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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	Obsolete
Core Processor	F ² MC-8FX
Core Size	8-Bit
Speed	16MHz
Connectivity	LINbus, SIO, UART/USART
Peripherals	LVD, POR, PWM, WDT
Number of I/O	13
Program Memory Size	12KB (12K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	496 x 8
Voltage - Supply (Vcc/Vdd)	2.4V ~ 5.5V
Data Converters	A/D 5x8/10b
Oscillator Type	External
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	16-SOIC (0.209", 5.30mm Width)
Supplier Device Package	16-SOP
Purchase URL	https://www.e-xfl.com/product-detail/infineon-technologies/mb95f283kpf-g-sne1

MB95280H Series

Part number	MB95F282H	MB95F283H	MB95F284H	MB95F282K	MB95F283K	MB95F284K
Parameter						
Type	Flash memory product					
Clock supervisor counter	It supervises the main clock oscillation.					
Flash memory capacity	8 Kbyte	12 Kbyte	20 Kbyte	8 Kbyte	12 Kbyte	20 Kbyte
RAM capacity	240 bytes	496 bytes	496 bytes	240 bytes	496 bytes	496 bytes
Power-on reset	Yes					
Low-voltage detection reset	No			Yes		
Reset input	Dedicated			Selected by software		
CPU functions	<ul style="list-style-type: none">• Number of basic instructions : 136• Instruction bit length : 8 bits• Instruction length : 1 to 3 bytes• Data bit length : 1, 8 and 16 bits• Minimum instruction execution time : 61.5 ns (machine clock frequency = 16.25 MHz)• Interrupt processing time : 0.6 μs (machine clock frequency = 16.25 MHz)					
General-purpose I/O	<ul style="list-style-type: none">• I/O ports (Max) : 12• CMOS I/O : 11• N-ch open drain : 1			<ul style="list-style-type: none">• I/O ports (Max) : 13• CMOS I/O : 11• N-ch open drain : 2		
Time-base timer	Interval time: 0.256 ms to 8.3 s (external clock frequency = 4 MHz)					
Hardware/software watchdog timer	<ul style="list-style-type: none">• Reset generation cycle Main oscillation clock at 10 MHz: 105 ms (Min)• The sub-internal CR clock can be used as the source clock of the hardware watchdog timer.					
Wild register	It can be used to replace three bytes of data.					
LIN-UART	<ul style="list-style-type: none">• A wide range of communication speed can be selected by a dedicated reload timer.• It has a full duplex double buffer.• Clock-synchronized serial data transfer and clock-asynchronized serial data transfer is enabled.• The LIN function can be used as a LIN master or a LIN slave.					
8/10-bit A/D converter	5 channels					
	8-bit or 10-bit resolution can be selected.					
8/16-bit composite timer	1 channel					
	<ul style="list-style-type: none">• The timer can be configured as an "8-bit timer × 2 channels" or a "16-bit timer × 1 channel".• It has built-in timer function, PWC function, PWM function and input capture function.• Count clock: it can be selected from internal clocks (seven types) and external clocks.• It can output square wave.					
External interrupt	6 channels					
	<ul style="list-style-type: none">• Interrupt by edge detection (The rising edge, falling edge, or both edges can be selected.)• It can be used to wake up the device from standby modes.					
On-chip debug	<ul style="list-style-type: none">• 1-wire serial control• It supports serial writing. (asynchronous mode)					

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Part number	MB95F282H	MB95F283H	MB95F284H	MB95F282K	MB95F283K	MB95F284K
Parameter						
Watch prescaler	Eight different time intervals can be selected.					
Flash memory	<ul style="list-style-type: none"> • It supports automatic programming, Embedded Algorithm, program/erase/erase-suspend/erase-resume commands. • It has a flag indicating the completion of the operation of Embedded Algorithm. • Number of program/erase cycles: 100000 • Data retention time: 20 years • Flash security feature for protecting the content of the Flash memory 					
Standby mode	Sleep mode, stop mode, watch mode, time-base timer mode					
Package	LCC-32P-M19 DIP-16P-M06 FPT-16P-M06					

3. Differences among Products and Notes on Product Selection

Current consumption

When using the on-chip debug function, take account of the current consumption of flash erase/write.

For details of current consumption, see “24. Electrical Characteristics”.

Package

For details of information on each package, see “2. Packages and Corresponding Products” and “28. Package Dimension”.

Operating voltage

The operating voltage varies, depending on whether the on-chip debug function is used or not.

For details of the operating voltage, see “24. Electrical Characteristics”.

On-chip debug function

The on-chip debug function requires that V_{CC} , V_{SS} and 1 serial-wire be connected to an evaluation tool. In addition, if the Flash memory data has to be updated, the PF2/RST pin must also be connected to the same evaluation tool.

(Continued)

Pin no.	Pin name	I/O circuit type*	Function
21	P05	E	General-purpose I/O port High-current pin
	INT05		External interrupt input pin
	AN05		A/D converter analog input pin
	TO00		8/16-bit composite timer ch. 0 output pin
22	P06	G	General-purpose I/O port High-current pin
	INT06		External interrupt input pin
	TO01		8/16-bit composite timer ch. 0 output pin
23	P12	H	General-purpose I/O port
	EC0		8/16-bit composite timer ch. 0 clock input pin
	DBG		DBG input pin
24	P07	G	General-purpose I/O port
	INT07		External interrupt input pin
25	NC	—	It is an internally connected pin. Always leave it unconnected.
26	NC	—	It is an internally connected pin. Always leave it unconnected.
27	NC	—	It is an internally connected pin. Always leave it unconnected.
28	NC	—	It is an internally connected pin. Always leave it unconnected.
29	NC	—	It is an internally connected pin. Always leave it unconnected.
30	NC	—	It is an internally connected pin. Always leave it unconnected.
31	NC	—	It is an internally connected pin. Always leave it unconnected.
32	NC	—	It is an internally connected pin. Always leave it unconnected.

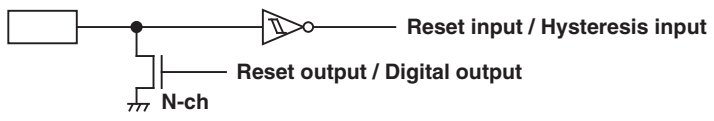
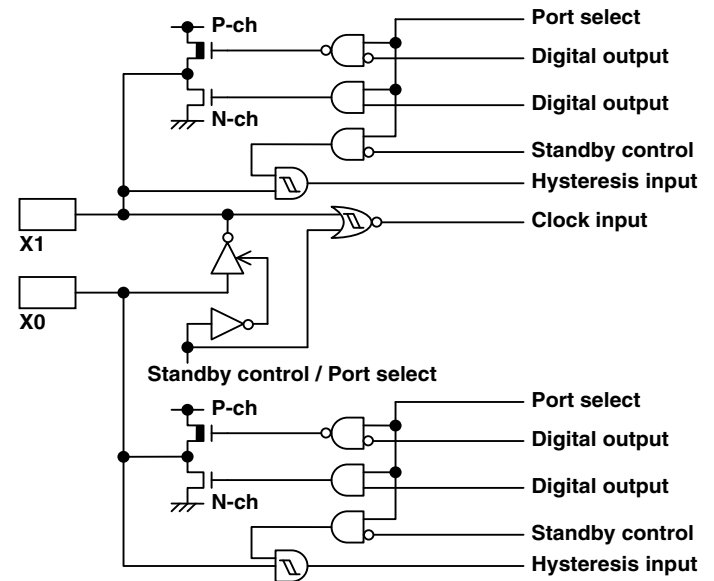
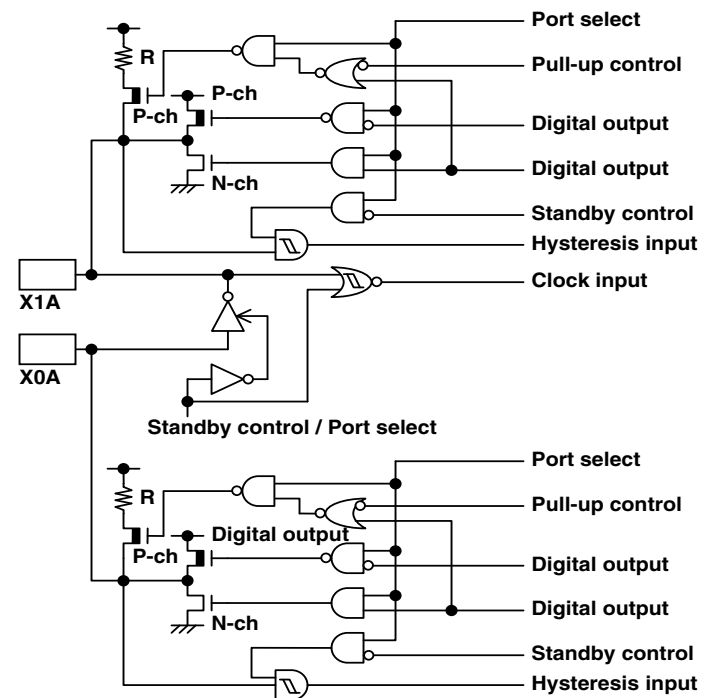
*: For the I/O circuit types, see “11. I/O Circuit Type”.

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Pin no.	Pin name	I/O circuit type*	Function
13	P05	E	General-purpose I/O port High-current pin
	INT05		External interrupt input pin
	AN05		A/D converter analog input pin
	TO00		8/16-bit composite timer ch. 0 clock input pin
14	P06	G	General-purpose I/O port High-current pin
	INT06		External interrupt input pin
	TO01		8/16-bit composite timer ch. 0 clock input pin
15	P07	G	General-purpose I/O port
	INT07		External interrupt input pin
16	P12	H	General-purpose I/O port
	EC0		8/16-bit composite timer ch. 0 clock input pin
	DBG		DBG input pin

*: For the I/O circuit types, see "11. I/O Circuit Type".

11. I/O Circuit Type

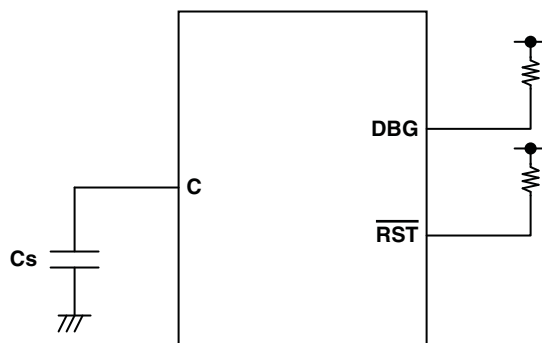
Type	Circuit	Remarks
A		<ul style="list-style-type: none"> • N-ch open drain output • Hysteresis input • Reset output
B		<ul style="list-style-type: none"> • Oscillation circuit • High-speed side • Feedback resistance: approx. 1 MΩ • CMOS output • Hysteresis input
C		<ul style="list-style-type: none"> • Oscillation circuit • Low-speed side • Feedback resistance: approx. 10 MΩ • CMOS output • Hysteresis input • Pull-up control available

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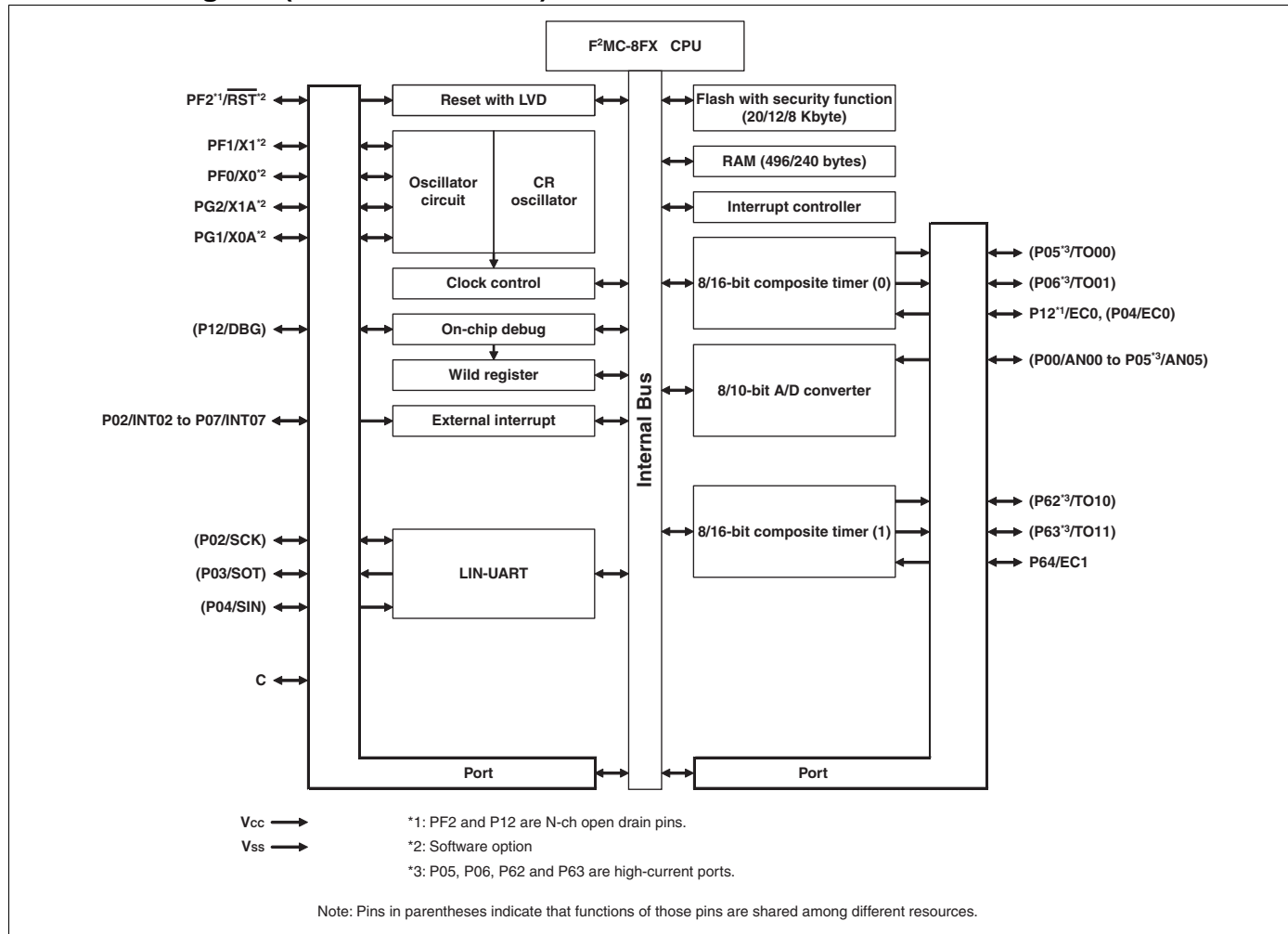
C pin

Use a ceramic capacitor or a capacitor with equivalent frequency characteristics. The bypass capacitor for the V_{CC} pin must have a capacitance larger than C_S . For the connection to a smoothing capacitor C_S , see the diagram below. To prevent the device from unintentionally entering a mode to which the device is not set to transit due to noise, minimize the distance between the C pin and C_S and the distance between C_S and the V_{SS} pin when designing the layout of a printed circuit board.

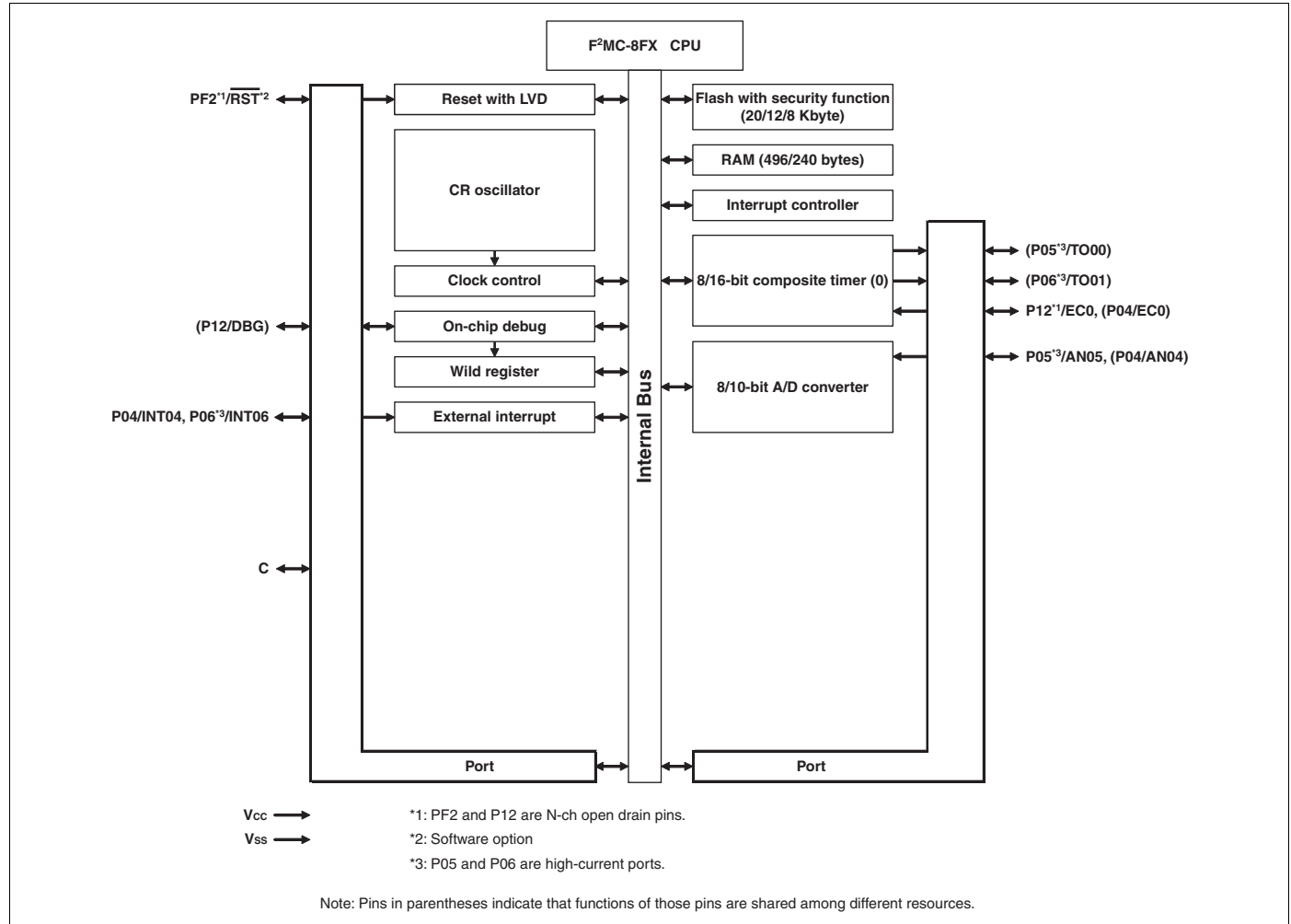
DBG/ $\overline{\text{RST}}$ /C pins connection diagram



14. Block Diagram (MB95260H Series)



15. Block Diagram (MB95270H Series)



18. I/O Map (MB95260H Series)

Address	Register abbreviation	Register name	R/W	Initial value
0000 _H	PDR0	Port 0 data register	R/W	00000000 _B
0001 _H	DDR0	Port 0 direction register	R/W	00000000 _B
0002 _H	PDR1	Port 1 data register	R/W	00000000 _B
0003 _H	DDR1	Port 1 direction register	R/W	00000000 _B
0004 _H	—	(Disabled)	—	—
0005 _H	WATR	Oscillation stabilization wait time setting register	R/W	11111111 _B
0006 _H	—	(Disabled)	—	—
0007 _H	SYCC	System clock control register	R/W	0000X011 _B
0008 _H	STBC	Standby control register	R/W	00000XXX _B
0009 _H	RSRR	Reset source register	R/W	000XXXXX _B
000A _H	TBTC	Time-base timer control register	R/W	00000000 _B
000B _H	WPCR	Watch prescaler control register	R/W	00000000 _B
000C _H	WDTC	Watchdog timer control register	R/W	00XX0000 _B
000D _H	SYCC2	System clock control register 2	R/W	XX100011 _B
000E _H to 0015 _H	—	(Disabled)	—	—
0016 _H	PDR6	Port 6 data register	R/W	00000000 _B
0017 _H	DDR6	Port 6 direction register	R/W	00000000 _B
0018 _H to 0027 _H	—	(Disabled)	—	—
0028 _H	PDRF	Port F data register	R/W	00000000 _B
0029 _H	DDRF	Port F direction register	R/W	00000000 _B
002A _H	PDRG	Port G data register	R/W	00000000 _B
002B _H	DDRG	Port G direction register	R/W	00000000 _B
002C _H	PUL0	Port 0 pull-up register	R/W	00000000 _B
002D _H to 0034 _H	—	(Disabled)	—	—
0035 _H	PULG	Port G pull-up register	R/W	00000000 _B
0036 _H	T01CR1	8/16-bit composite timer 01 status control register 1 ch. 0	R/W	00000000 _B
0037 _H	T00CR1	8/16-bit composite timer 00 status control register 1 ch. 0	R/W	00000000 _B
0038 _H	T11CR1	8/16-bit composite timer 11 status control register 1 ch. 1	R/W	00000000 _B
0039 _H	T10CR1	8/16-bit composite timer 10 status control register 1 ch. 1	R/W	00000000 _B
003A _H to 0048 _H	—	(Disabled)	—	—
0049 _H	EIC10	External interrupt circuit control register ch. 2/ch. 3	R/W	00000000 _B

(Continued)

Address	Register abbreviation	Register name	R/W	Initial value
0F81 _H	WRARL0	Wild register address setting register (Lower) ch. 0	R/W	00000000 _B
0F82 _H	WRDR0	Wild register data setting register ch. 0	R/W	00000000 _B
0F83 _H	WRARH1	Wild register address setting register (Upper) ch. 1	R/W	00000000 _B
0F84 _H	WRARL1	Wild register address setting register (Lower) ch. 1	R/W	00000000 _B
0F85 _H	WRDR1	Wild register data setting register ch. 1	R/W	00000000 _B
0F86 _H	WRARH2	Wild register address setting register (Upper) ch. 2	R/W	00000000 _B
0F87 _H	WRARL2	Wild register address setting register (Lower) ch. 2	R/W	00000000 _B
0F88 _H	WRDR2	Wild register data setting register ch. 2	R/W	00000000 _B
0F89 _H to 0F91 _H	—	(Disabled)	—	—
0F92 _H	T01CR0	8/16-bit composite timer 01 status control register 0 ch. 0	R/W	00000000 _B
0F93 _H	T00CR0	8/16-bit composite timer 00 status control register 0 ch. 0	R/W	00000000 _B
0F94 _H	T01DR	8/16-bit composite timer 01 data register ch. 0	R/W	00000000 _B
0F95 _H	T00DR	8/16-bit composite timer 00 data register ch. 0	R/W	00000000 _B
0F96 _H	TMCR0	8/16-bit composite timer 00/01 timer mode control register ch. 0	R/W	00000000 _B
0F97 _H	T11CR0	8/16-bit composite timer 11 status control register 0 ch. 1	R/W	00000000 _B
0F98 _H	T10CR0	8/16-bit composite timer 10 status control register 0 ch. 1	R/W	00000000 _B
0F99 _H	T11DR	8/16-bit composite timer 11 data register ch. 1	R/W	00000000 _B
0F9A _H	T10DR	8/16-bit composite timer 10 data register ch. 1	R/W	00000000 _B
0F9B _H	TMCR1	8/16-bit composite timer 10/11 timer mode control register ch. 1	R/W	00000000 _B
0F9C _H to 0FBB _H	—	(Disabled)	—	—
0FBC _H	BGR1	LIN-UART baud rate generator register 1	R/W	00000000 _B
0FBD _H	BGR0	LIN-UART baud rate generator register 0	R/W	00000000 _B
0FBE _H to 0FC2 _H	—	(Disabled)	—	—
0FC3 _H	AIDRL	A/D input disable register (Lower)	R/W	00000000 _B
0FC4 _H to 0FE3 _H	—	(Disabled)	—	—
0FE4 _H	CRTTH	Main CR clock trimming register (Upper)	R/W	1XXXXXXX _B
0FE5 _H	CRTL	Main CR clock trimming register (Lower)	R/W	000XXXXX _B

(Continued)

24. Electrical Characteristics

24.1 Absolute Maximum Ratings

Parameter	Symbol	Rating		Unit	Remarks
		Min	Max		
Power supply voltage* ¹	V_{CC}	$V_{SS} - 0.3$	$V_{SS} + 6$	V	
Input voltage* ¹	V_I	$V_{SS} - 0.3$	$V_{SS} + 6$	V	* ²
Output voltage* ¹	V_O	$V_{SS} - 0.3$	$V_{SS} + 6$	V	* ²
Maximum clamp current	I_{CLAMP}	- 2	+ 2	mA	Applicable to specific pins* ³
Total maximum clamp current	$\sum I_{CLAMP}$	—	20	mA	Applicable to specific pins* ³
“L” level maximum output current	I_{OL1}	—	15	mA	Other than P05, P06, P62 and P63* ⁴
	I_{OL2}		15		P05, P06, P62 and P63* ⁴
“L” level average current	I_{OLAV1}	—	4	mA	Other than P05, P06, P62 and P63* ⁴ Average output current= operating current × operating ratio (1 pin)
	I_{OLAV2}		12		P05, P06, P62 and P63* ⁴ Average output current= operating current × operating ratio (1 pin)
“L” level total maximum output current	$\sum I_{OL}$	—	100	mA	
“L” level total average output current	$\sum I_{OLAV}$	—	50	mA	Total average output current= operating current × operating ratio (Total number of pins)
“H” level maximum output current	I_{OH1}	—	- 15	mA	Other than P05, P06, P62 and P63* ⁴
	I_{OH2}		- 15		P05, P06, P62 and P63* ⁴
“H” level average current	I_{OHAV1}	—	- 4	mA	Other than P05, P06, P62 and P63* ⁴ Average output current= operating current × operating ratio (1 pin)
	I_{OHAV2}		- 8		P05, P06, P62 and P63* ⁴ Average output current= operating current × operating ratio (1 pin)
“H” level total maximum output current	$\sum I_{OH}$	—	- 100	mA	
“H” level total average output current	$\sum I_{OHAV}$	—	- 50	mA	Total average output current= operating current × operating ratio (Total number of pins)
Power consumption	P_d	—	320	mW	
Operating temperature	T_A	- 40	+ 85	°C	
Storage temperature	T_{stg}	- 55	+ 150	°C	

(Continued)

24.3 DC Characteristics
 $(V_{CC} = 5.0\text{ V} \pm 10\%, V_{SS} = 0.0\text{ V}, T_A = -40^\circ\text{C to } +85^\circ\text{C})$

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min	Typ	Max		
"H" level input voltage	V_{IH1}	P04	*1	$0.7 V_{CC}$	—	$V_{CC} + 0.3$	V	When CMOS input level (hysteresis input) is selected
	V_{IHS}	P00 to P07, P12, P62 to P64, PF0, PF1, PG1, PG2	*1	$0.8 V_{CC}$	—	$V_{CC} + 0.3$	V	Hysteresis input
	V_{IHM}	PF2	—	$0.7 V_{CC}$	—	$V_{CC} + 0.3$	V	Hysteresis input
"L" level input voltage	V_{IL}	P04	*1	$V_{SS} - 0.3$	—	$0.3 V_{CC}$	V	When CMOS input level (hysteresis input) is selected
	V_{ILS}	P00 to P07, P12, P62 to P64, PF0, PF1, PG1, PG2	*1	$V_{SS} - 0.3$	—	$0.2 V_{CC}$	V	Hysteresis input
	V_{ILM}	PF2	—	$V_{SS} - 0.3$	—	$0.3 V_{CC}$	V	Hysteresis input
Open-drain output application voltage	V_D	PF2, P12	—	$V_{SS} - 0.3$	—	$V_{SS} + 5.5$	V	
"H" level output voltage	V_{OH1}	Output pins other than P05, P06, P12, P62, P63, PF2*2	$I_{OH} = -4\text{ mA}$	$V_{CC} - 0.5$	—	—	V	
	V_{OH2}	P05, P06, P62, P63*2	$I_{OH} = -8\text{ mA}$	$V_{CC} - 0.5$	—	—	V	
"L" level output voltage	V_{OL1}	Output pins other than P05, P06, P62, P63*2	$I_{OL} = 4\text{ mA}$	—	—	0.4	V	
	V_{OL2}	P05, P06, P62, P63*2	$I_{OL} = 12\text{ mA}$	—	—	0.4	V	
Input leak current (Hi-Z output leak current)	I_{LI}	All input pins	$0.0\text{ V} < V_I < V_{CC}$	- 5	—	+ 5	μA	When pull-up resistance is disabled
Pull-up resistance	R_{PULL}	P00 to P07, PG1, PG2*3*4	$V_I = 0\text{ V}$	25	50	100	k Ω	When pull-up resistance is enabled
Input capacitance	C_{IN}	Other than V_{CC} and V_{SS}	$f = 1\text{ MHz}$	—	5	15	pF	

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24.4.3 External Reset

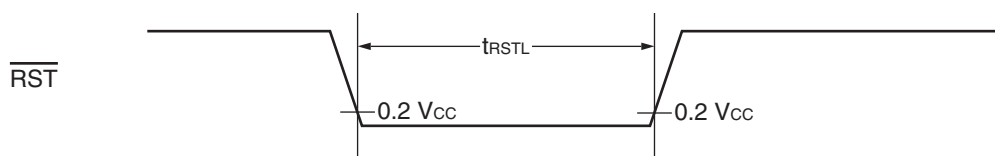
($V_{CC} = 5.0 \text{ V} \pm 10\%$, $V_{SS} = 0.0 \text{ V}$, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$)

Parameter	Symbol	Value		Unit	Remarks
		Min	Max		
$\overline{\text{RST}}$ "L" level pulse width	t_{RSTL}	$2 t_{\text{MCLK}}^{*1}$	—	ns	In normal operation
		Oscillation time of the oscillator ^{*2} + 100	—	μs	In stop mode, subclock mode, sub-sleep mode, watch mode, and power-on
		100	—	μs	In time-base timer mode

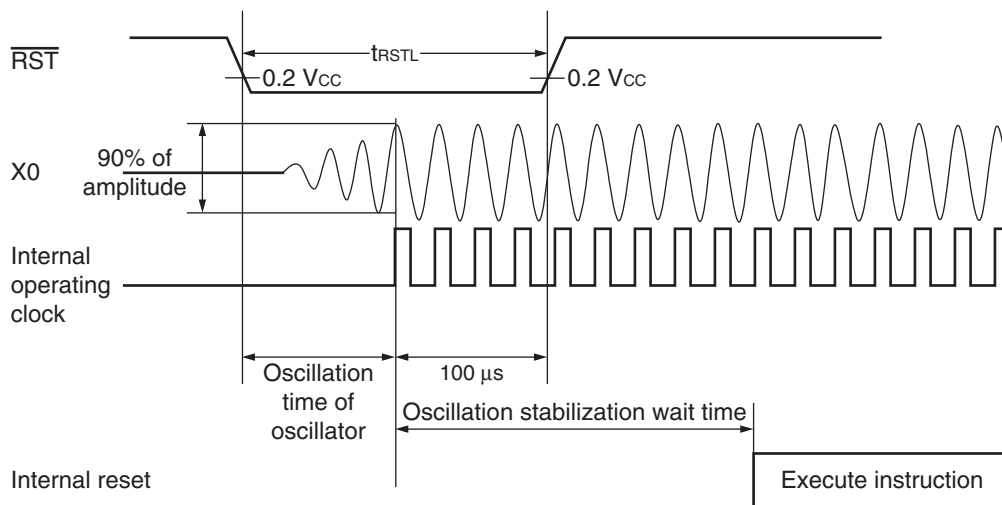
*1 : See "24.4.2. Source Clock / Machine Clock" for t_{MCLK} .

*2 : The oscillation time of an oscillator is the time for it to reach 90% of its amplitude. The crystal oscillator has an oscillation time of between several ms and tens of ms. The ceramic oscillator has an oscillation time of between hundreds of μs and several ms. The external clock has an oscillation time of 0 ms. The CR oscillator clock has an oscillation time of between several μs and several ms.

In normal operation



In stop mode, subclock mode,



24.4.6 LIN-UART Timing (only available on MB95F262H/F262K/F263H/F263K/F264H/F264K/F282H/F282K/F283H/F283K/F284H/F284K)

Sampling is executed at the rising edge of the sampling clock*1, and serial clock delay is disabled*2.

(ESCR register: SCES bit = 0, ECCR register: SCDE bit = 0)

($V_{CC} = 5.0\text{ V} \pm 10\%$, $AV_{SS} = V_{SS} = 0.0\text{ V}$, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$)

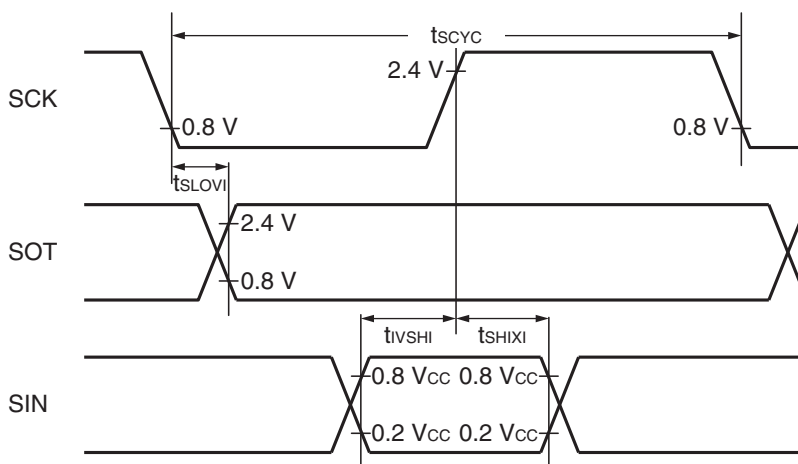
Parameter	Symbol	Pin name	Condition	Value		Unit
				Min	Max	
Serial clock cycle time	t_{SCYC}	SCK	Internal clock operation output pin: $C_L = 80\text{ pF} + 1\text{ TTL}$	$5 t_{MCLK}^{*3}$	—	ns
SCK $\downarrow \rightarrow$ SOT delay time	t_{SLOVI}	SCK, SOT		- 95	+ 95	ns
Valid SIN \rightarrow SCK \uparrow	t_{IVSHI}	SCK, SIN		$t_{MCLK}^{*3} + 190$	—	ns
SCK $\uparrow \rightarrow$ valid SIN hold time	t_{SHIXI}	SCK, SIN		0	—	ns
Serial clock "L" pulse width	t_{SLSH}	SCK	External clock operation output pin: $C_L = 80\text{ pF} + 1\text{ TTL}$	$3 t_{MCLK}^{*3} - t_R$	—	ns
Serial clock "H" pulse width	t_{SHSL}	SCK		$t_{MCLK}^{*3} + 95$	—	ns
SCK $\downarrow \rightarrow$ SOT delay time	t_{SLOVE}	SCK, SOT		—	$2 t_{MCLK}^{*3} + 95$	ns
Valid SIN \rightarrow SCK \uparrow	t_{IVSHE}	SCK, SIN		190	—	ns
SCK $\uparrow \rightarrow$ valid SIN hold time	t_{SHIXE}	SCK, SIN		$t_{MCLK}^{*3} + 95$	—	ns
SCK fall time	t_F	SCK		—	10	ns
SCK rise time	t_R	SCK		—	10	ns

*1: There is a function used to choose whether the sampling of reception data is performed at a rising edge or a falling edge of the serial clock.

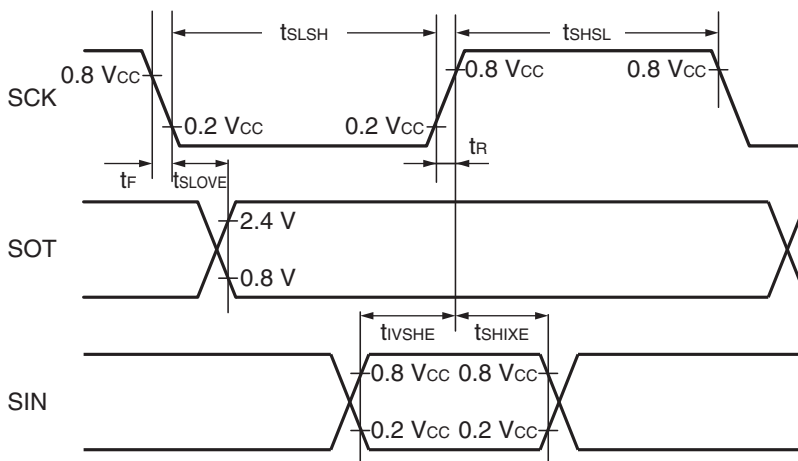
*2: The serial clock delay function is a function used to delay the output signal of the serial clock for half the clock.

*3: See "24.4.2. Source Clock / Machine Clock" for t_{MCLK} .

Internal shift clock mode



External shift clock mode



Sampling is executed at the rising edge of the sampling clock*1, and serial clock delay is enabled*2.
 (ESCR register: SCES bit = 0, ECCR register: SCDE bit = 1)

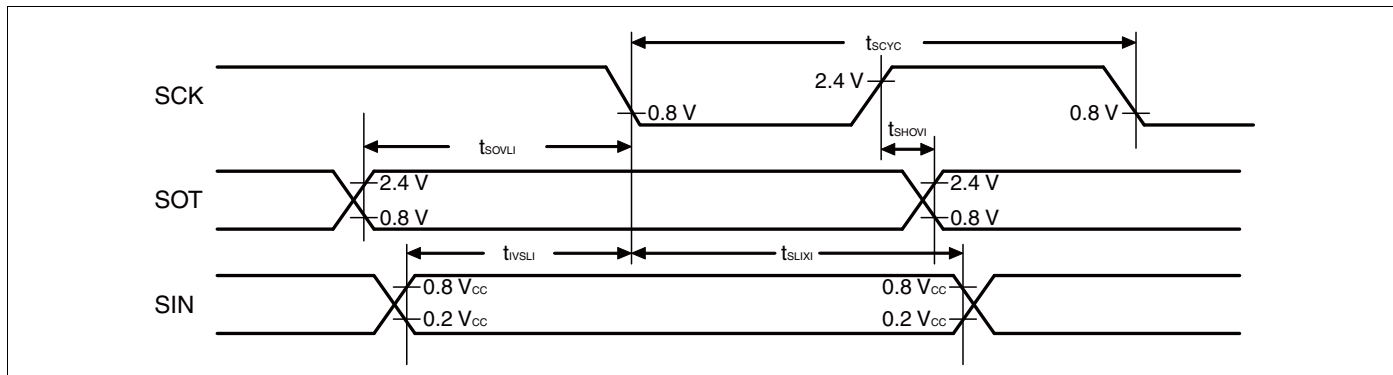
($V_{CC} = 5.0\text{ V} \pm 10\%$, $V_{SS} = 0.0\text{ V}$, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$)

Parameter	Symbol	Pin name	Condition	Value		Unit
				Min	Max	
Serial clock cycle time	t_{SCYC}	SCK	Internal clock operation output pin: $C_L = 80\text{ pF} + 1\text{ TTL}$	$5 t_{MCLK}^{*3}$	—	ns
SCK $\uparrow \rightarrow$ SOT delay time	t_{SHOVI}	SCK, SOT		- 95	+ 95	ns
Valid SIN \rightarrow SCK \downarrow	t_{IVSLI}	SCK, SIN		$t_{MCLK}^{*3} + 190$	—	ns
SCK $\downarrow \rightarrow$ valid SIN hold time	t_{SLIXI}	SCK, SIN		0	—	ns
SOT \rightarrow SCK \downarrow delay time	t_{SOVLI}	SCK, SOT		—	$4 t_{MCLK}^{*3}$	ns

*1: There is a function used to choose whether the sampling of reception data is performed at a rising edge or a falling edge of the serial clock.

*2: The serial clock delay function is a function that delays the output signal of the serial clock for half clock.

*3: See “24.4.2. Source Clock / Machine Clock” for t_{MCLK} .



Sampling is executed at the falling edge of the sampling clock*1, and serial clock delay is enabled*2.
 (ESCR register: SCES bit = 1, ECCR register: SCDE bit = 1)

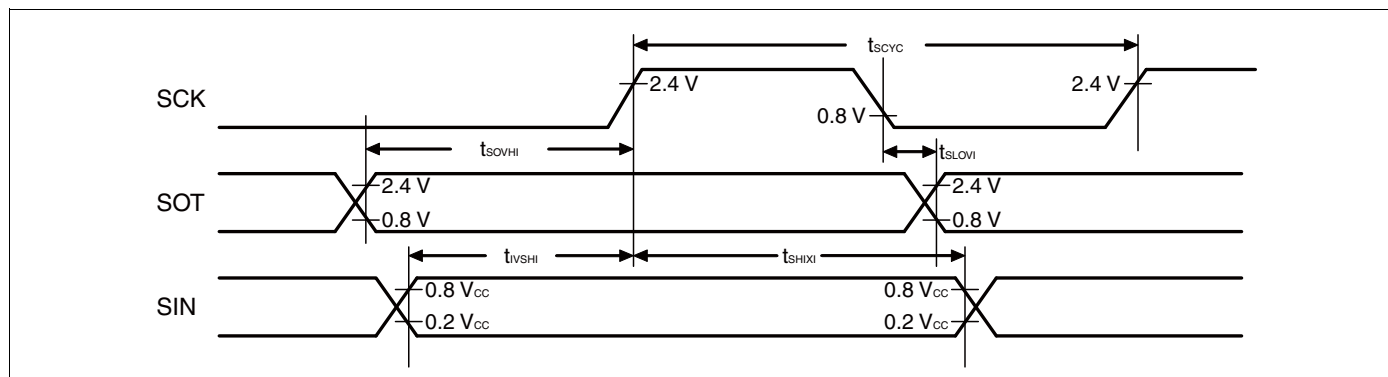
($V_{CC} = 5.0\text{ V} \pm 10\%$, $V_{SS} = 0.0\text{ V}$, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$)

Parameter	Symbol	Pin name	Condition	Value		Unit
				Min	Max	
Serial clock cycle time	t_{SCYC}	SCK	Internal clock operating output pin: $C_L = 80\text{ pF} + 1\text{ TTL}$	$5 t_{MCLK}^{*3}$	—	ns
SCK $\downarrow \rightarrow$ SOT delay time	t_{SLOVI}	SCK, SOT		- 95	+ 95	ns
Valid SIN \rightarrow SCK \uparrow	t_{IVSHI}	SCK, SIN		$t_{MCLK}^{*3} + 190$	—	ns
SCK $\uparrow \rightarrow$ valid SIN hold time	t_{SHIXI}	SCK, SIN		0	—	ns
SOT \rightarrow SCK \uparrow delay time	t_{SOVHI}	SCK, SOT		—	$4 t_{MCLK}^{*3}$	ns

*1: There is a function used to choose whether the sampling of reception data is performed at a rising edge or a falling edge of the serial clock.

*2: The serial clock delay function is a function that delays the output signal of the serial clock for half clock.

*3: See "24.4.2. Source Clock / Machine Clock" for t_{MCLK} .

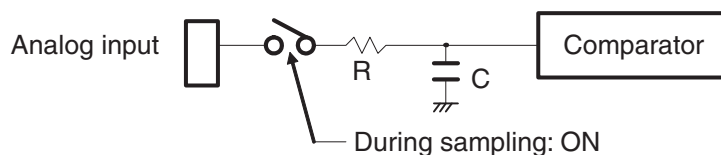


24.5.2 Notes on Using the A/D Converter

External impedance of analog input and its sampling time

The A/D converter has a sample and hold circuit. If the external impedance is too high to keep sufficient sampling time, the analog voltage charged to the capacitor of the internal sample and hold circuit is insufficient, adversely affecting A/D conversion precision. Therefore, to satisfy the A/D conversion precision standard, considering the relationship between the external impedance and minimum sampling time, either adjust the register value and operating frequency or decrease the external impedance so that the sampling time is longer than the minimum value. In addition, if sufficient sampling time cannot be secured, connect a capacitor of about 0.1 μF to the analog input pin.

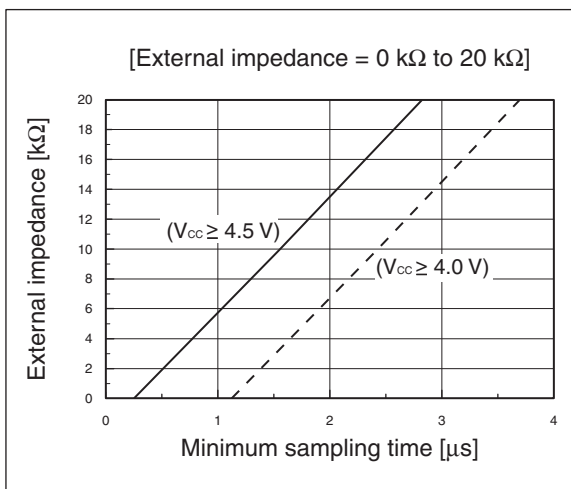
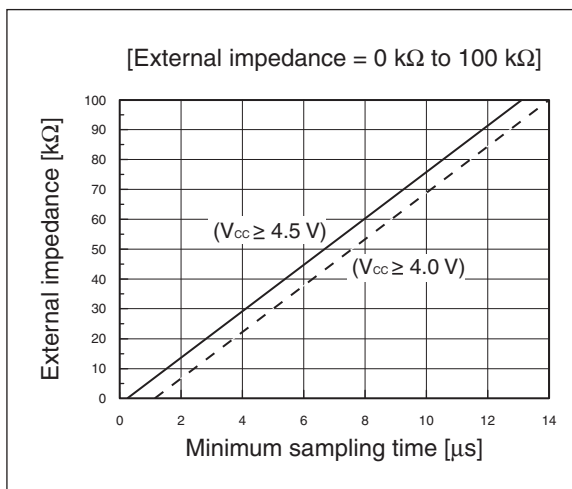
Analog input equivalent circuit



$4.5\text{ V} \leq V_{CC} \leq 5.5\text{ V} : R \approx 1.95\text{ k}\Omega\text{ (Max)}, C \approx 17\text{ pF (Max)}$
 $4.0\text{ V} \leq V_{CC} < 4.5\text{ V} : R \approx 8.98\text{ k}\Omega\text{ (Max)}, C \approx 17\text{ pF (Max)}$

Note: The values are reference values.

Relationship between external impedance and minimum sampling time



A/D conversion error

As $|V_{CC} - V_{SS}|$ decreases, the A/D conversion error increases proportionately.

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