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"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	96KB (96K x 8)
Program Memory Type	FLASH
EEPROM Size	8K x 8
RAM Size	10K 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 ~ 105°C (TA)
Mounting Type	Surface Mount
Package / Case	80-LQFP
Supplier Device Package	80-LQFP (12x12)
Purchase URL	https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f110mfgfb-30

2.3 DC Characteristics

2.3.1 Pin characteristics

(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 current, high Note 1	I_{OH1}	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				-10.0 Note 2	mA
		Total of 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 (When duty ≤ 70% Note 3)	2.7 V ≤ V_{DD} ≤ 3.6 V			-15.0	mA
			1.8 V ≤ V_{DD} < 2.7 V			-7.0	mA
<R>			1.6 V ≤ V_{DD} < 1.8 V			-3.0	mA
	I_{OH2}	Per pin for P150 to P156	1.6 V ≤ V_{DD} ≤ 3.6 V			-0.1 Note 2	mA
		Total of all pins	1.6 V ≤ V_{DD} ≤ 3.6 V			-0.7	mA

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

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

<R> **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_{OH} × 0.7)/(n × 0.01)

<Example> Where n = 80% and I_{OH} = -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.

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.

Note 1. Total current flowing into V_{DD}, including the input leakage current flowing when the level of the input pin is fixed to V_{DD}, or V_{SS}. The values below the MAX. column include the peripheral operation current. However, not including the current flowing into the LCD controller/driver, A/D converter, D/A converter, comparator, LVD circuit, USB 2.0 function module, I/O port, and on-chip pull-up/pull-down resistors and the current flowing during data flash rewrite.

Note 2. When high-speed on-chip oscillator and subsystem clock are stopped.

Note 3. When high-speed system clock and subsystem clock are stopped.

Note 4. When high-speed on-chip oscillator and high-speed system clock are stopped. When AMPHS1 = 1 (Ultra-low power consumption oscillation). However, not including the current flowing into the real-time clock 2, 12-bit interval timer, and watchdog timer.

Note 5. Relationship between operation voltage width, operation frequency of CPU and operation mode is as below.

HS (high-speed main) mode:	2.7 V ≤ V_{DD} ≤ 3.6 V@1 MHz to 24 MHz
	2.4 V ≤ V_{DD} ≤ 3.6 V@1 MHz to 16 MHz
LS (low-speed main) mode:	1.8 V ≤ V_{DD} ≤ 3.6 V@1 MHz to 8 MHz
LV (low-voltage main) mode	1.6 V ≤ V_{DD} ≤ 3.6 V@1 MHz to 4 MHz

Remark 1. f_{MX}: High-speed system clock frequency (X1 clock oscillation frequency or external main system clock frequency)

Remark 2. f_{HOCO}: High-speed on-chip oscillator clock frequency (48 MHz max.)

Remark 3. f_{IH}: Main system clock source frequency when the high-speed on-chip oscillator clock divided 1, 2, 4, or 8, or the PLL clock divided by 2, 4, or 8 is selected (24 MHz max.)

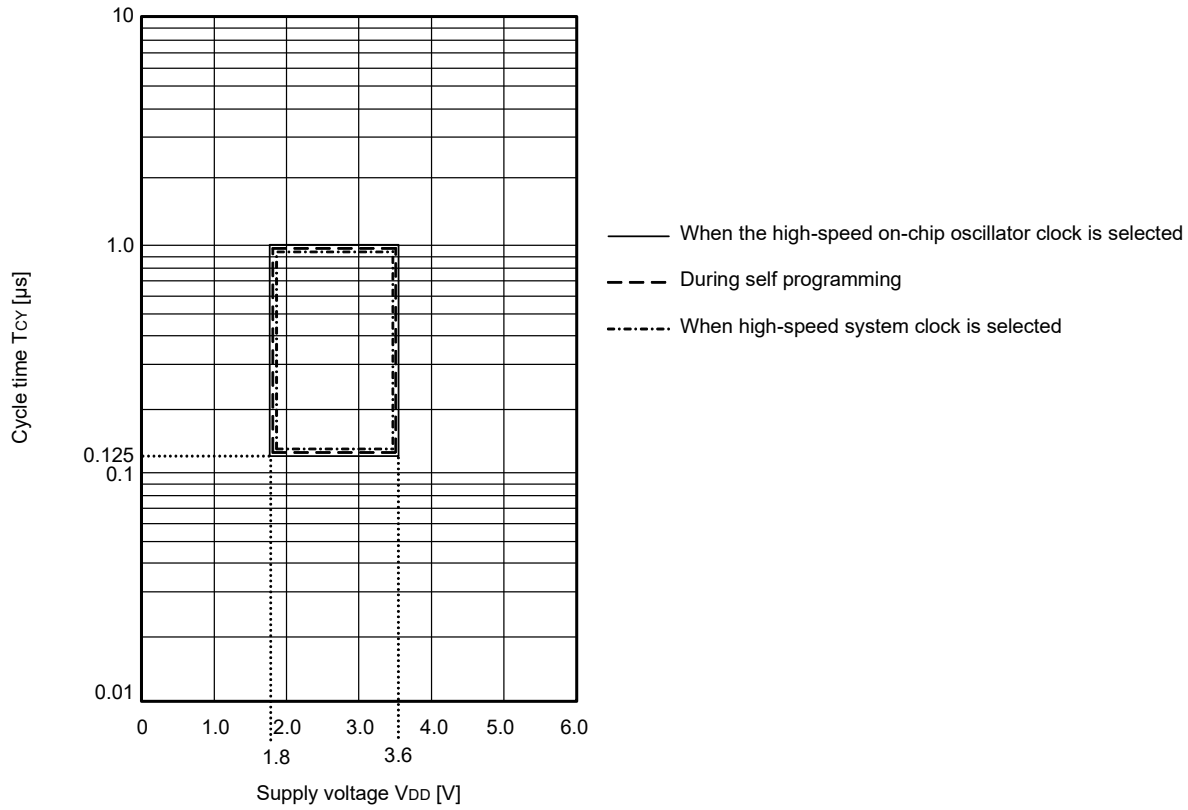
Remark 4. f_{SUB}: Subsystem clock frequency (XT1 clock oscillation frequency)

Remark 5. Except subsystem clock operation, temperature condition of the TYP. value is T_A = 25°C

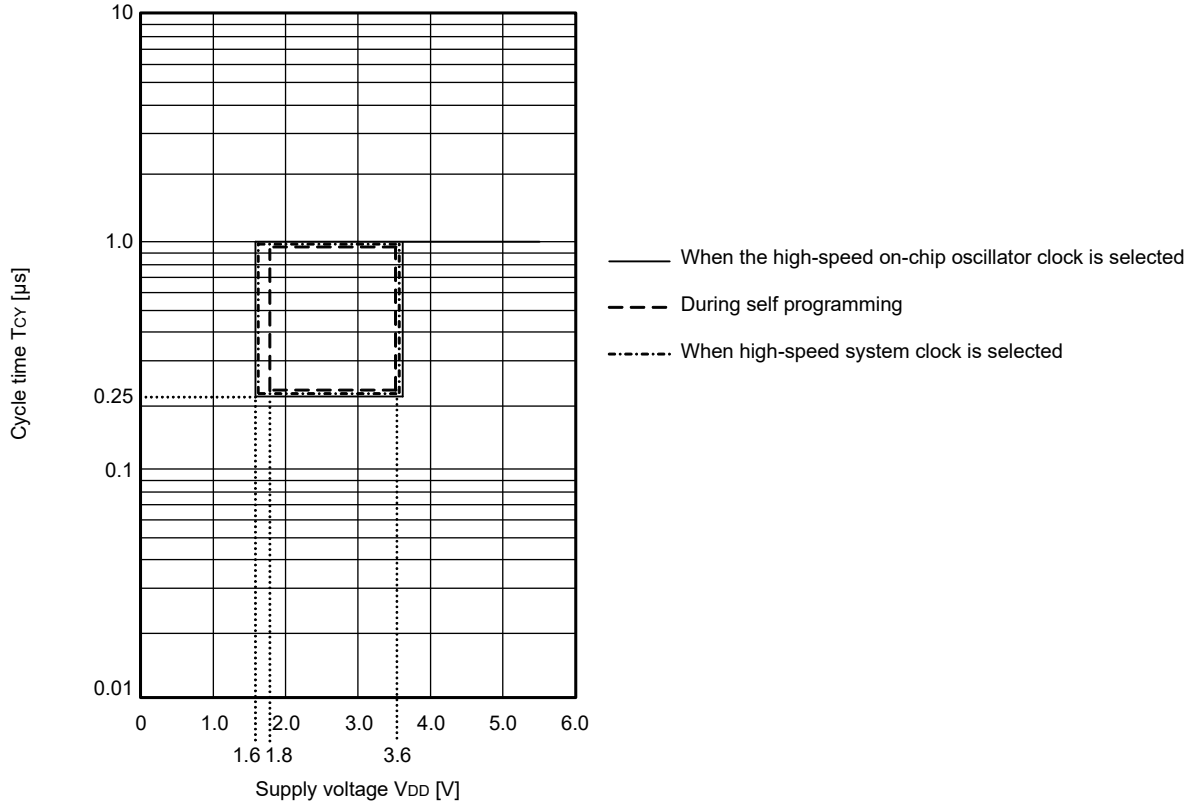
(T_A = -40 to +85°C, 1.6 V ≤ AV_{DD} = V_{DD} ≤ 3.6 V, V_{SS} = 0 V) **(2/2)**

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
		LS (low-speed main) mode	1.8 V ≤ V_{DD} ≤ 3.6 V			4	MHz
		LV (low-voltage main) mode	1.6 V ≤ V_{DD} ≤ 3.6 V			2	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
		LS (low-speed main) mode	1.8 V ≤ V_{DD} ≤ 3.6 V			4	MHz
		LV (low-voltage main) mode	1.8 V ≤ V_{DD} ≤ 3.6 V			2	MHz
Interrupt input high-level width, low-level width	t_{INTH}, t_{INTL}	INTP0 to INTP7	1.6 V ≤ V_{DD} ≤ 3.6 V	1			µs
Key interrupt input low-level width	t_{KR}	1.8 V ≤ V_{DD} ≤ 3.6 V		250			ns
		1.6 V ≤ V_{DD} < 1.8 V		1			µs
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}
$\overline{\text{RESET}}$ low-level width	t_{RSL}			10			µs

T_{CY} vs V_{DD} (LS (low-speed main) mode)



T_{CY} vs V_{DD} (LV (low-voltage main) mode)



(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.

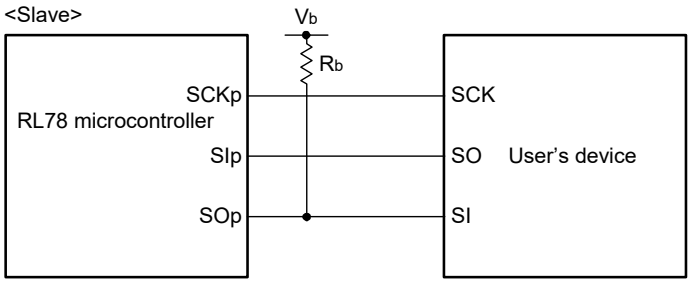
Note 5. The maximum transfer rate when using the SNOOZE mode is 1 Mbps.

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))

CSI mode connection diagram (during communication at different potential)



Remark 1. R_b[Ω]: Communication line (SOp) pull-up resistance, C_b[F]: Communication line (SOp) load capacitance, V_b[V]: Communication line voltage

Remark 2. p: CSI number (p = 00, 10, 20, 30), m: Unit number (m = 0, 1), n: Channel number (n = 0 to 3), g: PIM and POM number (g = 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, n: Channel number (mn = 00, 02, 10, 12))

2.5.2 Serial interface IICA

(1) I²C standard mode

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

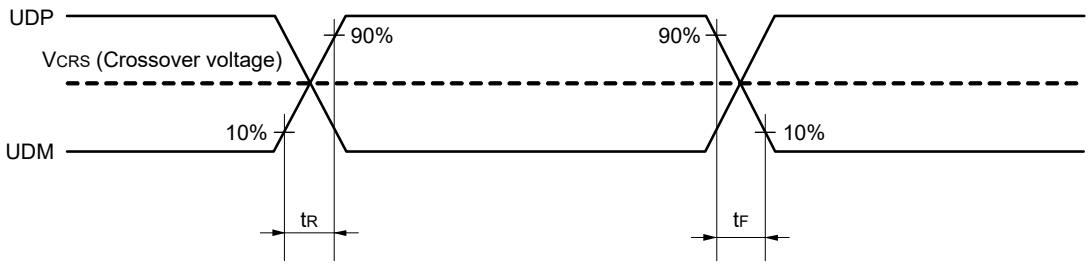
Parameter	Symbol	Conditions		HS (high-speed main) Mode		LS (low-speed main) Mode		LV (low-voltage main) Mode		Unit
				MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
SCLA0 clock frequency	f_{SCL}	Standard mode: f_{CLK} ≥ 1 MHz	2.7 V ≤ V_{DD} ≤ 3.6 V	0	100	0	100	0	100	kHz
			1.8 V ≤ V_{DD} ≤ 3.6 V	—	—	0	100	0	100	kHz
			1.6 V ≤ V_{DD} ≤ 3.6 V	—	—	—	—	0	100	kHz
Setup time of restart condition	$t_{SU: STA}$	2.7 V ≤ V_{DD} ≤ 3.6 V		4.7		4.7		4.7		µs
		1.8 V ≤ V_{DD} ≤ 3.6 V		—		4.7		4.7		µs
		1.6 V ≤ V_{DD} ≤ 3.6 V		—		—		4.7		µs
Hold time Note 1	$t_{HD: STA}$	2.7 V ≤ V_{DD} ≤ 3.6 V		4.0		4.0		4.0		µs
		1.8 V ≤ V_{DD} ≤ 3.6 V		—		4.0		4.0		µs
		1.6 V ≤ V_{DD} ≤ 3.6 V		—		—		4.0		µs
Hold time when SCLA0 = “L”	t_{LOW}	2.7 V ≤ V_{DD} ≤ 3.6 V		4.7		4.7		4.7		µs
		1.8 V ≤ V_{DD} ≤ 3.6 V		—		4.7		4.7		µs
		1.6 V ≤ V_{DD} ≤ 3.6 V		—		—		4.7		µs
Hold time when SCLA0 = “H”	t_{HIGH}	2.7 V ≤ V_{DD} ≤ 3.6 V		4.0		4.0		4.0		µs
		1.8 V ≤ V_{DD} ≤ 3.6 V		—		4.0		4.0		µs
		1.6 V ≤ V_{DD} ≤ 3.6 V		—		—		4.0		µs
Data setup time (reception)	$t_{SU: DAT}$	2.7 V ≤ V_{DD} ≤ 3.6 V		250		250		250		ns
		1.8 V ≤ V_{DD} ≤ 3.6 V		—		250		250		ns
		1.6 V ≤ V_{DD} ≤ 3.6 V		—		—		250		ns
Data hold time (transmission) Note 2	$t_{HD: DAT}$	2.7 V ≤ V_{DD} ≤ 3.6 V		0	3.45	0	3.45	0	3.45	µs
		1.8 V ≤ V_{DD} ≤ 3.6 V		—	—	0	3.45	0	3.45	µs
		1.6 V ≤ V_{DD} ≤ 3.6 V		—	—	—	—	0	3.45	µs
Setup time of stop condition	$t_{SU: STO}$	2.7 V ≤ V_{DD} ≤ 3.6 V		4.0		4.0		4.0		µs
		1.8 V ≤ V_{DD} ≤ 3.6 V		—		4.0		4.0		µs
		1.6 V ≤ V_{DD} ≤ 3.6 V		—		—		4.0		µs
Bus-free time	t_{BUF}	2.7 V ≤ V_{DD} ≤ 3.6 V		4.7		4.7		4.7		µs
		1.8 V ≤ V_{DD} ≤ 3.6 V		—		4.7		4.7		µs
		1.6 V ≤ V_{DD} ≤ 3.6 V		—		—		4.7		µs

Note 1. The first clock pulse is generated after this period when the start/restart condition is detected.

Note 2. The maximum value (MAX.) of $t_{HD:DAT}$ is during normal transfer and a wait state is inserted in the ACK (acknowledge) timing.

Remark The maximum value of C_b (communication line capacitance) and the value of R_b (communication line pull-up resistor) at that time in each mode are as follows.
Standard mode: C_b = 400 pF, R_b = 2.7 kΩ

Timing of UDP and UDM



(2) BC standard

(T_A = -40 to +85°C, 4.35 V ≤ UV_{BUS} ≤ 5.25 V, 2.4 V ≤ V_{DD} ≤ 3.6 V, V_{SS} = 0 V, HS (High-speed main) mode only)

Parameter		Symbol	Conditions	MIN.	TYP.	MAX.	Unit
USB standard BC1.2	UDP sink current	I_{DP_SINK}		25	100	175	μA
	UDM sink current	I_{DM_SINK}		25	100	175	μA
	DCD source current	I_{DP_SRC}		7	10	13	μA
	Data detection voltage	V_{DAT_REF}		0.25	0.325	0.4	V
	UDP source voltage	V_{DP_SRC}	Output current 250 μA	0.5	0.6	0.7	V
	UDM source voltage	V_{DM_SRC}	Output current 250 μA	0.5	0.6	0.7	V

2.6 Analog Characteristics

2.6.1 A/D converter characteristics

Classification of A/D converter characteristics

Reference Voltage / Input Channel	Reference voltage (+) = AV_{REFP} Reference voltage (-) = AV_{REFM}	Reference voltage (+) = AV_{DD} Reference voltage (-) = AV_{SS}	Reference voltage (+) = Internal reference voltage Reference voltage (-) = AV_{SS}
High-accuracy channel; ANI0 to ANI6 (input buffer power supply: AV_{DD})	Refer to **2.6.1 (1)**. Refer to **2.6.1 (2)**.	Refer to **2.6.1 (3)**.	Refer to **2.6.1 (6)**.
Standard channel; ANI16 to ANI21 (input buffer power supply: V_{DD})	Refer to **2.6.1 (4)**.	Refer to **2.6.1 (5)**.	
Internal reference voltage, Temperature sensor output voltage	Refer to **2.6.1 (4)**.	Refer to **2.6.1 (5)**.	—

(1) When reference voltage (+) = AV_{REFP}/ANI0 (ADREFP1 = 0, ADREFP0 = 1), reference voltage (-) = AV_{REFM}/ANI1 (ADREFM = 1), target for conversion: ANI2 to ANI6

(T_A = -40 to +85°C, 2.4 V ≤ AV_{REFP} ≤ AV_{DD} = V_{DD} ≤ 3.6 V, V_{SS} = 0 V, AV_{SS} = 0 V, reference voltage (+) = AV_{REFP}, reference voltage (-) = AV_{REFM} = 0 V, HALT mode)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Resolution	RES				12	bit
Overall error Notes 1, 2, 3	AINL	12-bit resolution		±1.7	±3.3	LSB
Conversion time	tCONV	ADTYP = 0, 12-bit resolution	3.375			μs
Zero-scale error Notes 1, 2, 3	EZS	12-bit resolution		±1.3	±3.2	LSB
Full-scale error Notes 1, 2, 3	EFS	12-bit resolution		±0.7	±2.9	LSB
Integral linearity error Notes 1, 2, 3	ILE	12-bit resolution		±1.0	±1.4	LSB
Differential linearity error Notes 1, 2, 3	DLE	12-bit resolution		±0.9	±1.2	LSB
Analog input voltage	VAIN		0		AV_{REFP}	V

Note 1. TYP. Value is the average value at AV_{DD} = AV_{REFP} = 3 V and T_A = 25°C. MAX. value is the average value ±3σ at normalized distribution.

Note 2. These values are the results of characteristic evaluation and are not checked for shipment.

Note 3. Excludes quantization error (±1/2 LSB).

Caution 1. Route the wiring so that noise will not be superimposed on each power line and ground line, and insert a capacitor to suppress noise.
In addition, separate the reference voltage line of AV_{REFP} from the other power lines to keep it free from the influences of noise.

Caution 2. During A/D conversion, keep a pulse, such as a digital signal, that abruptly changes its level from being input to or output from the pins adjacent to the converter pins and P150 to P156.

2.8 LCD Characteristics

2.8.1 Resistance division method

(1) Static display mode

(T_A = -40 to +85°C, V_{L4} (MIN.) ≤ V_{DD} ≤ 3.6 V, V_{SS} = 0 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
LCD drive voltage	V_{L4}		2.0		V_{DD}	V

(2) 1/2 bias method, 1/4 bias method

(T_A = -40 to +85°C, V_{L4} (MIN.) ≤ V_{DD} ≤ 3.6 V, V_{SS} = 0 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
LCD drive voltage	V_{L4}		2.7		V_{DD}	V

(3) 1/3 bias method

(T_A = -40 to +85°C, V_{L4} (MIN.) ≤ V_{DD} ≤ 3.6 V, V_{SS} = 0 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
LCD drive voltage	V_{L4}		2.5		V_{DD}	V

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

Items	Symbol	Conditions			MIN.	TYP.	MAX.	Unit
Input leakage current, high	I_{LIH1}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P46, P50 to P57, P60, P61, P70 to P77, P80 to P83, P125 to P127, P137, P140 to P143, $\overline{RESET}$	V_I = V_{DD}				1	μA
	I_{LIH2}	P20, P21, P140 to P143	V_I = V_{DD}				1	μA
	I_{LIH3}	P121 to P124 (X1, X2, EXCLK, XT1, XT2, EXCLKS)	V_I = V_{DD}	In input port or external clock input			1	μA
				In resonator connection			10	μA
	I_{LIH4}	P150 to P156	V_I = AV_{DD}				1	μA
Input leakage current, low	I_{LIL1}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P46, P50 to P57, P60, P61, P70 to P77, P80 to P83, P125 to P127, P137, P140 to P143, $\overline{RESET}$	V_I = V_{SS}				-1	μA
	I_{LIL2}	P20, P21, P140 to P143	V_I = V_{SS}				-1	μA
	I_{LIL3}	P121 to P124 (X1, X2, EXCLK, XT1, XT2, EXCLKS)	V_I = V_{SS}	In input port or external clock input			-1	μA
				In resonator connection			-10	μA
	I_{LIL4}	P150 to P156	V_I = AV_{SS}				-1	μA
On-chip pull-up resistance	R_{U1}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P50 to P57, P70 to P77, P140 to P143, P125 to P127	V_I = V_{SS}	2.4 V ≤ V_{DD} ≤ 3.6 V	10	20	100	kΩ
	R_{U2}	P40 to P46, P80 to P83	V_I = V_{SS}		10	20	100	kΩ

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

3.3.2 Supply current characteristics

(T_A = -40 to +105°C, 2.4 V ≤ V_{DD} ≤ 3.6 V, V_{SS} = 0 V) (1/2)

Parameter	Symbol	Conditions					MIN.	TYP.	MAX.	Unit
Supply current Note 1	I_{DD1}	Operating mode	HS (high-speed main) mode Note 5	f_{HOCO} = 48 MHz Note 3, f_{IH} = 24 MHz Note 3	Basic operation	V_{DD} = 3.6 V		2.2	2.9	mA
						V_{DD} = 3.0 V		2.2	2.9	
					Normal operation	V_{DD} = 3.6 V		4.4	9.2	
						V_{DD} = 3.0 V		4.4	9.2	
				f_{HOCO} = 24 MHz Note 3, f_{IH} = 24 MHz Note 3	Basic operation	V_{DD} = 3.6 V		2.0	2.6	
						V_{DD} = 3.0 V		2.0	2.6	
					Normal operation	V_{DD} = 3.6 V		4.2	7.0	
						V_{DD} = 3.0 V		4.2	7.0	
				f_{HOCO} = 16 MHz Note 3, f_{IH} = 16 MHz Note 3	Normal operation	V_{DD} = 3.6 V		3.1	5.0	
						V_{DD} = 3.0 V		3.1	5.0	
			HS (high-speed main) mode Note 5	f_{MX} = 20 MHz Note 2, V_{DD} = 3.6 V	Normal operation	Square wave input		3.5	5.9	mA
						Resonator connection		3.6	6.0	
				f_{MX} = 20 MHz Note 2, V_{DD} = 3.0 V	Normal operation	Square wave input		3.5	5.9	
						Resonator connection		3.6	6.0	
				f_{MX} = 16 MHz Note 2, V_{DD} = 3.6 V	Normal operation	Square wave input		2.9	4.5	
						Resonator connection		3.1	4.6	
				f_{MX} = 16 MHz Note 2, V_{DD} = 3.0 V	Normal operation	Square wave input		2.9	4.5	
						Resonator connection		3.1	4.6	
				f_{MX} = 10 MHz Note 2, V_{DD} = 3.6 V	Normal operation	Square wave input		2.1	3.5	
						Resonator connection		2.2	3.5	
				f_{MX} = 10 MHz Note 2, V_{DD} = 3.0 V	Normal operation	Square wave input		2.1	3.5	
						Resonator connection		2.2	3.5	
			HS (High-speed main) mode (PLL operation)	f_{PLL} = 48 MHz, f_{CLK} = 24 MHz Note 2	Normal operation	V_{DD} = 3.6 V		4.7	7.6	mA
						V_{DD} = 3.0 V		4.7	7.6	
				f_{PLL} = 48 MHz, f_{CLK} = 12 MHz Note 2	Normal operation	V_{DD} = 3.6 V		3.1	5.2	
						V_{DD} = 3.0 V		3.1	5.1	
				f_{PLL} = 48 MHz, f_{CLK} = 6 MHz Note 2	Normal operation	V_{DD} = 3.6 V		2.3	3.9	
						V_{DD} = 3.0 V		2.3	3.9	
			Subsystem clock operation	f_{SUB} = 32.768 kHz Note 4 T_A = -40°C	Normal operation	Square wave input		4.6	6.9	μA
						Resonator connection		4.7	6.9	
				f_{SUB} = 32.768 kHz Note 4 T_A = +25°C	Normal operation	Square wave input		4.9	7.0	
						Resonator connection		5.0	7.2	
				f_{SUB} = 32.768 kHz Note 4 T_A = +50°C	Normal operation	Square wave input		5.2	7.6	
						Resonator connection		5.2	7.7	
				f_{SUB} = 32.768 kHz Note 4 T_A = +70°C	Normal operation	Square wave input		5.5	9.3	
						Resonator connection		5.6	9.4	
				f_{SUB} = 32.768 kHz Note 4 T_A = +85°C	Normal operation	Square wave input		6.2	13.3	
						Resonator connection		6.2	13.4	
				f_{SUB} = 32.768 kHz Note 4 T_A = +105°C	Normal operation	Square wave input		8.3	46.0	
						Resonator connection		8.4	46.0	

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

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

Parameter	Symbol	Conditions				MIN.	TYP.	MAX.	Unit
Supply current Note 1	I_{DD2} Note 2	HALT mode	HS (high-speed main) mode Note 7	f_{HOCO} = 48 MHz Note 4, f_{IH} = 24 MHz Note 4	V_{DD} = 3.6 V		0.77	3.4	mA
					V_{DD} = 3.0 V		0.77	3.4	
				f_{HOCO} = 24 MHz Note 4, f_{IH} = 24 MHz Note 4	V_{DD} = 3.6 V		0.55	2.7	
					V_{DD} = 3.0 V		0.55	2.7	
				f_{HOCO} = 16 MHz Note 4, f_{IH} = 16 MHz Note 4	V_{DD} = 3.6 V		0.48	1.9	
					V_{DD} = 3.0 V		0.47	1.9	
			HS (high-speed main) mode Note 7	f_{MX} = 20 MHz Note 3, V_{DD} = 3.6 V	Square wave input		0.35	2.10	mA
					Resonator connection		0.51	2.20	
				f_{MX} = 20 MHz Note 3, V_{DD} = 3.0 V	Square wave input		0.34	2.10	
					Resonator connection		0.51	2.20	
				f_{MX} = 16 MHz Note 3, V_{DD} = 3.6 V	Square wave input		0.30	1.25	
					Resonator connection		0.45	1.41	
				f_{MX} = 16 MHz Note 3, V_{DD} = 3.0 V	Square wave input		0.29	1.23	
					Resonator connection		0.45	1.41	
				f_{MX} = 10 MHz Note 3, V_{DD} = 3.6 V	Square wave input		0.23	1.10	
					Resonator connection		0.30	1.20	
				f_{MX} = 10 MHz Note 3, V_{DD} = 3.0 V	Square wave input		0.22	1.10	
					Resonator connection		0.30	1.20	
			HS (High-speed main) mode (PLL operation)	f_{MX} = 48 MHz, f_{CLK} = 24 MHz Note 3	V_{DD} = 3.6 V		0.99	2.93	mA
					V_{DD} = 3.0 V		0.99	2.92	
				f_{MX} = 48 MHz, f_{CLK} = 12 MHz Note 3	V_{DD} = 3.6 V		0.89	2.51	
					V_{DD} = 3.0 V		0.89	2.50	
				f_{MX} = 48 MHz, f_{CLK} = 6 MHz Note 3	V_{DD} = 3.6 V		0.84	2.30	
					V_{DD} = 3.0 V		0.84	2.29	
			Subsystem clock operation	f_{SUB} = 32.768 kHz Note 5 T_A = -40°C	Square wave input		0.32	0.61	μA
					Resonator connection		0.51	0.80	
				f_{SUB} = 32.768 kHz Note 5 T_A = +25°C	Square wave input		0.41	0.74	
					Resonator connection		0.62	0.91	
				f_{SUB} = 32.768 kHz Note 5 T_A = +50°C	Square wave input		0.52	2.30	
					Resonator connection		0.75	2.49	
				f_{SUB} = 32.768 kHz Note 5 T_A = +70°C	Square wave input		0.82	4.03	
					Resonator connection		1.08	4.22	
				f_{SUB} = 32.768 kHz Note 5 T_A = +85°C	Square wave input		1.38	8.04	
					Resonator connection		1.62	8.23	
				f_{SUB} = 32.768 kHz Note 5 T_A = +105°C	Square wave input		3.29	41.00	
					Resonator connection		3.63	41.00	
	I_{DD3} Note 6	STOP mode Note 8	T_A = -40°C				0.18	0.52	μA
			T_A = +25°C				0.25	0.52	
			T_A = +50°C				0.34	2.21	
			T_A = +70°C				0.64	3.94	
			T_A = +85°C				1.18	7.95	
			T_A = +105°C				2.92	40.00	

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

Note 1. Total current flowing into V_{DD}, including the input leakage current flowing when the level of the input pin is fixed to V_{DD} or V_{SS}. The values below the MAX. column include the peripheral operation current. However, not including the current flowing into the LCD controller/driver, A/D converter, D/A converter, comparator, LVD circuit, USB 2.0 function module, I/O port, and on-chip pull-up/pull-down resistors and the current flowing during data flash rewrite.

Note 2. During HALT instruction execution by flash memory.

Note 3. When high-speed on-chip oscillator and subsystem clock are stopped.

Note 4. When high-speed system clock and subsystem clock are stopped.

Note 5. When high-speed on-chip oscillator and high-speed system clock are stopped. When RTCLPC = 1 and setting ultra-low current consumption (AMPHS1 = 1). The current flowing into the real-time clock 2 is included. However, not including the current flowing into the 12-bit interval timer and watchdog timer.

Note 6. Not including the current flowing into the real-time clock 2, 12-bit interval timer, and watchdog timer.

Note 7. Relationship between operation voltage width, operation frequency of CPU and operation mode is as below.

HS (high-speed main) mode: 2.7 V ≤ V_{DD} ≤ 3.6 V@1 MHz to 24 MHz
2.4 V ≤ V_{DD} ≤ 3.6 V@1 MHz to 16 MHz

Note 8. Regarding the value for current to operate the subsystem clock in STOP mode, refer to that in HALT mode.

Remark 1. f_{MX}: High-speed system clock frequency (X1 clock oscillation frequency or external main system clock frequency)

Remark 2. f_{HOCO}: High-speed on-chip oscillator clock frequency (48 MHz max.)

Remark 3. f_{IH}: Main system clock source frequency when the high-speed on-chip oscillator clock divided 1, 2, 4, or 8, or the PLL clock divided by 2, 4, or 8 is selected (24 MHz max.)

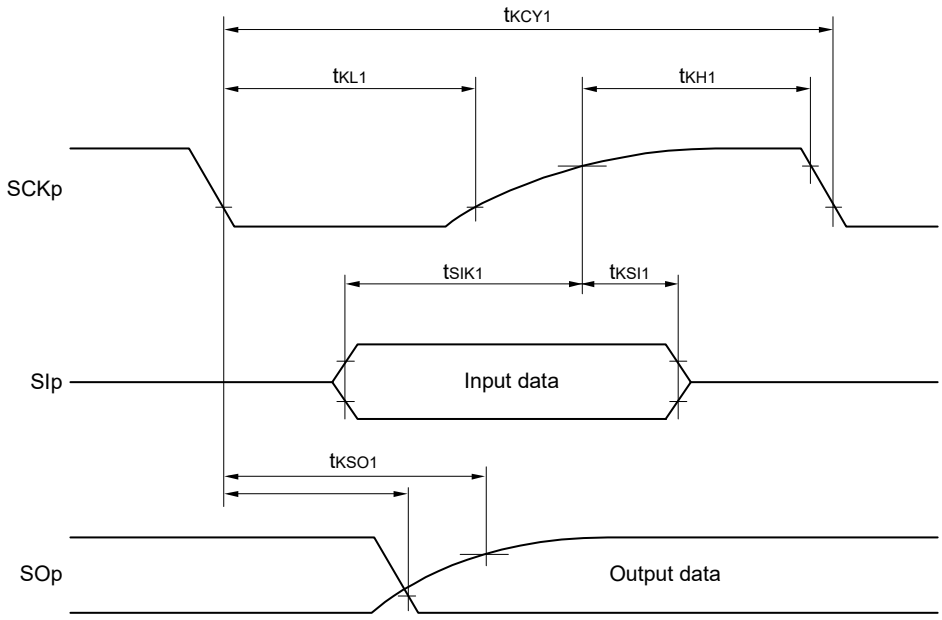
Remark 4. f_{SUB}: Subsystem clock frequency (XT1 clock oscillation frequency)

Remark 5. Except subsystem clock operation, temperature condition of the TYP. value is T_A = 25°C

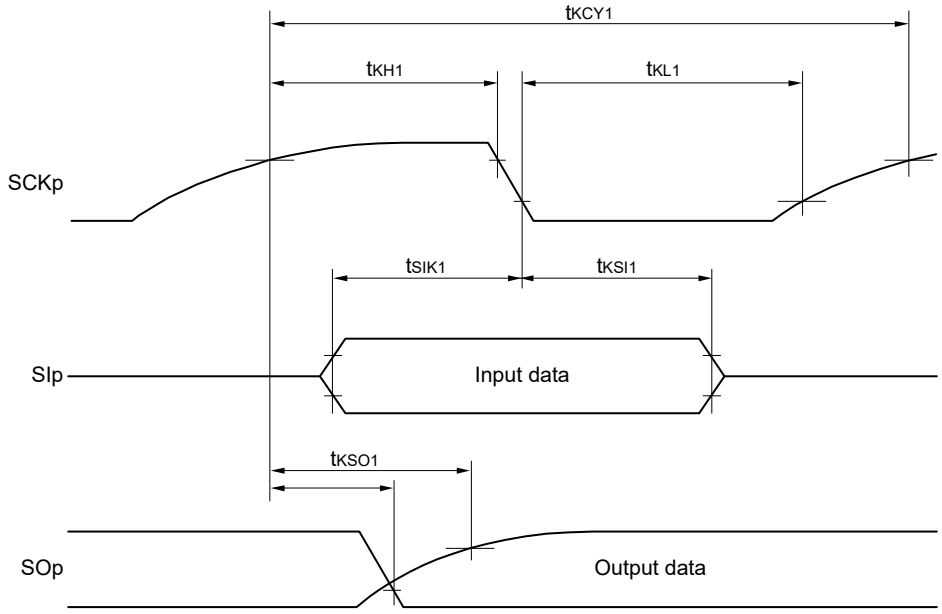
(T_A = -40 to +105°C, 2.4 V ≤ AV_{DD} = V_{DD} ≤ 3.6 V, V_{SS} = 0 V) **(2/2)**

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

CSI mode serial transfer timing (master mode) (during communication at different potential)
(When DAPmn = 0 and CKPmn = 0, or DAPmn = 1 and CKPmn = 1.)



CSI mode serial transfer timing (master mode) (during communication at different potential)
(When DAPmn = 0 and CKPmn = 1, or DAPmn = 1 and CKPmn = 0.)



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

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

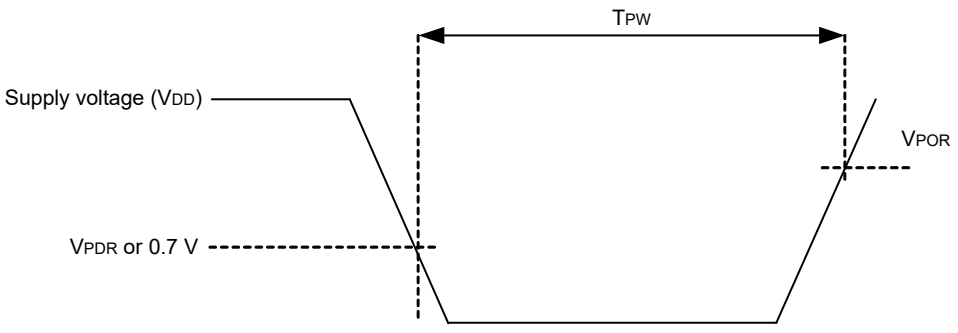
Note Not usable in sub-clock operation or STOP mode.

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).

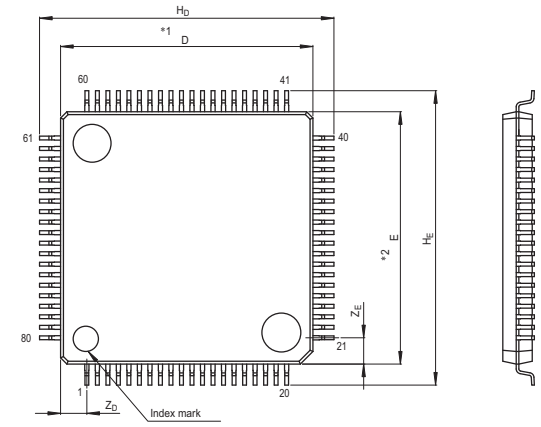


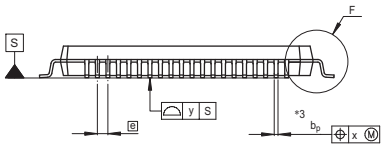
4. PACKAGE DRAWINGS

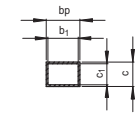
4.1 80-pin products

R5F110MEAFB, R5F110MFAFB, R5F110MGAFB, R5F110MHAFB, R5F110MJAFB
R5F111MEAFB, R5F111MFAFB, R5F111MGAFB, R5F111MHAFB, R5F111MJAFB
R5F110MEGFB, R5F110MFGFB, R5F110MGGFB, R5F110MHGFB, R5F110MJGFB
R5F111MEGFB, R5F111MFGFB, R5F111MGGFB, R5F111MHGFB, R5F111MJGFB

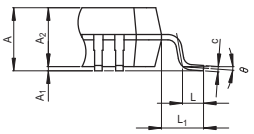
JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-LFQFP80-12x12-0.50	PLQP0080KB-A	80P6Q-A	0.5g







Terminal cross section



Detail F

NOTE)
1. DIMENSIONS "*1" AND "*2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION "*3" DOES NOT INCLUDE TRIM OFFSET.

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	11.9	12.0	12.1
E	11.9	12.0	12.1
A_2	—	1.4	—
H_D	13.8	14.0	14.2
H_E	13.8	14.0	14.2
A	—	—	1.7
A_1	0	0.1	0.2
b_p	0.15	0.20	0.25
b_1	—	0.18	—
c	0.09	0.145	0.20
c_1	—	0.125	—
θ	0°	—	10°
e	—	0.5	—
x	—	—	0.08
y	—	—	0.08
Z_D	—	1.25	—
Z_E	—	1.25	—
L	0.3	0.5	0.7
L_1	—	1.0	—

REVISION HISTORY	RL78/L1C Datasheet

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