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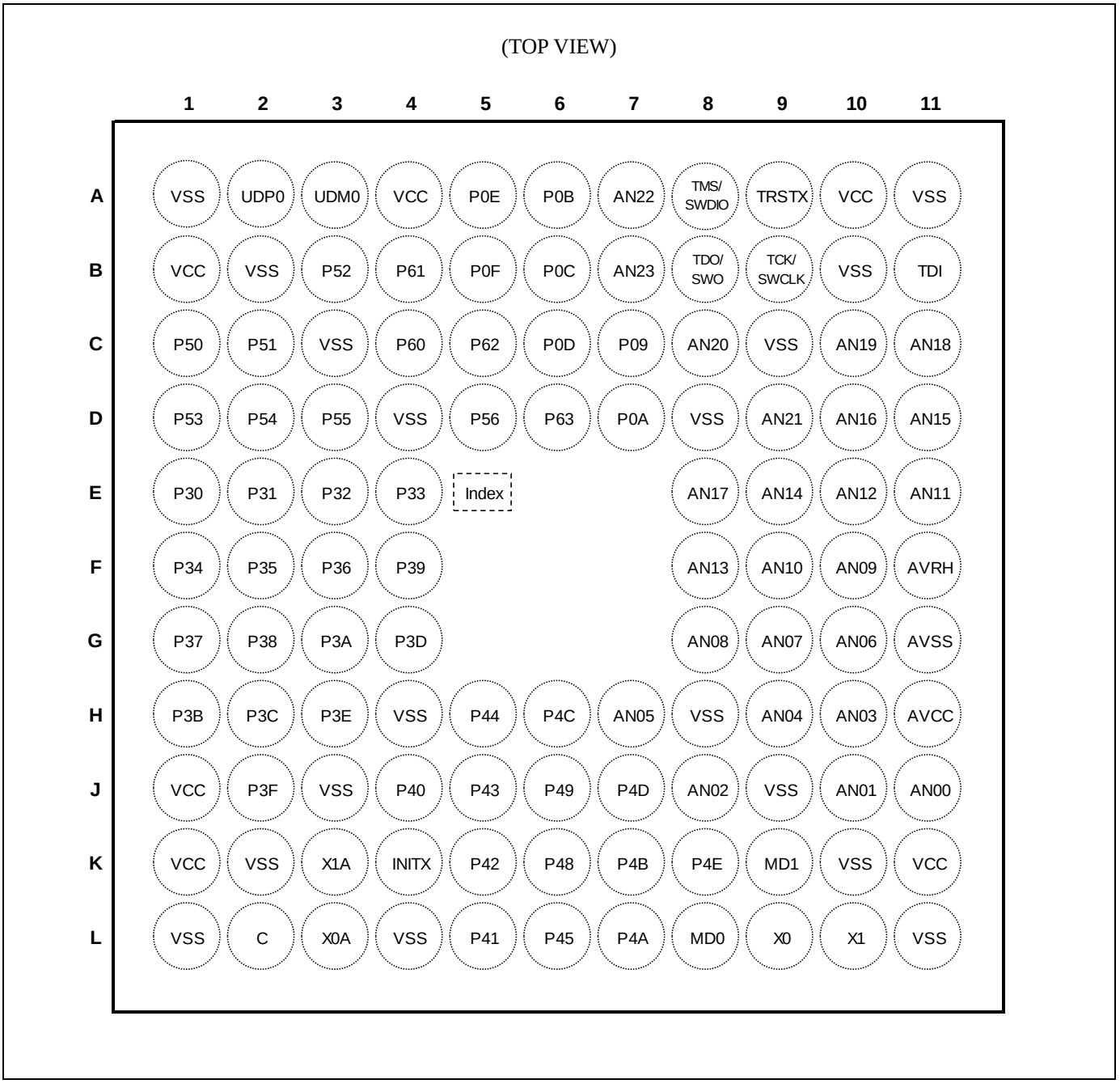
What is "Embedded - Microcontrollers"?

"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	ARM® Cortex®-M3
Core Size	32-Bit Single-Core
Speed	40MHz
Connectivity	CSIO, EBI/EMI, I²C, UART/USART, USB
Peripherals	DMA, LVD, POR, PWM, WDT
Number of I/O	83
Program Memory Size	288KB (288K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	32K x 8
Voltage - Supply (Vcc/Vdd)	1.65V ~ 3.6V
Data Converters	A/D 24x12b SAR
Oscillator Type	External, Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	112-LFBGA
Supplier Device Package	112-PFBGA (10x10)
Purchase URL	https://www.e-xfl.com/product-detail/rochester-electronics/mb9af344nbbgl-ge1

BGA-112P-M04



Note:

The number after the underscore ("_") in pin names such as XXX_1 and XXX_2 indicates the relocated port number. For these pins, there are multiple pins that provide the same function for the same channel. Use the extended port function register (EPFR) to select the pin.

Pin No						Pin Name	I/O Circuit Type	Pin State Type
LQFP-100	QFP-100	BGA-112	LQFP-80	BGA-96	LQFP-64 QFN-64			
54	32	J8	44	J8	36	P12	F	M
						AN02		
						SOT1_1 (SDA1_1)		
					-	MAD10_1		
-	-	K10	-	K10	-	VSS	-	
-	-	J9	-	J9	-	VSS	-	
55	33	H10	45	H10	37	P13	F	M
						AN03		
						SCK1_1 (SCL1_1)		
						RTCCO_1		
						SUBOUT_1		
					-	MAD11_1		
56	34	H9	46	H9	38	P14	F	N
						AN04		
						INT03_1		
					-	SIN0_1		
						MAD12_1		
57	35	H7	47	G10	39	P15	F	M
						AN05		
					-	SOT0_1 (SDA0_1)		
						MAD13_1		
58	36	G10	48	G9	-	P16	F	M
						AN06		
						SCK0_1 (SCL0_1)		
						MAD14_1		
59	37	G9	49	F10	40	P17	F	N
						AN07		
						SIN2_2		
						INT04_1		
					-	MAD15_1		
60	38	H11	50	H11	41	AVCC	-	
61	39	F11	51	F11	42	AVRH	-	
62	40	G11	52	G11	43	AVSS	-	

Pin Function	Pin Name	Function Description	Pin No					
			LQFP-100	QFP-100	BGA-112	LQFP-80	BGA-96	LQFP/ QFN-64
Debugger	SWCLK	Serial wire debug interface clock input pin	78	56	B9	62	B9	50
	SWDIO	Serial wire debug interface data input / output pin	80	58	A8	64	A9	52
	SWO	Serial wire viewer output pin	81	59	B8	65	B8	53
	TCK	J-TAG test clock input pin	78	56	B9	62	B9	50
	TDI	J-TAG test data input pin	79	57	B11	63	B11	51
	TDO	J-TAG debug data output pin	81	59	B8	65	B8	53
	TMS	J-TAG test mode state input/output pin	80	58	A8	64	A9	52
	TRACECLK	Trace CLK output pin of ETM	86	64	C7	-	-	-
	TRACED0	Trace data output pins of ETM	82	60	C8	-	-	-
	TRACED1		83	61	D9	-	-	-
	TRACED2		84	62	A7	-	-	-
	TRACED3		85	63	B7	-	-	-
	TRSTX	J-TAG test reset input pin	77	55	A9	61	A10	49
External Bus	MAD00_1	External bus interface address bus	31	9	H5	21	L5	-
	MAD01_1		32	10	L6	22	K5	-
	MAD02_1		39	17	K6	29	J5	-
	MAD03_1		40	18	J6	30	K6	-
	MAD04_1		41	19	L7	31	J6	-
	MAD05_1		42	20	K7	32	L7	-
	MAD06_1		43	21	H6	33	K7	-
	MAD07_1		44	22	J7	34	J7	-
	MAD08_1		45	23	K8	35	K8	-
	MAD09_1		53	31	J10	43	J10	-
	MAD10_1		54	32	J8	44	J8	-
	MAD11_1		55	33	H10	45	H10	-
	MAD12_1		56	34	H9	46	H9	-
	MAD13_1		57	35	H7	47	G10	-
	MAD14_1		58	36	G10	48	G9	-
	MAD15_1		59	37	G9	49	F10	-
	MAD16_1		63	41	G8	53	F9	-
	MAD17_1		64	42	F10	54	E11	-
	MAD18_1		65	43	F9	55	E10	-
	MAD19_1		66	44	E11	56	E9	-
	MAD20_1		67	45	E10	-	-	-
	MAD21_1		68	46	F8	-	-	-
	MAD22_1		69	47	E9	-	-	-
	MAD23_1		70	48	D11	-	-	-
	MAD24_1		74	52	C10	60	C10	-

Pin Function	Pin Name	Function Description	Pin No					
			LQFP-100	QFP-100	BGA-112	LQFP-80	BGA-96	LQFP/QFN-64
GPIO	P00	General-purpose I/O port 0	77	55	A9	61	A10	49
	P01		78	56	B9	62	B9	50
	P02		79	57	B11	63	B11	51
	P03		80	58	A8	64	A9	52
	P04		81	59	B8	65	B8	53
	P05		82	60	C8	-	-	-
	P06		83	61	D9	-	-	-
	P07		84	62	A7	66	A8	-
	P08		85	63	B7	-	-	-
	P09		86	64	C7	-	-	-
	P0A		87	65	D7	67	C8	54
	P0B		88	66	A6	68	C7	55
	P0C		89	67	B6	69	B7	56
	P0D		90	68	C6	70	B6	-
	P0E		91	69	A5	71	C6	-
	P0F		92	70	B5	72	A6	57
	P10	General-purpose I/O port 1	52	30	J11	42	J11	34
	P11		53	31	J10	43	J10	35
	P12		54	32	J8	44	J8	36
	P13		55	33	H10	45	H10	37
	P14		56	34	H9	46	H9	38
	P15		57	35	H7	47	G10	39
	P16		58	36	G10	48	G9	-
	P17		59	37	G9	49	F10	40
	P18		63	41	G8	53	F9	44
	P19		64	42	F10	54	E11	45
	P1A		65	43	F9	55	E10	-
	P1B		66	44	E11	56	E9	-
	P1C		67	45	E10	-	-	-
	P1D		68	46	F8	-	-	-
	P1E		69	47	E9	-	-	-
	P1F		70	48	D11	-	-	-
	P20	General-purpose I/O port 2	74	52	C10	60	C10	-
	P21		73	51	C11	59	C11	48
	P22		72	50	E8	58	D9	47
	P23		71	49	D10	57	D10	46

Pin Function	Pin Name	Function Description	Pin No					
			LQFP-100	QFP-100	BGA-112	LQFP-80	BGA-96	LQFP/ QFN-64
GPIO	P30	General-purpose I/O port 3	9	87	E1	9	E2	5
	P31		10	88	E2	10	E3	6
	P32		11	89	E3	11	G1	7
	P33		12	90	E4	12	G2	8
	P34		13	91	F1	-	-	-
	P35		14	92	F2	-	-	-
	P36		15	93	F3	-	-	-
	P37		16	94	G1	-	-	-
	P38		17	95	G2	-	-	-
	P39		18	96	F4	13	G3	9
	P3A		19	97	G3	14	H1	10
	P3B		20	98	H1	15	H2	11
	P3C		21	99	H2	16	H3	12
	P3D		22	100	G4	17	J1	13
	P3E		23	1	H3	18	J2	14
	P3F		24	2	J2	19	J4	15
	P40	General-purpose I/O port 4	27	5	J4	-	-	-
	P41		28	6	L5	-	-	-
	P42		29	7	K5	-	-	-
	P43		30	8	J5	-	-	-
	P44		31	9	H5	21	L5	-
	P45		32	10	L6	22	K5	-
	P46		36	14	L3	26	L3	19
	P47		37	15	K3	27	K3	20
	P48		39	17	K6	29	J5	-
	P49		40	18	J6	30	K6	22
	P4A		41	19	L7	31	J6	23
	P4B		42	20	K7	32	L7	24
	P4C		43	21	H6	33	K7	25
	P4D		44	22	J7	34	J7	26
	P4E		45	23	K8	35	K8	27
	P50	General-purpose I/O port 5	2	80	C1	2	C1	2
	P51		3	81	C2	3	C2	3
	P52		4	82	B3	4	B3	4
	P53		5	83	D1	5	D1	-
	P54		6	84	D2	6	D2	-
	P55		7	85	D3	7	D3	-
	P56		8	86	D5	8	E1	-
	P60	General-purpose I/O port 6	96	74	C4	76	C4	60
	P61		95	73	B4	75	B4	59
	P62		94	72	C5	74	C5	58
	P63		93	71	D6	73	B5	-
	P80	General-purpose I/O port 8	98	76	A3	78	A3	62
	P81		99	77	A2	79	A2	63
	PE0	General-purpose I/O port E	46	24	K9	36	K9	28
	PE2		48	26	L9	38	L9	30
	PE3		49	27	L10	39	L10	31

List of Pin Status

Pin status type	Function group	Power-on reset or low-voltage detection state	INITX input state	Device internal reset state	Run mode or Sleep mode state	Timer mode, RTC mode, or Stop mode state		Deep standby RTC mode or Deep standby Stop mode state		Return from Deep standby mode state
		Power supply unstable	Power supply stable		Power supply stable	Power supply stable		Power supply stable		Power supply stable
		-	INITX = 0	INITX = 1	INITX = 1	INITX = 1		INITX = 1		INITX = 1
		-	-	-	-	SPL = 0	SPL = 1	SPL = 0	SPL = 1	-
A	GPIO selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Hi-Z / Internal input fixed at 0	GPIO selected Internal input fixed at 0	Hi-Z / Internal input fixed at 0	GPIO selected
	Main crystal oscillator input pin/ External main clock input selected	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled
B	GPIO selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Hi-Z / Internal input fixed at 0	GPIO selected Internal input fixed at 0	Hi-Z / Internal input fixed at 0	GPIO selected
	External main clock input selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Hi-Z / Internal input fixed at 0	Maintain previous state	Hi-Z / Internal input fixed at 0	Maintain previous state
	Main crystal oscillator output pin	Hi-Z / Internal input fixed at 0/ or Input enabled	Hi-Z / Internal input fixed at 0	Hi-Z / Internal input fixed at 0	Maintain previous state/When oscillation stops*1, Hi-Z / Internal input fixed at 0	Maintain previous state/When oscillation stops*1, Hi-Z / Internal input fixed at 0	Maintain previous state/When oscillation stops*1, Hi-Z / Internal input fixed at 0	Maintain previous state/When oscillation stops*1, Hi-Z / Internal input fixed at 0	Maintain previous state/When oscillation stops*1, Hi-Z / Internal input fixed at 0	Maintain previous state/When oscillation stops*1, Hi-Z / Internal input fixed at 0
C	INITX input pin	Pull-up / Input enabled	Pull-up / Input enabled	Pull-up / Input enabled	Pull-up / Input enabled	Pull-up / Input enabled	Pull-up / Input enabled	Pull-up / Input enabled	Pull-up / Input enabled	Pull-up / Input enabled
D	Mode input pin	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled
E	Mode input pin	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled
	GPIO selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Hi-Z / Input enabled	GPIO selected	Hi-Z / Input enabled	GPIO selected

Pin status type	Function group	Power-on reset or low-voltage detection state	INITX input state	Device internal reset state	Run mode or Sleep mode state	Timer mode, RTC mode, or Stop mode state		Deep standby RTC mode or Deep standby Stop mode state		Return from Deep standby mode state
		Power supply unstable	Power supply stable		Power supply stable	Power supply stable		Power supply stable		Power supply stable
		-	INITX = 0	INITX = 1	INITX = 1	INITX = 1		INITX = 1		INITX = 1
		-	-	-	-	SPL = 0	SPL = 1	SPL = 0	SPL = 1	-
P	Analog input selected	Hi-Z	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled
	Trace selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Trace output	GPIO selected Internal input fixed at 0	Hi-Z / Internal input fixed at 0	GPIO selected
	Resource other than above selected						Hi-Z / Internal input fixed at 0			
	GPIO selected									
Q	Analog input selected	Hi-Z	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled
	Trace selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Trace output	GPIO selected Internal input fixed at 0	Hi-Z / Internal input fixed at 0	GPIO selected
	External interrupt enabled selected						Maintain previous state			
	Resource other than above selected						Hi-Z / Internal input fixed at 0			
	GPIO selected									

Pin status type	Function group	Power-on reset or low-voltage detection state	INITX input state	Device internal reset state	Run mode or Sleep mode state	Timer mode, RTC mode, or Stop mode state		Deep standby RTC mode or Deep standby Stop mode state		Return from Deep standby mode state
		Power supply unstable	Power supply stable		Power supply stable	Power supply stable		Power supply stable		Power supply stable
		-	INITX = 0	INITX = 1	INITX = 1	INITX = 1		INITX = 1		INITX = 1
		-	-	-	-	SPL = 0	SPL = 1	SPL = 0	SPL = 1	-
R	Analog input selected	Hi-Z	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled	Hi-Z / Internal input fixed at 0 / Analog input enabled
	WKUP enabled	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Maintain previous state	WKUP input enabled	Hi-Z / WKUP input enabled	GPIO selected
	External interrupt enabled selected							GPIO selected Internal input fixed at 0	Hi-Z / Internal input fixed at 0	
	Resource other than above selected						Hi-Z / Internal input fixed at 0			
	GPIO selected									
S	CEC enabled	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state
	Resource other than above selected	Hi-Z	Hi-Z / Input enabled	Hi-Z / Input enabled	Maintain previous state	Maintain previous state	Hi-Z / Internal input fixed at 0	GPIO selected Internal input fixed at 0	Hi-Z / Internal input fixed at 0	GPIO selected
	GPIO selected									

12.3 DC Characteristics

12.3.1 Current rating

(V_{CC} = AV_{CC} = 1.65V to 3.6V, V_{SS} = AV_{SS} = 0V, T_A = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions		Value		Unit	Remarks
					Typ*3	Max*4		
Power supply current	I_{CC}	VCC	PLL Rrun mode	CPU: 40 MHz, Peripheral: 40 MHz	15.5	21	mA	*1, *5
				CPU: 40 MHz, Peripheral: the clock stops NOP operation	8.7	12	mA	*1, *5
			High-speed CR Rrun mode	CPU/ Peripheral: 4 MHz*2	1.8	2.9	mA	*1
			Sub Rrun mode	CPU/ Peripheral: 32 kHz	110	680	µA	*1, *6
			Low-speed CR Run mode	CPU/ Peripheral: 100 kHz	125	700	µA	*1
	I_{CCS}		PLL Sleep mode	Peripheral: 40 MHz	9	12.5	mA	*1, *5
			High-speed CR Sleep mode	Peripheral: 4 MHz*2	0.8	1.6	mA	*1
			Sub Sleep mode	Peripheral: 32 kHz	96	670	µA	*1, *6
			Low-speed CR Sleep mode	Peripheral: 100 kHz	110	680	µA	*1

*1: When all ports are fixed.

*2: When setting it to 4 MHz by trimming.

*3: T_A=+25°C, V_{CC}=3.6 V

*4: T_A=+85°C, V_{CC}=3.6 V

*5: When using the crystal oscillator of 4 MHz(Including the current consumption of the oscillation circuit)

*6: When using the crystal oscillator of 32 kHz(Including the current consumption of the oscillation circuit)

12.3.2 Pin Characteristics

(V_{CC} = AV_{CC} = 1.65V to 3.6V, V_{SS} = AV_{SS} = 0V, T_A = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
H level input voltage (hysteresis input)	V_{IHS}	CMOS hysteresis input pin, MD0, MD1	$V_{CC} \geq 2.7$ V	$V_{CC} \times 0.8$	-	V_{CC} + 0.3	V	
			$V_{CC} < 2.7$ V	$V_{CC} \times 0.7$				
		5V tolerant input pin	$V_{CC} \geq 2.7$ V	$V_{CC} \times 0.8$	-	V_{SS} + 5.5	V	
			$V_{CC} < 2.7$ V	$V_{CC} \times 0.7$				
L level input voltage (hysteresis input)	V_{ILS}	CMOS hysteresis input pin, MD0, MD1	$V_{CC} \geq 2.7$ V	V_{SS} - 0.3	-	$V_{CC} \times 0.2$	V	
			$V_{CC} < 2.7$ V			$V_{CC} \times 0.3$		
		5V tolerant input pin	$V_{CC} \geq 2.7$ V	V_{SS} - 0.3	-	$V_{CC} \times 0.2$	V	
			$V_{CC} < 2.7$ V			$V_{CC} \times 0.3$		
H level output voltage	V_{OH}	4 mA type	$V_{CC} \geq 2.7$ V, I_{OH} = - 4 mA	V_{CC} - 0.5	-	V_{CC}	V	
			$V_{CC} < 2.7$ V, I_{OH} = - 2 mA	V_{CC} - 0.45				
		The pin doubled as USB I/O	$V_{CC} \geq 2.7$ V, I_{OH} = - 12 mA	V_{CC} - 0.4	-	V_{CC}	V	
			$V_{CC} < 2.7$ V, I_{OH} = - 6.5 mA					
L level output voltage	V_{OL}	4 mA type	$V_{CC} \geq 2.7$ V, I_{OL} = 4 mA	V_{SS}	-	0.4	V	
			$V_{CC} < 2.7$ V, I_{OL} = 2 mA					
		The pin doubled as USB I/O	$V_{CC} \geq 2.7$ V, I_{OL} = 10.5 mA	V_{SS}	-	0.4	V	
			$V_{CC} < 2.7$ V, I_{OL} = 5 mA					
Input leak current	I_{IL}	-	-	- 5	-	+ 5	µA	
		CEC0, CEC1	V_{CC} = AV_{CC} = AVRH = V_{SS} = AV_{SS} = 0.0 V	-	-	+1.8	µA	
Pull-up resistor value	R_{PU}	Pull-up pin	$V_{CC} \geq 2.7$ V	21	33	66	kΩ	
			$V_{CC} < 2.7$ V	-	-	134		
Input capacitance	C_{IN}	Other than VCC, VSS, AVCC, AVSS, AVRH	-	-	5	15	pF	

12.4.6 Reset Input Characteristics

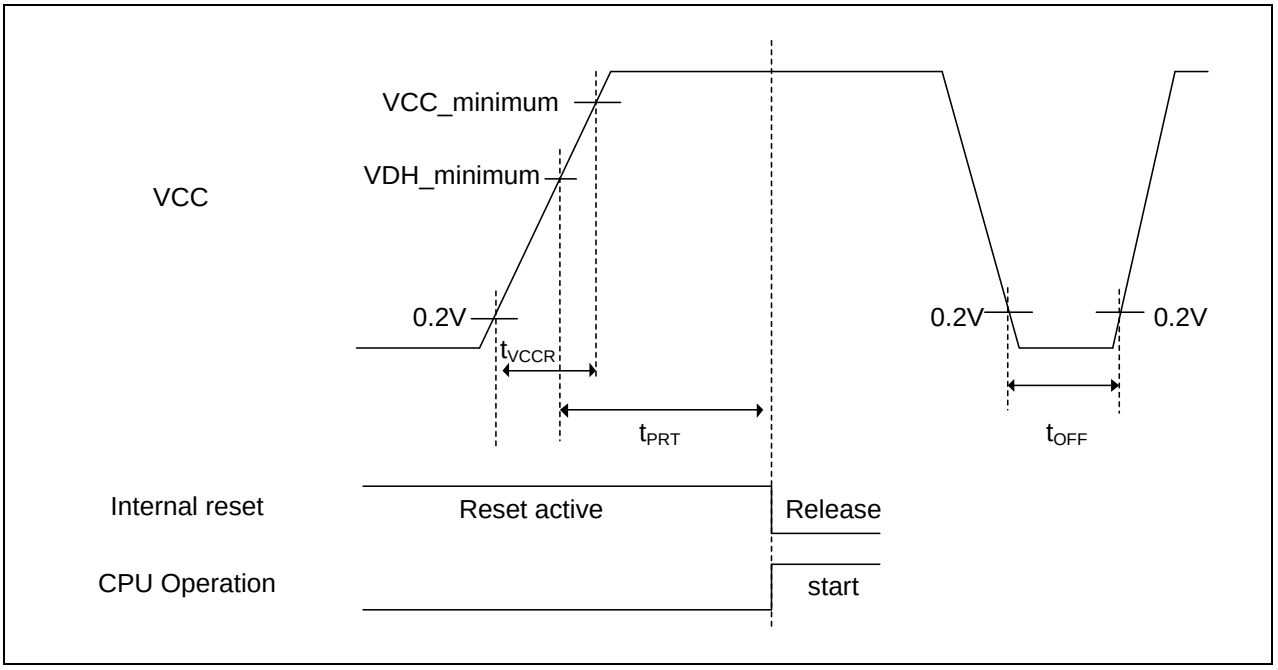
(V_{CC} = 1.65V to 3.6V, V_{SS} = 0V, T_A = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	Max		
Reset input time	t_{INITX}	INITX	-	500	-	ns	

12.4.7 Power-on Reset Timing

(V_{CC}= 1.65V to 3.6V, V_{SS} = 0V, T_A = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Value		Unit	Remarks
			Min	Max		
Power supply rising time	t_{VCCR}	VCC	0	-	ms	
Power supply shut down time	t_{OFF}		1	-	ms	
Time until releasing Power-on reset	t_{PRT}		1.34	16.09	ms	



Glossary

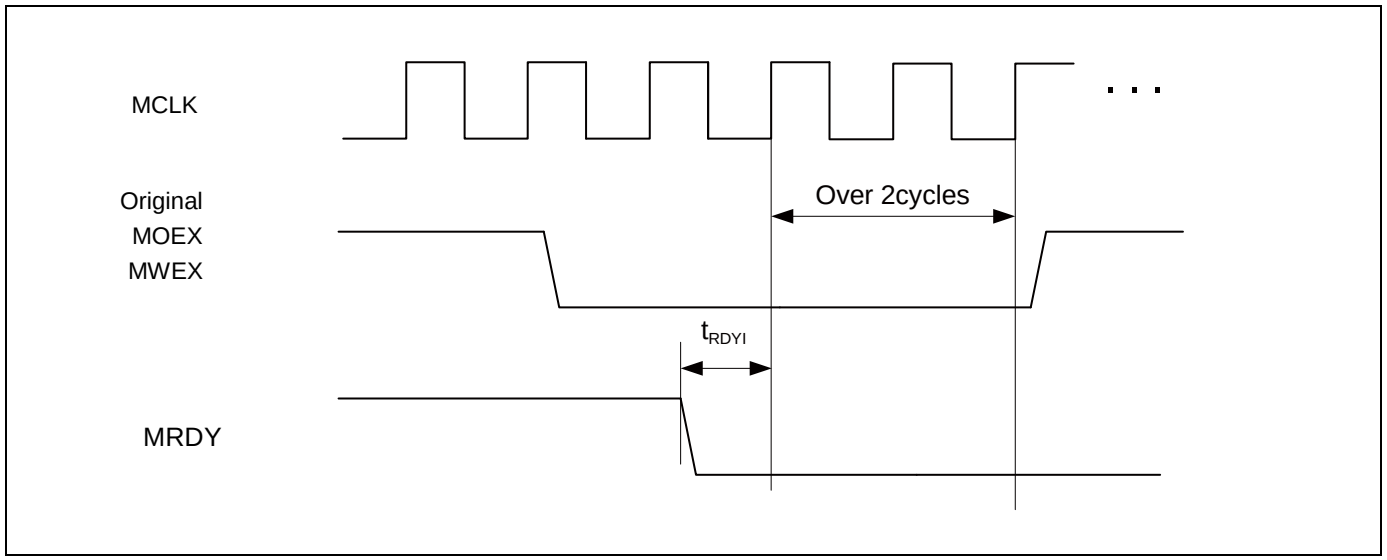
- VCC_minimum: Minimum V_{CC} of recommended operating conditions
- VDH_minimum: Minimum detection voltage (when SVHR=00000) of Low-Voltage detection reset
  See 7. Low-Voltage Detection Characteristics

External Ready Input Timing

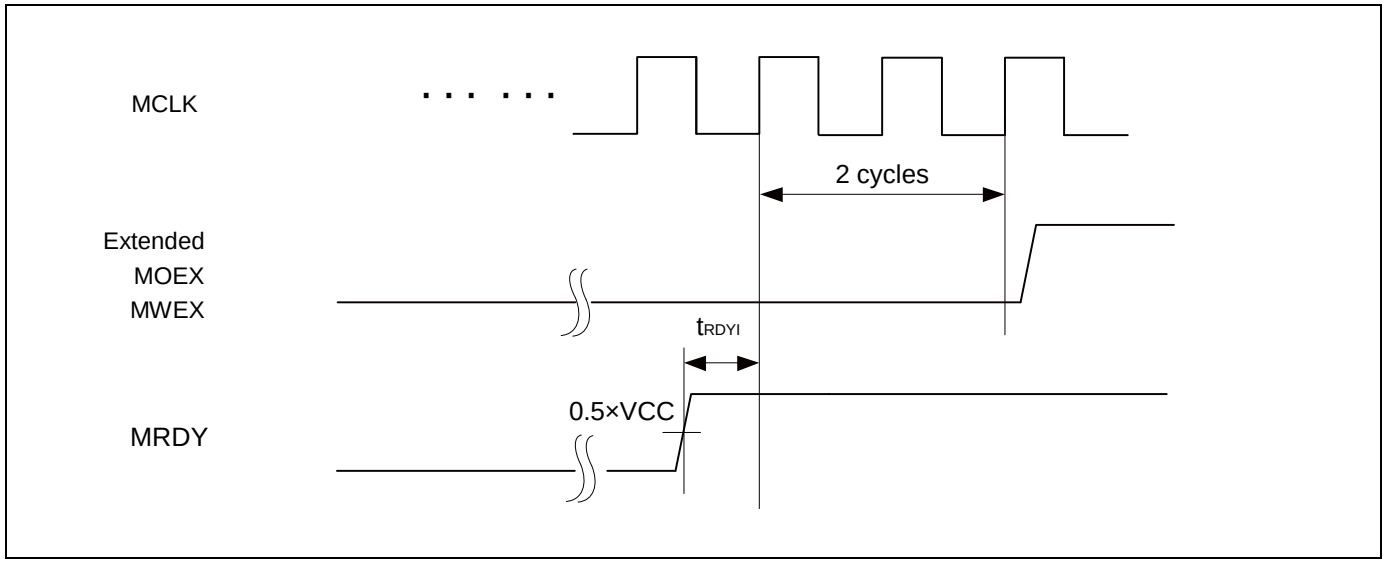
(V_{CC} = 1.65V to 3.6V, V_{SS} = 0V, T_A = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	Max		
MCLK ↑ MRDY input setup time	t_{RDYI}	MCLK, MRDY	V_{CC} ≥ 2.7 V	23	-	ns	
			V_{CC} < 2.7 V	37			

When RDY is input



When RDY is released

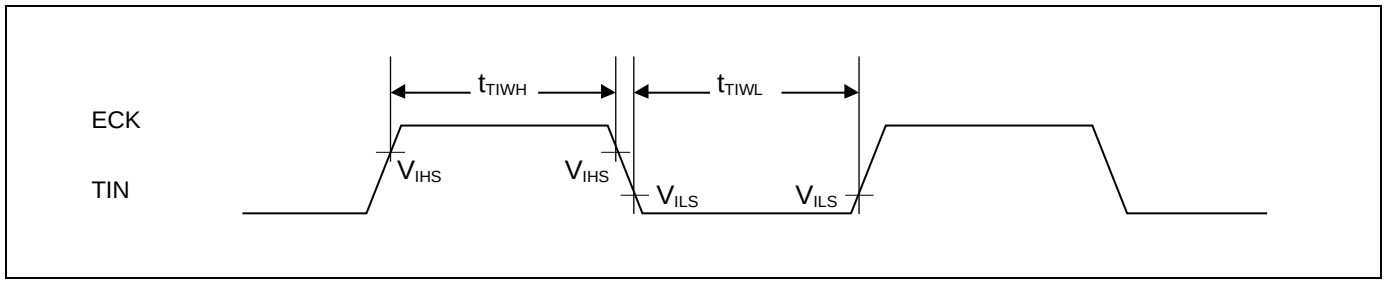


12.4.9 Base Timer Input Timing

Timer input timing

(V_{CC} = 1.65V to 3.6V, V_{SS} = 0V, T_A = - 40°C to + 85°C)

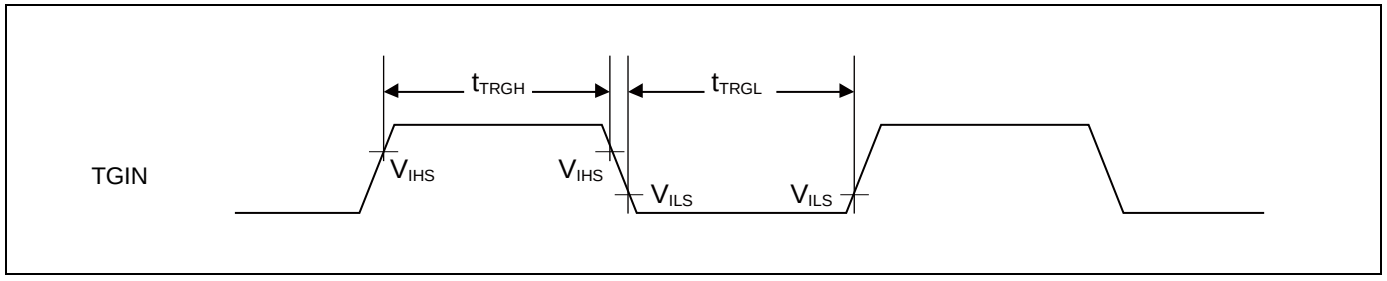
Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	Max		
Input pulse width	t_{TIWH}, t_{TIWL}	TIOAn/TIOBn (when using as ECK, TIN)	-	$2t_{CYCP}$	-	ns	



Trigger input timing

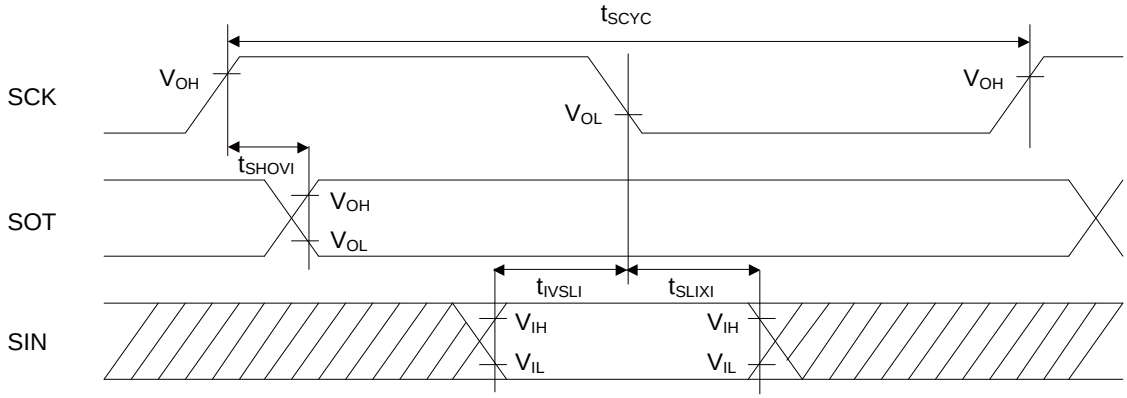
(V_{CC} = 1.65V to 3.6V, V_{SS} = 0V, T_A = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	Max		
Input pulse width	t_{TRGH}, t_{TRGL}	TIOAn/TIOBn (when using as TGIN)	-	$2t_{CYCP}$	-	ns	

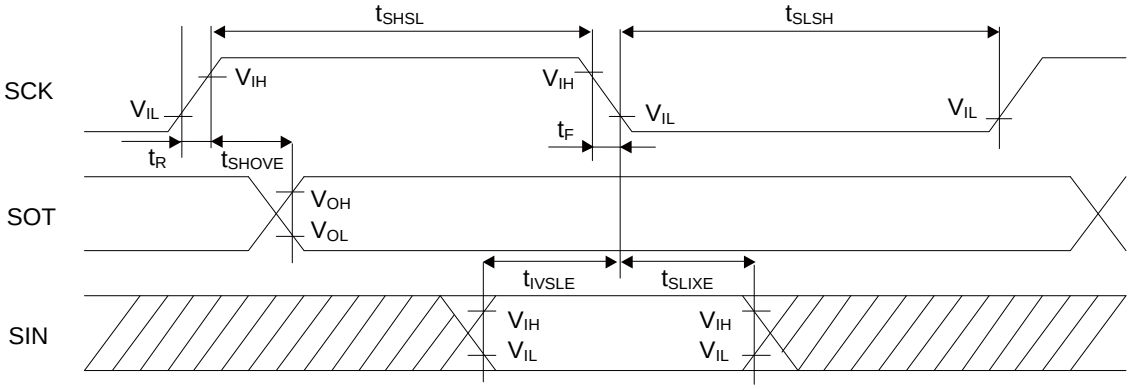


Note:

t_{CYCP} indicates the APB bus clock cycle time.
About the APB bus number which the Base Timer is connected to, see Block Diagram in this data sheet.



Master mode



Slave mode

CSIO (SPI = 0, SCINV = 1)

(V_{CC} = 1.65V to 3.6V, V_{SS} = 0V, T_A = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	V_{CC} < 2.7 V		V_{CC} ≥ 2.7 V		Unit
				Min	Max	Min	Max	
Serial clock cycle time	t_{SCYC}	SCKx	Master mode	$4t_{CYCP}$	-	$4t_{CYCP}$	-	ns
SCK ↑ → SOT delay time	t_{SHOVI}	SCKx, SOTx		- 30	+ 30	- 20	+ 20	ns
SIN → SCK ↓ setup time	t_{IVSLI}	SCKx, SINx		50	-	36	-	ns
SCK ↓ → SIN hold time	t_{SLIXI}	SCKx, SINx		0	-	0	-	ns
Serial clock L pulse width	t_{SLSH}	SCKx	Slave mode	$2t_{CYCP}$ - 10	-	$2t_{CYCP}$ - 10	-	ns
Serial clock H pulse width	t_{SHSL}	SCKx		t_{CYCP} + 10	-	t_{CYCP} + 10	-	ns
SCK ↑ → SOT delay time	t_{SHOVE}	SCKx, SOTx		-	50	-	33	ns
SIN → SCK ↓ setup time	t_{IVSLE}	SCKx, SINx		10	-	10	-	ns
SCK ↓ → SIN hold time	t_{SLIXE}	SCKx, SINx		20	-	20	-	ns
SCK falling time	t_F	SCKx		-	5	-	5	ns
SCK rising time	t_R	SCKx		-	5	-	5	ns

Notes:
- The above characteristics apply to clock synchronous mode.
- t_{CYCP} indicates the APB bus clock cycle time.
- About the APB bus number which Multi-function serial is connected to, see Block Diagram in this data sheet.
- These characteristics only guarantee the same relocate port number.
  For example, the combination of SCKx_0 and SOTx_1 is not guaranteed.
- When the external load capacitance C_L = 30 pF.

CSIO (SPI = 1, SCINV = 0)

(V_{CC} = 1.65V to 3.6V, V_{SS} = 0V, T_A = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	V_{CC} < 2.7 V		V_{CC} ≥ 2.7 V		Unit
				Min	Max	Min	Max	
Serial clock cycle time	t_{SCYC}	SCKx	Master mode	$4t_{CYCP}$	-	$4t_{CYCP}$	-	ns
SCK ↑ → SOT delay time	t_{SHOVI}	SCKx, SOTx		- 30	+ 30	- 20	+ 20	ns
SIN → SCK ↓ setup time	t_{IVSLI}	SCKx, SINx		50	-	36	-	ns
SCK ↓→ SIN hold time	t_{SLIXI}	SCKx, SINx		0	-	0	-	ns
SOT → SCK ↓ delay time	t_{SOVLI}	SCKx, SOTx		$2t_{CYCP}$ - 34	-	$2t_{CYCP}$ - 34	-	ns
Serial clock L pulse width	t_{SLSH}	SCKx	Slave mode	$2t_{CYCP}$ - 10	-	$2t_{CYCP}$ - 10	-	ns
Serial clock H pulse width	t_{SHSL}	SCKx		t_{CYCP} + 10	-	t_{CYCP} + 10	-	ns
SCK ↑ → SOT delay time	t_{SHOVE}	SCKx, SOTx		-	50	-	33	ns
SIN → SCK ↓ setup time	t_{IVSLE}	SCKx, SINx		10	-	10	-	ns
SCK ↓→ SIN hold time	t_{SLIXE}	SCKx, SINx		20	-	20	-	ns
SCK falling time	t_F	SCKx		-	5	-	5	ns
SCK rising time	t_R	SCKx		-	5	-	5	ns

Notes:
- The above characteristics apply to clock synchronous mode.
- t_{CYCP} indicates the APB bus clock cycle time.
- About the APB bus number which Multi-function serial is connected to, see Block Diagram in this data sheet.
- These characteristics only guarantee the same relocate port number.
  For example, the combination of SCKx_0 and SOTx_1 is not guaranteed.
- When the external load capacitance C_L = 30 pF.

12.4.12 I^2C Timing

(V_{CC} = 1.65V to 3.6V, V_{SS} = 0V, T_A = - 40°C to + 85°C)

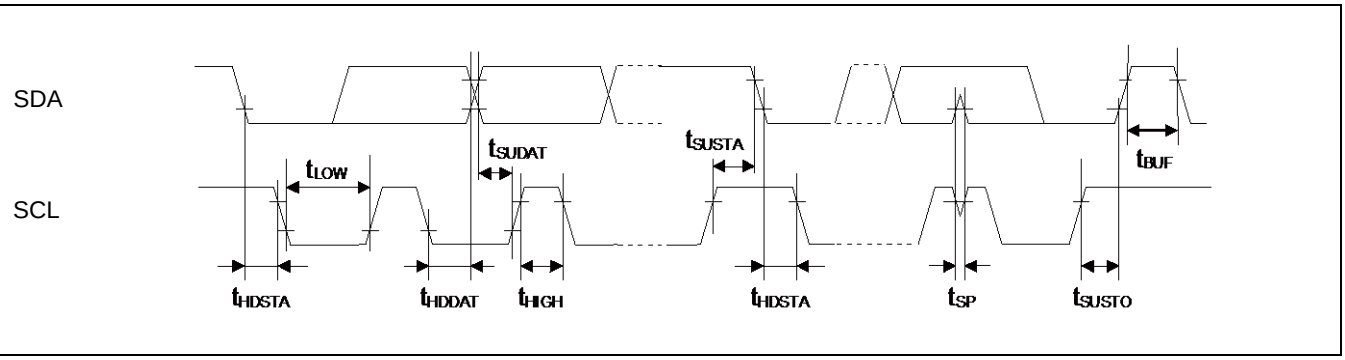
Parameter	Symbol	Conditions	Standard-mode		Fast-mode		Unit	Remarks
			Min	Max	Min	Max		
SCL clock frequency	F_{SCL}	C_L = 30 pF, R = (Vp/I_{OL})*1	0	100	0	400	kHz	
(Repeated) START condition hold time SDA ↓ → SCL ↓	t_{HDSTA}		4.0	-	0.6	-	µs	
SCL clock L width	t_{LOW}		4.7	-	1.3	-	µs	
SCL clock H width	t_{HIGH}		4.0	-	0.6	-	µs	
(Repeated) START condition setup time SCL ↑ → SDA ↓	t_{SUSTA}		4.7	-	0.6	-	µs	
Data hold time SCL ↓ → SDA ↓ ↑	t_{HDDAT}		0	3.45*2	0	0.9*3	µs	
Data setup time SDA ↓ ↑ → SCL ↑	t_{SUDAT}		250	-	100	-	ns	
STOP condition setup time SCL ↑ → SDA ↑	t_{SUSTO}		4.0	-	0.6	-	µs	
Bus free time between STOP condition and START condition	t_{BUF}		4.7	-	1.3	-	µs	
Noise filter	t_{SP}	-	2 t_{CYCP}*4	-	2 t_{CYCP}*4	-	ns	

*1: R and C represent the pull-up resistor and load capacitance of the SCL and SDA lines, respectively.
Vp indicates the power supply voltage of the pull-up resistor and I_{OL} indicates V_{OL} guaranteed current.

*2: The maximum t_{HDDAT} must satisfy that it does not extend at least L period (t_{LOW}) of device's SCL signal.

*3: A Fast-mode I^2C bus device can be used on a Standard-mode I^2C bus system as long as the device satisfies the requirement of t_{SUDAT} ≥ 250 ns.

*4: t_{CYCP} is the APB bus clock cycle time.
About the APB bus number that I^2C is connected to, see Block Diagram in this data sheet.
To use Standard-mode, set the APB bus clock at 2 MHz or more.
To use Fast-mode, set the APB bus clock at 8 MHz or more.



12.5 12-bit A/D Converter

Electrical Characteristics for the A/D Converter

(V_{CC} = AV_{CC} = 1.65V to 3.6V, V_{SS} = AV_{SS} = 0V, T_A = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Value			Unit	Remarks
			Min	Typ	Max		
Resolution	-	-	-	-	12	bit	
Integral Nonlinearity	-	-	-	± 2	± 4.5	LSB	
Differential Nonlinearity	-	-	-	± 2.2	± 2.5	LSB	
Zero transition voltage	V_{ZT}	ANxx	-	± 6	± 15	mV	
Full-scale transition voltage	V_{FST}	ANxx	-	AVRH ± 6	AVRH ± 15	mV	
Conversion time	-	-	2.0*1	-	-	µs	AV_{CC} ≥ 2.7 V
			4.0*1	-	-		1.8 V≤ AV_{CC} < 2.7 V
			10*1	-	-		1.65 V≤ AV_{CC} < 1.8 V
Sampling time*2	t_S	-	0.6	-	10	us	AV_{CC} ≥ 2.7 V
			1.2	-			1.8 V≤ AV_{CC} < 2.7 V
			3.0	-			1.65 V≤ AV_{CC} < 1.8 V
Compare clock cycle*3	t_{CCK}	-	100	-	1000	ns	AV_{CC} ≥ 2.7 V
			200				1.8 V≤ AV_{CC} < 2.7 V
			500				1.65 V≤ AV_{CC} < 1.8 V
State transition time to operation permission	t_{STT}	-	-	-	1.0	µs	
Power supply current (analog + digital)	-	AVCC	-	0.27	0.42	mA	A/D 1unit operation
			-	0.03	10	µA	When A/D stops
Reference power supply current (between AVRH to AVSS)	-	AVRH	-	0.72	1.29	mA	A/D 1unit operation AVRH=3.6 V
			-	0.02	2.6	µA	When A/D stops
Analog input capacity	C_{AIN}	-	-	-	9.4	pF	
Analog input resistor	R_{AIN}	-	-	-	2.2	kΩ	AV_{CC} ≥ 2.7 V
					5.5		1.8 V≤ AV_{CC} < 2.7 V
					10.5		1.65 V≤ AV_{CC} < 1.8 V
Interchannel disparity	-	-	-	-	4	LSB	
Analog port input current	-	ANxx	-	-	5	µA	
Analog input voltage	-	ANxx	AV_{SS}	-	AVRH	V	
Reference voltage	-	AVRH	2.7	-	AV_{CC}	V	AV_{CC} ≥ 2.7 V
			AV_{CC}				AV_{CC} < 2.7 V

*1: The conversion time is the value of sampling time (t_S) + compare time (t_C).

The condition of the minimum conversion time is the following.

AV_{CC} ≥ 2.7 V, HCLK=40 MHz — sampling time: 0.6 µs, compare time: 1.4 µs

1.8 V ≤ AV_{CC} < 2.7 V, HCLK=40 MHz — sampling time: 1.2 µs, compare time: 2.8 µs

1.65 V ≤ AV_{CC} < 1.8 V, HCLK=40 MHz — sampling time: 3 µs, compare time: 7 µs

Ensure that it satisfies the value of the sampling time (t_S) and compare clock cycle (t_{CCK}).

For setting of the sampling time and the compare clock cycle, see Chapter 1-1: A/D Converter in FM3 Family Peripheral Manual Analog Macro Port.

The register setting of the A/D Converter are reflected in the operation according to the APB bus clock timing.

The sampling clock and compare clock is generated from the Base clock (HCLK).

About the APB bus number which the A/D Converter is connected to, see Block Diagram in this data sheet.

*2: A necessary sampling time changes by external impedance.

Ensure that it set the sampling time to satisfy (Equation 1).

*3: The compare time (t_C) is the value of (Equation 2).

12.7 Low-Voltage Detection Characteristics

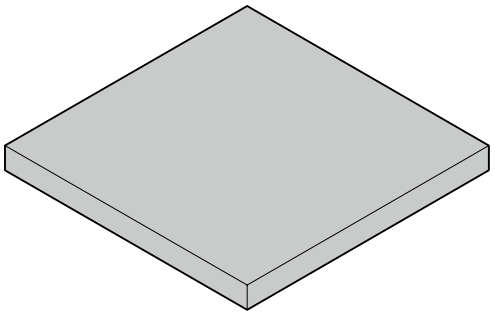
12.7.1 Low-Voltage Detection Reset

(T_A = - 40°C to + 85°C)

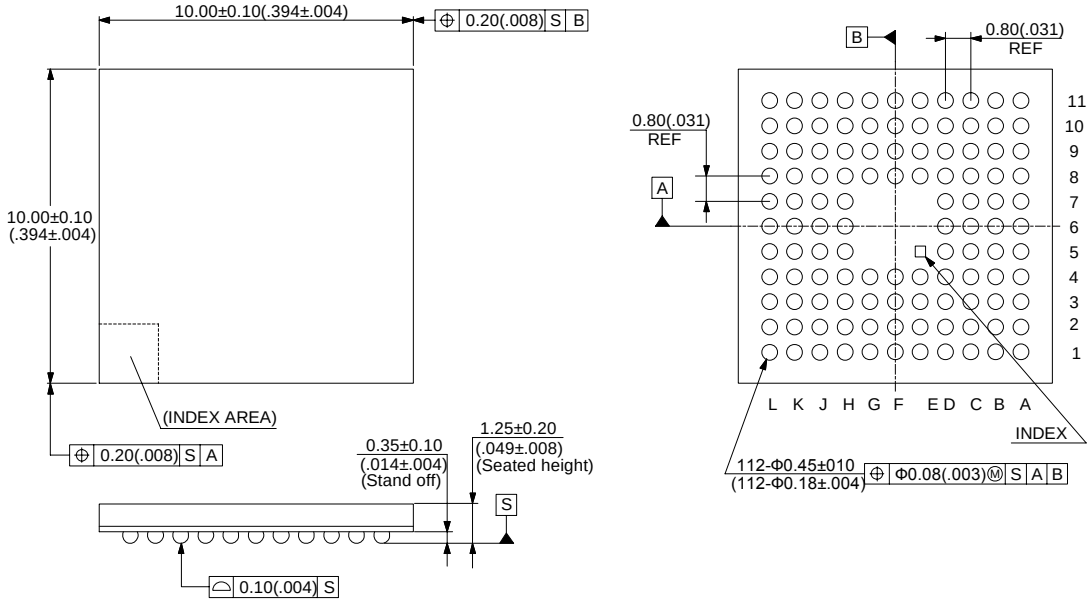
Parameter	Symbol	Conditions	Value			Unit	Remarks
			Min	Typ	Max		
Detected voltage	VDL	SVHR*1 = 00000	1.38	1.50	1.60	V	When voltage drops
Released voltage	VDH		1.43	1.55	1.65	V	When voltage rises
Detected voltage	VDL	SVHR*1 = 00001	1.43	1.55	1.65	V	When voltage drops
Released voltage	VDH		Same as SVHR = 00000 value			V	When voltage rises
Detected voltage	VDL	SVHR*1 = 00010	1.47	1.60	1.73	V	When voltage drops
Released voltage	VDH		Same as SVHR = 00000 value			V	When voltage rises
Detected voltage	VDL	SVHR*1 = 00011	1.52	1.65	1.78	V	When voltage drops
Released voltage	VDH		Same as SVHR = 00000 value			V	When voltage rises
Detected voltage	VDL	SVHR*1 = 00100	1.56	1.70	1.84	V	When voltage drops
Released voltage	VDH		Same as SVHR = 00000 value			V	When voltage rises
Detected voltage	VDL	SVHR*1 = 00101	1.61	1.75	1.89	V	When voltage drops
Released voltage	VDH		Same as SVHR = 00000 value			V	When voltage rises
Detected voltage	VDL	SVHR*1 = 00110	1.66	1.80	1.94	V	When voltage drops
Released voltage	VDH		Same as SVHR = 00000 value			V	When voltage rises
Detected voltage	VDL	SVHR*1 = 00111	1.70	1.85	2.00	V	When voltage drops
Released voltage	VDH		Same as SVHR = 00000 value			V	When voltage rises
Detected voltage	VDL	SVHR*1 = 01000	1.75	1.90	2.05	V	When voltage drops
Released voltage	VDH		Same as SVHR = 00000 value			V	When voltage rises
Detected voltage	VDL	SVHR*1 = 01001	1.79	1.95	2.11	V	When voltage drops
Released voltage	VDH		Same as SVHR = 00000 value			V	When voltage rises
Detected voltage	VDL	SVHR*1 = 01010	1.84	2.00	2.16	V	When voltage drops
Released voltage	VDH		Same as SVHR = 00000 value			V	When voltage rises
Detected voltage	VDL	SVHR*1 = 01011	1.89	2.05	2.21	V	When voltage drops
Released voltage	VDH		Same as SVHR = 00000 value			V	When voltage rises
Detected voltage	VDL	SVHR*1 = 01100	2.30	2.50	2.70	V	When voltage drops
Released voltage	VDH		Same as SVHR = 00000 value			V	When voltage rises
Detected voltage	VDL	SVHR*1 = 01101	2.39	2.60	2.81	V	When voltage drops
Released voltage	VDH		Same as SVHR = 00000 value			V	When voltage rises
Detected voltage	VDL	SVHR*1 = 01110	2.48	2.70	2.92	V	When voltage drops
Released voltage	VDH		Same as SVHR = 00000 value			V	When voltage rises
Detected voltage	VDL	SVHR*1 = 01111	2.58	2.80	3.02	V	When voltage drops
Released voltage	VDH		Same as SVHR = 00000 value			V	When voltage rises
Detected voltage	VDL	SVHR*1 = 10000	2.67	2.90	3.13	V	When voltage drops
Released voltage	VDH		Same as SVHR = 00000 value			V	When voltage rises
Detected voltage	VDL	SVHR*1 = 10001	2.76	3.00	3.24	V	When voltage drops
Released voltage	VDH		Same as SVHR = 00000 value			V	When voltage rises
Detected voltage	VDL	SVHR*1 = 10010	2.85	3.10	3.35	V	When voltage drops
Released voltage	VDH		Same as SVHR = 00000 value			V	When voltage rises
Detected voltage	VDL	SVHR*1 = 10011	2.94	3.20	3.46	V	When voltage drops
Released voltage	VDH		Same as SVHR = 00000 value			V	When voltage rises
LVD stabilization wait time	t_{LVDW}	-	-	-	5200 × t_{CYCP}*2	µs	
LVD detection delay time	t_{LVDDL}	-	-	-	200	µs	

*1: The SVHR bit of Low-Voltage Detection Voltage Control Register (LVD_CTL) is initialized to 00000 by Low-Voltage Detection Reset.

*2: t_{CYCP} indicates the APB2 bus clock cycle time.

112-ball plastic PFBGA		
	Ball pitch	0.80 mm
	Package width × package length	10.00 × 10.00 mm
	Lead shape	Soldering ball
	Sealing method	Plastic mold
	Ball size	Φ 0.45 mm
	Mounting height	1.45 mm Max.
(BGA-112P-M04)	Weight	0.22 g

112-ball plastic PFBGA
(BGA-112P-M04)



Dimensions in mm (inches).
Note: The values in parentheses are reference values.