_{RH}		0	tϕ – 3	
Write data setup time	t_{WS}		2tϕ – 30	—	
Write data hold time	t_{WH}		tϕ – 3	—	

Note: $t\phi = t_{cyc}/2$



Bus timing during no wait cycle time

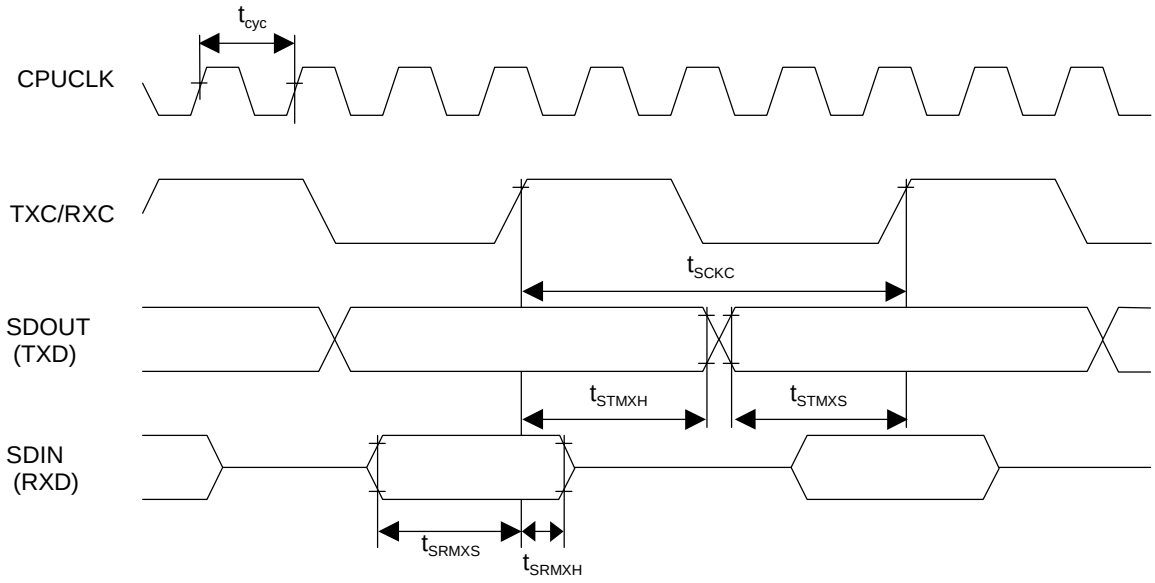
(3) Serial port control

Master mode (Clock synchronous serial port)

(V_{DD} = 4.5 to 5.5 V, Ta = –40 to +85°C)

Parameter	Symbol	Condition	Min.	Max.	Unit
Cycle time	t_{cyc}	fOSC = 25 MHz	40	—	ns
Serial clock cycle time	tSCKC	CL = 50 pF	4 t_{cyc}	—	
Output data setup time	tSTMXS		2tϕ – 5	—	
Output data hold time	tSTMXH		5tϕ – 10	—	
Input data setup time	tSRMXS		13	—	
Input data hold time	tSRMXH		0	—	

Note: tϕ = t_{cyc}/2

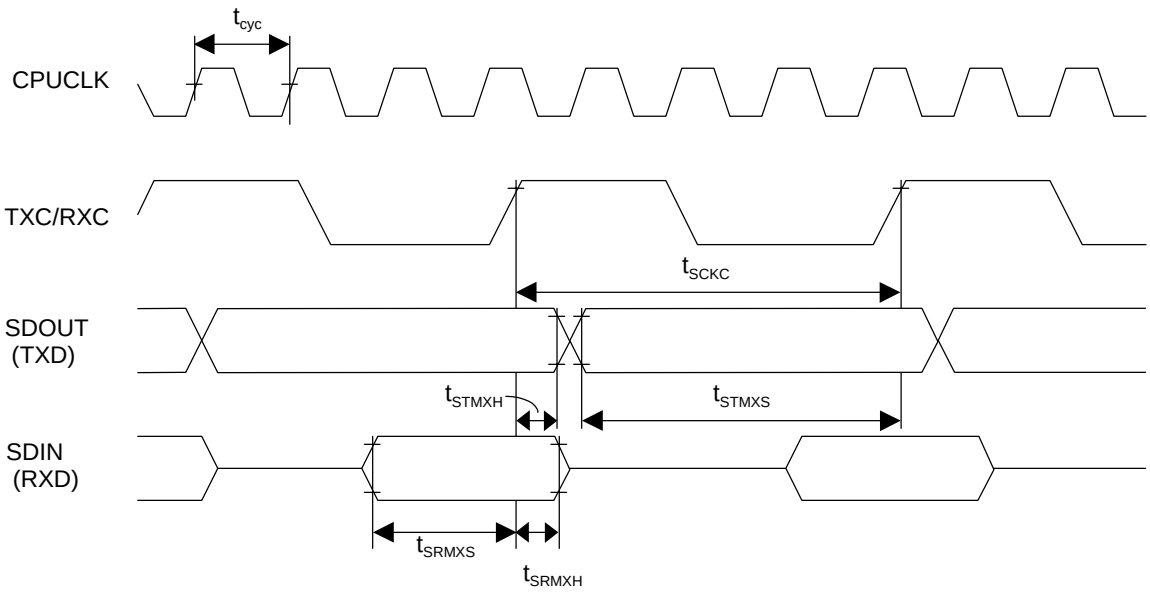


Slave mode (Clock synchronous serial port)

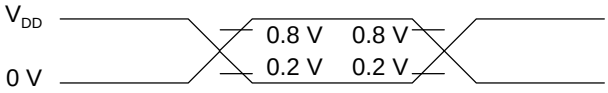
(V_{DD} = 4.5 to 5.5 V, Ta = –40 to +85°C)

Parameter	Symbol	Condition	Min.	Max.	Unit
Cycle time	t_{cyc}	fOSC = 25 MHz	40	—	ns
Serial clock cycle time	tSCKC	CL = 50 pF	4 t_{cyc}	—	
Output data setup time	tSTMXS		2tϕ – 15	—	
Output data hold time	tSTMXH		4tϕ – 10	—	
Input data setup time	tSRMXS		13	—	
Input data hold time	tSRMXH		3	—	

Note: tϕ = t_{cyc}/2



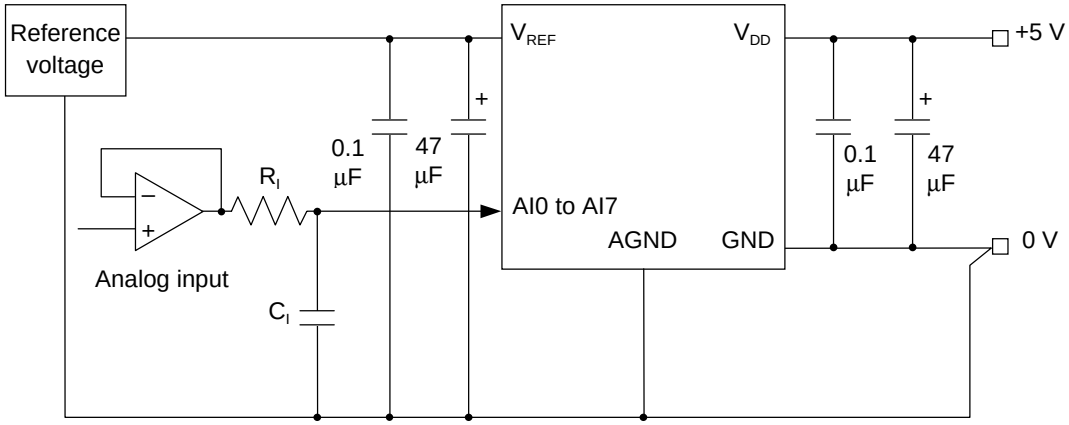
Measurement points for AC timing



A/D Converter Characteristics

(Ta = –40 to +85°C, V_{DD} = 4.5 to 5.5 V, AGND = GND = 0 V)

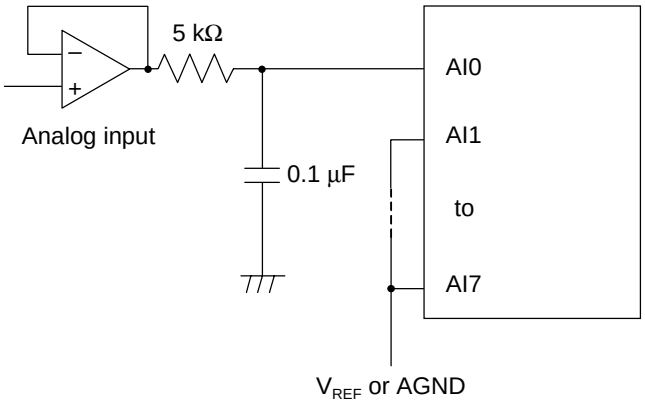
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Resolution	n	Refer to measurement circuit 1 Analog input source impedance RI ≤ 5 kΩ t_{CONV} = 10.7 µs	—	10	—	Bit
Linearity error	E_L		—	—	±3	LSB
Differential linearity error	E_D		—	—	±2	
Zero scale error	E_{ZS}		—	—	+3	
Full-scale error	E_{FS}		—	—	–3	
Cross talk	E_{CT}	Refer to measurement circuit 2	—	—	±1	
Conversion time	t_{CONV}	Set according to ADTM set data	10.7	—	—	µs/ch



R_I (impedance of analog input source) ≤5 kΩ

$C_I \cong 0.1$ µF

Measurement Circuit 1



Cross talk is the difference between the A/D conversion results when the same analog input is applied to AI0 through AI7 and the A/D conversion results of the circuit to the left.

Measurement Circuit 2

Definition of Terminology

1. Resolution
   Resolution is the value of minimum discernible analog input.
   With 10 bits, since $2^{10} = 1024$, resolution of $(V_{REF} - AGND) \div 1024$ is possible.

2. Linearity error
   Linearity error is the difference between ideal conversion characteristics and actual conversion characteristics of a 10-bit A/D converter (not including quantization error).
   Ideal conversion characteristics can be obtained by dividing the voltage between V_{REF} and AGND into 1024 equal steps.

3. Differential linearity error
   Differential linearity error indicates the smoothness of conversion characteristics. Ideally, the range of analog input voltage that corresponds to 1 converted bit of digital output is $1LSB = (V_{REF} - AGND) \div 1024$. Differential error is the difference between this ideal bit size and bit size of an arbitrary point in the conversion range.

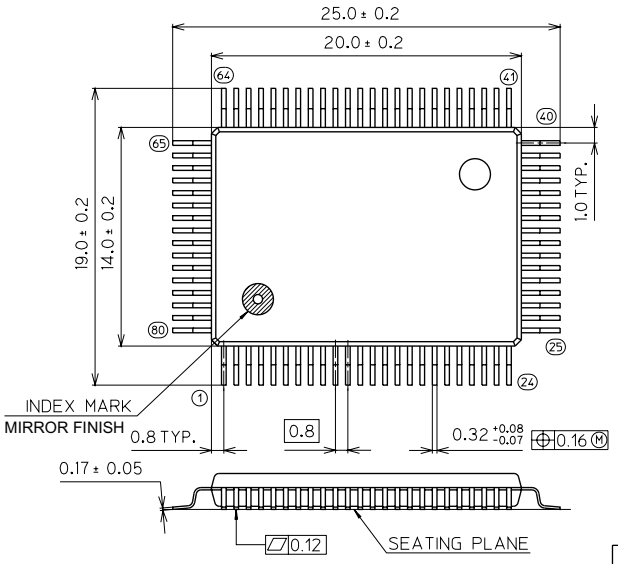
4. Zero scale error
   Zero scale error is the difference between ideal conversion characteristics and actual conversion characteristics at the point where the digital output changes from 000H to 001H.

5. Full-scale error
   Full-scale error is the difference between ideal conversion characteristics and actual conversion characteristics at the point where the digital output changes from 3FEH to 3FFH.

PACKAGE DIMENSIONS

(Unit : mm)

QFP80-P-1420-0.80-BK



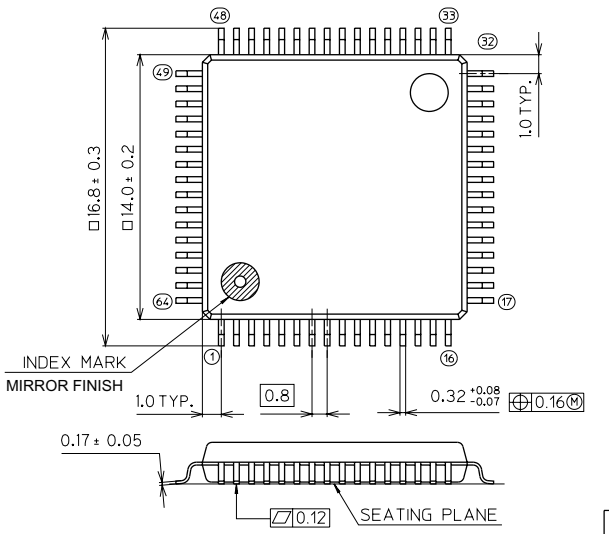
Package material	Epoxy resin
Lead frame material	42 alloy
Pin treatment	Solder plating
Solder plate thicknes	5 m or more
Package weight (g)	1.27 TYP.

Notes for Mounting the Surface Mount Type Packages

The surface mount type packages are very susceptible to heat in reflow mounting and humidity absorbed in storage.
Therefore, before you perform reflow mounting, contact Oki's responsible sales person for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

(Unit : mm)

QFP64-P-1414-0.80-BK



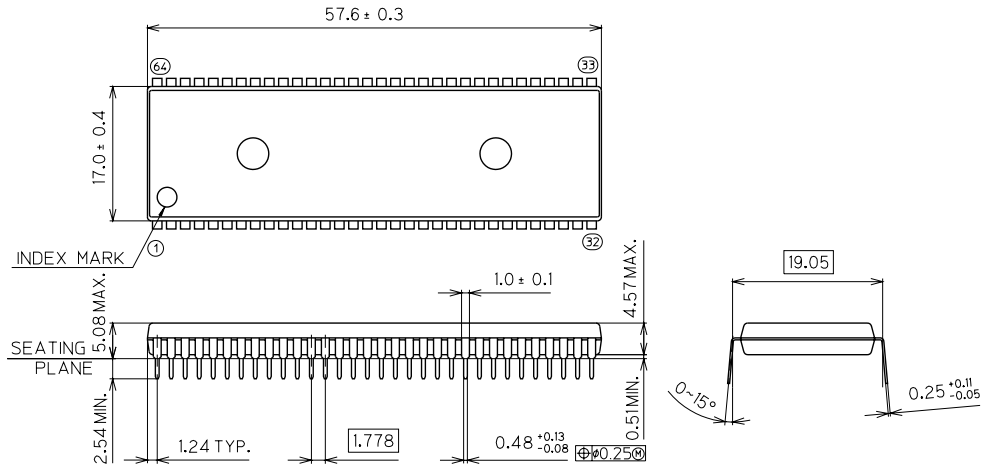
Package material	Epoxy resin
Lead frame material	42 alloy
Pin treatment	Solder plating
Solder plate thickness	5 m or more
Package weight (g)	0.87 TYP.

Notes for Mounting the Surface Mount Type Packages

The surface mount type packages are very susceptible to heat in reflow mounting and humidity absorbed in storage.
Therefore, before you perform reflow mounting, contact Oki's responsible sales person for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

(Unit : mm)

SDIP64-P-750-1.778



Package material	Epoxy resin
Lead frame material	Cu alloy
Pin treatment	Solder plating
Solder plate thickness	5 m or more
Package weight (g)	8.70 TYP.

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