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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 "<u>Embedded -</u> <u>Microcontrollers</u>"

Details

E·XFl

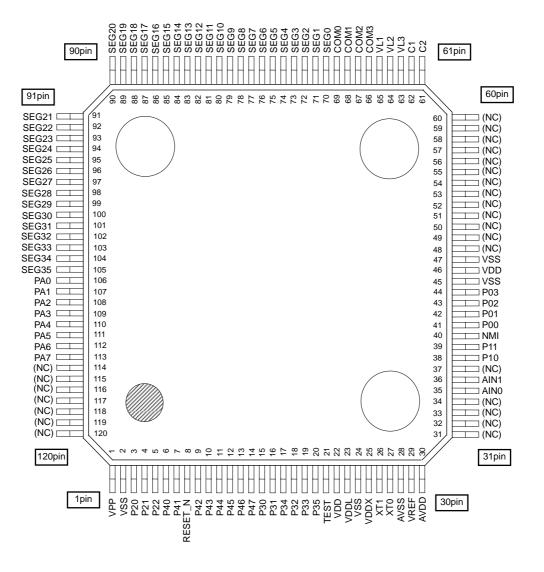
Product Status	Obsolete
Core Processor	nX-U8/100
Core Size	8-Bit
Speed	625kHz
Connectivity	I ² C, SSP, UART/USART
Peripherals	LCD, POR, PWM, WDT
Number of I/O	14
Program Memory Size	16KB (8K × 16)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	1K x 8
Voltage - Supply (Vcc/Vdd)	1.1V ~ 3.6V
Data Converters	A/D 2x12b, 2x24b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	120-TQFP
Supplier Device Package	-
Purchase URL	https://www.e-xfl.com/product-detail/rohm-semi/ml610q412p-nnntb03a7

Email: info@E-XFL.COM

Address: Room A, 16/F, Full Win Commercial Centre, 573 Nathan Road, Mongkok, Hong Kong

- Frame frequency selecable (approx. 64 Hz, 73 Hz, 85 Hz, and 102 Hz)
- Bias voltage multiplying clock selectable (8 types)
- Contrast adjustment (32 steps)
- LCD drive stop mode, LCD display mode, all LCDs on mode, and all LCDs off mode selectable
- Reset
 - Reset through the RESET_N pin
 - Power-on reset generation when powered on
 - Reset when oscillation stop of the low-speed clock is detected
 - Reset by the watchdog timer (WDT) overflow
- Battery Level Detector
 - Threshold voltages: One of 16 levels
 - Accuracy: ±2% (Typ.)
- Clock
 - Low-speed clock: (This LSI can not guarantee the operation withoug low-speed crystal oscillation clock) Crystal oscillation (32.768 kHz)
 - High-speed clock: Built-in RC oscillation (500 kHz)
 - External clock (500kH or less)
 - High-speed Clock gear: 1/2(250kHz), 1/4(125kHz), 1/8(62.5kHz: default)
 - Selection of high-speed clock mode by software: Built-in RC oscillation, External clock
- Power management
 - HALT mode: Instruction execution by CPU is suspended (peripheral circuits are in operating states).
 - STOP mode: Stop of low-speed oscillation and high-speed oscillation (Operations of CPU and peripheral circuits are stopped.)
 - High-speed Clock gear: The frequency of high-speed system clock can be changed by software (1/1, 1/2, 1/4, 1/8 of the oscillation clock)
 - Block Control Function: Resets and completely turns circuits of unused peripherals off.
- Guaranteed operating range
 - Operating temperature: -20°C to +70°C (P version: -40°C to +85°C)
 - Operating voltage: $V_{DD} = 1.1V$ to 3.6V, $AV_{DD} = 2.2V$ to 3.6V

PIN CONFIGURATION ML610Q411 TQFP120 Pin Layout



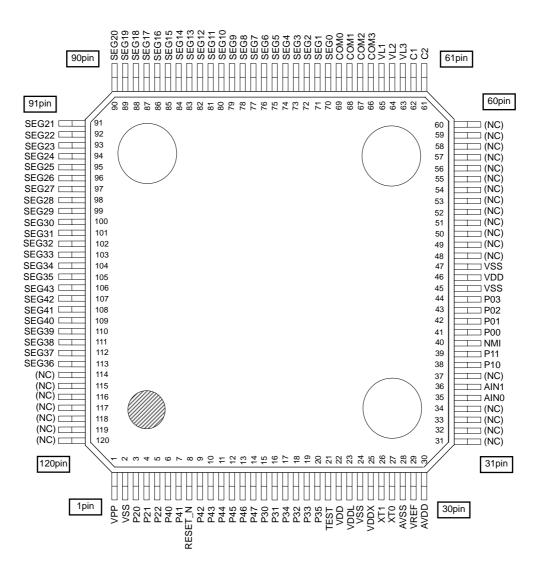
(NC): No Connection

Note:

The assignment of the P30 to P35 are not in order.

Figure 3 ML610Q411 TQFP120 Pin Configuration

ML610Q412 TQFP120 Pin Layout



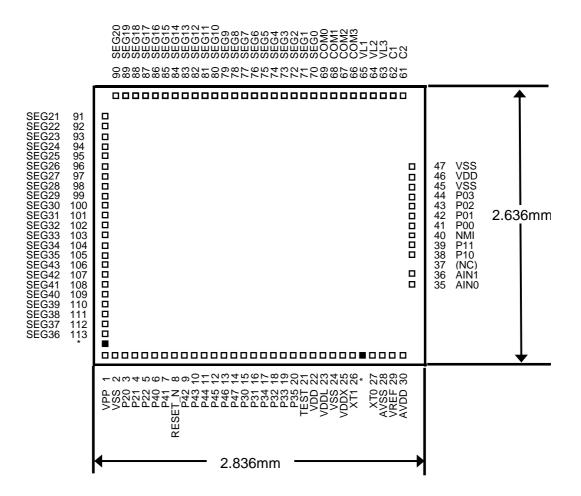
⁽NC): No Connection

Note:

The assignment of the P30 to P35 are not in order.

Figure 4 ML610Q412 TQFP120 Pin Configuration

ML610Q412 Chip Pin Layout & Dimension



* Dummy pad

Note: These dummy pads are visible and do have any function, they are placed for a mechanical evaluation in LAPIS Semiconductor. Please do NOT implement wire-bonding to the dummy pad.

Figure 6 ML610Q412 Chip Layout & Dimension

ML610Q411 Pad Coordinates

Table 1 ML610Q411 Pad Coordinates

PAD No.	Pad Name	X (µm)	Y (µm)	PAD No.	Pad Name	X (µm)	Υ (μm)
1	VPP	-1230	-1212	51	(NC)		
2	VSS	-1230	-1212	52	(NC)	-	
3	P20	-1070	-1212	53	(NC)	-	-
4	P21	-990	-1212	54	(NC)	-	
4 5	P21		-1212	54 55	(NC)	-	-
5 6	P40	-910 -830	-1212	55 56	(NC)	-	-
	P40		-1212	57	(NC)	-	-
7	RESET N	-750			(NC)	-	-
8	P42	-670	-1212	58	(NC)	-	-
9		-590	-1212	59		-	-
10	P43	-510	-1212	60	(NC)	-	-
11	P44	-430	-1212	61	C2	1220	1212
12	P45	-350	-1212	62	C1	1140	1212
13	P46	-270	-1212	63	VL3	1060	1212
14	P47	-190	-1212	64	VL2	980	1212
15	P30	-110	-1212	65	VL1	900	1212
16	P31	-30	-1212	66	COM3	820	1212
17	P34	50	-1212	67	COM2	740	1212
18	P32	130	-1212	68	COM1	660	1212
19	P33	210	-1212	69	COMO	580	1212
20	P35	290	-1212	70	SEGO	500	1212
21	TEST	370	-1212	71	SEG1	420	1212
22	VDD	450	-1212	72	SEG2	340	1212
23	VDDL	530	-1212	73	SEG3	260	1212
24	VSS	610	-1212	74	SEG4	180	1212
25	VDDX	690	-1212	75	SEG5	100	1212
26	XT1	770	-1212	76	SEG6	20	1212
-	Dummy	850	-1212	77	SEG7	-60	1212
27	XT0	930	-1212	78	SEG8	-140	1212
28	AVSS	1030	-1212	79	SEG9	-220	1212
29	VREF	1110	-1212	80	SEG10	-300	1212
30	AVDD	1190	-1212	81	SEG11	-380	1212
31	(NC)	-	-	82	SEG12	-460	1212
32	(NC)	-	-	83	SEG13	-540	1212
33	(NC)	-	-	84	SEG14	-620	1212
34	(NC)	-	-	85	SEG15	-700	1212
35	AINO	1312	-522	86	SEG16	-780	1212
36	AIN1	1312	-350	87	SEG17	-860	1212
37	(NC)	-	-	88	SEG18	-940	1212
38	P10	1312	-210	89	SEG19	-1020	1212
39	P11	1312	-130	90	SEG20	-1100	1212
40	NMI	1312	-50	91	SEG21	-1312	960
41	P00	1312	30	92	SEG22	-1312	880
42	P01	1312	110	93	SEG23	-1312	800
43	P02	1312	190	93	SEG24	-1312	720
43	P03	1312	270	94	SEG25	-1312	640
44	VSS			95 96	SEG26		560
45 46	VSS	1312	350 430	96 97	SEG27	-1312 -1312	480
	VDD VSS	1312			SEG28		
47		1312	510	98		-1312	400
48	(NC)	-	-	99	SEG29	-1312	320
49	(NC) (NC)	-	-	100	SEG30	-1312	240

es								
	Chip C	enter: X	=0,Y=0					
PAD	Pad	Х	Y					
No.	Name	(µm)	(µm)					
101	SEG31	-1312	160					
102	SEG32	-1312	80					
103	SEG33	-1312	0					
104	SEG34	-1312	-80					
105	SEG35	-1312	-160					
106	PA0	-1312	-240					
107	PA1	-1312	-320					
108	PA2	-1312	-400					
109	PA3	-1312	-480					
110	PA4	-1312	-560					
111	PA5	-1312	-640					
112	PA6	-1312	-720					
113	PA7	-1312	-800					
	Dummy	-1312	-908					

PIN LIST

PAD		Prim	ary function	S	econda	ry function	-	Tertiary	function
No.	Pin name	I/O	Function	Pin name	I/O	Function	Pin name	I/O	Function
2, 24,45,47	V _{SS}		Negative power supply pin	_	_			_	_
22, 46	V _{DD}	_	Positive power supply pin	_	_	_	_		—
23	V_{DDL}	_	Power supply pin for internal logic (internally generated)	—		_	_		—
25	V _{DDX}		Power supply pin for low-speed oscillation (internally generated)	_	_	_	_	_	—
1	V _{PP}	_	Power supply pin for Flash ROM	_	_	_	_		—
28	AV_{SS}	_	Negative power supply pin for successive approximation type ADC	_	_	—	_	_	—
30	AV_{DD}		Positive power supply pin for successive approximation type ADC	_		_	_		—
65	V _{L1}		Power supply pin for LCD bias (internally generated)			_			—
64	V_{L2}		Power supply pin for LCD bias (internally generated)		_	_		_	—
63	V_{L3}	_	Power supply pin for LCD bias (internally generated)	_	_		_		—
62	C1	_	Capacitor connection pin for LCD bias generation	_	_	_	_		—
61	C2	_	Capacitor connection pin for LCD bias generation	_		_	_		—
21	TEST	I/O	Input/output pin for testing	_	_	_	—	_	—
8	RESET_N	Ι	Reset input pin				_	_	
27	ХТ0	Ι	Low-speed clock oscillation pin	_			_		—
26	XT1	0	Low-speed clock oscillation pin	_	_		_	_	_
29	V_{REF}	_	Reference power supply pin for successive approximation type ADC	—	_		_	_	_

PIN DESCRIPTION

Pin name	I/O	Description	Primary/ Secondary/ Tertiary	Logic
System				
RESET_N	Ι	Reset input pin. When this pin is set to a "L" level, system reset mode is set and the internal section is initialized. When this pin is set to a "H" level subsequently, program execution starts. A pull-up resistor is internally connected.	_	Negative
XT0	Ι	Crystal connection pin for low-speed clock.	—	
XT1	0	A 32.768 kHz crystal oscillator (see measuring circuit 1) is connected to this pin. Capacitors CDL and CGL are connected across this pin and V_{SS} as required.	_	_
OSC0	Ι	High-speed external clock input pin. This pin is used as the secondary function of the P10.	Secondary	
LSCLK	0	Low-speed clock output pin. This pin is used as the secondary function of the P20 pin.	Secondary	
OUTCLK	0	High-speed clock output pin. This pin is used as the secondary function of the P21 pin.	Secondary	
General-purp	ose in	put port		
P00-P03	I	General-purpose input port. Since these pins have secondary functions, the pins cannot be used as a port when the secondary functions are used.	Primary	Positive
P10-P11	I	General-purpose input port. Since these pins have secondary functions, the pins cannot be used as a port when the secondary functions are used.	Primary	Positive
General-purp	ose ol	utput port		
P20-P22	0	General-purpose output port. Since these pins have secondary functions, the pins cannot be used as a port when the secondary functions are used.	Primary	Positive
General-purp	ose in	put/output port		
P30-P35	I/O	General-purpose input/output port. Since these pins have secondary functions, the pins cannot be used as a port when the secondary functions are used.	Primary	Positive
P40-P47	I/O	General-purpose input/output port. Since these pins have secondary functions, the pins cannot be used as a port when the secondary functions are used.	Primary	Positive
PA0-PA7	I/O	General-purpose input/output port. These pins are for the ML610Q411, but are not provided in the ML610Q412.	Primary	Positive

LAPIS Semiconductor Co., Ltd.

Pin name	I/O	Description	Primary/ Secondary/ Tertiary	Logic
RC oscillation	type	A/D converter		
INO	1	Channel 0 oscillation input pin. This pin is used as the secondary function of the P30 pin.	Secondary	_
CS0	0	Channel 0 reference capacitor connection pin. This pin is used as the secondary function of the P31 pin.	Secondary	_
RCT0	0	Resistor/capacitor sensor connection pin of Channel 0 for measurement. This pin is used as the secondary function of the P33 pin.	Secondary	_
RS0	0	This pin is used as the secondary function of the P32 pin which is the reference resistor connection pin of Channel 0.	Secondary	_
RT0	0	Resistor sensor connection pin of Channel 0 for measurement. This pin is used as the secondary function of the P34 pin.	Secondary	_
RCM	0	RC oscillation monitor pin. This pin is used as the secondary function of the P35 pin.	Secondary	_
IN1	I	Oscillation input pin of Channel 1. This pin is used as the secondary function of the P44 pin.	Secondary	_
CS1	0	Reference capacitor connection pin of Channel 1. This pin is used as the secondary function of the P45 pin.	Secondary	_
RS1	0	Reference resistor connection pin of Channel 1. This pin is used as the secondary function of the P46 pin.	Secondary	_
RT1	0	Resistor sensor connection pin for measurement of Channel 1. This pin is used as the secondary function of the P47 pin.	Secondary	_
Successive a	pproxi	mation type A/D converter		
AV_{SS}	[-	Negative power supply pin for successive approximation type A/D converter.	—	—
AV_{DD}	—	Positive power supply pin for successive approximation type A/D converter.	—	—
V_{REF}	—	Reference power supply pin for successive approximation type A/D converter.	—	—
AIN0	I	Channel 0 analog input for successive approximation type A/D converter.	_	
AIN1	1	Channel 1 analog input for successive approximation type A/D converter.	_	_
LCD drive sig	nal		11	
COM0-3	0	Common output pins.		
SEG0-35	0	Segment output pins.		
SEG36-43	0	Segment output pin. These pins are for the ML610Q412, but are not provided in the ML610Q411.	—	_
LCD driver po	wer s			
V _{L1}		Power supply pins for LCD bias (internally generated). Capacitors Ca, Cb,		
V _{L1} V _{L2}		and Cc (see measuring circuit 1) are connected between V_{SS} and V_{L1} , V_{L2} ,		
V _{L2} V _{L3}		and V_{L3} , respectively.		
C1	<u> </u>	Power supply pins for LCD bias (internally generated). Capacitors C12 is	-	_
C2	_	connected between C1 and C2.		
	_			_
For testing	1/0	Input/output pin for testing. A pull-down resistor is internally connected.	<u> </u>	
TEST	I/O	mpurouput pinnon testing. A puil-down resistor is internally connected.	—	
Power supply			1	
V _{SS}	<u> </u>	Negative power supply pin.		
V _{DD}	_	Positive power supply pin for I/O, internal regulator, battery low detector, and power-on reset.		
V _{DDL}		Positive power supply pin (internally generated) for internal logic. Capacitors CL0 and CL1 (see measuring circuit 1) are connected between this pin and V_{SS} .	—	_
V _{DDX}	_	Positive power supply pin (internally generated) for low-speed oscillation. When using ML610Q411 and ML610Q412, connect capacitor Cx (see measuring circuit 1) between this pin and V_{SS} .	-	
V _{PP}		Power supply pin for programming Flash ROM. A pull-down resistor is internally connected.		

ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS

			(V _{SS} =	= AV _{SS} = 0
Parameter	Symbol	Condition	Rating	Unit
Power supply voltage 1	V _{DD}	Ta = 25°C	-0.3 to +4.6	V
Power supply voltage 2	AV _{DD}	Ta = 25°C	-0.3 to +4.6	V
Power supply voltage 3	V _{PP}	Ta = 25°C	-0.3 to +9.5	V
Power supply voltage 4	V _{DDL}	Ta = 25°C	-0.3 to +3.6	V
Power supply voltage 5	V _{DDX}	Ta = 25°C	-0.3 to +3.6	V
Power supply voltage 6	V _{L1}	Ta = 25°C	-0.3 to +1.75	V
Power supply voltage 7	V _{L2}	Ta = 25°C	-0.3 to +3.5	V
Power supply voltage 8	V _{L3}	Ta = 25°C	-0.3 to +5.25	V
Input voltage	V _{IN}	Ta = 25°C	–0.3 to V _{DD} +0.3	V
Output voltage	Vout	Ta = 25°C	–0.3 to V _{DD} +0.3	V
Output current 1	I _{OUT1}	Port3–A, Ta = 25°C	-12 to +11	mA
Output current 2	I _{OUT2}	Port2, Ta = 25°C	-12 to +20	mA
Power dissipation	PD	Ta = 25°C	1.25	W
Storage temperature	T _{STG}	_	-55 to +150	°C

RECOMMENDED OPERATING CONDITIONS

 $(V_{SS} = AV_{SS} = 0V)$

Parameter	Symbol	Condition	Range	Unit	
		ML610Q411, ML610Q412,	-20 to +70		
Operating temperature	T _{OP}	ML610Q411P, ML610Q411PA, ML610Q412P	-40 to +85	°C	
	V _{DD}	_	1.1 to 3.6	v	
Operating voltage	AV _{DD}	_	2.2 to 3.6	v	
Operating frequency (CPU)	f _{OP}	V _{DD} = 1.1 to 3.6V	30k to 36k 46.9k to 78.1k	Hz	
Operating frequency (OF O)	ΤΟΡ	V _{DD} = 1.3 to 3.6V	30k to 625k 23k to 625k		
Capacitor externally connected to	C _{L0}	_	1.0±30%		
V _{DDL} pin	C _{L1}		0.1±30%	μF	
Capacitor externally connected to V_{DDX} pin	Cx	_	0.1±30%	μF	
Capacitors externally connected to $V_{L1, 2, 3}$ pins	C _{1, 2, 3}	_	1.0±30%	μF	
Capacitors externally connected across C1 and C2 pins	C ₁₂	—	1.0±30%	μF	

 $(V_{SS} = 0V)$

CLOCK GENERATION CIRCUIT OPERATING CONDITIONS

						(00 -)
Parameter	Symbol	Condition		Unit		
Falameter	Symbol	Condition	Min.	Тур.	Max.	Onit
Low-speed crystal oscillation frequency	f _{XTL}	_	_	32.768k		Hz
Recommended equivalent series resistance value of low-speed crystal oscillation	RL		_		40k	Ω
		C _L =6pF of crystal oscillation ^{*2}	—	0	_	
Low-speed crystal oscillation external capacitor ^{*1}	$C_{\text{DL}}/C_{\text{GL}}$	C _L =9pF of crystal oscillation		6	_	pF
		C _L =12pF of crystal oscillation		12	_	
	C _{GH}			24	_	1

^{*1}: The external C_{DL} and C_{GL} need to be adjusted in consideration of variation of internal loading capacitance C_D and C_G, and other additional capacitance such as PCB layout.

^{*2}: When using a crystal oscillator $C_L = 6pF$, there is a possibility that can not be adjusted by external C_{DL} and C_{GL} .

OPERATING CONDITIONS OF FLASH ROM

			(V _{SS}	$= AV_{SS} = 0V$
Parameter	Symbol	Condition	Range	Unit
Operating temperature	T _{OP}	At write/erase	0 to +40	°C
	V _{DD}	At write/erase ^{*1}	2.75 to 3.6	
Operating voltage	V _{DDL}	At write/erase ^{*1}	2.5 to 2.75	V
	V _{PP}	At write/erase ^{*1}	7.7 to 8.3	
Write cycles	C _{EP}		80	cycles
Data retention	Y _{DR}		10	years

¹: Those voltages must be supplied to V_{DDL} pin and V_{PP} pin when programming and eraseing Flash ROM. V_{PP} pin has an internal pulldown resister.

DC CHARACTERISTICS (1/5)

 $(V_{DD} = 1.1 \text{ to } 3.6\text{V}, \text{AV}_{DD} = 2.2 \text{ to } 3.6\text{V}, \text{V}_{SS} = \text{AV}_{SS} = 0\text{V}, \text{Ta} = -20 \text{ to } +70^{\circ}\text{C}, \text{Ta} = -40 \text{ to } +85^{\circ}\text{C} \text{ for P version},$ unless otherwise specified) (1/5)

						unless otr	nerwise s	pecified) (1/5)
Parameter	Symbol	Symbol Condition		Rating			Unit	Measuring
	Symbol		Condition		Тур.	Max.	Unit	circuit
500kHz RC oscillation	fac	V _{DD} = 1.3	Ta = 25°C	Тур. –10%	500	Typ. +10%	kHz	
frequency	f _{RC}	to 3.6V	*3	Тур. –25%	500	Typ. +25%	kHz	
Low-speed crystal oscillation start time* ²	T _{XTL}	—		_	0.3	2	s	
500kHz RC oscillation start time	T _{RC}			—	50	500	μS	1
Low-speed oscillation stop detect time ^{*1}	T _{STOP}		_	0.2	3	20	ms	
Reset pulse width	P _{RST}			200		—		
Reset noise elimination pulse width	P _{NRST}	_		_		0.3	μS	
Power-on reset activation power rise time	T _{POR}			_		10	ms	

*¹: When low-speed crystal oscillation stops for a duration more than the low-speed oscillation stop detect time, the system is reset to shift to system reset mode.

 $*^2$: Use 32.768KHz Crystal Oscillator C-001R (Epson Toyocom) with capacitance C_{GL}/C_{DL}=0pF.

0.9xV_{DD}

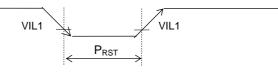
 T_{POR}

 $0.1 \mathrm{xV}_{\mathrm{DD}}$

 $*^3$: Recommended operating temperature (Ta = -40 to +85°C for P version, Ta = -20 to +70°C for non-P version)

[Reset pulse width]

RESET_N



Reset pulse width (PRST)

[Power-on reset activation power rise time]

VDD

Power-on reset activation power rise time (T_{POR})

ML610Q411/ML610Q412

DC CHARACTERISTICS (2/5)

 $(V_{DD} = 1.1 \text{ to } 3.6V, \text{AV}_{DD} = 2.2 \text{ to } 3.6V, \text{V}_{SS} = \text{AV}_{SS} = 0\text{V}, \text{Ta} = -20 \text{ to } +70^{\circ}\text{C}, \text{Ta} = -40 \text{ to } +85^{\circ}\text{C}$ for P version, unless otherwise specified) (2/5)

$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$, i					unless	s otherwise specified) (2/5		
$V_{L1} \text{ voltage} V_{L1} V_{DD} = 3.0V, \\ T_{J} = 25^{\circ}C \\ \hline V_{L1} \text{ voltage} V_{L1} V_{DD} = 3.0V, \\ T_{J} = 25^{\circ}C \\ \hline V_{L1} \text{ voltage} V_{L1} V_{DD} = 3.0V, \\ T_{J} = 25^{\circ}C \\ \hline V_{L2} \text{ voltage} V_{L3} V_{DD} = 3.0V, \\ T_{J} = 25^{\circ}C \\ \hline V_{L2} \text{ voltage} V_{L3} V_{DD} = 3.0V, \\ \hline V_{L2} \text{ voltage} V_{L3} V_{DD} = 3.0V, \\ \hline V_{L2} \text{ voltage} V_{L3} V_{DD} = 3.0V, \\ \hline V_{L2} \text{ voltage} V_{L3} V_{DD} = 3.0V, \\ \hline V_{L3} \text{ voltage} V_{L3} V_{DD} = 3.0V, \\ \hline V_{L3} \text{ voltage} V_{L3} V_{DD} = 3.0V, \\ \hline V_{L3} \text{ voltage} V_{L3} V_{DD} = 3.0V, \\ \hline V_{L3} \text{ voltage} V_{L3} V_{L3} $	Parameter	Symbol	Condition			T		Unit	-	
$V_{L1} \text{ voltage} V_{L1} V_{D0} = 3.0V, \\ T_J = 25^{\circ}C \\ \hline V_{L1} \text{ voltage} V_{L1} V_{D0} = 3.0V, \\ T_J = 25^{\circ}C \\ \hline V_{L2} \text{ voltage} V_{L3} V_{D0} = 3.0V, \\ T_J = 25^{\circ}C \\ \hline V_{L2} \text{ voltage} V_{L3} \\ \hline V_{D0} = 3.0V, \\ T_J = 25^{\circ}C \\ \hline V_{L2} \text{ voltage} V_{L3} \\ \hline V_{D0} = 1.3 \text{ to } 3.6V \\ \hline V_{D0} = 3.0V, \\ T_J = 25^{\circ}C \\ \hline V_{L3} \text{ voltage} V_{L3} \\ \hline V_{D0} = 1.3 \text{ to } 3.6V \\ \hline V_{D0} = 3.0V, \\ \hline V_{D0} = 3.0V, \\ \hline V_{D0} = 3.0V, \\ \hline T_{D1} = 25^{\circ}C \\ \hline V_{L3} \text{ voltage} V_{L3} \\ \hline V_{D0} = 1.3 \text{ to } 3.6V \\ \hline V_{D0} = 3.0V, \\ \hline T_{D1} = 25^{\circ}C \\ \hline V_{L3} \text{ voltage} V_{L3} \\ \hline V_{D0} = 1.3 \text{ to } 3.6V \\ \hline V_{D0} = 3.0V, \\ \hline T_{D1} = 25^{\circ}C \\ \hline V_{L3} \text{ voltage} V_{L3} \\ \hline V_{D0} = 1.0V, \\ \hline T_{D1} = 25^{\circ}C \\ \hline V_{L3} \text{ voltage} V_{L3} \\ \hline V_{D0} = 3.0V, \\ \hline T_{D1} = 25^{\circ}C \\ \hline V_{L3} \text{ voltage} V_{L3} \\ \hline V_{D1} \text{ voltage} V_{L3} \\ \hline V_{D2} \text{ voltage} V_{L3} \\ \hline V_{D1} \text{ voltage} V_{L3} \\ \hline V_{D1} \text{ voltage} V_{L3} \\ \hline V_{D2} \text{ voltage} V_{L3} \\ \hline V_{D1} \text{ voltage} V_{L3} \\ \hline V_{D1} \text{ voltage} V_{L3} \\ \hline V_{L3} vol$									circuit	
$V_{L1} \text{ voltage} V_{L1} V_{DD} = 3.0V, \\ T_{1} = 25^{\circ}C V_{L1} V_{DD} = 3.0V, \\ T_{1} \text{ temperature} \\ \frac{V_{L1}}{V_{L1} \text{ temperature}} \Delta V_{L1} V_{DD} = 3.0V, \\ T_{1} \text{ voltage} V_{L3} V_{DD} = 3.0V, \\ T_{1} = 25^{\circ}C V_{DD} = 3.0V, \\ V_{L1} \text{ temperature} \\ V_{L1} V_{DD} = 3.0V, \\ V_{L1} V_{DD} = 3.0V, \\ V_{L2} \text{ voltage} V_{L3} V_{DD} = 3.0V, \\ V_{L2} \text{ voltage} V_{L3} V_{DD} = 3.0V, \\ T_{1} = 25^{\circ}C V_{1} \text{ voltage} V_{L3} V_{1} V_{DD} = 3.0V, \\ T_{1} = 3^{\circ}V_{L3} V_{1} V_{DD} = 3.0V, \\ T_{1} = 3^{\circ}V_{L3} V_{1} = 3^{\circ}V_{L3} V_{1} V_{1} = 3^{\circ}V_{1} V_{1} V_{1} = 3^{\circ}V_{1} V_{1} V_{1} = 3^{\circ}V_{1} V_{1} V_{1} = 3^{\circ}V_{1} V_{1} V_{$										
$V_{L1} \text{ voltage} V_{L1} V_{D0} = 3.0V, \\ T_{J} = 25^{\circ}C V_{L1} V_{D0} = 1.3 \text{ to } 3.6V V_{-1} V_{21} V_{11} V_{22} V_{11} V_{22} V_{11} V_{21} V_{21} $										
$V_{L1} \text{ voltage} V_{L1} V_{DD} = 3.0V, \\ \overline{U}_{L1} \text{ voltage} V_{L1} V_{DD} = 3.0V, \\ \overline{U}_{L1} \text{ temperature} \\ \frac{V_{L1} \text{ temperature}}{\text{dependency *}^{1}} AV_{L1} V_{DD} = 3.0V, \\ \overline{U}_{L1} \text{ voltage} V_{L2} V_{DD} = 3.0V, \\ \overline{U}_{L1} \text{ voltage} V_{L3} V_{DD} = 3.0V, \\ \overline{U}_{L2} \text{ voltage} V_{L3} V_{L3} V_{L1} V_{DD} = 3.0V, \\ \overline{U}_{L2} \text{ voltage} V_{L3} V_{L$										
$V_{L1} \text{ voltage} V_{L1} V_{DD} = 3.0V, \\ T_j = 25^\circ C V_{L1} V_{DD} = 3.0V, \\ T_j = 25^\circ C V_{L1} V_{DD} = 3.0V, \\ T_j = 25^\circ C V_{L1} V_{DD} = 3.0V, \\ T_j = 25^\circ C V_{L1} V_{DD} = 3.0V, \\ T_j = 25^\circ C V_{L1} V_{DD} = 3.0V, \\ T_j = 25^\circ C V_{L1} V_{DD} = 3.0V, \\ T_j = 25^\circ C V_{L1} V_{D1} = 1.11 1.26 1.31 \\ CN4-0 = 0DH 1.11 1.26 1.31 \\ CN4-0 = 0DH 1.11 1.26 1.31 \\ CN4-0 = 0DH 1.11 1.26 1.31 \\ CN4-0 = 10H 1.22 1.22 \\ CN4-0 = 0DH 1.11 1.26 1.31 \\ CN4-0 = 10H 1.22 1.26 1.31 \\ CN4-0 = 10H 1.22 1.32 1.35 \\ CN4-0 = 12H 1.22 1.30 1.35 \\ CN4-0 = 12H 1.25 1.30 1.35 \\ CN4-0 = 12H 1.32 1.34 1.39 \\ CN4-0 = 18H 1.33 1.38 1.43 \\ CN4-0 = 19H 1.39 1.44 1.49 \\ CN4-0 = 19H 1.39 1.44 1.49 \\ CN4-0 = 19H 1.39 1.44 1.49 \\ CN4-0 = 10H 1.43 1.56 1.65 \\ CN4-0 = 10H 1.43 1.56 1.61 \\ CN4-0 = 10H 1.43 1.56 1.61 \\ CN4-0 = 10H 1.44 1.56 1.55 \\ CN4-0 = 10H 1.44 1.56 1.56 \\ CN4-0 = 10H 1.44 1.44 1.56 1.56 \\ CN4-0 = 10H 1.44 1.56 1.56 \\ CN4-0 = 10H 1.44 1.56 1.56 \\ CN4-0 = 10H 1.44 1.44 1.56 1.56 \\ CN4-0 = 10H 1.44 1.56 1.56 \\ CN4-0 = 1.$								-		
$V_{L1} \text{ voltage} V_{L1} V_{DD} = 3.0V, \\ T_{j} = 25^{\circ}C V_{L1} V_{DD} = 1.11 1.26 1.31 \\ CN4-0 = 0BH & 1.11 & 1.16 & 1.21 \\ CN4-0 = 0BH & 1.11 & 1.16 & 1.21 \\ CN4-0 = 0BH & 1.11 & 1.16 & 1.21 \\ CN4-0 = 0BH & 1.11 & 1.16 & 1.21 \\ CN4-0 = 0BH & 1.11 & 1.16 & 1.21 \\ CN4-0 = 0BH & 1.11 & 1.16 & 1.21 \\ CN4-0 = 0BH & 1.11 & 1.26 & 1.31 \\ CN4-0 = 0BH & 1.11 & 1.26 & 1.31 \\ CN4-0 = 0BH & 1.11 & 1.26 & 1.31 \\ CN4-0 = 0BH & 1.12 & 1.22 & 1.32 \\ CN4-0 = 0BH & 1.27 & 1.32 & 1.33 \\ CN4-0 = 13H & 1.27 & 1.32 & 1.33 \\ CN4-0 = 14H & 1.29 & 1.34 & 1.39 \\ CN4-0 = 16H & 1.33 & 1.38 & 1.43 \\ CN4-0 = 18H & 1.37 & 1.42 & 1.47 \\ CN4-0 = 18H & 1.37 & 1.42 & 1.47 \\ CN4-0 = 18H & 1.37 & 1.42 & 1.47 \\ CN4-0 = 1BH & 1.43 & 1.48 & 1.53 \\ CN4-0 = 1BH & 1.43 & 1.48 & 1.53 \\ CN4-0 = 1BH & 1.43 & 1.48 & 1.53 \\ CN4-0 = 1BH & 1.43 & 1.48 & 1.53 \\ CN4-0 = 1BH & 1.43 & 1.48 & 1.53 \\ CN4-0 = 1BH & 1.43 & 1.48 & 1.53 \\ CN4-0 = 1DH & 1.47 & 1.52 & 1.57 \\ CN4-0 = 1DH & 1.47 & 1.52 & 1.57 \\ CN4-0 = 1DH & 1.47 & 1.52 & 1.57 \\ CN4-0 = 1DH & 1.48 & 1.53 \\ CN4-0 = 1BH & 1.43 & 1.48 & 1.53 \\ CN4-0 = 1BH & 1.43 & 1.48 & 1.53 \\ CN4-0 = 1BH & 1.43 & 1.48 & 1.53 \\ CN4-0 = 1BH & 1.43 & 1.48 & 1.53 \\ CN4-0 = 1BH & 1.43 & 1.48 & 1.53 \\ CN4-0 = 1DH & 1.47 & 1.52 & 1.57 \\ CN4-0 = 1DH & 1.47 & 1.52 & 1.57 \\ CN4-0 = 1DH & 1.47 & 1.52 & 1.57 \\ CN4-0 = 1DH & 1.48 & 1.53 \\ CN4-0 = 1DH & 1.54 & 1.59 \\ CN4-0 = 1.3 \text{ to } 3.6V & - & 5 & 20 \\ \text{withor s}^{*} \Delta V_{L1} V_{DD} = 3.0V, T_{j} = 25^{\circ}C \\ 1M\Omega \log (V_{L3}-V_{S9}) Typ, \\ V_{L1}N_{2} V_{L1}N_{2} Typ, \\ V_{L1}N_{3} Typ, \\ V_{L1}N_{3} Typ, \\ V_{L2} V_{L3} V_{L3} Typ, \\ V_{L3} V_{L3} V_{L3} Typ, \\ V_{L3} V_{L3} V_{L3} Typ, \\ V_{L3} V_{L3} V_{L3} V_{L3} Typ, \\ V_{L3} V_{L3} V_{L3} Typ, \\ V_{L3} V_{L3} V_{L3} Typ, \\ V_{L3} V_{L3} V_{L3} V_{L3} Typ, \\ V_{L3} V_{L3} V_{L3} V_{L3} Typ, \\ V_{L3} V_{L3} V_{L3} $										
$V_{L1} \text{ voltage} V_{L1} V_{DD} = 3.0V, \\ T_{j} = 25^{\circ}C V_{L1} V_{DD} = 3.0V, \\ T_{j} = 25^{\circ}C V_{L1} V_{DD} = 3.0V, \\ V_{L1} \text{ voltage} V_{L2} V_{DD} = 3.0V, \\ V_{L2} \text{ voltage} V_{L3} V_{DD} = 3.0V, \\ V_{L1} \text{ voltage} V_{L3} V_{DD} = 3.0V, \\ V_{L2} \text{ voltage} V_{L3} V_{DD} = 3.0V, \\ V_{L2} \text{ voltage} V_{L3} V_{DD} = 3.0V, \\ V_{L2} \text{ voltage} V_{L3} V_{L1} V_{DD} = 3.0V, \\ V_{L2} \text{ voltage} V_{L3} V_{L1} V_{DD} = 3.0V, \\ V_{L2} \text{ voltage} V_{L3} V_{L1} V_{DD} = 3.0V, \\ V_{L2} \text{ voltage} V_{L3} V_{L1} V_{DD} = 3.0V, \\ V_{L2} \text{ voltage} V_{L3} V_{L1} V_{DD} = 3.0V, \\ V_{L3} \text{ voltage} V_{L3} V_{L1} V_{DD} = 3.0V, \\ V_{L2} \text{ voltage} V_{L3} V_{L1} V_{DD} = 3.0V, \\ V_{L2} \text{ voltage} V_{L3} V_{L1} V_{DD} = 3.0V, \\ V_{L3} \text{ voltage} V_{L3} V_{L1} V_{DD} = 3.0V, \\ V_{L2} \text{ voltage} V_{L3} V_{L1} V_{DD} = 3.0V, \\ V_{L3} \text{ voltage} V_{L3} V_{L1} V_{DD} = 3.0V, \\ V_{L3} \text{ voltage} V_{L3} V_{L1} V_{DD} = 3.0V, \\ V_{L3} \text{ voltage} V_{L3} V_{L1} V_{D1} = 25^{\circ}C \\ M_{L2} \text{ voltage} V_{L3} V_{L1} V_{L1$										
$V_{L1} \text{ voltage} V_{L1} V_{DD} = 3.0V, \\ T_{j} = 25^{\circ}C V_{L1} V_{DD} = 3.0V, \\ T_{j} = 25^{\circ}C V_{L1} V_{DD} = 1.3 \text{ to } 3.0V, \\ T_{j} = 25^{\circ}C V_{L1} V_{DD} = 1.3 \text{ to } 3.0V, \\ T_{j} = 25^{\circ}C V_{L1} V_{DD} = 3.0V, \\ T_{j} = 25^{\circ}C V_{L1} V_{DD} = 1.3 \text{ to } 3.0V, \\ T_{j} = 25^{\circ}C V_{L1} V_{DD} = 1.3 \text{ to } 3.0V, \\ T_{j} = 25^{\circ}C V_{L1} V_{DD} = 1.3 \text{ to } 3.0V, \\ T_{j} = 25^{\circ}C V_{L1} V_{DD} = 1.3 \text{ to } 3.0V, \\ T_{j} = 25^{\circ}C V_{L1} V_{DD} = 1.3 \text{ to } 3.0V, \\ T_{j} = 25^{\circ}C V_{L1} V_{DD} = 1.3 \text{ to } 3.0V, \\ T_{j} = 25^{\circ}C V_{L1} V_{DD} = 1.3 \text{ to } 3.0V, \\ T_{j} = 25^{\circ}C V_{L1} V_{DD} = 1.3 \text{ to } 3.0V, \\ T_{j} = 25^{\circ}C V_{L1} V_{DD} = 1.3 \text{ to } 3.0V \\ T_{j} = 25^{\circ}C V_{L1} V_{L1} $						1				
$V_{L1} \text{ voltage} V_{L1} V_{D0} = 3.0V, \\ Tj = 25^{\circ}C V_{L1} V_{D0} = 0 + 1.17 1.12 1.18 1.23 \\ CN4-0 = 0CH 1.13 1.18 1.23 \\ CN4-0 = 0CH 1.17 1.22 1.27 \\ CN4-0 = 0CH 1.19 1.24 1.26 1.31 \\ CN4-0 = 10H 1.21 1.26 1.31 \\ CN4-0 = 10H 1.21 1.26 1.31 \\ CN4-0 = 11H 1.22 1.37 \\ CN4-0 = 13H 1.32 1.38 1.43 \\ CN4-0 = 13H 1.32 1.38 1.43 \\ CN4-0 = 13H 1.33 1.38 1.43 \\ CN4-0 = 18H 1.33 1.43 1.48 \\ CN4-0 = 18H 1.33 1.44 1.49 \\ CN4-0 = 18H 1.37 1.42 1.47 \\ CN4-0 = 18H 1.37 1.42 1.47 \\ CN4-0 = 18H 1.37 1.42 1.47 \\ CN4-0 = 18H 1.43 1.48 1.53 \\ CN4-0 = 10H 1.43 1.48 1.53 \\ CN4-0 = 10H 1.43 1.48 1.53 \\ CN4-0 = 10H 1.47 1.52 1.57 \\ CN4-0 = 18H 1.43 1.48 1.59 \\ CN4-0 = 10H 1.47 1.52 1.57 \\ CN4-0 = 10H 1.47 1.52 1.57 \\ CN4-0 = 10H 1.47 1.52 1.57 \\ CN4-0 = 10H 1.47 1.56 1.61 \\ CN4-0 = 10H 1.49 1.54 1.56 \\ CN4-0 = 10H 1.49 1.54 1.56 \\ CN4-0 = 10H 1.49 1.54 1.56 \\ CN4-0 = 10H 1.49 1.54 \\ CN4-0 = 10H 1.47 1.52 1.57 \\ CN4-0 = 10H 1.47 1.52 1.57 \\ CN4-0 = 10H 1.49 1.54 1.56 \\ CN4-0 = 10H 1.47 1.52 1.57 \\ CN4-0 = 10H 1.49 1.54 1.56 1.61 \\ CN4-0 = 10H 1.49 1.54 1.56 1.61 \\ CN4-0 = 10H 1.49 1.54 1.56 1.61 \\ CN4-0 = 10H 1.49 1.56 1.61 \\ CN4-$					1.03	1	1.13			
$V_{L1} \text{ voltage} V_{L1} V_{DD} = 3.0V, \\ T_{j} = 25^{\circ}C V_{L1} V_{D1} = 0 \\ CN4-0 = 0CH 1.15 1.20 1.25 \\ CN4-0 = 0CH 1.17 1.22 1.27 \\ CN4-0 = 0CH 1.19 1.24 1.29 \\ CN4-0 = 10H 1.21 1.26 1.31 \\ CN4-0 = 10H 1.21 1.26 1.33 \\ CN4-0 = 11H 1.22 1.27 \\ CN4-0 = 13H 1.27 1.32 1.37 \\ CN4-0 = 13H 1.27 1.32 1.37 \\ CN4-0 = 13H 1.27 1.32 1.37 \\ CN4-0 = 18H 1.33 1.38 1.43 \\ CN4-0 = 18H 1.33 1.38 1.43 \\ CN4-0 = 18H 1.33 1.38 1.43 \\ CN4-0 = 18H 1.33 1.42 1.47 \\ CN4-0 = 18H 1.33 1.42 1.47 \\ CN4-0 = 18H 1.43 1.48 1.53 \\ CN4-0 = 10H 1.47 1.52 1.57 \\ CN4-0 = 10H 1.47 1.52 1.57 \\ CN4-0 = 1CH 1.48 1.53 \\ CN4-0 = 1CH 1.49 1.54 1.59 \\ CN4-0 = 1EH 1.49 1.54 1.59 \\ CN4-0 1.56 1.61 100 10000000000000000000000000000$				CN4–0 = 08H	1.05	1.10	1.15			
$V_{L1} \text{ voltage} V_{L1} V_{D0} = 3.0V, \\ Tj = 25^{\circ}C V_{L1} V_{D0} = 3.0V, \\ Tj = 25^{\circ}C V_{L1} V_{D0} = 3.0V, \\ Tj = 25^{\circ}C V_{L1} V_{D0} = 0 \\ V_{L1} V_{D0} = 3.0V, \\ Tj = 25^{\circ}C V_{L1} V$				CN4–0 = 09H	1.07	1.12	1.17			
$V_{L1} \text{ voltage} V_{L1} V_{DD} = 3.0V, \\ T_{J} = 25^{\circ}C V_{T} = 10^{\circ}H 1.13 1.26 1.33 \\ CN4 - 0 = 10H 1.22 1.32 1.33 \\ CN4 - 0 = 13H 1.27 1.32 1.37 \\ CN4 - 0 = 13H 1.29 1.34 1.39 \\ CN4 - 0 = 13H 1.37 1.42 1.45 \\ CN4 - 0 = 16H 1.33 1.38 1.43 \\ CN4 - 0 = 18H 1.37 1.42 1.45 \\ CN4 - 0 = 18H 1.43 1.48 1.53 \\ CN4 - 0 = 10H 1.37 1.42 1.45 \\ CN4 - 0 = 10H 1.47 1.52 1.55 \\ CN4 - 0 = 10H 1.47 1.52 1.55 \\ CN4 - 0 = 10H 1.47 1.52 1.57 \\ CN4 - 0 = 10H 1.47 1.52 $				CN4–0 = 0AH	1.09	1.14	1.19			
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$				CN4–0 = 0BH	1.11	1.16	1.21			
$V_{L1} \text{ voltage} V_{L1} V_{DD} = 3.0V, \\ Tj = 25^{\circ}C V_{L1} V_{DD} = 3.0V, \\ Tj = 25^{\circ}C V_{L1} V_{DD} = 3.0V, \\ Tj = 25^{\circ}C V_{L1} = 1.21 1.22 1.27 \\ CN4-0 = 10H & 1.21 & 1.26 1.31 \\ CN4-0 = 10H & 1.21 & 1.26 & 1.31 \\ CN4-0 = 10H & 1.22 & 1.32 & 1.37 \\ CN4-0 = 13H & 1.27 & 1.32 & 1.37 \\ CN4-0 = 13H & 1.27 & 1.32 & 1.37 \\ CN4-0 = 15H & 1.31 & 1.36 & 1.41 \\ CN4-0 = 16H & 1.33 & 1.38 & 1.43 \\ CN4-0 = 16H & 1.33 & 1.38 & 1.43 \\ CN4-0 = 18H & 1.37 & 1.42 & 1.47 \\ CN4-0 = 18H & 1.37 & 1.42 & 1.47 \\ CN4-0 = 18H & 1.37 & 1.42 & 1.47 \\ CN4-0 = 10H & 1.43 & 1.48 & 1.53 \\ CN4-0 = 10H & 1.41 & 1.46 & 1.51 \\ CN4-0 = 10H & 1.43 & 1.48 & 1.53 \\ CN4-0 = 10H & 1.47 & 1.52 & 1.57 \\ CN4-0 = 10H & 1.47 & 1.52 & 1.57 \\ CN4-0 = 10H & 1.47 & 1.52 & 1.57 \\ CN4-0 = 10H & 1.47 & 1.52 & 1.57 \\ CN4-0 = 10H & 1.47 & 1.52 & 1.57 \\ CN4-0 = 10H & 1.54 & 1.59 \\ CN4-0 = 10H & 1.54 \\ CN4-0 = 10H & 1.54 & 1.59 \\ CN4-0 = $				CN4–0 = 0CH	1.13	1.18	1.23			
$\begin{array}{c c c c c c c c c c c c c c c c c c c $				CN4-0 = 0DH	1.15	1.20	1.25			
$\begin{array}{c c c c c c c c c c c c c c c c c c c $				CN4–0 = 0EH	1.17	1.22	1.27		1	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		V.	$V_{DD} = 3.0V,$	CN4–0 = 0FH	1.19	1.24	1.29	V		
$ \frac{\left \begin{array}{c c c c c c c c c c c c c c c c c c c$	VL1 Voltage	V L1	Tj = 25°C	CN4–0 = 10H	1.21	1.26	1.31			
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$				CN4–0 = 11H	1.23	1.28	1.33			
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$				CN4–0 = 12H	1.25	1.30	1.35			
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$				CN4–0 = 13H	1.27	1.32	1.37			
$\frac{(CN4-0 = 16H)}{(CN4-0 = 17H)} \frac{1.33}{1.38} \frac{1.43}{1.43} + \frac{1.43}{1.45} + \frac{1.43}{1.53} + \frac{1.43}{1.45} + \frac{1.43}{1.53} + \frac{1.43}{1.45} + \frac{1.43}{1.53} + \frac{1.43}{1.44} + \frac{1.49}{1.45} + \frac{1.41}{1.45} + \frac{1.49}{1.50} + \frac{1.41}{1.55} $				CN4–0 = 14H	1.29	1.34	1.39	-		
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$				CN4–0 = 15H	1.31	1.36	1.41			
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$				CN4–0 = 16H	1.33	1.38	1.43			
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$				CN4–0 = 17H	1.35	1.40	1.45			
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$				CN4–0 = 18H	1.37	1.42	1.47			
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$				CN4–0 = 19H	1.39	1.44	1.49			
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$				CN4–0 = 1AH	1.41	1.46	1.51			
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$				CN4–0 = 1BH	1.43	1.48	1.53			
$\begin{tabular}{ c c c c c c c c c c c c c c c c c c c$				CN4–0 = 1CH	1.45	1.50	1.55			
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $				CN4–0 = 1DH	1.47	1.52	1.57			
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $				CN4–0 = 1EH	1.49	1.54	1.59			
$\begin{array}{c c c c c c c c c c c c c c c c c c c $				CN4–0 = 1FH	1.51	1.56	1.61			
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	V _{L1} temperature deviation * ¹	ΔV_{L1}	V _{DD}	= 3.0V		-1.5		mV/°C		
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	V _{L1} voltage	ΔV_{L1}	V _{DD} = 1	.3 to 3.6V		5	20	mV/V		
$\frac{V_{L3} \text{ voltage }}{\text{LCD bias voltage }} \frac{V_{L3}}{T} = \frac{1000 \text{ load } (V_{L3} - V_{SS})}{1000 \text{ load } (V_{L3} - V_{SS})} = \frac{10000 \text{ rms}}{10000 \text{ rms}} = \frac{10000 \text{ rms}}{10000 \text{ rms}}$	V _{L2} voltage	V _{L2}	V _{DD} = 3.0	V, Tj = 25°C		V _{L1} ×2		V		
	V _{L3} voltage	V_{L3}	-			V _{L1} ×3		v		
		T _{BIAS}						ms		

*¹:V_{L1} can not exceed V_{DD} level. The maximum V_{L1} becomes V_{DD} level when the V_{L1} calculated by the temperature deviation and voltage dependency is going to exceed the V_{DD} level.

ML610Q411/ML610Q412

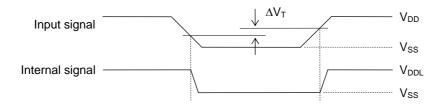
DC CHARACTERISTICS (5/5))

 $(V_{DD} = 1.1 \text{ to } 3.6\text{V}, \text{AV}_{DD} = 2.2 \text{ to } 3.6\text{V}, \text{V}_{SS} = \text{AV}_{SS} = 0\text{V}, \text{ Ta} = -20 \text{ to } +70^{\circ}\text{C}, \text{ Ta} = -40 \text{ to } +85^{\circ}\text{C} \text{ for P version},$ unless otherwise specified) (5/5)

			Rating				e specified) (5/5) Measuring
Parameter	Symbol	Condition	Min.	Тур.	Max.	Unit	circuit
Input voltage 1 (RESET_N) (TEST) (NMI) (P00–P03)	VIH1	V _{DD} = 1.3 to 3.6V	0.7 ×V _{DD}		V _{DD}		
	VIIII	$V_{DD} = 1.1 \text{ to } 3.6 \text{V}$	0.7 ×V _{DD}		V_{DD}		
(P10–P11) (P31–P35)		V_{DD} = 1.3 to 3.6V	0		0.3 ×V _{DD}		
(P40–P43) (P45–P47) (PA0–PA7) ^{*1}	VIL1	V _{DD} = 1.1 to 3.6V	0		0.2 ×V _{DD}		
Hysteresis width (RESET_N) (TEST_N) (NMI) (P00-P03) (P10-P11) (P31-P35) (P40-P43) (P45-P47) (PA0-PA7)*1	Δντ	$V_{DD} = 2.0 \text{ to } 3.6 \text{V}$	0.05 ×V _{DD}	0.18 ×V _{DD}	0.4 ×V _{DD}	V	5
		V _{DD} = 1.1 to 3.6V	0.02 ×V _{DD}	0.18 ×V _{DD}	0.4 ×V _{DD}		
Input voltage 2	VIH2	—	0.7 ×V _{DD}		V_{DD}		
(P30, P44)	VIL2	—	0		0.3 ×V _{DD}		
Input pin capacitance (NMI) (P00–P03) (P10–P11) (P30–P35) (P40–P47) (PA0–PA7) ^{*1}	CIN	f = 10kHz V _{rms} = 50mV Ta = 25°C			5	pF	_

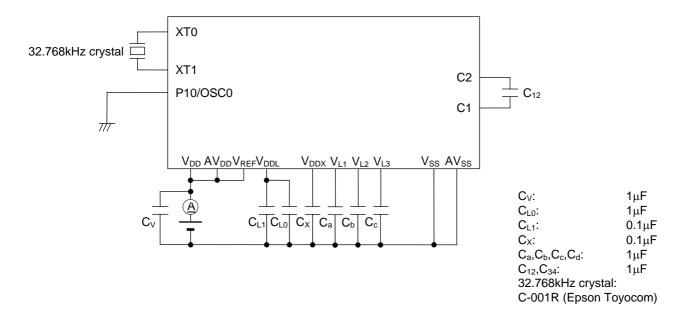
*1: ML610Q411

HYSTERESIS WIDTH

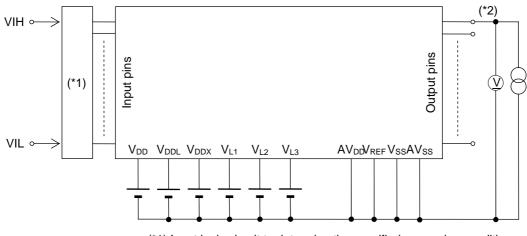


MEASURING CIRCUITS

MEASURING CIRCUIT 1



MEASURING CIRCUIT 2

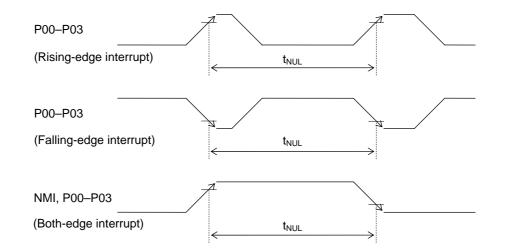


(*1) Input logic circuit to determine the specified measuring conditions. (*2) Measured at the specified output pins.

AC CHARACTERISTICS (External Interrupt)

 $(V_{DD} = 1.1 \text{ to } 3.6\text{V}, \text{AV}_{DD} = 2.2 \text{ to } 3.6\text{V}, \text{V}_{SS} = \text{AV}_{SS} = 0\text{V}, \text{Ta} = -20 \text{ to } +70^{\circ}\text{C}, \text{Ta} = -40 \text{ to } +85^{\circ}\text{C} \text{ for P version},$

			u	10000011	ei wise sp	
Parameter	Symbol	Condition	Rating			Linit
	Symbol	Condition	Min.	Тур.	Max.	Unit
External interrupt disable period	T _{NUL}	Interrupt: Enabled (MIE = 1), CPU: NOP operation System clock: 32.768kHz	76.8		106.8	μs

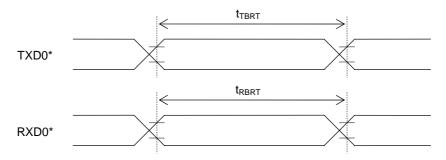


AC CHARACTERISTICS (Serial Port)

 $(V_{DD} = 1.3 \text{ to } 3.6\text{V}, \text{AV}_{DD} = 2.2 \text{ to } 3.6\text{V}, \text{V}_{SS} = \text{AV}_{SS} = 0\text{V}, \text{Ta} = -20 \text{ to } +70^{\circ}\text{C}, \text{Ta} = -40 \text{ to } +85^{\circ}\text{C} \text{ for P version},$ unless otherwise specified)

Parameter	Symbol	Condition		Unit			
Falalletei	Symbol	Condition	Min.	Тур.	Max.	Unit	
Transmit baud rate	t _{tbrt}			BRT* ¹	_	s	
Receive baud rate	t _{rbrt}		BRT* ¹ –3%	BRT* ¹	BRT* ¹ +3%	s	

*1: Baud rate period (including the error of the clock frequency selected) set with the serial port baud rate register (SIOBRTL,H) and the serial port mode register 0 (SIOMOD0).



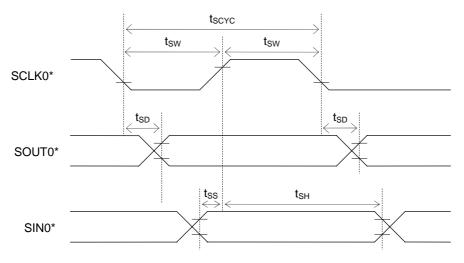
*: Indicates the secondary function of the port.

AC CHARACTERISTICS (Synchronous Serial Port)

 $(V_{DD} = 1.3 \text{ to } 3.6V, AV_{DD} = 2.2 \text{ to } 3.6V, V_{SS} = AV_{SS} = 0V, Ta = -20 \text{ to } +70^{\circ}C, Ta = -40 \text{ to } +85^{\circ}C \text{ for P version},$

				unless o	otherwise sp	ecified)	
Parameter	Cymetriad	Condition		1.1			
Parameter	Symbol	Condition	Min.		Max.	Unit	
SCLK input cycle (slave mode)	tscyc	When high-speed oscillation is not active	10			μs	
SCLK output cycle (master mode)	t _{scyc}			SCLK*1		s	
SCLK input pulse width (slave mode)	t _{SW}	When high-speed oscillation is not active	4			μs	
SCLK output pulse width (master mode)	t _{SW}		SCLK* ¹ ×0.4	SCLK* ¹ ×0.5	SCLK* ¹ ×0.6	S	
SOUT output delay time (slave mode)	t _{SD}				500	ns	
SOUT output delay time (master mode)	t _{SD}		—	—	500	ns	
SIN input setup time (slave mode)	t _{ss}	—	80	_		ns	
SIN input setup time (master mode)	t _{ss}	_	500			ns	
SIN input hold time	t _{SH}		300			ns	

*1: Clock period selected with S0CK3-0 of the serial port 0 mode register (SIO0MOD1)



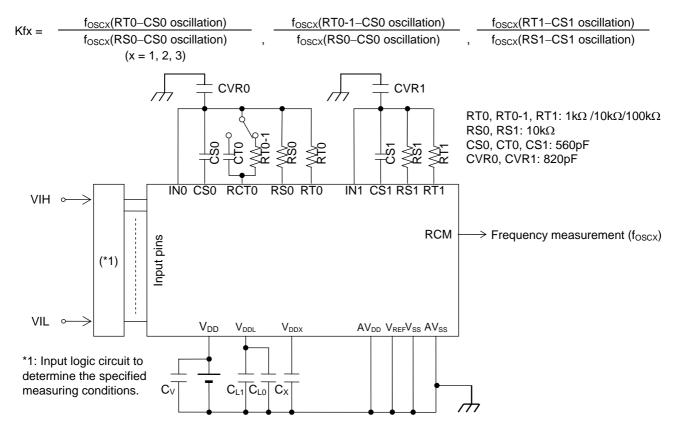
*: Indicates the secondary function of the port.

AC CHARACTERISTICS (RC Oscillation A/D Converter)

 $(V_{DD} = 1.3 \text{ to } 3.6\text{V}, \text{AV}_{DD} = 2.2 \text{ to } 3.6\text{V}, \text{V}_{SS} = \text{AV}_{SS} = 0\text{V}, \text{Ta} = -20 \text{ to } +70^{\circ}\text{C}, \text{Ta} = -40 \text{ to } +85^{\circ}\text{C} \text{ for P version},$

				unless oth	erwise spe	cified)
Parameter	Symbol	Condition		Unit		
Falameter	Cymbol		Min.	Тур.	Max.	Unit
Resistors for oscillation	RS0, RS1, RT0, RT0-1,RT1	CS0, CT0, CS1 \ge 740pF	1			kΩ
Oppillation fraguancy	f _{OSC1}	Resistor for oscillation = $1k\Omega$	209.4	330.6	435.1	kHz
Oscillation frequency VDD = 1.5V	f _{OSC2}	Resistor for oscillation = $10k\Omega$	41.29	55.27	64.16	kHz
	f _{OSC3}	Resistor for oscillation = $100k\Omega$	4.71	5.97	7.06	kHz
RS to RT oscillation frequency	Kf1	RT0, RT0-1, RT1 = 1kHz	5.567	5.982	6.225	_
ratio ^{*1}	Kf2	RT0, RT0-1, RT1 = 10kHz	0.99	1	1.01	
VDD = 1.5V	Kf3	RT0, RT0-1, RT1 = 100kHz	0.104	0.108	0.118	_
Operillation from up ou	f _{OSC1}	Resistor for oscillation = $1k\Omega$	407.3	486.7	594.6	kHz
Oscillation frequency VDD = 3.0V	f _{OSC2}	Resistor for oscillation = $10k\Omega$	49.76	59.28	72.76	kHz
VDD = 3.0V	f _{OSC3}	Resistor for oscillation = $100k\Omega$	5.04	5.993	7.04	kHz
RS to RT oscillation frequency ratio *1 VDD = 3.0V	Kf1	RT0, RT0-1, RT1 = 1kHz	8.006	8.210	8.416	_
	Kf2	RT0, RT0-1, RT1 = 10kHz	0.99	1	1.01	
	Kf3	RT0, RT0-1, RT1 = 100kHz	0.100	0.108	0.115	

*1: Kfx is the ratio of the oscillation frequency by the sensor resistor to the oscillation frequency by the reference resistor on the same conditions.



Note:

- Please have the shortest layout for the common node (wiring patterns which are connected to the external capacitors, resistors and IN0/IN1 pin), including CVR0/CVR1. Especially, do not have long wire between IN0/IN1 and RS0/RS1. The coupling capacitance on the wires may occur incorrect A/D conversion. Also, please do not have signals which may be a source of noise around the node.

- When RT0/RT1 (Thermistor and etc.) requires long wiring due to the restricted placement, please have VSS(GND) trace next to the signal.

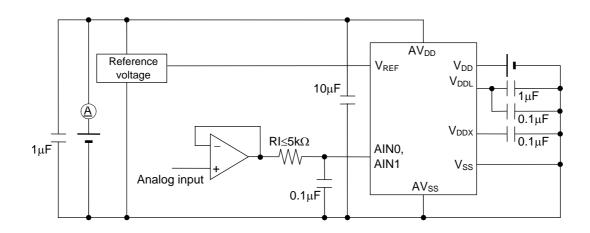
- Please make wiring to components (capacitor, resisteor and etc.) necessory for objective measurement. Wiring to reserved components may affect to the A/D conversion operation by noise the components itself may have.

ML610Q411/ML610Q412

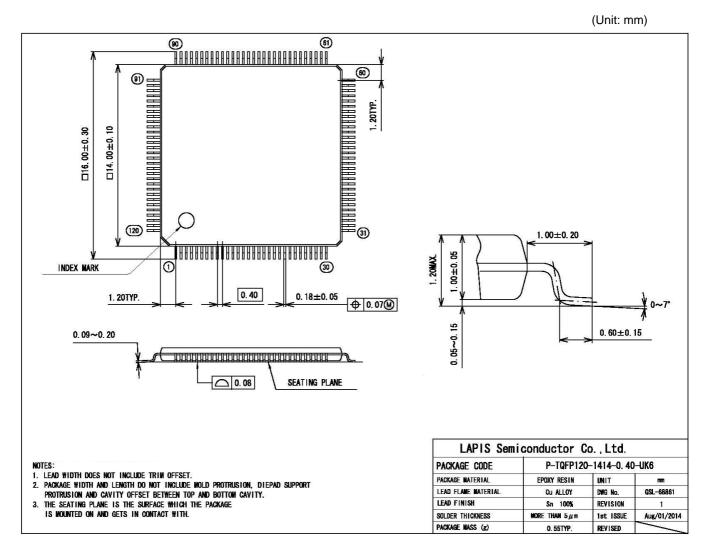
Electrical Characteristics of Successive Approximation Type A/D Converter (V_{DD} = 1.8 to 3.6V, AV_{DD} = 2.2 to 3.6V, V_{SS} = AV_{SS} = 0V, Ta = -20 to +70°C, Ta = -40 to +85°C for P version, unless otherwise specified)

			u	nless oth	erwise s	pecified)
Parameter	Symbol	Condition		Rating		
Falameter	Symbol		Min.	Тур.	Max.	Unit
Resolution	n				12	bit
Integral non-linearity error	IDL	$2.7V \le V_{REF} \le 3.6V$	-4		+4	LSB
Integral non-linearity end		$2.2V \leq V_{REF} \leq 2.7V$	-6		+6	
Differential non-linearity error	DNL	$2.7V \leq V_{REF} \leq 3.6V$	-3		+3	
Differential non-intearity end	DINL	$2.2V \leq V_{REF} \leq 2.7V$	-5		+5	
Zero-scale error	V _{OFF}		-6		+6	
Full-scale error	FSE		-6		+6	
Reference voltage	V _{REF}		2.2		AV_{DD}	V
Conversion time	t _{CONV}			23* ¹		∳/CH

 ϕ : Period of high-speed clock (HSCLK) *¹: 2 ϕ / CH is required as an interval time for each conversion in the case of consecutive A/D conversion.



PACKAGE DIMENSIONS



Notes for Mounting the Surface Mount Type Package

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 a ROHM sales office for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

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2-4-8 Shinyokohama, Kouhoku-ku, Yokohama 222-8575, Japan http://www.lapis-semi.com/en/