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What is "Embedded - Microcontrollers"?

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

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	RL78
Core Size	16-Bit
Speed	24MHz
Connectivity	CSI, I²C, LINbus, UART/USART, USB
Peripherals	LCD, LVD, POR, PWM, WDT
Number of I/O	51
Program Memory Size	64KB (64K x 8)
Program Memory Type	FLASH
EEPROM Size	8K x 8
RAM Size	8K x 8
Voltage - Supply (Vcc/Vdd)	1.6V ~ 3.6V
Data Converters	A/D 9x8/12b; D/A 2x8b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	85-VFLGA
Supplier Device Package	85-VFLGA (7x7)
Purchase URL	https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f110neala-u0

1.2 Ordering Information

Products with USB

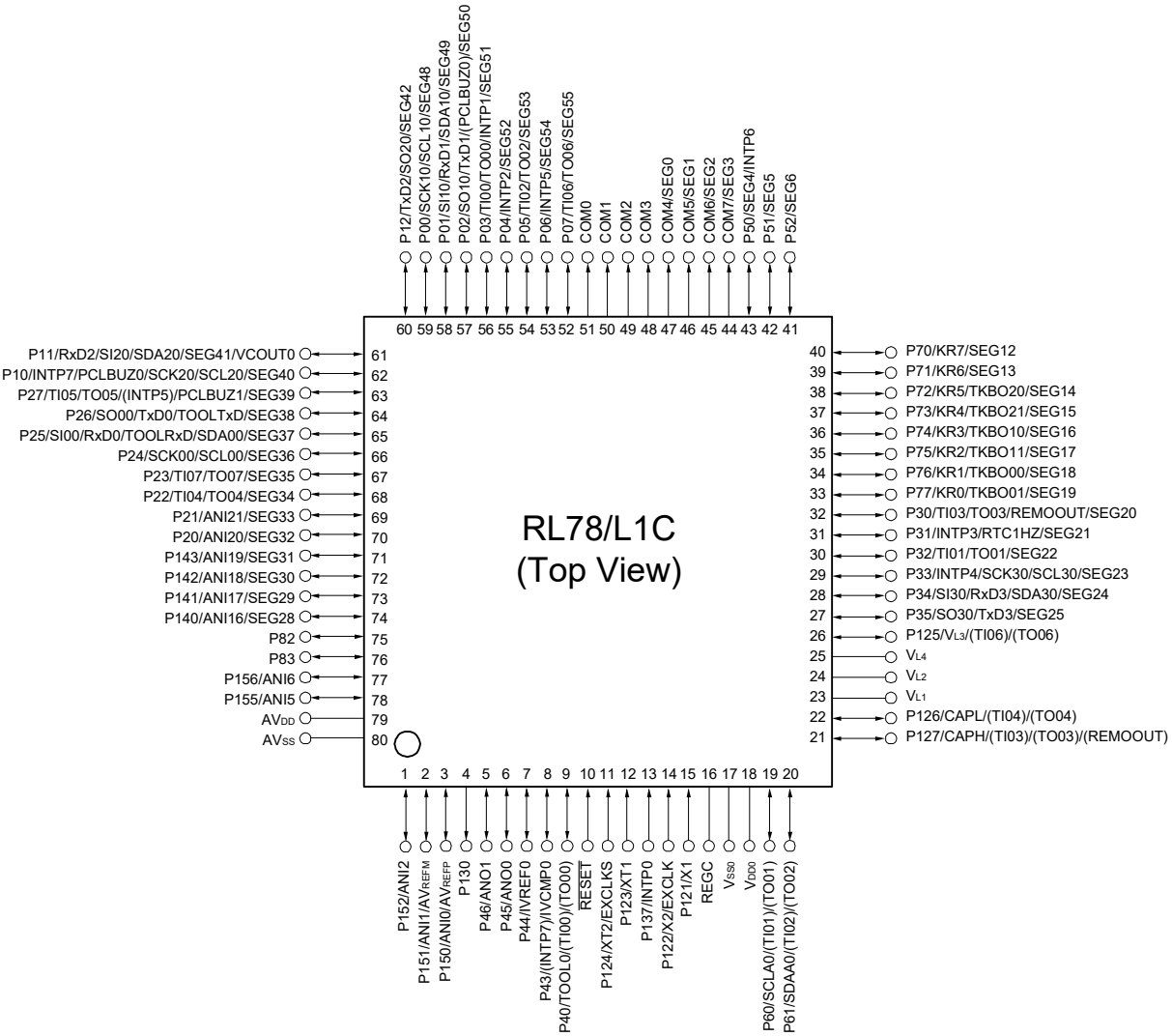
Pin Count	Package	Fields of Application	Orderable Part Number
80 pins	80-pin plastic LFQFP (12 × 12 mm, 0.5 mm pitch)	A	R5F110MEAFB#30, R5F110MFAFB#30, R5F110MGAFB#30, R5F110MHAFB#30, R5F110MJAFB#30 R5F110MEAFB#50, R5F110MFAFB#50, R5F110MGAFB#50, R5F110MHAFB#50, R5F110MJAFB#50
		G	R5F110MEGFB#30, R5F110MFGFB#30, R5F110MGGFB#30, R5F110MHGFB#30, R5F110MJGFB#30 R5F110MEGFB#50, R5F110MFGFB#50, R5F110MGGFB#50, R5F110MHGFB#50, R5F110MJGFB#50
85 pins	85-pin plastic VFLGA (7 × 7 mm, 0.65 mm pitch)	A	R5F110NEALA#U0, R5F110NFALA#U0, R5F110NGALA#U0, R5F110NHALA#U0, R5F110NJALA#U0 R5F110NEALA#W0, R5F110NFALA#W0, R5F110NGALA#W0, R5F110NHALA#W0, R5F110NJALA#W0
		G	R5F110NEGLA#U0, R5F110NFGLA#U0, R5F110NGGLA#U0, R5F110NHGLA#U0, R5F110NJGLA#U0 R5F110NEGLA#W0, R5F110NFGLA#W0, R5F110NGGLA#W0, R5F110NHGLA#W0, R5F110NJGLA#W0
100 pins	100-pin plastic LFQFP (14 × 14 mm, 0.5 mm pitch)	A	R5F110PEAFB#30, R5F110PFAFB#30, R5F110PGAFB#30, R5F110PHAFB#30, R5F110PJAFB#30 R5F110PEAFB#50, R5F110PFAFB#50, R5F110PGAFB#50, R5F110PHAFB#50, R5F110PJAFB#50
		G	R5F110PEGFB#30, R5F110PFGFB#30, R5F110PGGFB#30, R5F110PHGFB#30, R5F110PJGFB#30 R5F110PEGFB#50, R5F110PFGFB#50, R5F110PGGFB#50, R5F110PHGFB#50, R5F110PJGFB#50

Products without USB

Pin Count	Package	Fields of Application	Orderable Part Number
80 pins	80-pin plastic LFQFP (12 × 12 mm, 0.5 mm pitch)	A	R5F111MEAFB#30, R5F111MFAFB#30, R5F111MGAFB#30, R5F111MHAFB#30, R5F111MJAFB#30 R5F111MEAFB#50, R5F111MFAFB#50, R5F111MGAFB#50, R5F111MHAFB#50, R5F111MJAFB#50
		G	R5F111MEGFB#30, R5F111MFGFB#30, R5F111MGGFB#30, R5F111MHGFB#30, R5F111MJGFB#30 R5F111MEGFB#50, R5F111MFGFB#50, R5F111MGGFB#50, R5F111MHGFB#50, R5F111MJGFB#50
85 pins	85-pin plastic VFLGA (7 × 7 mm, 0.65 mm pitch)	A	R5F111NEALA#U0, R5F111NFALA#U0, R5F111NGALA#U0, R5F111NHALA#U0, R5F111NJALA#U0 R5F111NEALA#W0, R5F111NFALA#W0, R5F111NGALA#W0, R5F111NHALA#W0, R5F111NJALA#W0
		G	R5F111NEGLA#U0, R5F111NFGLA#U0, R5F111NGGLA#U0, R5F111NHGLA#U0, R5F111NJGLA#U0 R5F111NEGLA#W0, R5F111NFGLA#W0, R5F111NGGLA#W0, R5F111NHGLA#W0, R5F111NJGLA#W0
100 pins	100-pin plastic LFQFP (14 × 14 mm, 0.5 mm pitch)	A	R5F111PEAFB#30, R5F111PFAFB#30, R5F111PGAFB#30, R5F111PHAFB#30, R5F111PJAFB#30 R5F111PEAFB#50, R5F111PFAFB#50, R5F111PGAFB#50, R5F111PHAFB#50, R5F111PJAFB#50
		G	R5F111PEGFB#30, R5F111PFGFB#30, R5F111PGGFB#30, R5F111PHGFB#30, R5F111PJGFB#30 R5F111PEGFB#50, R5F111PFGFB#50, R5F111PGGFB#50, R5F111PHGFB#50, R5F111PJGFB#50

1.3.2 80-pin products (without USB)

• 80-pin plastic LFQFP (fine pitch) (12 × 12 mm, 0.5 mm pitch)

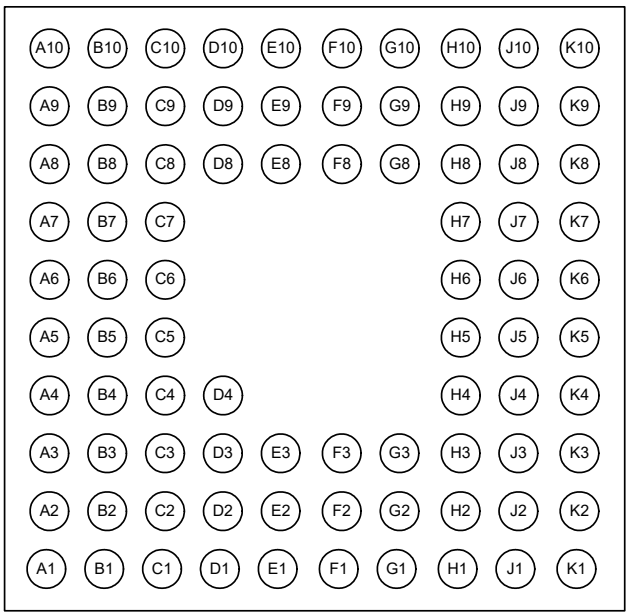


Caution Connect the REGC pin to Vss pin via a capacitor (0.47 to 1 µF).

Remark 1. For pin identification, see **1.4 Pin Identification**.

Remark 2. Functions in parentheses in the above figure can be assigned via settings in the peripheral I/O redirection register (PIOR).

1.3.4 85-pin products (without USB)



Pin	Name	Pin	Name	Pin	Name	Pin	Name	Pin	Name
A1	COM7/SEG3	C1	COM2	E1	P04/INTP2/SEG52	G1	P00/SCK10/SCL10/ SEG48	J1	V_{SS0}
A2	P51/SEG5	C2	COM5/SEG1	E2	P05/TI02/TO02/SEG53	G2	V_{SS0}	J2	P11/RxD2/SI20/SDA20/ SEG41/VCOUT0
A3	P70/KR7/SEG12	C3	COM6/SEG2	E3	P06/INTP5/SEG54	G3	P12/TxD2/SO20/SEG42/ VCOUT1	J3	P26/SO00/TxD0/ TOOLTxD/SEG38
A4	P73/KR4/TKBO21/SEG15	C4	P71/KR6/SEG13	E4	—	G4	—	J4	P23/TI07/TO07/SEG35
A5	P74/KR3/TKBO10/SEG16	C5	P76/KR1/TKBO00/SEG18	E5	—	G5	—	J5	P20/ANI20/SEG32
A6	P31/INTP3/RTC1HZ/ SEG21	C6	P77/KR0/TKBO01/ SEG19	E6	—	G6	—	J6	P141/ANI17/SEG29
A7	P33/INTP4/SCK30/ SCL30/SEG23	C7	P34/SI30/RxD3/SDA30/ SEG24	E7	—	G7	—	J7	P82
A8	P35/SO30/TxD3/SEG25	C8	V_{L1}	E8	P40/TOOL0/(TI00)/(TO00)	G8	P44/(SCK10)/(SCL10)/ IVREF0	J8	P83
A9	V_{L4}	C9	P61/SDAA0/(TI02)/(TO02)	E9	P137/INTP0	G9	P45/ANO0	J9	AV_{DD}
A10	P126/CAPL/(TI04)/(TO04)	C10	V_{DD0}	E10	P122/X2/EXCLK	G10	P123/XT1	J10	P150/ANI0/AV_{REFP}
B1	COM4/SEG0	D1	COM0	F1	P03/TI00/TO00/INTP1/ SEG51	H1	V_{SS0}	K1	V_{SS0}
B2	P50/SEG4/INTP6	D2	COM1	F2	P02/SO10/TxD1/ (PCLBUZ0)/SEG50	H2	V_{SS0}	K2	P27/TI05/TO05/(INTP5)/ PCLBUZ1/SEG39
B3	P52/SEG6	D3	P07/TI06/TO06/SEG55	F3	P01/SI10/RxD1/SDA10/ SEG49	H3	P10/INTP7/PCLBUZ0/ SCK20/SCL20/SEG40	K3	P25/SI00/RxD0/ TOOLRxD/SDA00/SEG37
B4	P72/KR5/TKBO20/SEG14	D4	COM3	F4	—	H4	P24/SCK00/SCL00/ SEG36	K4	P22/TI04/TO04/SEG34
B5	P75/KR2/TKBO11/SEG17	D5	—	F5	—	H5	P21/ANI21/SEG33	K5	P143/ANI19/SEG31
B6	P30/TI03/TO03/ REMOOUT/SEG20	D6	—	F6	—	H6	P140/ANI16/SEG28	K6	P142/ANI18/SEG30
B7	P32/TI01/TO01/SEG22	D7	—	F7	—	H7	P152/ANI2	K7	P156/ANI6
B8	P125/V_{L3}/(TI06)/(TO06)	D8	P60/SCLA0/(TI01)/(TO01)	F8	P43/(INTP7)/(SI10)/ (RxD1)/(SDA10)/IVCMP0	H8	P46/ANO1	K8	P155/ANI5
B9	V_{L2}	D9	REGC	F9	$\overline{\text{RESET}}$	H9	P130	K9	AV_{SS}
B10	P127/CAPH/(TI03)/ (TO03)/(REMOOUT)	D10	P121/X1	F10	V_{SS0}	H10	P124/XT2/EXCLKS	K10	P151/ANI1/AV_{REFM}

1.6 Outline of Functions

[80/85-pin, 100-pin products (with USB)] **(1/2)**

Item		80/85-pin	100-pin
		R5F110Mx/R5F110Nx (x = E to H, J)	R5F110Px (x = E to H, J)
Code flash memory (KB)		64 to 256	64 to 256
Data flash memory (KB)		8	8
RAM (KB)		8 to 16 Note 1	8 to 16 Note 1
Memory space		1 MB	
Main system clock	High-speed system clock	X1 (crystal/ceramic) oscillation, external main system clock input (EXCLK) 1 to 20 MHz: VDD = 2.7 to 3.6 V, 1 to 8 MHz: VDD = 1.8 to 2.7 V, 1 to 4 MHz: VDD = 1.6 to 1.8 V	
	High-speed on-chip oscillator clock	HS (high-speed main) operation mode: 1 to 24 MHz (VDD = 2.7 to 3.6 V), HS (high-speed main) operation mode: 1 to 16 MHz (VDD = 2.4 to 3.6 V), LS (low-speed main) operation mode: 1 to 8 MHz (VDD = 1.8 to 3.6 V), LV (low-voltage main) operation mode: 1 to 4 MHz (VDD = 1.6 to 3.6 V)	
	PLL clock	6, 12, 24 MHz Note 2: VDD = 2.4 to 3.6 V	
Subsystem clock		XT1 (crystal) oscillation, external subsystem clock input (EXCLKS) 32.768 kHz (TYP.): VDD = 1.6 to 3.6 V	
Low-speed on-chip oscillator clock		15 kHz (TYP.): VDD = 1.6 to 3.6 V	
General-purpose register		8 bits × 32 registers (8 bits × 8 registers × 4 banks)	
Minimum instruction execution time		0.04167 μs (High-speed on-chip oscillator clock: fHOCO = fIH = 24 MHz operation)	
		0.04167 μs (PLL clock: fPLL = 48 MHz/fIH = 24 MHz Note 2 operation)	
		0.05 μs (High-speed system clock: fMX = 20 MHz operation)	
		30.5 μs (Subsystem clock: fSUB = 32.768 kHz operation)	
Instruction set		• Data transfer (8/16 bits) • Adder and subtractor/logical operation (8/16 bits) • Multiplication (8 bits × 8 bits, 16 bits × 16 bits), Division (16 bits ÷ 16 bits, 32 bits ÷ 32 bits) • Multiplication and Accumulation (16 bits × 16 bits + 32 bits) • Rotate, barrel shift, and bit manipulation (Set, reset, test, and Boolean operation), etc.	
I/O port	Total	59	77
	CMOS I/O	51	69
	CMOS input	5	5
	CMOS output	1	1
	N-ch open-drain I/O (6 V tolerance)	2	2
Timer	16-bit timer TAU	8 channels (with 1 channel remote control output function) (Timer outputs: 8, PWM outputs: 7 Note 3)	
	16-bit timer KB2	3 channels (PWM outputs: 6)	
	Watchdog timer	1 channel	
	12-bit interval timer	1 channel	
	Real-time clock 2	1 channel	
	RTC output	1 1 Hz (subsystem clock: fSUB = 32.768 kHz)	

Note 1. In the case of the 16 KB, this is about 15 KB when the self-programming function and data flash function are used (For details, see **CHAPTER 3** in the RL78/L1C User's Manual).

Note 2. In the PLL clock 48 MHz operation, the system clock is 2/4/8 dividing ratio.

Note 3. The number of outputs varies, depending on the setting of channels in use and the number of the master.

2.2.2 On-chip oscillator characteristics

(T_A = -40 to +85°C, 1.6 V ≤ V_{DD} ≤ 3.6 V, V_{SS} = 0 V)

Oscillators	Parameters	Conditions		MIN.	TYP.	MAX.	Unit
High-speed on-chip oscillator clock frequency Notes 1, 2	f_{HOCO}			1		48	MHz
High-speed on-chip oscillator clock frequency accuracy		-20 to +85°C	1.8 V ≤ V_{DD} ≤ 3.6 V	-1.0		+1.0	%
			1.6 V ≤ V_{DD} ≤ 1.8 V	-5.0		+5.0	%
		-40 to -20°C	1.8 V ≤ V_{DD} < 3.6 V	-1.5		+1.5	%
			1.6 V ≤ V_{DD} ≤ 1.8 V	-5.5		+5.5	%
Low-speed on-chip oscillator clock frequency	f_{IL}				15		kHz
Low-speed on-chip oscillator clock frequency accuracy				-15		+15	%

Note 1. High-speed on-chip oscillator frequency is selected with bits 0 to 4 of the option byte (000C2H) and bits 0 to 2 of the HOCODIV register.

Note 2. This only indicates the oscillator characteristics. Refer to **AC Characteristics** for instruction execution time.

2.2.3 PLL oscillator characteristics

(T_A = -40 to +85°C, 2.4 V ≤ V_{DD} ≤ 3.6 V, V_{SS} = 0 V)

Oscillators	Parameters	Conditions	MIN.	TYP.	MAX.	Unit
PLL input frequency Note	f_{PLLIN}	High-speed system clock	6.00		16.00	MHz
PLL output frequency Note	f_{PLL}			48.00		MHz

Note Indicates only oscillator characteristics. Refer to **AC Characteristics** for instruction execution time.

(T_A = -40 to +85°C, 1.6 V ≤ AV_{DD} = V_{DD} ≤ 3.6 V, V_{SS} = 0 V)

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Items	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Output current, low Note 1	I_{OL1}	Per pin for P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P46, P50 to P57, P70 to P77, P80 to P83, P125 to P127, P130, P140 to P143				20.0 Note 2	mA
		Per pin for P60 and P61				15.0 Note 2	mA
		Total of P40 to P46, P130 (When duty ≤ 70% Note 3)	2.7 V ≤ V_{DD} ≤ 3.6 V			15.0	mA
			1.8 V ≤ V_{DD} < 2.7 V			9.0	mA
			1.6 V ≤ V_{DD} < 1.8 V			4.5	mA
		Total of P00 to P07, P10 to P17, P20 to P27, P30 to P37, P50 to P57, P60, P61, P70 to P77, P80 to P83, P125 to P127, P140 to P143 (When duty ≤ 70% Note 3)	2.7 V ≤ V_{DD} ≤ 3.6 V			35.0	mA
			1.8 V ≤ V_{DD} < 2.7 V			20.0	mA
			1.6 V ≤ V_{DD} < 1.8 V			10.0	mA
		Total of all pins (When duty ≤ 70% Note 3)				50.0	mA
	I_{OL2}	Per pin for P150 to P156				0.4 Note 2	mA
		Total of all pins	1.6 V ≤ V_{DD} ≤ 3.6 V			2.8	mA

Note 1. Value of current at which the device operation is guaranteed even if the current flows from an output pin to the V_{SS} pin.

Note 2. However, do not exceed the total current value.

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Note 3. Specification under conditions where the duty factor ≤ 70%.
The output current value that has changed to the duty factor > 70% the duty ratio can be calculated with the following expression
(when changing the duty factor from 70% to n%).

- Total output current of pins = (I_{OL} × 0.7)/(n × 0.01)

<Example> Where n = 80% and I_{OL} = 10.0 mA
Total output current of pins = (10.0 × 0.7)/(80 × 0.01) ≈ 8.7 mA

However, the current that is allowed to flow into one pin does not vary depending on the duty factor. A current higher than the absolute maximum rating must not flow into one pin.

Remark Unless specified otherwise, the characteristics of alternate-function pins are the same as those of the port pins.

(T_A = -40 to +85°C, 1.6 V ≤ AV_{DD} = V_{DD} ≤ 3.6 V, V_{SS} = 0 V)

Items	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Output voltage, high	V_{OH1}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P46, P50 to P57, P70 to P77, P80 to P83, P125 to P127, P130, P140 to P143	2.7 V ≤ V_{DD} ≤ 3.6 V, I_{OH1} = -2.0 mA	V_{DD} - 0.6			V
			1.8 V ≤ V_{DD} ≤ 3.6 V, I_{OH1} = -1.5 mA	V_{DD} - 0.5			V
			1.6 V ≤ V_{DD} < 3.6 V, I_{OH1} = -1.0 mA	V_{DD} - 0.5			V
	V_{OH2}	P150 to P156	1.6 V ≤ V_{DD} ≤ 3.6 V, I_{OH2} = -100 µA	AV_{DD} - 0.5			V
Output voltage, low	V_{OL1}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P46, P50 to P57, P70 to P77, P80 to P83, P125 to P127, P130, P140 to P143	2.7 V ≤ V_{DD} ≤ 3.6 V, I_{OL1} = 3.0 mA			0.6	V
			2.7 V ≤ V_{DD} ≤ 3.6 V, I_{OL1} = 1.5 mA			0.4	V
			1.8 V ≤ V_{DD} ≤ 3.6 V, I_{OL1} = 0.6 mA			0.4	V
			1.6 V ≤ V_{DD} < 1.8 V, I_{OL1} = 0.3 mA			0.4	V
	V_{OL2}	P150 to P156	1.6 V ≤ V_{DD} ≤ 3.6 V, I_{OL2} = 400 µA			0.4	V
	V_{OL3}	P60, P61	2.7 V ≤ V_{DD} ≤ 3.6 V, I_{OL3} = 3.0 mA			0.4	V
			1.8 V ≤ V_{DD} ≤ 3.6 V, I_{OL3} = 2.0 mA			0.4	V
			1.6 V ≤ V_{DD} ≤ 1.8 V, I_{OL3} = 1.0 mA			0.4	V

Caution P00 to P02, P10 to P12, P24 to P26, P33 to P35, and P42 to P44 do not output high level in N-ch open-drain mode.

Remark Unless specified otherwise, the characteristics of alternate-function pins are the same as those of the port pins.

(4) During communication at same potential (CSI mode) (slave mode, SCKp... external clock input)

(T_A = -40 to +85°C, 1.6 V ≤ V_{DD} ≤ 3.6 V, V_{SS} = 0 V)

Parameter	Symbol	Conditions		HS (high-speed main) Mode		LS (low-speed main) Mode		LV (low-voltage main) Mode		Unit
				MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
SCKp cycle time Note 5	t_{KCY2}	2.7 V ≤ V_{DD} < 3.6 V	f_{MCK} > 16 MHz	8/f_{MCK}		—		—		ns
			f_{MCK} ≤ 16 MHz	6/f_{MCK}		6/f_{MCK}		6/f_{MCK}		ns
		2.4 V ≤ V_{DD} < 3.6 V		6/f_{MCK} and 500		6/f_{MCK} and 500		6/f_{MCK} and 500		ns
		1.8 V ≤ V_{DD} < 3.6 V		—		6/f_{MCK} and 750		6/f_{MCK} and 750		ns
		1.6 V ≤ V_{DD} < 3.6 V		—		—		6/f_{MCK} and 1500		ns
SCKp high-/low-level width	t_{KH2}, t_{KL2}	2.7 V ≤ V_{DD} ≤ 3.6 V		t_{KCY2}/2 - 8		t_{KCY2}/2 - 8		t_{KCY2}/2 - 8		ns
		1.8 V ≤ V_{DD} ≤ 3.6 V		—		t_{KCY2}/2 - 18		t_{KCY2}/2 - 18		ns
		1.6 V ≤ V_{DD} ≤ 3.6 V		—		—		t_{KCY1}/2 - 66		ns
SIp setup time (to SCKp↑) Note 1	t_{SIK2}	2.7 V ≤ V_{DD} ≤ 3.6 V		1/f_{MCK} + 20		1/f_{MCK} + 30		1/f_{MCK} + 30		ns
		2.4 V ≤ V_{DD} ≤ 3.6 V		1/f_{MCK} + 30		1/f_{MCK} + 30		1/f_{MCK} + 30		ns
		1.8 V ≤ V_{DD} < 3.6 V		—		1/f_{MCK} + 30		1/f_{MCK} + 30		ns
		1.6 V ≤ V_{DD} < 3.6 V		—		—		1/f_{MCK} + 40		ns
SIp hold time (from SCKp↑) Note 2	t_{KSI2}	2.4 V ≤ V_{DD} < 3.6 V		1/f_{MCK} + 31		1/f_{MCK} + 31		1/f_{MCK} + 31		ns
		1.8 V ≤ V_{DD} < 3.6 V		—		1/f_{MCK} + 31		1/f_{MCK} + 31		ns
		1.6 V ≤ V_{DD} < 3.6 V		—		—		1/f_{MCK} + 250		ns
Delay time from SCKp↓ to SOp output Note 3	t_{KSO2}	C = 30 pF Note 4	2.7 V ≤ V_{DD} ≤ 3.6 V		2/f_{MCK} + 44		2/f_{MCK} + 110		2/f_{MCK} + 110	ns
			2.4 V ≤ V_{DD} < 3.6 V		2/f_{MCK} + 75		2/f_{MCK} + 110		2/f_{MCK} + 110	ns
			1.8 V ≤ V_{DD} < 3.6 V		—		2/f_{MCK} + 110		2/f_{MCK} + 110	ns
			1.6 V ≤ V_{DD} < 3.6 V		—		—		2/f_{MCK} + 220	ns

Note 1. When DAPmn = 0 and CKPmn = 0, or DAPmn = 1 and CKPmn = 1. The SIp setup time becomes "to SCKp↓" when DAPmn = 0 and CKPmn = 1, or DAPmn = 1 and CKPmn = 0.

Note 2. When DAPmn = 0 and CKPmn = 0, or DAPmn = 1 and CKPmn = 1. The SIp hold time becomes "from SCKp↓" when DAPmn = 0 and CKPmn = 1, or DAPmn = 1 and CKPmn = 0.

Note 3. When DAPmn = 0 and CKPmn = 0, or DAPmn = 1 and CKPmn = 1. The delay time to SOp output becomes "from SCKp↑" when DAPmn = 0 and CKPmn = 1, or DAPmn = 1 and CKPmn = 0.

Note 4. C is the load capacitance of the SOp output lines.

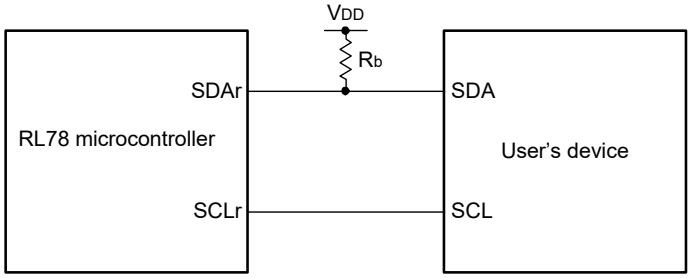
Note 5. The maximum transfer rate when using the SNOOZE mode is 1 Mbps.

Caution Select the normal input buffer for the SIp pin and the normal output mode for the SOp pin by using port input mode register g (PIMg) and port output mode register g (POMg).

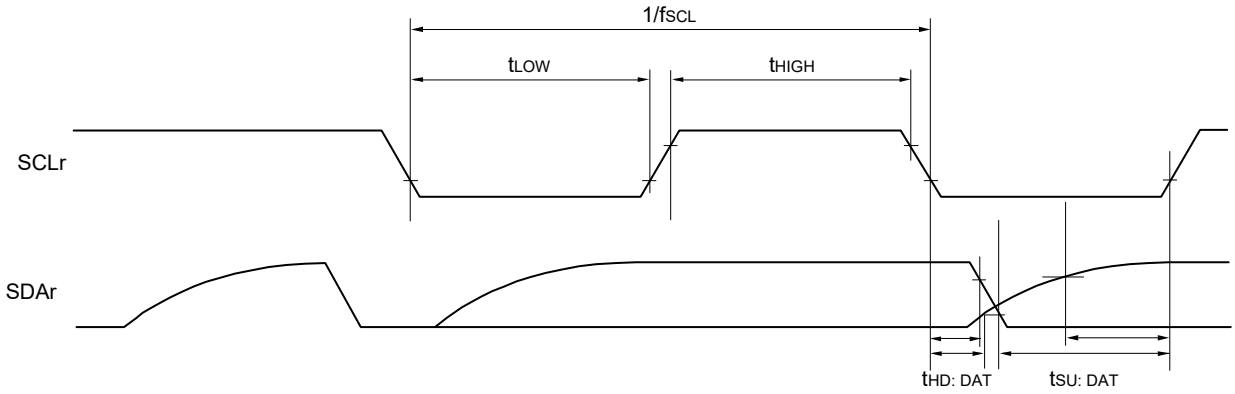
Remark 1. p: CSI number (p = 00, 10, 20, 30), m: Unit number (m = 0, 1), n: Channel number (n = 0 to 3), g: PIM number (g = 0 to 3)

Remark 2. f_{MCK}: Serial array unit operation clock frequency (Operation clock to be set by the CKSmn bit of serial mode register mn (SMRmn). m: Unit number, n: Channel number (mn = 00 to 03, 10 to 13))

Simplified I²C mode connection diagram (during communication at same potential)



Simplified I²C mode serial transfer timing (during communication at same potential)



Remark 1. R_b[Ω]: Communication line (SDAr) pull-up resistance, C_b[F]: Communication line (SDAr, SCLr) load capacitance

Remark 2. r: IIC number (r = 00, 10, 20, 30), g: PIM number (g = 0 to 3),
h: POM number (h = 0 to 3)

Remark 3. f_{MCK}: Serial array unit operation clock frequency
(Operation clock to be set by the CKSmn bit of serial mode register mn (SMRmn). m: Unit number (m = 0, 1),
n: Channel number (n = 0 to 3), mn = 00 to 03, 10 to 13)

(8) Communication at different potential (1.8 V, 2.5 V) (CSI mode) (master mode, SCKp... internal clock output)

(T_A = -40 to +85°C, 1.8 V ≤ V_{DD} ≤ 3.6 V, V_{SS} = 0 V) (1/2)

Parameter	Symbol	Conditions		HS (high-speed main) Mode		LS (low-speed main) Mode		LV (low-voltage main) Mode		Unit
				MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
SCKp cycle time	t_{KCY1}	t_{KCY1} ≥ f_{CLK}/4	2.7V ≤ V_{DD} < 3.6 V, 2.3 V ≤ V_b ≤ 2.7 V, C_b = 30 pF, R_b = 2.7 kΩ	500 Note		1150		1150		ns
			1.8 V ≤ V_{DD} < 3.3 V, 1.6 V ≤ V_b ≤ 1.8 V, C_b = 30 pF, R_b = 5.5 kΩ	1150 Note		1150		1150		ns
SCKp high-level width	t_{KH1}	2.7 V ≤ V_{DD} ≤ 3.6 V, 2.3 V ≤ V_b ≤ 2.7 V, C_b = 30 pF, R_b = 2.7 kΩ		t_{KCY1}/2 - 170		t_{KCY1}/2 - 170		t_{KCY1}/2 - 170		ns
		1.8 V ≤ V_{DD} < 3.3 V, 1.6 V ≤ V_b ≤ 2.0 V, C_b = 30 pF, R_b = 5.5 kΩ		t_{KCY1}/2 - 458		t_{KCY1}/2 - 458		t_{KCY1}/2 - 458		ns
SCKp low-level width	t_{KL1}	2.7 V ≤ V_{DD} ≤ 3.6 V, 2.3 V ≤ V_b ≤ 2.7 V, C_b = 30 pF, R_b = 2.7 kΩ		t_{KCY1}/2 - 18		t_{KCY1}/2 - 50		t_{KCY1}/2 - 50		ns
		1.8 V ≤ V_{DD} < 3.3 V, 1.6 V ≤ V_b ≤ 2.0 V, C_b = 30 pF, R_b = 5.5 kΩ		t_{KCY1}/2 - 50		t_{KCY1}/2 - 50		t_{KCY1}/2 - 50		ns

Note Use it with V_{DD} ≥ V_b.

Caution Select the TTL input buffer for the SIp pin and the N-ch open drain output (V_{DD} tolerance) mode for the SOp pin and SCKp pin by using port input mode register g (PIMg) and port output mode register g (POMg). For V_{IH} and V_{IL}, see the DC characteristics with TTL input buffer selected.

(**Remarks** are listed on the page after the next page.)

(8) Communication at different potential (1.8 V, 2.5 V) (CSI mode) (master mode, SCKp... internal clock output)

(T_A = -40 to +85°C, 1.8 V ≤ V_{DD} ≤ 3.6 V, V_{SS} = 0 V) **(2/2)**

Parameter	Symbol	Conditions	HS (high-speed main) Mode		LS (low-speed main) Mode		LV (low-voltage main) Mode		Unit
			MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
SIp setup time (to SCKp↑) Note 1	t_{SIK1}	2.7 V ≤ V_{DD} ≤ 3.6 V, 2.3 V ≤ V_b ≤ 2.7 V, C_b = 30 pF, R_b = 2.7 kΩ	177		479		479		ns
		1.8 V ≤ V_{DD} < 3.3 V, 1.6 V ≤ V_b ≤ 2.0 V Note 3, C_b = 30 pF, R_b = 5.5 kΩ	479		479		479		ns
SIp hold time (from SCKp↑) Note 1	t_{KSI1}	2.7 V ≤ V_{DD} ≤ 3.6 V, 2.3 V ≤ V_b ≤ 2.7 V, C_b = 30 pF, R_b = 2.7 kΩ	19		19		19		ns
		1.8 V ≤ V_{DD} < 3.3 V, 1.6 V ≤ V_b ≤ 2.0 V Note 3, C_b = 30 pF, R_b = 5.5 kΩ	19		19		19		ns
Delay time from SCKp↓ to SOp output Note 1	t_{KSO1}	2.7 V ≤ V_{DD} ≤ 3.6 V, 2.3 V ≤ V_b ≤ 2.7 V, C_b = 30 pF, R_b = 2.7 kΩ		195		195		195	ns
		1.8 V ≤ V_{DD} < 3.3 V, 1.6 V ≤ V_b ≤ 2.0 V Note 3, C_b = 30 pF, R_b = 5.5 kΩ		483		483		483	ns
SIp setup time (to SCKp↓) Note 2	t_{SIK1}	2.7 V ≤ V_{DD} ≤ 3.6 V, 2.3 V ≤ V_b ≤ 2.7 V, C_b = 30 pF, R_b = 2.7 kΩ	44		110		110		ns
		1.8 V ≤ V_{DD} < 3.3 V, 1.6 V ≤ V_b ≤ 2.0 V Note 3, C_b = 30 pF, R_b = 5.5 kΩ	110		110		110		ns
SIp hold time (from SCKp↓) Note 2	t_{KSI1}	2.7 V ≤ V_{DD} ≤ 3.6 V, 2.3 V ≤ V_b ≤ 2.7 V, C_b = 30 pF, R_b = 2.7 kΩ	19		19		19		ns
		1.8 V ≤ V_{DD} < 3.3 V, 1.6 V ≤ V_b ≤ 2.0 V Note 3, C_b = 30 pF, R_b = 5.5 kΩ	19		19		19		ns
Delay time from SCKp↑ to SOp output Note 2	t_{KSO1}	2.7 V ≤ V_{DD} ≤ 3.6 V, 2.3 V ≤ V_b ≤ 2.7 V, C_b = 30 pF, R_b = 2.7 kΩ		25		25		25	ns
		1.8 V ≤ V_{DD} < 3.3 V, 1.6 V ≤ V_b ≤ 2.0 V Note 3, C_b = 30 pF, R_b = 5.5 kΩ		25		25		25	ns

Note 1. When DAPmn = 0 and CKPmn = 0, or DAPmn = 1 and CKPmn = 1.

Note 2. When DAPmn = 0 and CKPmn = 1, or DAPmn = 1 and CKPmn = 0.

Note 3. Use it with V_{DD} ≥ V_b.

Caution Select the TTL input buffer for the SIp pin and the N-ch open drain output (V_{DD} tolerance) mode for the SOp pin and SCKp pin by using port input mode register g (PIMg) and port output mode register g (POMg). For V_{IH} and V_{IL}, see the DC characteristics with TTL input buffer selected.

(**Remarks** are listed on the next page.)

3.2.2 On-chip oscillator characteristics

(TA = -40 to +105°C, 2.4 V ≤ VDD ≤ 3.6 V, VSS = 0 V)

Oscillators	Parameters	Conditions	MIN.	TYP.	MAX.	Unit
High-speed on-chip oscillator clock frequency Notes 1, 2	fHOCO		1		24	MHz
High-speed on-chip oscillator clock frequency accuracy		-20 to +85°C	-1.0		+1.0	%
		-40 to -20°C	-1.5		+1.5	%
		+85 to +105°C	-2.0		+2.0	%
Low-speed on-chip oscillator clock frequency	fIL			15		kHz
Low-speed on-chip oscillator clock frequency accuracy			-15		+15	%

Note 1. High-speed on-chip oscillator frequency is selected with bits 0 to 4 of the option byte (000C2H) and bits 0 to 2 of the HOCODIV register.

Note 2. This only indicates the oscillator characteristics. Refer to **AC Characteristics** for instruction execution time.

3.2.3 PLL oscillator characteristics

(TA = -40 to +105°C, 2.4 V ≤ VDD ≤ 3.6 V, VSS = 0 V)

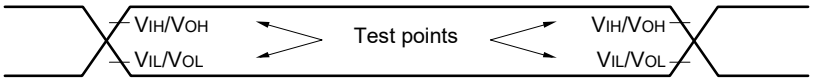
Oscillators	Parameters	Conditions	MIN.	TYP.	MAX.	Unit
PLL input frequency Note	fPLLIN	High-speed system clock	6.00		16.00	MHz
PLL output frequency Note	fPLL			48.00		MHz

Note Indicates only oscillator characteristics. Refer to **AC Characteristics** for instruction execution time.

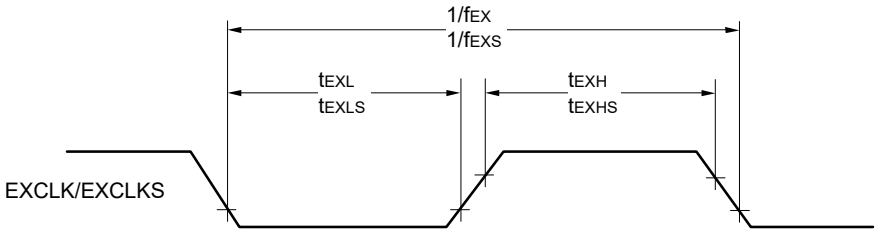
(T_A = -40 to +105°C, 2.4 V ≤ AV_{DD} = V_{DD} ≤ 3.6 V, V_{SS} = 0 V) **(2/2)**

Items	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
TO00 to TO07, TKBO00, TKBO01, TKBO10, TKBO11, TKBO20, TKBO21 output frequency	f_{TO}	HS (high-speed main) mode	2.7 V ≤ V_{DD} ≤ 3.6 V			8	MHz
			2.4 V ≤ V_{DD} < 2.7 V			8	MHz
PCLBUZ0, PCLBUZ1 output frequency	f_{PCL}	HS (high-speed main) mode	2.7 V ≤ V_{DD} ≤ 3.6 V			8	MHz
			2.4 V ≤ V_{DD} < 2.7 V			8	MHz
Interrupt input high-level width, low-level width	t_{INTH}, t_{INTL}	INTP0 to INTP7	2.4 V ≤ V_{DD} ≤ 3.6 V	1			µs
Key interrupt input low-level width	t_{KR}	2.4 V ≤ V_{DD} ≤ 3.6 V		250			ns
TMKB2 forced output stop input high-level width	t_{IHR}	INTP0 to INTP7	f_{CLK} > 16 MHz	125			ns
			f_{CLK} ≤ 16 MHz	2			f_{CLK}
$\overline{RESET}$ low-level width	t_{RSL}			10			µs

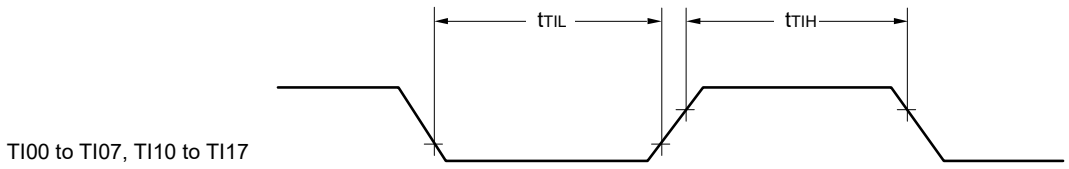
AC Timing Test Points

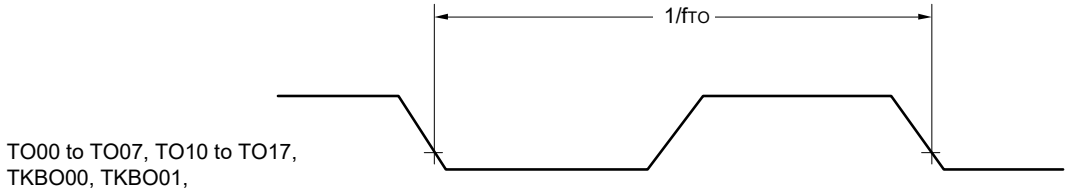


External System Clock Timing

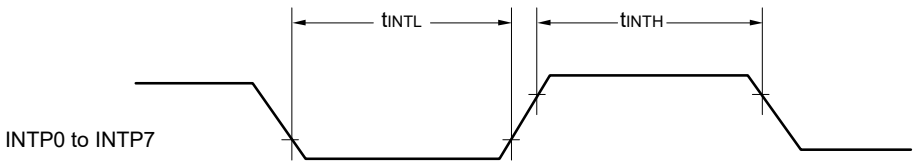


TI/TO Timing

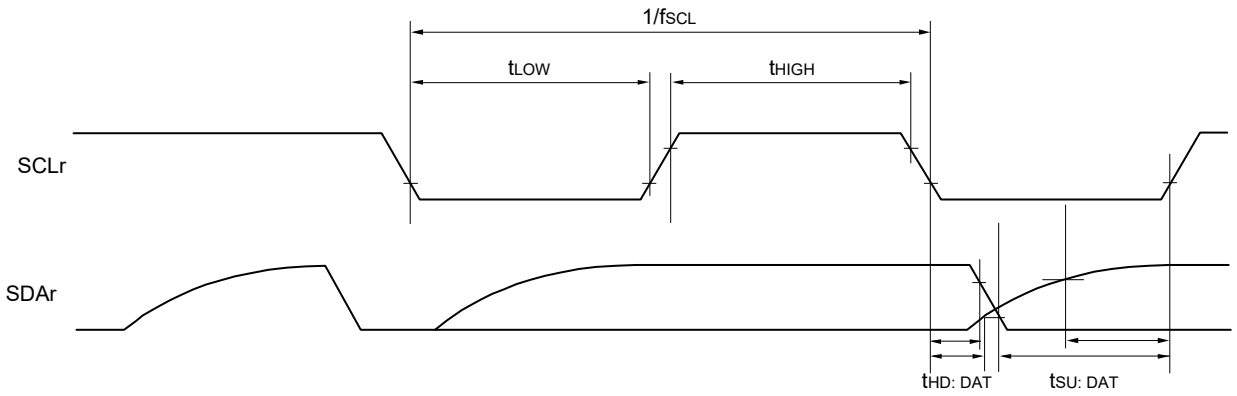




Interrupt Request Input Timing



Simplified I²C mode serial transfer timing (during communication at same potential)



Remark 1. R_b[Ω]: Communication line (SDAr) pull-up resistance, C_b[F]: Communication line (SDAr, SCLr) load capacitance

Remark 2. r: IIC number (r = 00, 10, 20, 30), g: PIM number (g = 0 to 3),
h: POM number (h = 0 to 3)

Remark 3. f_{MCK}: Serial array unit operation clock frequency
(Operation clock to be set by the CKSmn bit of serial mode register mn (SMRmn). m: Unit number (m = 0, 1),
n: Channel number (n = 0 to 3), mn = 00 to 03, 10 to 13)

(2) When reference voltage (+) = AV_{DD} (ADREFP1 = 0, ADREFP0 = 0), reference voltage (-) = AV_{SS} (ADREFM = 0), conversion target: ANI0 to ANI6

(T_A = -40 to +105°C, 2.4 V ≤ AV_{DD} = V_{DD} ≤ 3.6 V, V_{SS} = 0 V, AV_{SS} = 0 V, Reference voltage (+) = AV_{DD}, Reference voltage (-) = AV_{SS} = 0 V)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Resolution	RES		2.4 V ≤ AV_{DD} ≤ 3.6 V	8		12	bit
Overall error Note	AINL	12-bit resolution	2.4 V ≤ AV_{DD} ≤ 3.6 V			±7.5	LSB
Conversion time	t_{CONV}	ADTYP = 0, 12-bit resolution	2.4 V ≤ AV_{DD} ≤ 3.6 V	3.375			µs
Zero-scale error Note	E_{ZS}	12-bit resolution	2.4 V ≤ AV_{DD} ≤ 3.6 V			±6.0	LSB
Full-scale error Note	E_{FS}	12-bit resolution	2.4 V ≤ AV_{DD} ≤ 3.6 V			±6.0	LSB
Integral linearity error Note	ILE	12-bit resolution	2.4 V ≤ AV_{DD} ≤ 3.6 V			±3.0	LSB
Differential linearity error Note	DLE	12-bit resolution	2.4 V ≤ AV_{DD} ≤ 3.6 V			±2.0	LSB
Analog input voltage	V_{AIN}			0		AV_{DD}	V

Note Excludes quantization error (±1/2 LSB).

Caution Always use AV_{DD} pin with the same potential as the V_{DD} pin.

3.6.4 Comparator

(T_A = -40 to +105°C, 2.4 V ≤ V_{DD} ≤ 3.6 V, V_{SS} = 0 V)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Input voltage range	Ivref			0		V_{DD} - 1.4	V
	Ivcmp			-0.3		V_{DD} + 0.3	V
Output delay	td	V_{DD} = 3.0 V Input slew rate > 50 mV/μs	High-speed comparator mode, standard mode			1.2	μs
			High-speed comparator mode, window mode			2.0	μs
			Low-speed comparator mode, standard mode		3	5.0	μs
High-electric-potential judgment voltage	VTW+	High-speed comparator mode, window mode			0.76 V_{DD}		V
Low-electric-potential judgment voltage	VTW-	High-speed comparator mode, window mode			0.24 V_{DD}		V
Operation stabilization wait time	t_{CMP}			100			μs
Internal reference voltage Note	V_{BGR}	2.4 V ≤ V_{DD} ≤ 3.6 V, HS (high-speed main) mode		1.38	1.45	1.50	V

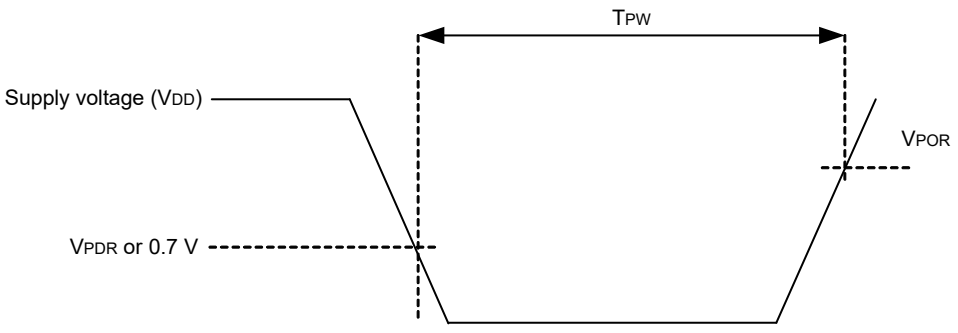
Note Not usable in sub-clock operation or STOP mode.

3.6.5 POR circuit characteristics

(T_A = -40 to +105°C, V_{SS} = 0 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Detection voltage	V_{POR}	Power supply rise time	1.45	1.51	1.57	V
	V_{PDR}	Power supply fall time Note	1.44	1.50	1.56	V
Minimum pulse width	T_{PW}		300			μs

Note Minimum time required for a POR reset when V_{DD} exceeds below V_{PDR}. This is also the minimum time required for a POR reset from when V_{DD} exceeds below 0.7 V to when V_{DD} exceeds V_{POR} while STOP mode is entered or the main system clock is stopped through setting bit 0 (HIOSTOP) and bit 7 (MSTOP) in the clock operation status control register (CSC).



3.8.2 Internal voltage boosting method

(1) 1/3 bias method

(T_A = -40 to +105°C, 2.4 V ≤ V_{DD} ≤ 3.6 V, V_{SS} = 0 V)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
LCD output voltage variation range	V_{L1}	C1 to C4 Note 1 = 0.47 μF Note 2	VLCD = 04H	0.90	1.00	1.08	V
			VLCD = 05H	0.95	1.05	1.13	V
			VLCD = 06H	1.00	1.10	1.18	V
			VLCD = 07H	1.05	1.15	1.23	V
			VLCD = 08H	1.10	1.20	1.28	V
			VLCD = 09H	1.15	1.25	1.33	V
			VLCD = 0AH	1.20	1.30	1.38	V
			VLCD = 0BH	1.25	1.35	1.43	V
			VLCD = 0CH	1.30	1.40	1.48	V
			VLCD = 0DH	1.35	1.45	1.53	V
			VLCD = 0EH	1.40	1.50	1.58	V
			VLCD = 0FH	1.45	1.55	1.63	V
			VLCD = 10H	1.50	1.60	1.68	V
			VLCD = 11H	1.55	1.65	1.73	V
			VLCD = 12H	1.60	1.70	1.78	V
			VLCD = 13H	1.65	1.75	1.83	V
Doubler output voltage	V_{L2}	C1 to C4 Note 1 = 0.47 μF		2 V_{L1} - 0.1	2 V_{L1}	2 V_{L1}	V
Tripler output voltage	V_{L3}	C1 to C4 Note 1 = 0.47 μF		3 V_{L1} - 0.15	3 V_{L1}	3 V_{L1}	V
Reference voltage setup time Note 2	t_{VWAIT1}			5			ms
Voltage boost wait time Note 3	t_{VWAIT2}	C1 to C4 Note 1 = 0.47μF		500			ms

Note 1. This is a capacitor that is connected between voltage pins used to drive the LCD.
C1: A capacitor connected between CAPH and CAPL
C2: A capacitor connected between V_{L1} and GND
C3: A capacitor connected between V_{L2} and GND
C4: A capacitor connected between V_{L4} and GND
C1 = C2 = C3 = C4 = 0.47 μF±30%

Note 2. This is the time required to wait from when the reference voltage is specified by using the VLCD register (or when the internal voltage boosting method is selected (by setting the MDSET1 and MDSET0 bits of the LCDM0 register to 01B) if the default value reference voltage is used) until voltage boosting starts (VLCON = 1).

Note 3. This is the wait time from when voltage boosting is started (VLCON = 1) until display is enabled (LCDON = 1).

3.10 Flash Memory Programming Characteristics

(T_A = -40 to +105°C, 2.4 V ≤ V_{DD} ≤ 3.6 V, V_{SS} = 0 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
CPU/peripheral hardware clock frequency	f_{CLK}	2.4 V ≤ V_{DD} ≤ 3.6 V	1		24	MHz
Number of code flash rewrites Notes 1, 2, 3	C_{erwr}	Retained for 20 years T_A = 85°C Note 4	1,000			Times
Number of data flash rewrites Notes 1, 2, 3		Retained for 1 year T_A = 25°C		1,000,000		
		Retained for 5 years T_A = 85°C Note 4	100,000			
		Retained for 20 years T_A = 85°C Note 4	10,000			

Note 1. 1 erase + 1 write after the erase is regarded as 1 rewrite. The retaining years are until next rewrite after the rewrite.

Note 2. When using flash memory programmer and Renesas Electronics self programming library

Note 3. These are the characteristics of the flash memory and the results obtained from reliability testing by Renesas Electronics Corporation.

Note 4. This temperature is the average value at which data are retained.

3.11 Dedicated Flash Memory Programmer Communication (UART)

(T_A = -40 to +105°C, 2.4 V ≤ V_{DD} ≤ 3.6 V, V_{SS} = 0 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Transfer rate		During serial programming	115,200		1,000,000	bps

REVISION HISTORY	RL78/L1C Datasheet

Rev.	Date	Description	
		Page	Summary
0.01	Oct 15, 2012	—	First Edition issued
1.00	Nov 18, 2013	1, 2	Modification of 1.1 Features
		3, 4	Modification of 1.2 Ordering Information
		5 to 8	Modification of package type in 1.3 Pin Configuration (Top View)
		14 to 17	Modification of vectored interrupt sources in 1.6 Outline of Functions
		14 to 17	Modification of operating ambient temperature in 1.6 Outline of Functions
		19 to 21	Modification of description in tables in 2.1 Absolute Maximum Ratings
		22, 23	Modification of description in 2.2 Oscillator Characteristics
		25	Modification of low-level output current in 2.3.1 Pin characteristics
		26	Modification of error of high-level input voltage conditions in 2.3.1 Pin characteristics
		26	Modification of error of low-level input voltage conditions in 2.3.1 Pin characteristics
		27	Modification of low-level output voltage in 2.3.1 Pin characteristics
		28	Modification of error of internal pull-up resistor conditions in 2.3.1 Pin characteristics
		29 to 34	Modification of 2.3.2 Supply current characteristics
		35, 36	Modification of 2.4 AC Characteristics
		37, 38	Addition of minimum instruction execution time during main system clock operation
		41 to 63	Addition of LS mode and LV mode characteristics in 2.5.1 Serial array unit
		64 to 66	Addition of LS mode and LV mode characteristics in 2.5.2 Serial interface IICA
		67, 68	Modification of conditions in 2.5.3 USB
		69	Addition of (3) BC option standard in 2.5.3 USB
		70 to 75	Addition of characteristics about conversion of internal reference voltage and temperature sensor in 2.6.1 A/D converter characteristics
		76	Addition of characteristic in 2.6.4 Comparator
		76	Deletion of detection delay in 2.6.5 POR circuit characteristics
		78	Modification of 2.7 Power supply voltage rising slope characteristics
		79 to 82	Modification of 2.8 LCD Characteristics
		83	Modification of 2.9 Data Memory STOP Mode Low Supply Voltage Data Retention Characteristics
		83	Modification of 2.10 Flash Memory Programming Characteristics
		84	Addition of 2.12 Timing Specs for Switching Modes
		85 to 144	Addition of 3. ELECTRICAL SPECIFICATIONS (G: T_A = -40 to +105°C)
2.00	Feb 21, 2014	All	Addition of 85-pin product information
		All	Modification from 80-pin to 80/85-pin
		All	Modification from x = M, P to x = M, N, P
		All	Modification from high-accuracy real-time clock to real-time clock 2
		All	Modification from RTC to RTC2
		1	Modification of 1.1 Features
		3	Modification of 1.2 Ordering Information