MB91460C Series

FR60 32-bit Microcontroller

MB91460C series is a line of general-purpose 32-bit RISC microcontrollers designed for embedded control applications which require high-speed real-time processing, such as consumer devices and on-board vehicle systems. This series uses the FR60 CPU, which is compatible with the FR family of CPUs.

This series contains the LIN-USART and CAN controllers.

Features

FR60 CPU core

- 32-bit RISC, load/store architecture, five-stage pipeline
- 16-bit fixed-length instructions (basic instructions)
- Instruction execution speed: 1 instruction per cycle
- Instructions including memory-to-memory transfer, bit manipulation, and barrel shift instructions: Instructions suitable for embedded applications
- Function entry/exit instructions and register data multi-load store instructions : Instructions supporting C language
- Register interlock function: Facilitating assembly-language coding
- Built-in multiplier with instruction-level support
  - Signed 32-bit multiplication: 5 cycles
  - Signed 16-bit multiplication: 3 cycles
- Interrupts (save PC/PS) : 6 cycles (16 priority levels)
- Harvard architecture enabling program access and data access to be performed simultaneously
- Instructions compatible with the FR family

Internal peripheral resources

- General-purpose ports : Maximum 104 ports
- DMAC (DMA Controller)
  - Maximum of 5 channels able to operate simultaneously.
  - 2 transfer sources (internal peripheral/software)
  - Activation source can be selected using software
  - Addressing mode specifies full 32-bit addresses (increment/decrement/fixed)
  - Transfer mode (demand transfer/burst transfer/step transfer/block transfer)
  - Transfer data size selectable from 8/16/32-bit
  - Multi-byte transfer enabled (by software)
  - DMAC descriptor in I/O areas (200H to 240H, 1000H to 1024H)
- A/D converter (successive approximation type)
  - 10-bit resolution: 30 channels
  - Conversion time: minimum 1 µs
- External interrupt inputs : 15 channels
  - 8 channels shared with CAN RX or I^2C pins
- Bit search module (for REALOS)
  - Function to search the first bit position of “1”, “0”, “changed” from the MSB (most significant bit) within one word
- LIN-USART (full duplex double buffer): 5 channels
  - Clock synchronous/asynchronous selectable
  - Sync-break detection
  - Internal dedicated baud rate generator
- I^2C bus interface (supports 400 kbps): 3 channels
  - Master/slave transmission and reception
  - Arbitration function, clock synchronization function
- CAN controller (C-CAN): 3 channels
  - Maximum transfer speed: 1 Mbps
  - 32 transmission/reception message buffers
- Stepper motor controller : 6 channels
  - 4 high current output to each channel
  - 2 synchronized PWMs per channel (8/10-bit)
- Sound generator : 1 channel
  - Tone frequency : PWM frequency divide-by-two (reload value + 1)
- Alarm comparator : 1 channel
  - Monitor external voltage
  - Generate an interrupt in case of voltage lower/higher than the defined thresholds (reference voltage)
- 16-bit PPG timer : 12 channels
- 16-bit PFM timer : 1 channel
- 16-bit reload timer: 8 channels
- 16-bit free-run timer: 8 channels (1 channel each for ICU and OCU)
- Input capture: 8 channels (operates in conjunction with the free-run timer)
- Output compare: 4 channels (operates in conjunction with the free-run timer)
- Up/Down counter: 3 channels (3*8-bit or 2*16-bit)
- Watchdog timer
- Real-time clock
- Low-power consumption modes : Sleep/stop mode function
- Low voltage detection circuit
- Clock supervisor
  - Monitors the sub-clock (32 kHz) and the main clock (4 MHz) , and switches to a recovery clock (CR oscillator, etc.) when the oscillations stop.
- Clock modulator
- Clock monitor

- Sub-clock calibration
  - Corrects the real-time clock timer when operating with the 32 kHz or CR oscillator
- Main oscillator stabilization timer
  - Generates an interrupt in sub-clock mode after the stabilization wait time has elapsed on the 23-bit stabilization wait time counter
  - Sub-oscillator stabilization timer
  - Generates an interrupt in main clock mode after the stabilization wait time has elapsed on the 15-bit stabilization wait time counter

Note: MB91F463CA is under development.

Package and technology

- Package: QFP-144
- CMOS 180 nm technology
- Power supply range 3 V to 5 V (1.8 V internal logic provided by a step-down voltage converter)
- Operating temperature range: between − 40°C and + 105°C

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1. Product Lineup

Feature	MB91V460	MB91F463CA	MB91F465CA	MB91F467CA MB91F467CB
Max. core frequency (CLKB)	80 MHz	100 MHz	100 MHz	100 MHz
Max. resource frequency (CLKP)	40 MHz	50 MHz	50 MHz	50 MHz
Max. external bus frequency (CLKT)	40 MHz	-	-	-
Max. CAN frequency (CLKCAN)	20 MHz	50 MHz	50 MHz	50 MHz
Max. FlexRay frequency (SCLK)	-	-	-	-
Technology	0.35µm	0.18µm	0.18µm	0.18µm
Watchdog timer	yes	yes	yes	yes
Watchdog timer (RC osc. based)	yes (disengageable)	yes	yes	yes
Bit Search	yes	yes	yes	yes
Reset input (INITX)	yes	yes	yes	yes
Hardware standby input (HSTX)	yes	no	no	no
Clock Modulator	yes	yes	yes	yes
Clock Monitor	yes	yes	yes	yes
Low Power Mode	yes	yes	yes	yes
DMA	5 ch	5 ch	5 ch	5 ch
MMU/MPU	MPU (16 ch)*1	MPU (4 ch)*1	MPU (8 ch)*1	MPU (8 ch)*1
Flash memory	Emulation SRAM 32bit read data	288 KByte	544 KByte	1088 KByte
Satellite Flash memory	-	-	-	-
Flash Protection	-	yes	yes	yes
D-RAM	64 KByte	16 KByte	16 KByte	32 KByte
ID-RAM	64 KByte	8 KByte	16 KByte	32 KByte
Flash-Cache (Instruction cache)	16 KByte	4 KByte	8 KByte	8 KByte
Boot-ROM / BI-ROM	4 KByte fixed	4 KByte	4 KByte	4 KByte
RTC	1 ch	1 ch	1 ch	1 ch
Free Running Timer	8 ch	8 ch	8 ch	8 ch
ICU	8 ch	8 ch	8 ch	8 ch
OCU	8 ch	4 ch	4 ch	4 ch
Reload Timer	8 ch	8 ch	8 ch	8 ch
PPG 16-bit	16 ch	12 ch	12 ch	12 ch
PFM 16-bit	1 ch	1 ch	1 ch	1 ch
Sound Generator	1 ch	1 ch	1 ch	1 ch
Up/Down Counter (8/16 bit)	4 ch (8-bit) / 2 ch (16-bit)	3 ch (8-bit) / 2ch (16-bit)	3 ch (8-bit) / 2ch (16-bit)	3 ch (8-bit) / 2ch (16-bit)
C_CAN	6 ch (128msg)	3 ch (32msg)	3 ch (32msg)	3 ch (32msg)
LIN-USART	4 ch + 4 ch FIFO + 8 ch	1 ch + 4 ch FIFO	1 ch + 4 ch FIFO	1 ch + 4 ch FIFO

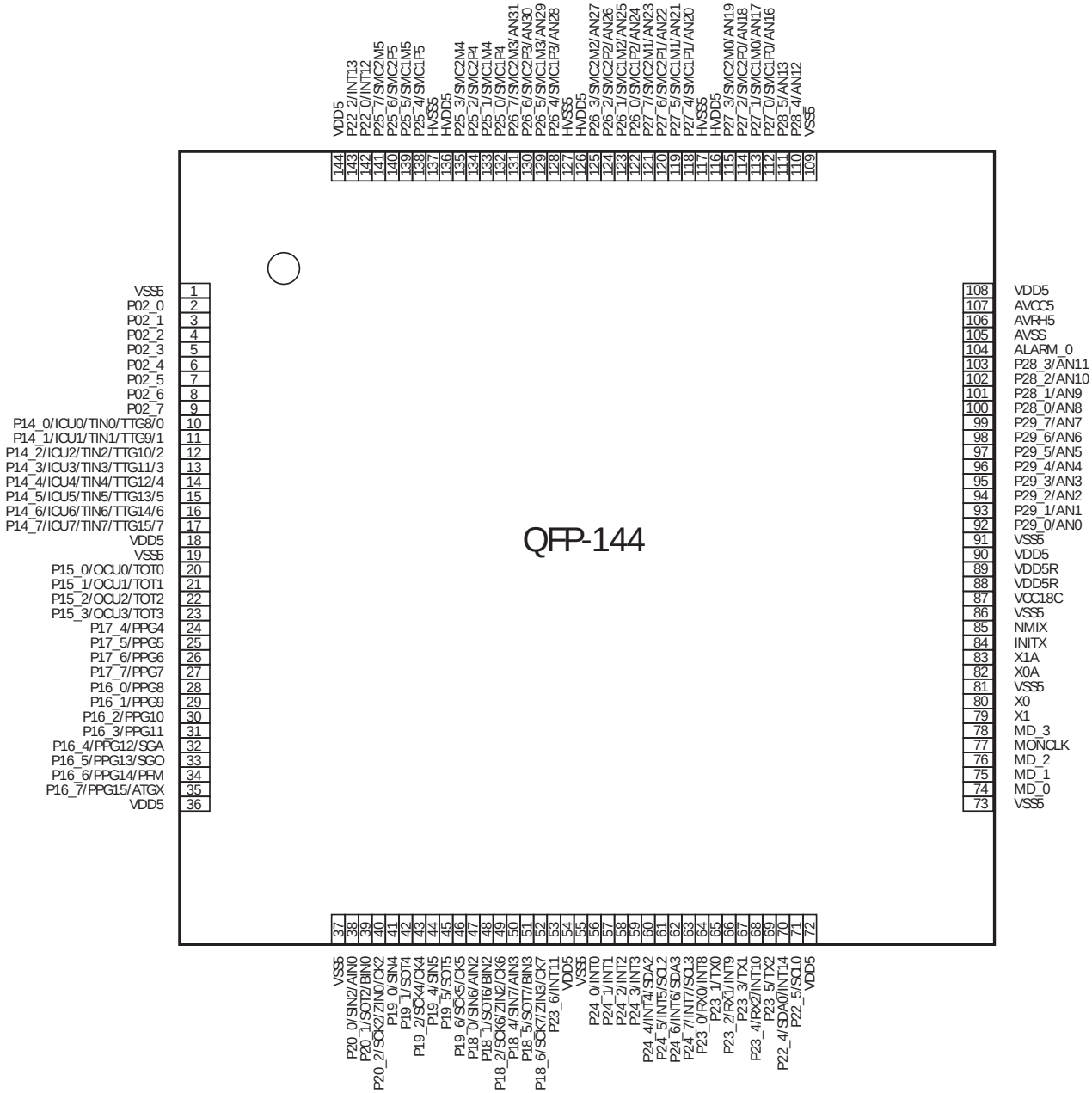
Feature	MB91V460	MB91F463CA	MB91F465CA	MB91F467CA MB91F467CB
I^2C (400K)	4 ch	3 ch	3 ch	3 ch
FR external bus	yes (32bit addr, 32bit data)	-	-	-
External Interrupts	16 ch	15 ch	15 ch	15 ch
NMI Interrupts	1 ch	1 ch	1 ch	1 ch
SMC	6 ch	6 ch	6 ch	6 ch
LCD controller (40x4)	1 ch	-	-	-
ADC (10-bit)	32 ch	30 ch	30 ch	30 ch
Alarm Comparator	2 ch	1 ch	1 ch	1 ch
Supply Supervisor (low voltage detection)	yes	yes	yes	yes
Clock Supervisor	yes	yes	yes	yes
Main clock oscillator	4 MHz	4 MHz	4 MHz	4 MHz
Sub clock oscillator	32kHz	32kHz	32kHz	32kHz
RC oscillator	100kHz	100kHz / 2MHz	100kHz / 2MHz	100kHz / 2MHz
PLL	x 20	x 25	x 25	x 25
DSU4	yes	no	no	no
EDSU	yes (32 BP)*1	yes (8 BP)*1	yes (16 BP)*1	yes (16 BP)*1
Supply voltage	3V/5V	3V/5V	3V/5V	3V/5V
Regulator	yes	yes	yes	yes
Power consumption	n.a.	< 1 W	< 1 W	< 1 W
Temperature Range (Ta)	0.70 C	-40.105 C	-40.105 C	-40.105 C
Package	BGA660	QFP-144	QFP-144	QFP-144
Power on to PLL run	< 20 ms	< 20 ms	< 20 ms	< 20 ms
Flash Download Time	n.a.	< 5 sec. typical	< 5 sec. typical	< 6 sec typical

*1: MPU channels use EDSU breakpoint registers (shared operation between MPU and EDSU).

2. Pin Assignment

2.1 MB91F463CA, MB91F465CA, MB91F467Cx

(TOP VIEW)



3. Pin Description

3.1 MB91F463CA, MB91F465CA, MB91F467Cx

Pin no.	Pin name	I/O	I/O circuit type*	Function
2 to 9	P02_0 to P02_7	I/O	A	General-purpose input/output ports
10 to 17	P14_0 to P14_7	I/O	A	General-purpose input/output ports
	ICU0 to ICU7			Input capture input pins
	TIN0 to TIN7			External trigger input pins of reload timer
	TTG8/0 to TTG15/7			External trigger input pins of PPG timer
20 to 23	P15_0 to P15_3	I/O	A	General-purpose input/output ports
	OCU0 to OCU3			Output compare output pins
	TOT0 to TOT3			Reload timer output pins
24 to 27	P17_4 to P17_7	I/O	A	General-purpose input/output ports
	PPG4 to PPG7			Output pins of PPG timer
28 to 31	P16_0 to P16_3	I/O	A	General-purpose input/output ports
	PPG8 to PPG11			Output pins of PPG timer
32	P16_4	I/O	A	General-purpose input/output ports
	PPG12			Output pins of PPG timer
	SGA			SGA output pin of sound generator
33	P16_5	I/O	A	General-purpose input/output ports
	PPG13			Output pins of PPG timer
	SGO			SGO output pin of sound generator
34	P16_6	I/O	A	General-purpose input/output ports
	PPG14			Output pins of PPG timer
	PFM			Pulse frequency modulator output pin
35	P16_7	I/O	A	General-purpose input/output ports
	PPG15			Output pins of PPG timer
	ATGX			A/D converter external trigger input pin
38	P20_0	I/O	A	General-purpose input/output ports
	SIN2			Data input pin of USART2
	AIN0			Up/down counter input pin
39	P20_1	I/O	A	General-purpose input/output ports
	SOT2			Data output pin of USART2
	BIN0			Up/down counter input pin
40	P20_2	I/O	A	General-purpose input/output ports
	SCK2			Clock input/output pin of USART2
	ZIN0			Up/down counter input pin
	CK2			External clock input pin of free-run timer 2

Pin no.	Pin name	I/O	I/O circuit type*	Function
41	P19_0	I/O	A	General-purpose input/output ports
	SIN4			Data input pin of USART4
42	P19_1	I/O	A	General-purpose input/output ports
	SOT4			Data output pin of USART4
43	P19_2	I/O	A	General-purpose input/output ports
	SCK4			Clock input/output pin of USART4
	CK4			External clock input pin of free-run timer 4
44	P19_4	I/O	A	General-purpose input/output ports
	SIN5			Data input pin of USART5
45	P19_5	I/O	A	General-purpose input/output ports
	SOT5			Data output pin of USART5
46	P19_6	I/O	A	General-purpose input/output ports
	SCK5			Clock input/output pin of USART5
	CK5			External clock input pin of free-run timer 5
47	P18_0	I/O	A	General-purpose input/output ports
	SIN6			Data input pin of USART6
	AIN2			Up/down counter input pin
48	P18_1	I/O	A	General-purpose input/output ports
	SOT6			Data output pin of USART6
	BIN2			Up/down counter input pin
49	P18_2	I/O	A	General-purpose input/output ports
	SCK6			Clock input/output pin of USART6
	ZIN2			Up/down counter input pin
	CK6			External clock input pin of free-run timer 6
50	P18_4	I/O	A	General-purpose input/output ports
	SIN7			Data input pin of USART7
	AIN3			Up/down counter input pin
51	P18_5	I/O	A	General-purpose input/output ports
	SOT7			Data output pin of USART7
	BIN3			Up/down counter input pin
52	P18_6	I/O	A	General-purpose input/output ports
	SCK7			Clock input/output pin of USART7
	ZIN3			Up/down counter input pin
	CK7			External clock input pin of free-run timer 7
53	P23_6	I/O	A	General-purpose input/output ports
	INT11			External Interrupt input (CAN wakeup)

Pin no.	Pin name	I/O	I/O circuit type*	Function
56 to 59	P24_0 to P24_3	I/O	A	General-purpose input/output ports
	INT0 to INT3			External Interrupt input
60	P24_4	I/O	A	General-purpose input/output ports
	INT4			External Interrupt input
	SDA2			I^2C bus DATA input/output pin (open drain)
61	P24_5	I/O	A	General-purpose input/output ports
	INT5			External Interrupt input
	SCL2			I^2C bus clock input/output pin (open drain)
62	P24_6	I/O	A	General-purpose input/output ports
	INT6			External Interrupt input
	SDA3			I^2C bus DATA input/output pin (open drain)
63	P24_7	I/O	A	General-purpose input/output ports
	INT7			External Interrupt input
	SCL3			I^2C bus clock input/output pin (open drain)
64	P23_0	I/O	A	General-purpose input/output ports
	RX0			RX input/output pin of CAN0
	INT8			External Interrupt input (CAN wakeup)
65	P23_1	I/O	A	General-purpose input/output ports
	TX0			TX output pin of CAN0
66	P23_2	I/O	A	General-purpose input/output ports
	RX1			RX input/output pin of CAN1
	INT9			External Interrupt input (CAN wakeup)
67	P23_3	I/O	A	General-purpose input/output ports
	TX1			TX output pin of CAN1
68	P23_4	I/O	A	General-purpose input/output ports
	RX2			RX input/output pin of CAN2
	INT10			External Interrupt input (CAN wakeup)
69	P23_5	I/O	A	General-purpose input/output ports
	TX2			TX output pin of CAN2
70	P22_4	I/O	A	General-purpose input/output ports
	SDA0			I^2C bus DATA input/output pin (open drain)
	INT14			External Interrupt input (I^2C wakeup)
71	P22_5	I/O	A	General-purpose input/output ports
	SCL0			I^2C bus clock input/output pin (open drain)
74 to 76	MD_0 to MD_2	I	G	Mode setting pins
77	MONCLK	O	G	Clock monitor pin
78	MD_3	I	G	To be connected to VSS

Pin no.	Pin name	I/O	I/O circuit type*	Function
79	X1	—	J1	Clock (oscillation) output
80	X0	—	J1	Clock (oscillation) output
82	X0A	—	J2	Sub clock (oscillation) output
83	X1A	—	J2	Sub clock (oscillation) output
84	INITX	I	H	External reset input pin
85	NMIX	I	H	Non-Maskable Interrupt input
92 to 99	P29_0 to P29_7	I/O	B	General-purpose input/output ports
	AN0 to AN7			Analog input pins of A/D converter
100 to 103	P28_0 to P28_3	I/O	B	General-purpose input/output ports
	AN8 to AN11			Analog input pins of A/D converter
104	ALARM_0	I	I	Alarm comparator input pin
110, 111	P28_4, P28_5	I/O	B	General-purpose input/output ports
	AN12 to AN13			Analog input pins of A/D converter
112	P27_0	I/O	F	General-purpose input/output ports
	SMC1P0			Controller output pin of Stepper motor
	AN16			Analog input pins of A/D converter
113	P27_1	I/O	F	General-purpose input/output ports
	SMC1M0			Controller output pin of Stepper motor
	AN17			Analog input pins of A/D converter
114	P27_2	I/O	F	General-purpose input/output ports
	SMC2P0			Controller output pin of Stepper motor
	AN18			Analog input pins of A/D converter
115	P27_3	I/O	F	General-purpose input/output ports
	SMC2M0			Controller output pin of Stepper motor
	AN19			Analog input pins of A/D converter
118	P27_4	I/O	F	General-purpose input/output ports
	SMC1P1			Controller output pin of Stepper motor
	AN20			Analog input pins of A/D converter
119	P27_5	I/O	F	General-purpose input/output ports
	SMC1M1			Controller output pin of Stepper motor
	AN21			Analog input pins of A/D converter
120	P27_6	I/O	F	General-purpose input/output ports
	SMC2P1			Controller output pin of Stepper motor
	AN22			Analog input pins of A/D converter
121	P27_7	I/O	F	General-purpose input/output ports
	SMC2M1			Controller output pin of Stepper motor
	AN23			Analog input pins of A/D converter

Pin no.	Pin name	I/O	I/O circuit type*	Function
122	P26_0	I/O	F	General-purpose input/output ports
	SMC1P2			Controller output pin of Stepper motor
	AN24			Analog input pins of A/D converter
123	P26_1	I/O	F	General-purpose input/output ports
	SMC1M2			Controller output pin of Stepper motor
	AN25			Analog input pins of A/D converter
124	P26_2	I/O	F	General-purpose input/output ports
	SMC2P2			Controller output pin of Stepper motor
	AN26			Analog input pins of A/D converter
125	P26_3	I/O	F	General-purpose input/output ports
	SMC2M2			Controller output pin of Stepper motor
	AN27			Analog input pins of A/D converter
128	P26_4	I/O	F	General-purpose input/output ports
	SMC1P3			Controller output pin of Stepper motor
	AN28			Analog input pins of A/D converter
129	P26_5	I/O	F	General-purpose input/output ports
	SMC1M3			Controller output pin of Stepper motor
	AN29			Analog input pins of A/D converter
130	P26_6	I/O	F	General-purpose input/output ports
	SMC2P3			Controller output pin of Stepper motor
	AN30			Analog input pins of A/D converter
131	P26_7	I/O	F	General-purpose input/output ports
	SMC2M3			Controller output pin of Stepper motor
	AN31			Analog input pins of A/D converter
132	P25_0	I/O	E	General-purpose input/output ports
	SMC1P4			Controller output pin of Stepper motor
133	P25_1	I/O	E	General-purpose input/output ports
	SMC1M4			Controller output pin of Stepper motor
134	P25_2	I/O	E	General-purpose input/output ports
	SMC2P4			Controller output pin of Stepper motor
135	P25_3	I/O	E	General-purpose input/output ports
	SMC2M4			Controller output pin of Stepper motor
138	P25_4	I/O	E	General-purpose input/output ports
	SMC1P5			Controller output pin of Stepper motor
139	P25_5	I/O	E	General-purpose input/output ports
	SMC1M5			Controller output pin of Stepper motor

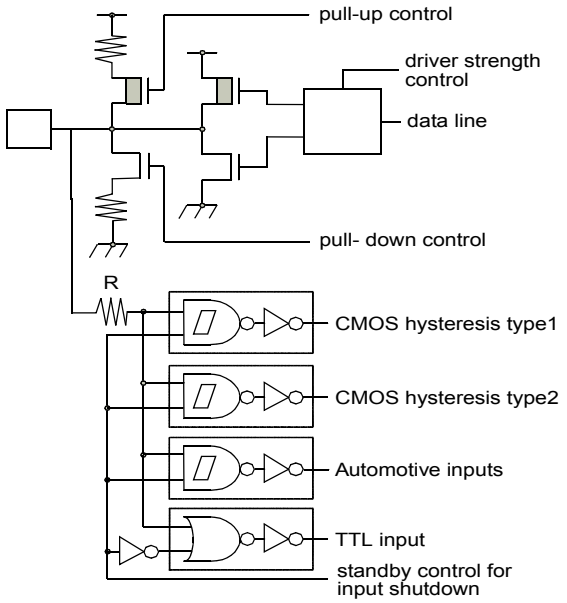
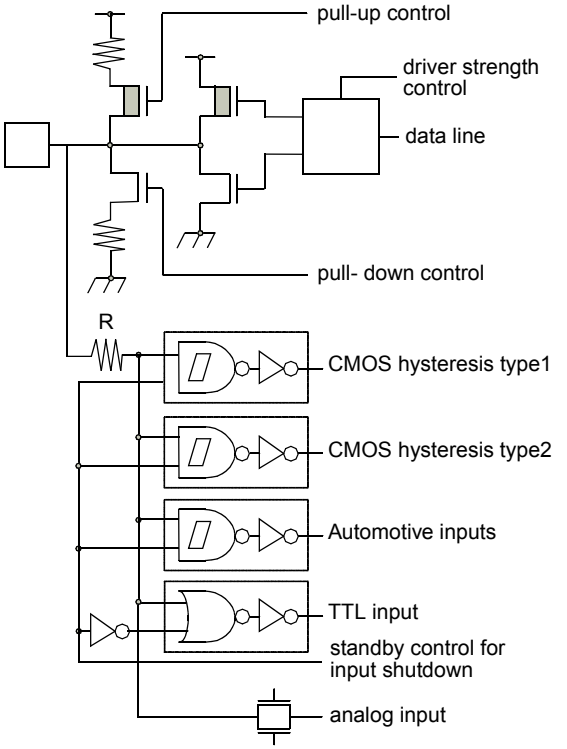
Pin no.	Pin name	I/O	I/O circuit type*	Function
140	P25_6	I/O	E	General-purpose input/output ports
	SMC2P5			Controller output pin of Stepper motor
141	P25_7	I/O	E	General-purpose input/output ports
	SMC2M5			Controller output pin of Stepper motor
142	P22_0	I/O	A	General-purpose input/output ports
	INT12			External Interrupt input (I^2C wakeup)
143	P22_2	I/O	A	General-purpose input/output ports
	INT13			External Interrupt input (I^2C wakeup)

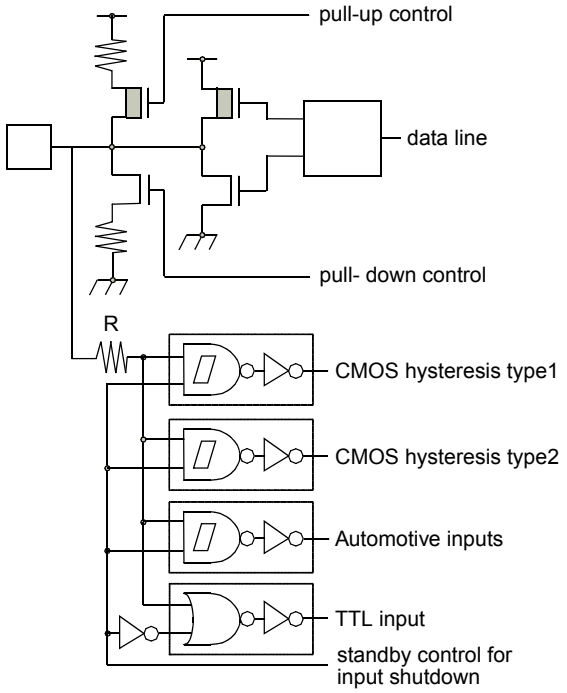
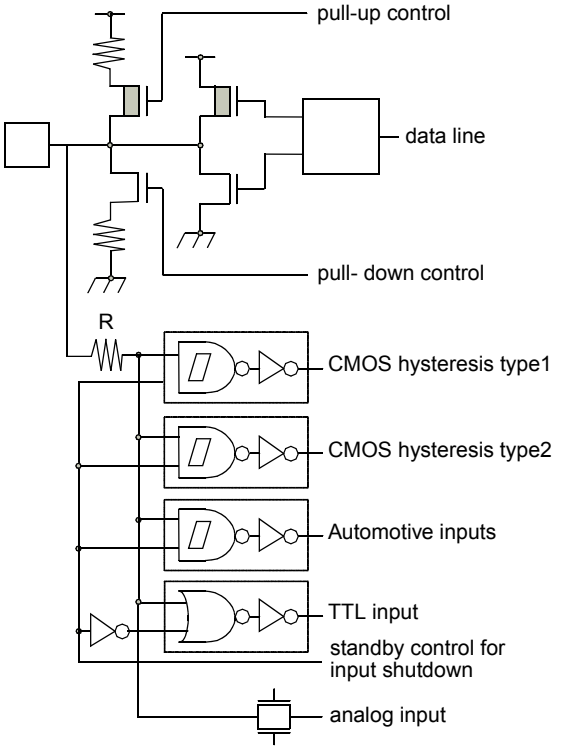
* : For information about the I/O circuit type, refer to “4. I/O Circuit Types”.

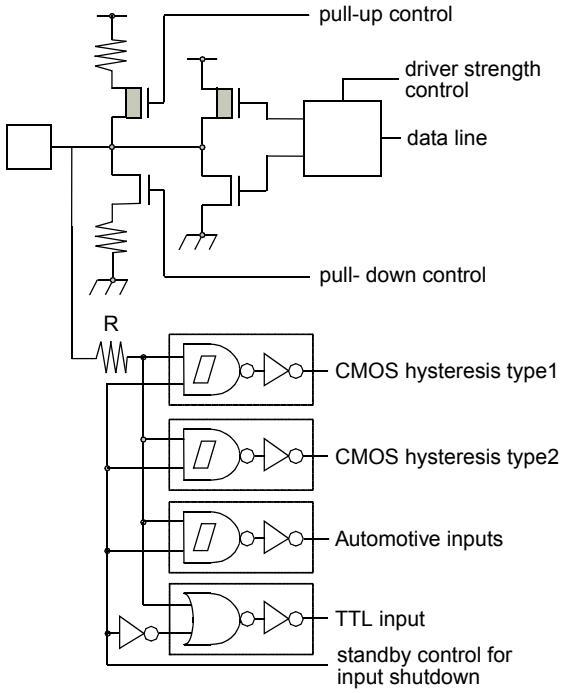
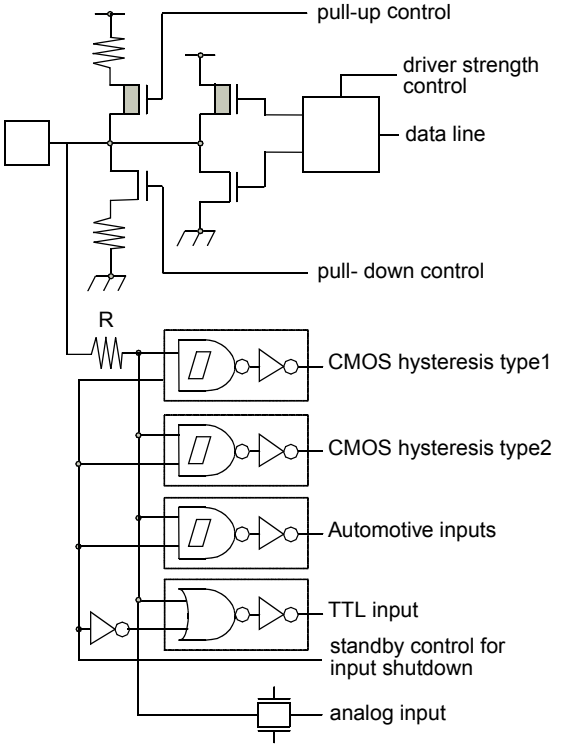
[Power supply/Ground pins]

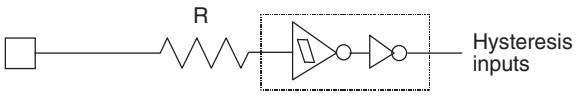
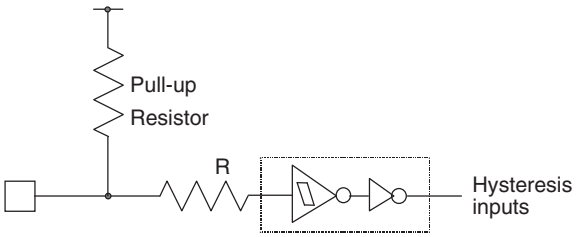
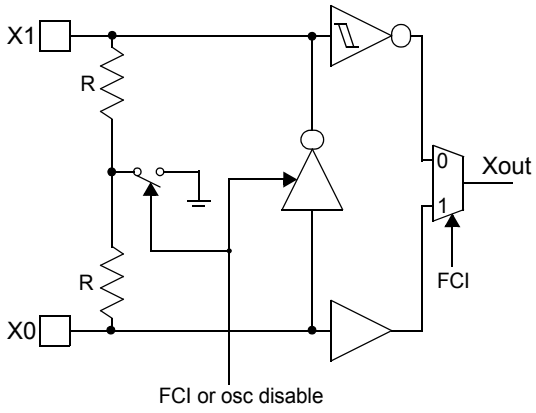
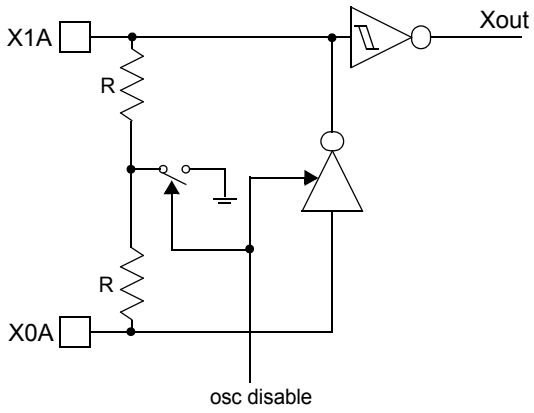
Pin no.	Pin name	I/O	Function
1, 19, 37, 55, 73, 81, 86, 91, 109	VSS5	Supply	Ground pins
117, 127, 137	HVSS5		Ground pins for Stepper motor controller
18, 36, 54, 72, 90, 108, 144	VDD5		Power supply pins
116, 126, 136	HVDD5		Power supply pins for Stepper motor controller
88, 89	VDD5R		Power supply pins for internal regulator
105	AVSS5		Analog ground pin for A/D converter
107	AVCC5		Power supply pin for A/D converter
106	AVRH5		Reference power supply pin for A/D converter
87	VCC18C		Capacitor connection pin for internal regulator

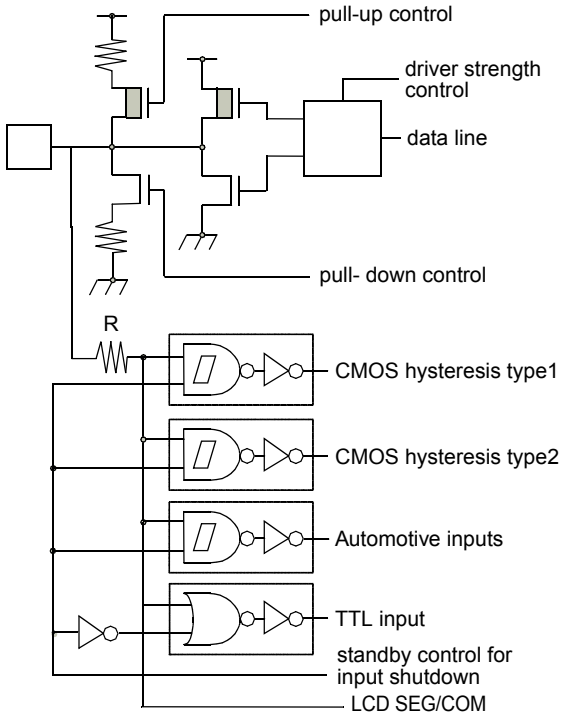
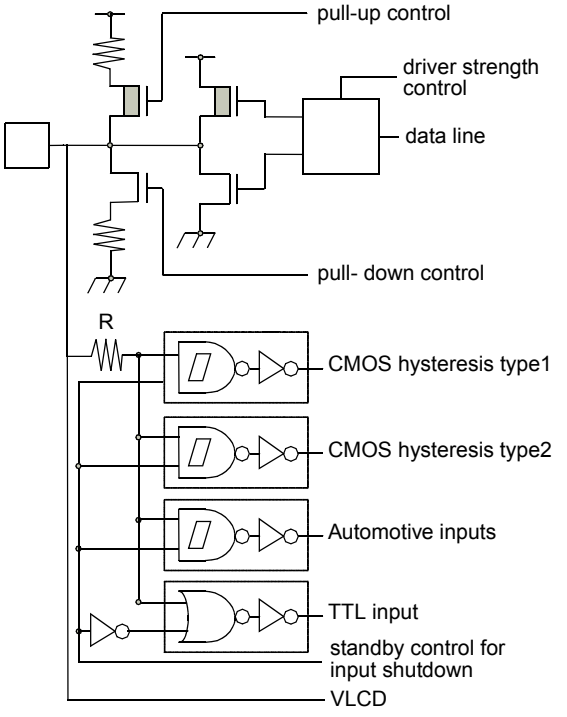
4. I/O Circuit Types

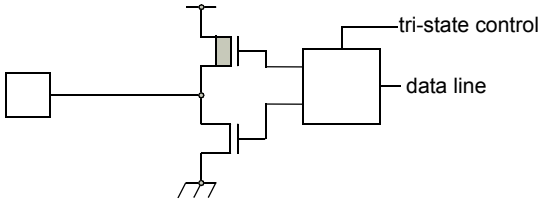
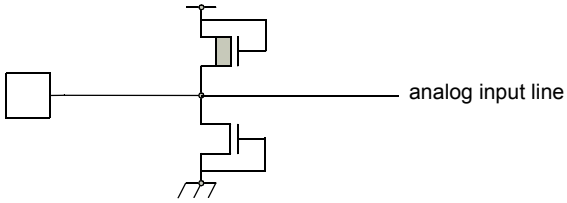
Type	Circuit	Remarks
A		CMOS level output (programmable I_{OL} = 5mA, I_{OH} = -5mA and I_{OL} = 2mA, I_{OH} = -2mA) 2 different CMOS hysteresis inputs with input shutdown function Automotive input with input shutdown function TTL input with input shutdown function Programmable pull-up resistor: 50kΩ approx.
B		CMOS level output (programmable I_{OL} = 5mA, I_{OH} = -5mA and I_{OL} = 2mA, I_{OH} = -2mA) 2 different CMOS hysteresis inputs with input shutdown function Automotive input with input shutdown function TTL input with input shutdown function Programmable pull-up resistor: 50kΩ approx. Analog input

Type	Circuit	Remarks
C		CMOS level output (I_{OL} = 3mA, I_{OH} = -3mA) 2 different CMOS hysteresis inputs with input shutdown function Automotive input with input shutdown function TTL input with input shutdown function Programmable pull-up resistor: 50kΩ approx.
D		CMOS level output (I_{OL} = 3mA, I_{OH} = -3mA) 2 different CMOS hysteresis inputs with input shutdown function Automotive input with input shutdown function TTL input with input shutdown function Programmable pull-up resistor: 50kΩ approx. Analog input

Type	Circuit	Remarks
E		CMOS level output (programmable I_{OL} = 5mA, I_{OH} = -5mA and I_{OL} = 2mA, I_{OH} = -2mA, and I_{OL} = 30mA, I_{OH} = -30mA) 2 different CMOS hysteresis inputs with input shutdown function Automotive input with input shutdown function TTL input with input shutdown function Programmable pull-up resistor: 50kΩ approx.
F		CMOS level output (programmable I_{OL} = 5mA, I_{OH} = -5mA and I_{OL} = 2mA, I_{OH} = -2mA, and I_{OL} = 30mA, I_{OH} = -30mA) 2 different CMOS hysteresis inputs with input shutdown function Automotive input with input shutdown function TTL input with input shutdown function Programmable pull-up resistor: 50kΩ approx. Analog input

Type	Circuit	Remarks
G		Mask ROM and EVA device: CMOS Hysteresis input pin Flash device: CMOS input pin 12 V withstand (for MD [2:0])
H		CMOS Hysteresis input pin Pull-up resistor value: 50 kΩ approx.
J1		High-speed oscillation circuit: • Programmable between oscillation mode (external crystal or resonator connected to X0/X1 pins) and Fast external Clock Input (FCI) mode (external clock connected to X0 pin) • Feedback resistor = approx. 2 * 0.5 MΩ. Feedback resistor is grounded in the center when the oscillator is disabled or in FCI mode.
J2		Low-speed oscillation circuit: • Feedback resistor = approx. 2 * 5 MΩ. Feedback resistor is grounded in the center when the oscillator is disabled.

Type	Circuit	Remarks
K		CMOS level output (programmable I_{OL} = 5mA, I_{OH} = -5mA and I_{OL} = 2mA, I_{OH} = -2mA) 2 different CMOS hysteresis inputs with input shutdown function Automotive input with input shutdown function TTL input with input shutdown function Programmable pull-up resistor: 50kΩ approx. LCD SEG/COM output
L		CMOS level output (programmable I_{OL} = 5mA, I_{OH} = -5mA and I_{OL} = 2mA, I_{OH} = -2mA) 2 different CMOS hysteresis inputs with input shutdown function Automotive input with input shutdown function) TTL input with input shutdown function Programmable pull-up resistor: 50kΩ approx. Analog input LCD Voltage input

Type	Circuit	Remarks
M		CMOS level tri-state output (I_{OL} = 5mA, I_{OH} = -5mA)
N		Analog input pin with protection

5. Handling Devices

5.1 Preventing Latch-up

Latch-up may occur in a CMOS IC if a voltage higher than ($V_{DD}5$, $V_{DD}35$ or $HV_{DD}5$ *1) or less than ($V_{SS}5$ or $HV_{SS}5$ *1) is applied to an input or output pin or if a voltage exceeding the rating is applied between the power supply pins and ground pins. If latch-up occurs, the power supply current increases rapidly, sometimes resulting in thermal breakdown of the device. Therefore, be very careful not to apply voltages in excess of the absolute maximum ratings.

Note *1: $HV_{DD}5$, $HV_{SS}5$ are available only on devices having Stepper Motor Controller.

5.2 Handling of unused input pins

If unused input pins are left open, abnormal operation may result. Any unused input pins should be connected to pull-up or pull-down resistor (2KΩ to 10KΩ) or enable internal pullup or pulldown resisters (PPER/PPCR) before the input enable (PORTEN) is activated by software. The mode pins MD_x can be connected to $V_{SS}5$ or $V_{DD}5$ directly. Unused ALARM input pins can be connected to $AV_{SS}5$ directly.

5.3 Power supply pins

In MB91460 series, devices including multiple power supply pins and ground pins are designed as follows; pins necessary to be at the same potential are interconnected internally to prevent malfunctions such as latch-up. All of the power supply pins and ground pins must be externally connected to the power supply and ground respectively in order to reduce unnecessary radiation, to prevent strobe signal malfunctions due to the ground level rising and to follow the total output current ratings. Furthermore, the power supply pins and ground pins of the MB91460 series must be connected to the current supply source via a low impedance.
It is also recommended to connect a ceramic capacitor of approximately 0.1 µF as a bypass capacitor between power supply pin and ground pin near this device.
This series has a built-in step-down regulator. Connect a bypass capacitor of 4.7 µF (use a X7R ceramic capacitor) to VCC18C pin for the regulator.

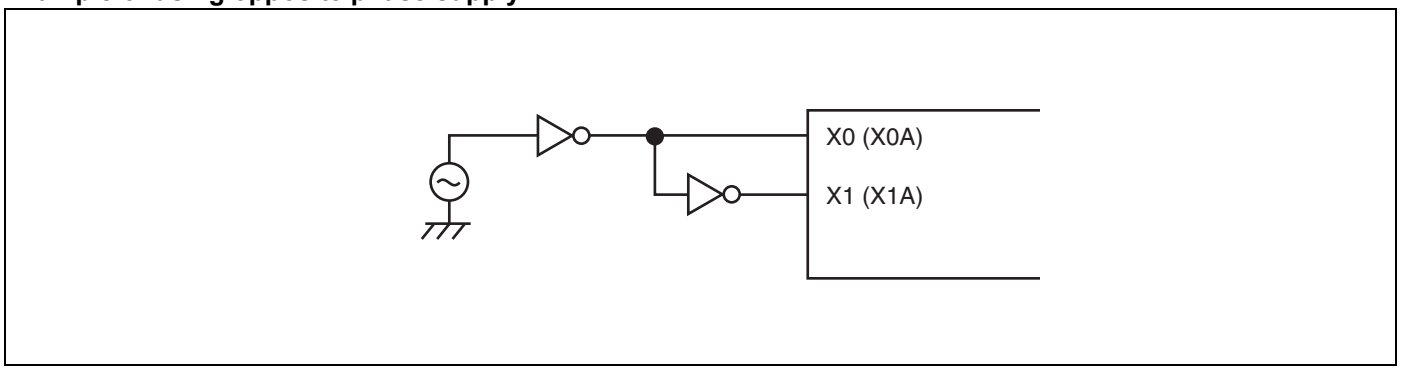
5.4 Crystal oscillator circuit

Noise in proximity to the X0 (X0A) and X1 (X1A) pins can cause the device to operate abnormally. Printed circuit boards should be designed so that the X0 (X0A) and X1 (X1A) pins, and crystal oscillator, as well as bypass capacitors connected to ground, are located near the device and ground.
It is recommended that the printed circuit board layout be designed such that the X0 and X1 pins or X0A and X1A pins are surrounded by ground plane for the stable operation.
Please request the oscillator manufacturer to evaluate the oscillational characteristics of the crystal and this device.

5.5 Notes on using external clock

When using the external clock, it is necessary to simultaneously supply the X0 (X0A) and the X1 (X1A) pins. In the described combination, X1 (X1A) should be supplied with a clock signal which has the opposite phase to the X0 (X0A) pins. At X0 and X1, a frequency up to 16 MHz is possible.

Example of using opposite phase supply



(Continued)

(Continued)

5.6 Mode pins (MD_x)

These pins should be connected directly to the power supply or ground pins. To prevent the device from entering test mode accidentally due to noise, minimize the lengths of the patterns between each mode pin and power supply pin or ground pin on the printed circuit board as possible and connect them with low impedance.

5.7 Notes on operating in PLL clock mode

If the oscillator is disconnected or the clock input stops when the PLL clock is selected, the microcontroller may continue to operate at the free-running frequency of the self-oscillating circuit of the PLL. However, this self-running operation cannot be guaranteed.

5.8 Pull-up control

The AC standard is not guaranteed in case a pull-up resistor is connected to the pin serving as an external bus pin.

6. Notes on Debugger

6.1 Execution of the RETI Command

If single-step execution is used in an environment where an interrupt occurs frequently, the corresponding interrupt handling routine will be executed repeatedly to the exclusion of other processing. This will prevent the main routine and the handlers for low priority level interrupts from being executed (For example, if the time-base timer interrupt is enabled, stepping over the RETI instruction will always break on the first line of the time-base timer interrupt handler).

Disable the corresponding interrupts when the corresponding interrupt handling routine no longer needs debugging.

6.2 Break function

If the range of addresses that cause a hardware break (including event breaks) is set to the address of the current system stack pointer or to an area that contains the stack pointer, execution will break after each instruction regardless of whether the user program actually contains data access instructions.

To prevent this, do not set (word) access to the area containing the address of the system stack pointer as the target of the hardware break (including an event breaks).

6.3 Operand break

It may cause malfunctions if a stack pointer exists in the area which is set as the DSU operand break. Do not set the access to the areas containing the address of system stack pointer as a target of data event break.

6.4 Notes on PS register

As the PS register is processed in advance by some instructions, when the debugger is being used, the exception handling may result in execution breaking in an interrupt handling routine or the displayed values of the flags in the PS register being updated.
As the microcontroller is designed to carry out reprocessing correctly upon returning from such an EIT event, the operation before and after the EIT always proceeds according to specification.

The following behavior may occur if any of the following occurs in the instruction immediately after a DIV0U/DIV0S instruction:

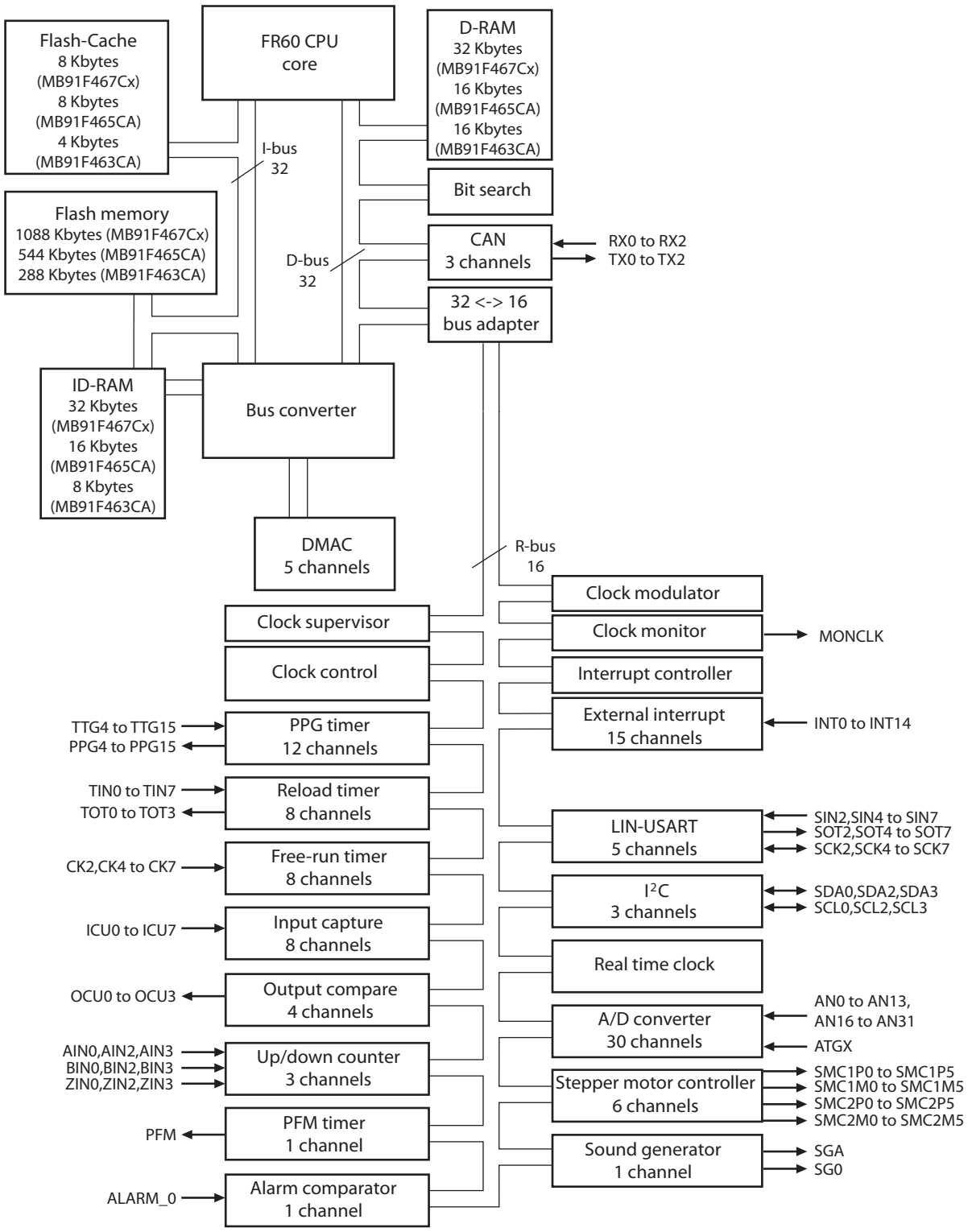
a. a user interrupt or NMI is accepted;
b. single-step execution is performed;
c. execution breaks due to a data event or from the emulator menu.
   1. D0 and D1 flags are updated in advance.
   2. An EIT handling routine (user interrupt/NMI or emulator) is executed.
   3. Upon returning from the EIT, the DIV0U/DIV0S instruction is executed and the D0 and D1 flags are updated to the same values as those in 1.

The following behavior occurs when an ORCCR, STILM, MOV Ri,PS instruction is executed to enable a user interrupt or NMI source while that interrupt is in the active state.

1. The PS register is updated in advance.
2. An EIT handling routine (user interrupt/NMI or emulator) is executed.
3. Upon returning from the EIT, the above instructions are executed and the PS register is updated to the same value as in 1.

7. Block Diagram

7.1 MB91F463CA, MB91F465CA, MB91F467Cx



8. CPU and Control Unit

The FR family CPU is a high performance core that is designed based on the RISC architecture with advanced instructions for embedded applications.

8.1 Features

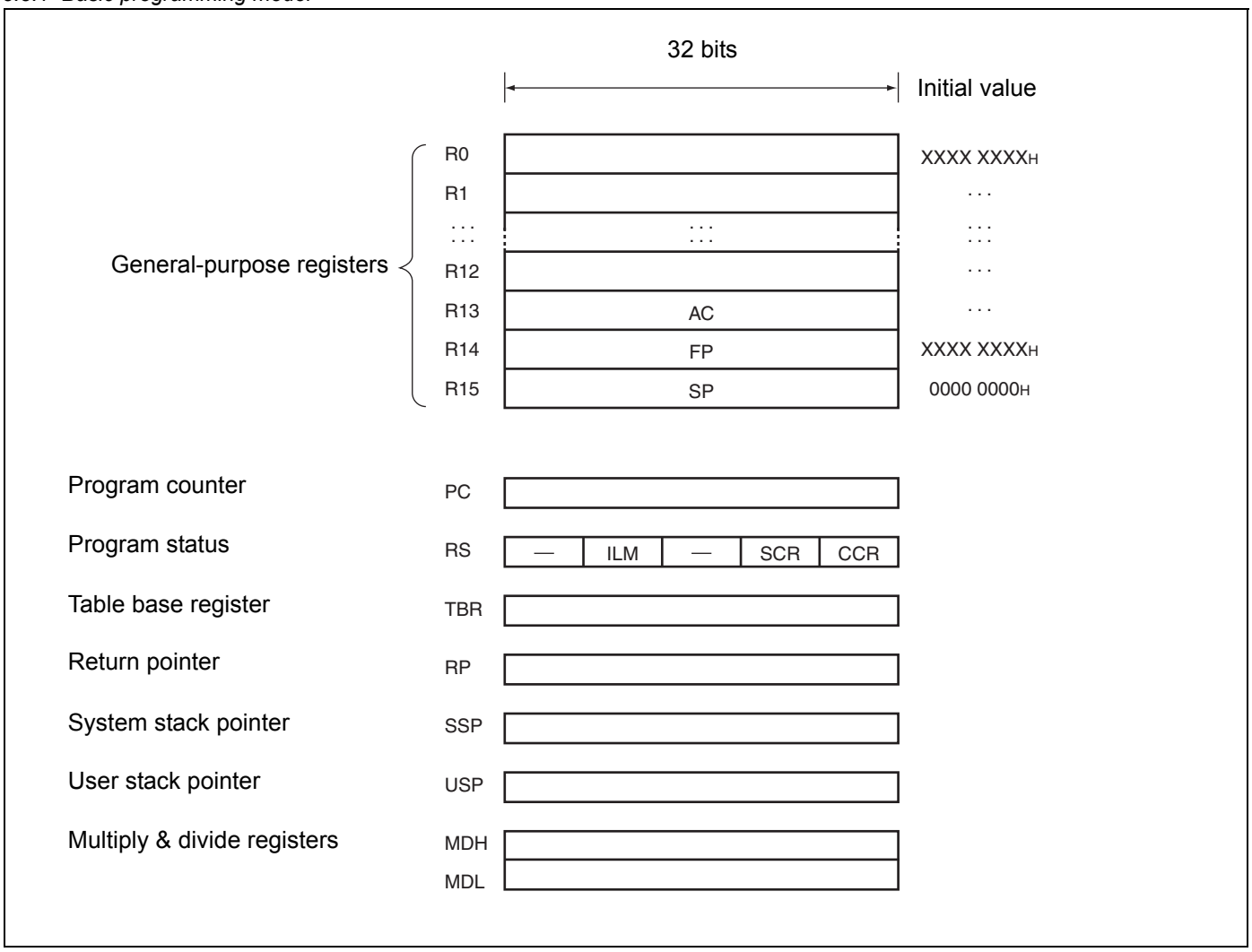
- Adoption of RISC architecture
  Basic instruction: 1 instruction per cycle
- General-purpose registers: 32-bit × 16 registers
- 4 Gbytes linear memory space
- Multiplier installed
  32-bit × 32-bit multiplication: 5 cycles
  16-bit × 16-bit multiplication: 3 cycles
- Enhanced interrupt processing function
  Quick response speed (6 cycles)
  Multiple-interrupt support
  Level mask function (16 levels)
- Enhanced instructions for I/O operation
  Memory-to-memory transfer instruction
  Bit processing instruction
  Basic instruction word length: 16 bits
- Low-power consumption
  Sleep mode/stop mode

8.2 Internal architecture

- The FR family CPU uses the Harvard architecture in which the instruction bus and data bus are independent of each other.
- A 32-bit ↔ 16-bit buffer is connected to the 32-bit bus (D-bus) to provide an interface between the CPU and peripheral resources.
- A Harvard ↔ Princeton bus converter is connected to both the I-bus and D-bus to provide an interface between the CPU and the bus controller.

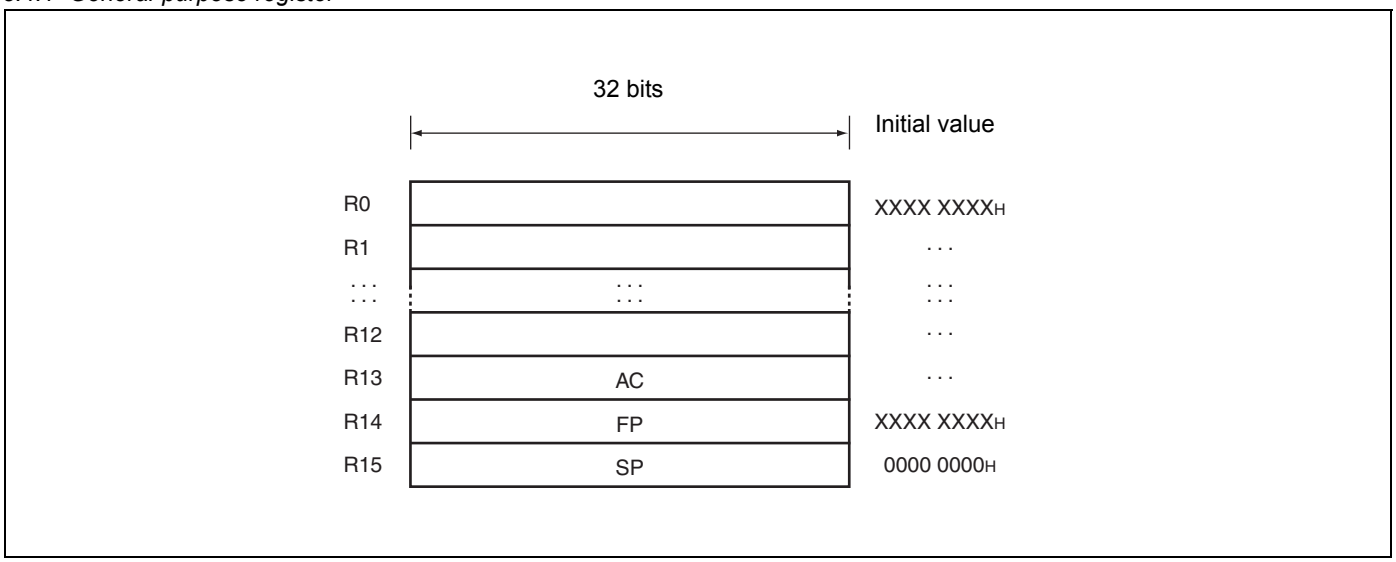
8.3 Programming model

8.3.1 Basic programming model



8.4 Registers

8.4.1 General-purpose register



Registers R0 to R15 are general-purpose registers. These registers can be used as accumulators for computation operations and as pointers for memory access.

Of the 16 registers, enhanced commands are provided for the following registers to enable their use for particular applications.

R13 : Virtual accumulator

R14 : Frame pointer

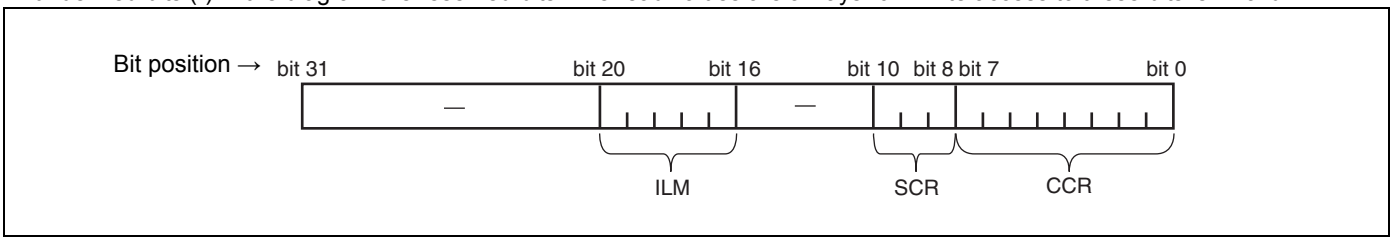
R15 : Stack pointer

Initial values at reset are undefined for R0 to R14. The value for R15 is 00000000_H (SSP value).

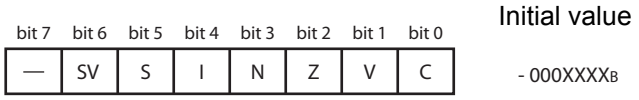
8.4.2 PS (Program Status)

This register holds the program status, and is divided into three parts, ILM, SCR, and CCR.

All undefined bits (-) in the diagram are reserved bits. The read values are always “0”. Write access to these bits is invalid.

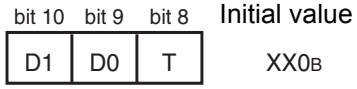


8.4.3 CCR (Condition Code Register)



SV : Supervisor flag
S : Stack flag
I : Interrupt enable flag
N : Negative enable flag
Z : Zero flag
V : Overflow flag
C : Carry flag

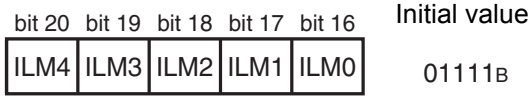
8.4.4 SCR (System Condition Register)



Flag for step division (D1, D0)
This flag stores interim data during execution of step division.

Step trace trap flag (T)
This flag indicates whether the step trace trap is enabled or disabled.
The step trace trap function is used by emulators. When an emulator is in use, it cannot be used in execution of user programs.

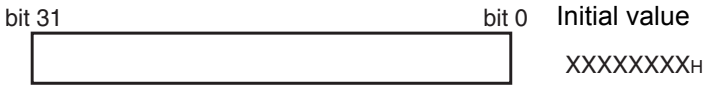
8.4.5 ILM (Interrupt Level Mask register)



This register stores interrupt level mask values, and the values stored in ILM4 to ILM0 are used for level masking.

The register is initialized to value “01111_B” at reset.

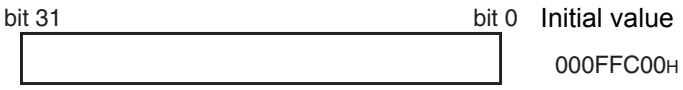
8.4.6 PC (Program Counter)



The program counter indicates the address of the instruction that is being executed.

The initial value at reset is undefined.

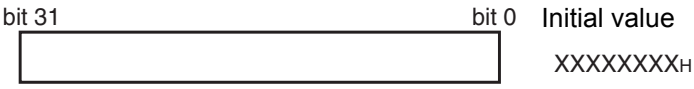
8.4.7 TBR (Table Base Register)



The table base register stores the starting address of the vector table used in EIT processing.

The initial value at reset is $000FFC00_H$.

8.4.8 RP (Return Pointer)



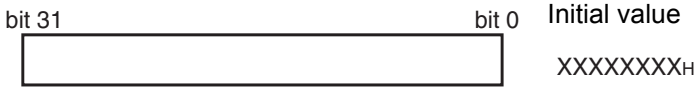
The return pointer stores the address for return from subroutines.

During execution of a CALL instruction, the PC value is transferred to this RP register.

During execution of a RET instruction, the contents of the RP register are transferred to PC.

The initial value at reset is undefined.

8.4.9 USP (User Stack Pointer)

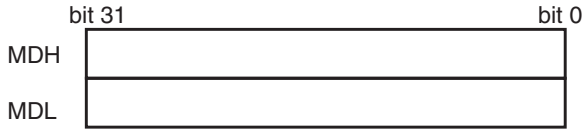


The user stack pointer, when the S flag is “1”, this register functions as the R15 register.

- The USP register can also be explicitly specified.

  The initial value at reset is undefined.
- This register cannot be used with RETI instructions.

8.4.10 Multiply & divide registers



These registers are for multiplication and division, and are each 32 bits in length.

The initial value at reset is undefined.

9. Embedded Program/data Memory (Flash)

9.1 Flash features

- MB91F467Cx: 1088 Kbytes (16 × 64 Kbytes + 8 × 8 Kbytes = 8.5 Mbits)
- MB91F465CA:544 Kbytes (8 × 64 Kbytes + 4 × 8 Kbytes = 4.25 Mbits)
- MB91F463CA:288 Kbytes (4 × 64 Kbytes + 4 × 8 Kbytes = 2.25 Mbits)
- Programmable wait states for read/write access
- Flash and Boot security with security vector at 0x0014:8000 - 0x0014:800F
- Boot security
- Basic specification: Same as MBM29LV400TC (except size and part of sector configuration)

9.2 Operation modes:

(1) 64-bit CPU mode (available on MB91F467Cx only) :
- CPU reads and executes programs in word (32-bit) length units.
- Flash writing is not possible.
- Actual Flash Memory access is performed in d-word (64-bit) length units.

(1) 32-bit CPU mode:
- CPU reads and executes programs in word (32-bit) length units.
- Actual Flash Memory access is performed in word (32-bit) length units.

(2) 16-bit CPU mode:
- CPU reads and writes in half-word (16-bit) length units.
- Program execution from the Flash is not possible.
- Actual Flash Memory access is performed in word (16-bit) length units.

Note: The operation mode of the MCU can be selected using a Boot-ROM function. The function start address is 0xBF60. The parameter description is given in the Hardware Manual in chapter 54.6 “Flash Access Mode Switching”.

9.3 Flash access in CPU mode

9.3.1 Flash configuration

Flash memory map MB91F467Cx

Address									
0014:FFFFh 0014:C000h	SA6 (8KB)				SA7 (8KB)				ROMS7
0014:BFFFh 0014:8000h	SA4 (8KB)				SA5 (8KB)				
0014:7FFFh 0014:4000h	SA2 (8KB)				SA3 (8KB)				
0014:3FFFh 0014:0000h	SA0 (8KB)				SA1 (8KB)				
0013:FFFFh 0012:0000h	SA22 (64KB)				SA23 (64KB)				ROMS6
0011:FFFFh 0010:0000h	SA20 (64KB)				SA21 (64KB)				
000F:FFFFh 000E:0000h	SA18 (64KB)				SA19 (64KB)				ROMS5
000D:FFFFh 000C:0000h	SA16 (64KB)				SA17 (64KB)				ROMS4
000B:FFFFh 000A:0000h	SA14 (64KB)				SA15 (64KB)				ROMS3
0009:FFFFh 0008:0000h	SA12 (64KB)				SA13 (64KB)				ROMS2
0007:FFFFh 0006:0000h	SA10 (64KB)				SA11 (64KB)				ROMS1
0005:FFFFh 0004:0000h	SA8 (64KB)				SA9 (64KB)				ROMS0
	addr+0	addr+1	addr+2	addr+3	addr+4	addr+5	addr+6	addr+7	
16bit read/write	dat[31:16]		dat[15:0]		dat[31:16]		dat[15:0]		
32bit read/write	dat[31:0]				dat[31:0]				
64bit read	dat[63:0]								

Flash memory map MB91F465CA

Addr									
0014:FFFFh 0014:C000h	SA6 (8KB)				SA7 (8KB)				ROMS7
0014:BFFFh 0014:8000h	SA4 (8KB)				SA5 (8KB)				
0014:7FFFh 0014:4000h	SA2 (8KB)				SA3 (8KB)				
0014:3FFFh 0014:0000h	SA0 (8KB)				SA1 (8KB)				
0013:FFFFh 0012:0000h	SA22 (64KB)				SA23 (64KB)				ROMS6
0011:FFFFh 0010:0000h	SA20 (64KB)				SA21 (64KB)				
000F:FFFFh 000E:0000h	SA18 (64KB)				SA19 (64KB)				ROMS5
000D:FFFFh 000C:0000h	SA16 (64KB)				SA17 (64KB)				ROMS4
000B:FFFFh 000A:0000h	SA14 (64KB)				SA15 (64KB)				ROMS3
0009:FFFFh 0008:0000h	SA12 (64KB)				SA13 (64KB)				ROMS2
0007:FFFFh 0006:0000h	SA10 (64KB)				SA11 (64KB)				ROMS1
0005:FFFFh 0004:0000h	SA8 (64KB)				SA9 (64KB)				ROMS0
	addr+0	addr+1	addr+2	addr+3	addr+4	addr+5	addr+6	addr+7	
16bit read/write	dat[31:16]		dat[15:0]		dat[31:16]		dat[15:0]		
32bit read	dat[31:0]				dat[31:0]				
Legend	Memory not available in this area				Memory available in this area				

Flash Memory Map MB91F463CA

Address									
0014:FFFFh 0014:C000h	SA6 (8KB)				SA7 (8KB)				ROMS7
0014:BFFFh 0014:8000h	SA4 (8KB)				SA5 (8KB)				
0014:7FFFh 0014:4000h	SA2 (8KB)				SA3 (8KB)				
0014:3FFFh 0014:0000h	SA0 (8KB)				SA1 (8KB)				
0013:FFFFh 0012:0000h	SA22 (64KB)				SA23 (64KB)				ROMS6
0011:FFFFh 0010:0000h	SA20 (64KB)				SA21 (64KB)				
000F:FFFFh 000E:0000h	SA18 (64KB)				SA19 (64KB)				ROMS5
000D:FFFFh 000C:0000h	SA16 (64KB)				SA17 (64KB)				ROMS4
000B:FFFFh 000A:0000h	SA14 (64KB)				SA15 (64KB)				ROMS3
0009:FFFFh 0008:0000h	SA12 (64KB)				SA13 (64KB)				ROMS2
0007:FFFFh 0006:0000h	SA10 (64KB)				SA11 (64KB)				ROMS1
0005:FFFFh 0004:0000h	SA8 (64KB)				SA9 (64KB)				ROMS0
	addr+0	addr+1	addr+2	addr+3	addr+4	addr+5	addr+6	addr+7	
16bit read/write	dat[31:16]		dat[15:0]		dat[31:16]		dat[15:0]		
32bit read	dat[31:0]				dat[31:0]				
Legend	Memory not available in this area				Memory available in this area				

9.3.2 Flash access timing settings in CPU mode

The following tables list all settings for a given maximum Core Frequency (through the setting of CLKB or maximum clock modulation) for Flash read and write access.

Flash read timing settings (synchronous read)

Core clock (CLKB)	ATD	ALEH	EQ	WEXH	WTC	Remark
to 24 MHz	0	0	0	-	1	
to 48 MHz	0	0	1	-	2	
to 100 MHz	1	1	3	-	4	

Flash write timing settings (synchronous write)

Core clock (CLKB)	ATD	ALEH	EQ	WEXH	WTC	Remark
to 16 MHz	0	-	-	0	3	
to 32 MHz	0	-	-	0	4	
to 48 MHz	0	-	-	0	5	
to 64 MHz	1	-	-	0	6	
to 96 MHz	1	-	-	0	7	
to 100 MHz	1	-	-	1	8	

9.3.3 Address mapping from CPU to parallel programming mode

The following tables show the calculation from CPU addresses to flash macro addresses which are used in parallel programming.

Address mapping MB91F467Cx

CPU Address (addr)	Condition	Flash sectors	FA (flash address) Calculation
14:0000h to 14:FFFFh	addr[2]==0	SA0, SA2, SA4, SA6 (8 Kbyte)	FA := addr - addr%00:4000h + (addr%00:4000h)/2 - (addr/2)%4 + addr%4 - 05:0000h
14:0000h to 14:FFFFh	addr[2]==1	SA1, SA3, SA5, SA7 (8 Kbyte)	FA := addr - addr%00:4000h + (addr%00:4000h)/2 + 00:2000h - (addr/2)%4 + addr%4 - 05:0000h
04:0000h to 13:FFFFh	addr[2]==0	SA8, SA10, SA12, SA14, SA16, SA18, SA20, SA22 (64 Kbyte)	FA := addr - addr%02:0000 + (addr%02:0000h)/2 - (addr/2)%4 + addr%4 + 0C:0000h
04:0000h to 13:FFFFh	addr[2]==1	SA9, SA11, SA13, SA15, SA17, SA19, SA21, SA23 (64 Kbyte)	FA := addr - addr%02:0000h + (addr%02:0000h)/2 + 01:0000h - (addr/2)%4 + addr%4 + 0C:0000h

Note: FA result is without 20:0000h offset for parallel Flash programming.
Set offset by keeping FA[21] = 1 as described in section “Parallel Flash programming mode”.

Address mapping MB91F463CA, MB91F465CA

CPU Address (addr)	Condition	Flash sectors	FA (flash address) Calculation
14:8000h to 14:FFFFh	addr[2]==0	SA4, SA6 (8 Kbyte)	FA := addr - addr%00:4000h + (addr%00:4000h)/2 - (addr/2)%4 + addr%4 - 0D:0000h
14:8000h to 14:FFFFh	addr[2]==1	SA5, SA7 (8 Kbyte)	FA := addr - addr%00:4000h + (addr%00:4000h)/2 + 00:2000h - (addr/2)%4 + addr%4 - 0D:0000h
08:0000h to 13F:FFFFh	addr[2]==0	SA12, SA14 (MB91F465CA) SA16, SA18 (64 Kbyte)	FA := addr - addr%02:0000 + (addr%02:0000h)/2 - (addr/2)%4 + addr%4
08:0000h to 13F:FFFFh	addr[2]==1	SA13, SA15 (MB91F465CA) SA17, SA19 (64 Kbyte)	FA := addr - addr%02:0000h + (addr%02:0000h)/2 + 01:0000h - (addr/2)%4 + addr%4

Note: FA result is without 10:0000h offset for parallel Flash programming.
Set offset by keeping FA[20] = 1 as described in section “Parallel Flash programming mode”.

9.4 Parallel Flash programming mode

9.4.1 Flash configuration in parallel Flash programming mode

Parallel Flash programming mode (MD[2:0] = 111):

MB91F467Cx

FA[21:0]	
003F:FFFFh 003F:0000h	SA23 (64KB)
003E:FFFFh 003E:0000h	SA22 (64KB)
003D:FFFFh 003D:0000h	SA21 (64KB)
003C:FFFFh 003C:0000h	SA20 (64KB)
003B:FFFFh 003B:0000h	SA19 (64KB)
003A:FFFFh 003A:0000h	SA18 (64KB)
0039:FFFFh 0039:0000h	SA17 (64KB)
0038:FFFFh 0038:0000h	SA16 (64KB)
0037:FFFFh 0037:0000h	SA15 (64KB)
0036:FFFFh 0036:0000h	SA14 (64KB)
0035:FFFFh 0035:0000h	SA13 (64KB)
0034:FFFFh 0034:0000h	SA12 (64KB)
0033:FFFFh 0033:0000h	SA11 (64KB)
0032:FFFFh 0032:0000h	SA10 (64KB)
0031:FFFFh 0031:0000h	SA9 (64KB)
0030:FFFFh 0030:0000h	SA8 (64KB)
002F:FFFFh 002F:E000h	SA7 (8KB)
002F:DFFFh 002F:C000h	SA6 (8KB)
002F:BFFFh 002F:A000h	SA5 (8KB)
002F:9FFFh 002F:8000h	SA4 (8KB)
002F:7FFFh 002F:6000h	SA3 (8KB)
002F:5FFFh 002F:4000h	SA2 (8KB)
002F:3FFFh 002F:2000h	SA1 (8KB)
002F:1FFFh 002F:0000h	SA0 (8KB)

	FA[1:0]=00	FA[1:0]=10
16bit write mode	DQ[15:0]	DQ[15:0]

Remark: Always keep FA[0] = 0 and FA[21] = 1

MB91F465CA

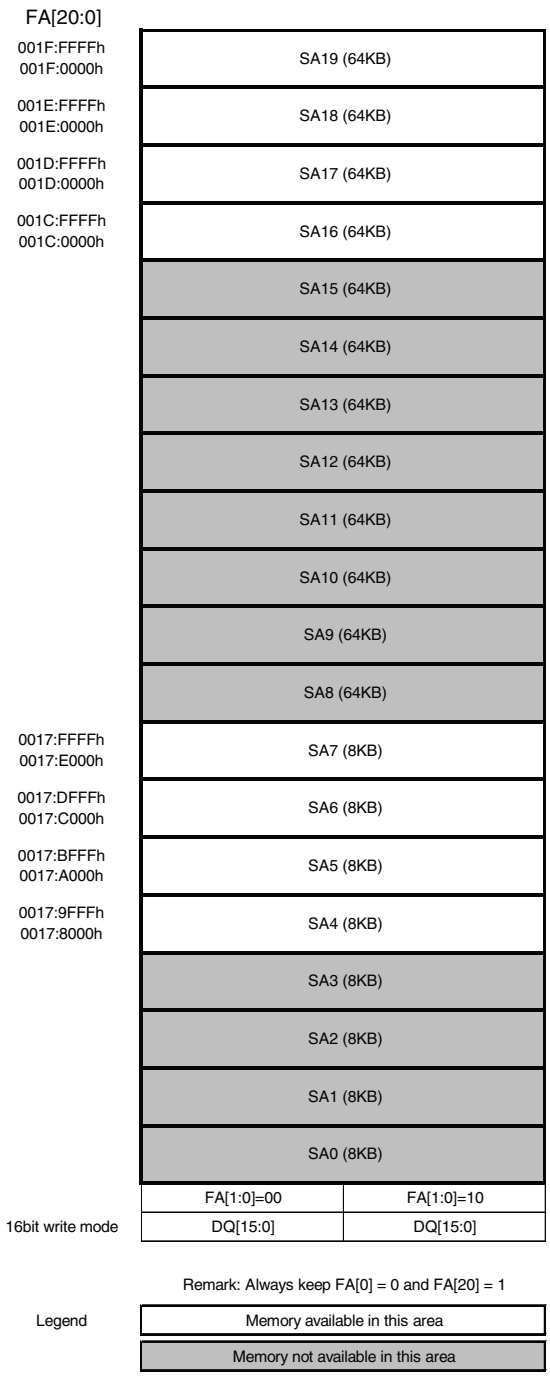
FA[20:0]	
001F:FFFFh 001F:0000h	SA19 (64KB)
001E:FFFFh 001E:0000h	SA18 (64KB)
001D:FFFFh 001D:0000h	SA17 (64KB)
001C:FFFFh 001C:0000h	SA16 (64KB)
001B:FFFFh 001B:0000h	SA15 (64KB)
001A:FFFFh 001A:0000h	SA14 (64KB)
0019:FFFFh 0019:0000h	SA13 (64KB)
0018:FFFFh 0018:0000h	SA12 (64KB)
	SA11 (64KB)
	SA10 (64KB)
	SA9 (64KB)
	SA8 (64KB)
0017:FFFFh 0017:E000h	SA7 (8KB)
0017:DFFFh 0017:C000h	SA6 (8KB)
0017:BFFFh 0017:A000h	SA5 (8KB)
0017:9FFFh 0017:8000h	SA4 (8KB)
	SA3 (8KB)
	SA2 (8KB)
	SA1 (8KB)
	SA0 (8KB)

	FA[1:0]=00	FA[1:0]=10
16bit write mode	DQ[15:0]	DQ[15:0]

Remark: Always keep FA[0] = 0 and FA[20] = 1

Legend	
	Memory available in this area
	Memory not available in this area

MB91F463CA


FA[20:0]
001F:FFFFh
001F:0000h
SA19 (64KB)
001E:FFFFh
001E:0000h
SA18 (64KB)
001D:FFFFh
001D:0000h
SA17 (64KB)
001C:FFFFh
001C:0000h
SA16 (64KB)
SA15 (64KB)
SA14 (64KB)
SA13 (64KB)
SA12 (64KB)
SA11 (64KB)
SA10 (64KB)
SA9 (64KB)
SA8 (64KB)
0017:FFFFh
0017:E000h
SA7 (8KB)
0017:DFFFh
0017:C000h
SA6 (8KB)
0017:BFFFh
0017:A000h
SA5 (8KB)
0017:9FFFh
0017:8000h
SA4 (8KB)
SA3 (8KB)
SA2 (8KB)
SA1 (8KB)
SA0 (8KB)
FA[1:0]=00
FA[1:0]=10
16bit write mode
DQ[15:0]
DQ[15:0]
Remark: Always keep FA[0] = 0 and FA[20] = 1
Legend
Memory available in this area
Memory not available in this area

9.4.2 Pin connections in parallel programming mode

Resetting after setting the MD[2:0] pins to [111] will halt CPU functioning. At this time, the Flash memory's interface circuit enables direct control of the Flash memory unit from external pins by directly linking some of the signals to GP-Ports. Please see table below for signal mapping.

In this mode, the Flash memory appears to the external pins as a stand-alone unit. This mode is generally set when writing/erasing using the parallel Flash programmer. In this mode, all operations of the 8.5 Mbits Flash memory's Auto Algorithms are available.

Correspondence between MBM29LV400TC and Flash Memory Control Signals

MBM29LV400TC External pins	FR-CPU mode	MB91F465CA, MB91F467Cx external pins			Comment
		Flash memory mode	Normal function	Pin number	
—	INITX	—	INITX	84	
RESET	—	FRSTX	NMIX	85	
—	—	MD_2	MD_2	76	Set to ‘1’
—	—	MD_1	MD_1	75	Set to ‘1’
—	—	MD_0	MD_0	74	Set to ‘1’
RY/BY	FMCS:RDY bit	RY/BYX	GP28_0	100	
BYTE	Internally fixed to ‘H’	BYTEX	GP28_2	102	
WE	Internal control signal + control via interface circuit	WEX	GP28_5	111	
OE		OEX	GP28_4	110	
CE		CEX	GP20_0	38	
—		ATDIN	GP17_7	27	Set to ‘0’
—		EQIN	GP17_6	26	Set to ‘0’
—		TESTX	GP28_3	103	Set to ‘1’
—		RDYI	GP28_1	101	Set to ‘0’
A-1	Internal address bus	FA0	GP17_5	25	Set to ‘0’
A0 to A3		FA1 to FA4	GP29_0 to GP29_3	92 to 95	
A4 to A7		FA5 to FA8	GP29_4 to GP29_7	96 to 99	
A8 to A11		FA9 to FA12	GP16_0 to GP16_3	28 to 31	
A12 to A15		FA13 to FA16	GP16_4 to GP16_7	32 to 35	
A16 to A18		FA17 to FA19	GP15_0 to GP15_2	20 to 22	
A19		FA20	GP15_3	23	Set to ‘1’ on MB91F463CA, MB91F465CA
—		FA21	GP17_4	24	Set to ‘1’
DQ0 to DQ7	Internal data bus	DQ0 to DQ7	GP14_0 to GP14_7	10 to 17	
DQ8 to DQ15		DQ8 to DQ15	GP02_0 to GP02_7	2 to 9	

9.5 Power on Sequence in parallel programming mode

The flash memory can be accessed in programming mode after a certain wait time, which is needed for Security Vector fetch:

- Minimum wait time after VDD5/VDD5R power on: 2.76 ms
- Minimum wait time after INITX rising: 1.0 ms

9.6 Flash Security

9.6.1 Vector addresses

Two Flash Security Vectors (FSV1, FSV2) are located parallel to the Boot Security Vectors (BSV1, BSV2) controlling the protection functions of the Flash Security Module:

FSV1: 0x14:8000 BSV1: 0x14:8004
FSV2: 0x14:8008 BSV2: 0x14:800C

9.6.2 Security Vector FSV1

The setting of the Flash Security Vector FSV1 is responsible for the read and write protection modes and the individual write protection of the 8 Kbytes sectors.

FSV1 (bit31 to bit16)

The setting of the Flash Security Vector FSV1 bits [31:16] is responsible for the read and write protection modes.

Explanation of the bits in the Flash Security Vector FSV1[31:16]

FSV1[31:19]	FSV1[18] Write Protection Level	FSV1[17] Write Protection	FSV1[16] Read Protection	Flash Security Mode
set all to ‘0’	set to ‘0’	set to ‘0’	set to ‘1’	Read Protection (all device modes, except INTVEC mode MD[2:0]=”000”)
set all to ‘0’	set to ‘0’	set to ‘1’	set to ‘0’	Write Protection (all device modes, without exception)
set all to ‘0’	set to ‘0’	set to ‘1’	set to ‘1’	Read Protection (all device modes, except INTVEC mode MD[2:0]=”000”) and Write Protection (all device modes)
set all to ‘0’	set to ‘1’	set to ‘0’	set to ‘1’	Read Protection (all device modes, except INTVEC mode MD[2:0]=”000”)
set all to ‘0’	set to ‘1’	set to ‘1’	set to ‘0’	Write Protection (all device modes, except INTVEC mode MD[2:0]=”000”)
set all to ‘0’	set to ‘1’	set to ‘1’	set to ‘1’	Read Protection (all device modes, except INTVEC mode MD[2:0]=”000”) and Write Protection (all device modes except INTVEC mode MD[2:0]=”000”)

FSV1 (bit15 to bit0)

The setting of the Flash Security Vector FSV1 bits [15:0] is responsible for the individual write protection of the 8 Kbytes sectors. It is only evaluated if write protection bit FSV1[17] is set.

Explanation of the bits in the Flash Security Vector FSV1[15:0]

FSV1 bit	Sector	Enable Write Protection	Disable Write Protection	Comment
FSV1[0]	SA0	set to “0”	set to “1”	Sectors available on MB91F467Cx only
FSV1[1]	SA1	set to “0”	set to “1”	
FSV1[2]	SA2	set to “0”	set to “1”	
FSV1[3]	SA3	set to “0”	set to “1”	
FSV1[4]	SA4	set to “0”	—	Write protection is mandatory!
FSV1[5]	SA5	set to “0”	set to “1”	
FSV1[6]	SA6	set to “0”	set to “1”	
FSV1[7]	SA7	set to “0”	set to “1”	
FSV1[15:8]	—	—	—	not available

Note: It is mandatory to always set the sector where the Flash Security Vectors FSV1 and FSV2 are located to write protected (here sector SA4). Otherwise it is possible to overwrite the Security Vector to a setting where it is possible to either read out the Flash content or manipulate data by writing.
See section “9.3. Flash access in CPU mode” for an overview about the sector organisation of the Flash Memory.

9.6.3 Security Vector FSV2

The setting of the Flash Security Vector FSV2 bits [31:0] is responsible for the individual write protection of the 64 KByte sectors. It is only evaluated if write protection bit FSV1[17] is set.

Explanation of the bits in the Flash Security Vector FSV2[31:0]

FSV2 bit	Sector	Enable Write Protection	Disable Write Protection	Comment
FSV2[0]	SA8	set to “0”	set to “1”	Sectors available on MB91F467Cx only
FSV2[1]	SA9	set to “0”	set to “1”	
FSV2[2]	SA10	set to “0”	set to “1”	
FSV2[3]	SA11	set to “0”	set to “1”	
FSV2[4]	SA12	set to “0”	set to “1”	Sectors available on MB91F467Cx and MB91F465CA
FSV2[5]	SA13	set to “0”	set to “1”	
FSV2[6]	SA14	set to “0”	set to “1”	
FSV2[7]	SA15	set to “0”	set to “1”	
FSV2[8]	SA16	set to “0”	set to “1”	Sectors available on MB91F467Cx, MB91F465CA, MB91F463CA
FSV2[9]	SA17	set to “0”	set to “1”	
FSV2[10]	SA18	set to “0”	set to “1”	
FSV2[11]	SA19	set to “0”	set to “1”	
FSV2[12]	SA20	set to “0”	set to “1”	Sectors available on MB91F467Cx only
FSV2[13]	SA21	set to “0”	set to “1”	
FSV2[14]	SA22	set to “0”	set to “1”	
FSV2[15]	SA23	set to “0”	set to “1”	
FSV2[31:16]	—	set to “0”	set to “1”	Sectors not available

Note : See section “9.3. Flash access in CPU mode” for an overview about the sector organisation of the Flash Memory.

10. Memory Space

The FR family has 4 Gbytes of logical address space (2^{32} addresses) available to the CPU by linear access.

Direct addressing area

The following address space area is used for I/O.

This area is called direct addressing area, and the address of an operand can be specified directly in an instruction.

The size of directly addressable area depends on the length of the data being accessed as shown below.

Byte data access : 000_H to $0FF_H$

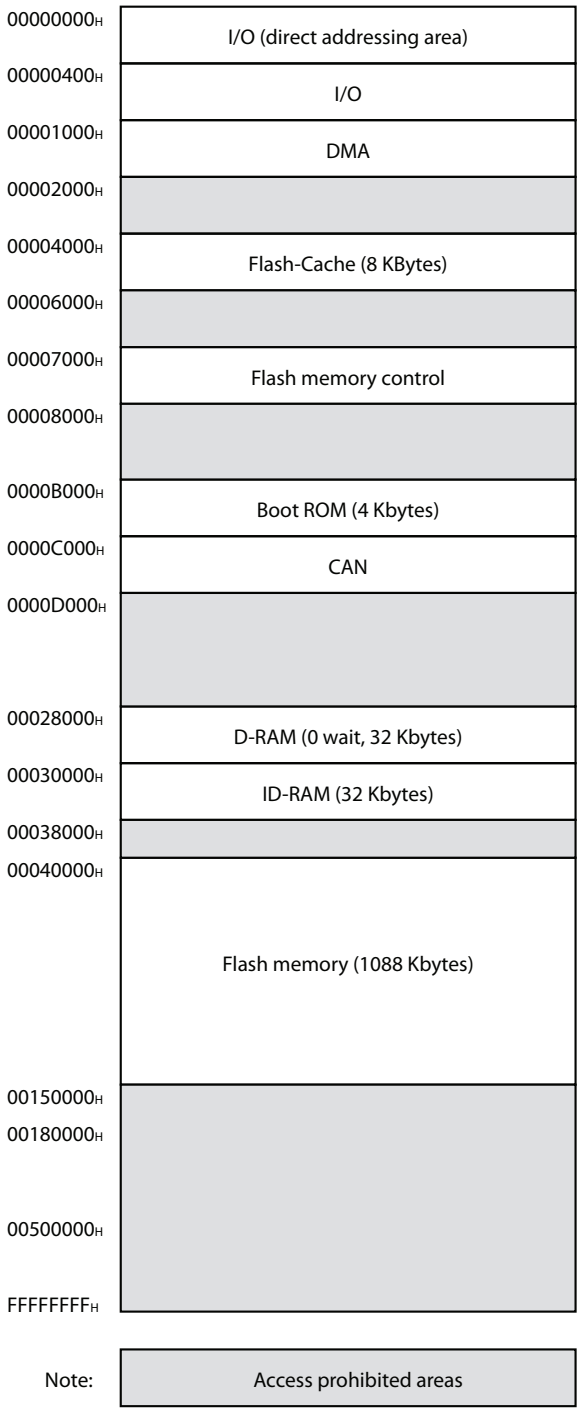
Half word access : 000_H to $1FF_H$

Word data access : 000_H to $3FF_H$

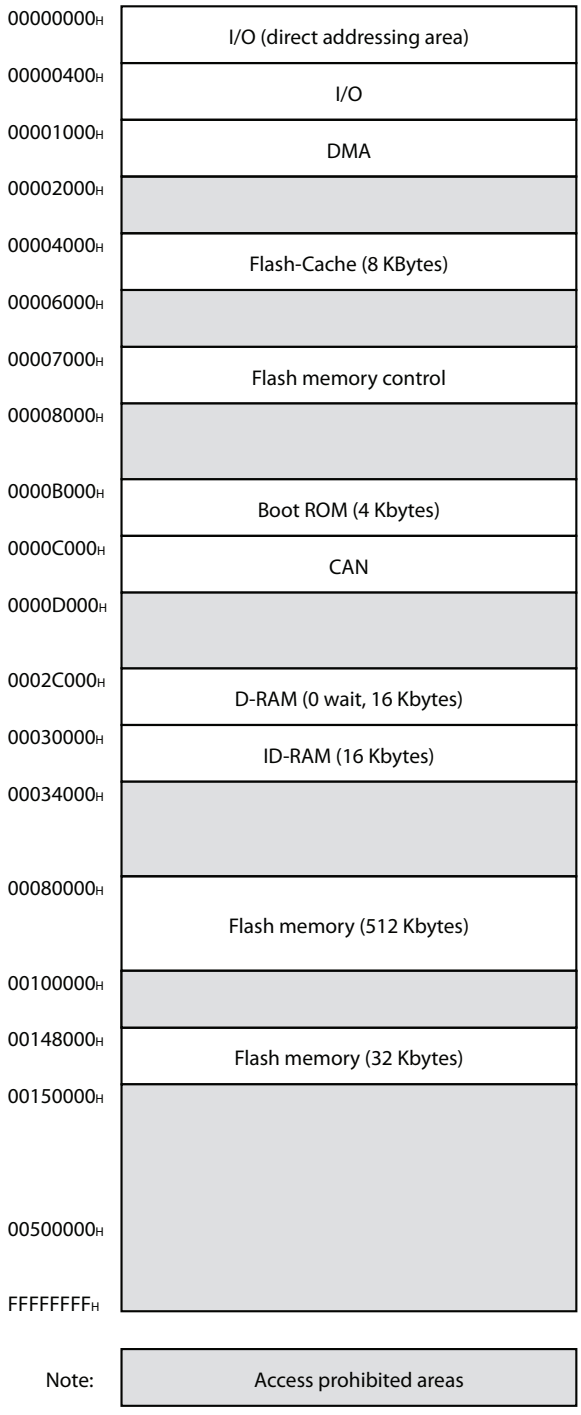
11. Memory Maps

11.1 MB91F467Cx, MB91F465CA

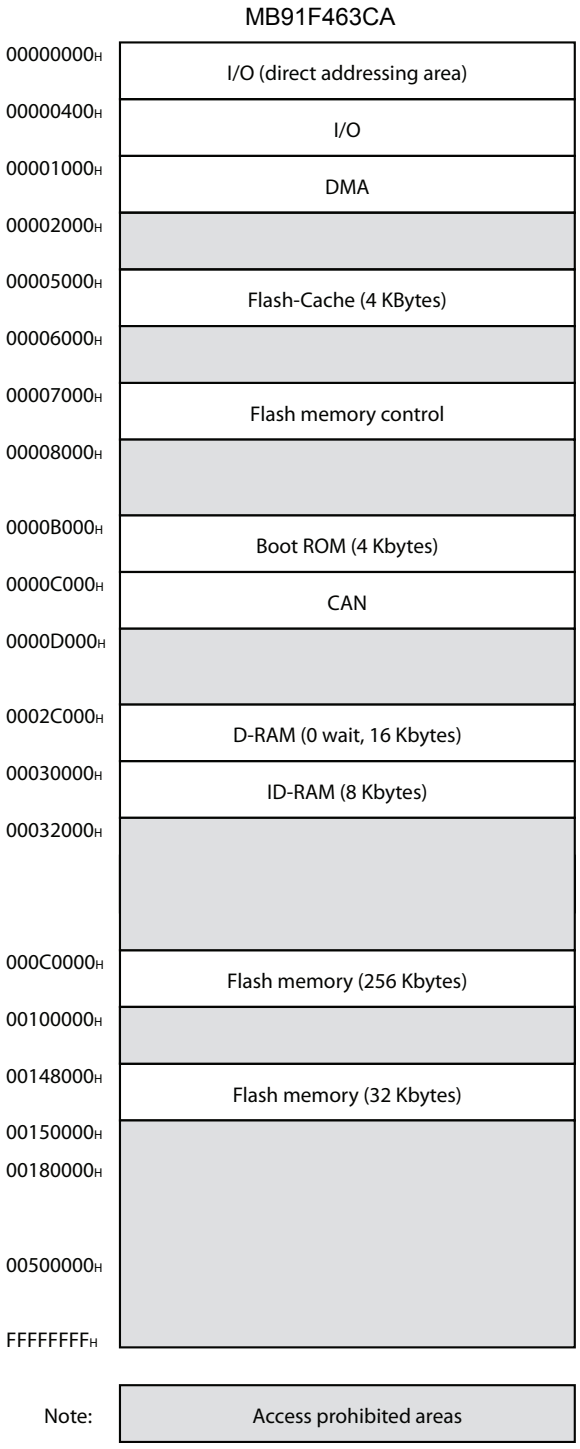
MB91F467Cx



MB91F465CA



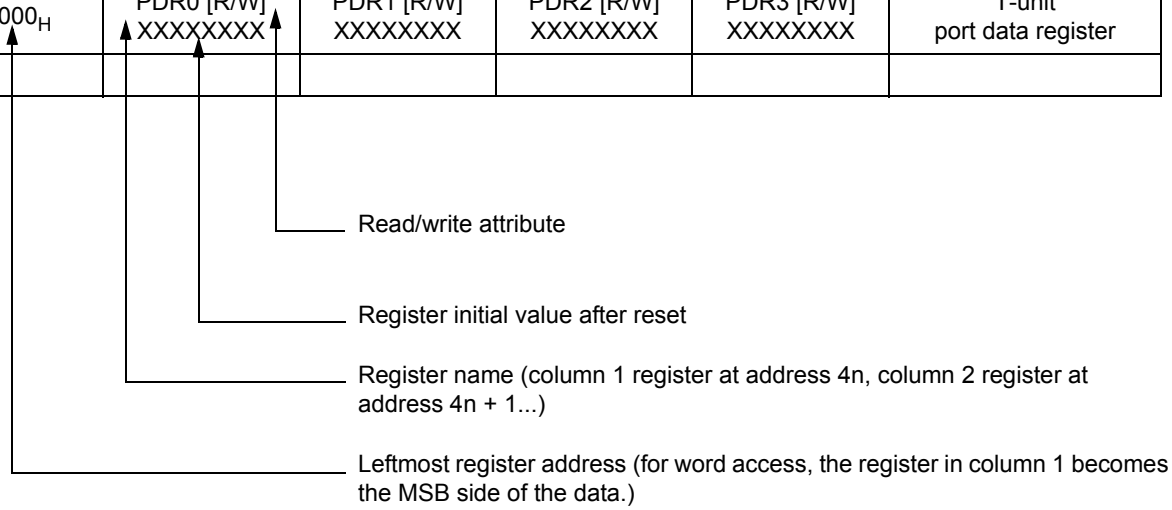
11.2 MB91F463CA



12. I/O Map

12.1 MB91F463CA, MB91F465CA, MB91F467Cx

Address	Register				Block
	+ 0	+ 1	+ 2	+ 3	
000000_H	PDR0 [R/W] XXXXXXXX	PDR1 [R/W] XXXXXXXX	PDR2 [R/W] XXXXXXXX	PDR3 [R/W] XXXXXXXX	T-unit port data register



Note : Initial values of register bits are represented as follows:

" 1 " : Initial value " 1 "
" 0 " : Initial value " 0 "
" X " : Initial value " undefined "
" - " : No physical register at this location
Access is barred with an undefined data access attribute.

Address	Register				Block
	+0	+1	+2	+3	
000000_H	Reserved	Reserved	PDR02 [R/W] XXXXXXXX	Reserved	R-bus Port Data Register
000004_H	Reserved	Reserved	Reserved	Reserved	
000008_H	Reserved	Reserved	Reserved	Reserved	
$00000C_H$	Reserved	Reserved	PDR14 [R/W] XXXXXXXX	PDR15 [R/W] - - - - XXXX	
000010_H	PDR16 [R/W] XXXXXXXX	PDR17 [R/W] XXXX - - - -	PDR18 [R/W] - XXX - XXX	PDR19 [R/W] - XXX - XXX	
000014_H	PDR20 [R/W] - - - - - XXX	Reserved	PDR22 [R/W] - - XX - X - X	PDR23 [R/W] - XXXXXXX	
000018_H	PDR24 [R/W] XXXXXXXX	PDR25 [R/W] XXXXXXXX	PDR26 [R/W] XXXXXXXX	PDR27 [R/W] XXXXXXXX	
$00001C_H$	PDR28 [R/W] - -XXXXX	PDR29 [R/W] XXXXXXXX	Reserved	Reserved	
000020_H to $00002C_H$	Reserved				Reserved
000030_H	EIRR0 [R/W] XXXXXXXX	ENIR0 [R/W] 00000000	ELVR0 [R/W] 00000000 00000000		External Interrupt (INT 0 to INT 7)
000034_H	EIRR1 [R/W] XXXXXXXX	ENIR1 [R/W] 00000000	ELVR1 [R/W] 00000000 00000000		External Interrupt (INT 8 to INT 14)
000038_H	DICR [R/W] - - - - - - - 0	HRCL [R/W] 0 - - 11111	Reserved		Delayed Interrupt
$00003C_H$ - $00004C_H$	Reserved				Reserved
000050_H	SCR02 [R/W,W] 00000000	SMR02 [R/W,W] 00000000	SSR02 [R/W,R] 00001000	RDR02/TDR02 [R/W] 00000000	LIN-USART 2
000054_H	ESCR02 [R/W] 00000X00	ECCR02 [R/W,R,W] -00000XX	Reserved		
000058_H to $00005C_H$	Reserved				Reserved
000060_H	SCR04 [R/W,W] 00000000	SMR04 [R/W,W] 00000000	SSR04 [R/W,R] 00001000	RDR04/TDR04 [R/W] 00000000	LIN-USART 4 with FIFO
000064_H	ESCR04 [R/W] 00000X00	ECCR04 [R/W,R,W] -00000XX	FSR04 [R] - - - 00000	FCR04 [R/W] 0001 - 000	

Address	Register				Block
	+0	+1	+2	+3	
000068_H	SCR05 [R/W,W] 00000000	SMR05 [R/W,W] 00000000	SSR05 [R/W,R] 00001000	RDR05/TDR05 [R/W] 00000000	LIN-USART 5 with FIFO
$00006C_H$	ESCR05 [R/W] 00000X00	ECCR05 [R/W,R,W] -00000XX	FSR05 [R] - - - 00000	FCR05 [R/W] 0001 - 000	
000070_H	SCR06 [R/W,W] 00000000	SMR06 [R/W,W] 00000000	SSR06 [R/W,R] 00001000	RDR06/TDR06 [R/W] 00000000	LIN-USART 6 with FIFO
000074_H	ESCR06 [R/W] 00000X00	ECCR06 [R/W,R,W] -00000XX	FSR06 [R] - - - 00000	FCR06 [R/W] 0001 - 000	
000078_H	SCR07 [R/W,W] 00000000	SMR07 [R/W,W] 00000000	SSR07 [R/W,R] 00001000	RDR07/TDR07 [R/W] 00000000	LIN-USART 7 with FIFO
$00007C_H$	ESCR07 [R/W] 00000X00	ECCR07 [R/W,R,W] -00000XX	FSR07 [R] - - - 00000	FCR07 [R/W] 0001 - 000	
000080_H	Reserved				Reserved
000084_H	BGR102 [R/W] 00000000	BGR002 [R/W] 00000000	Reserved	Reserved	Baud rate Generator LIN-USART 0 to 7
000088_H	BGR104 [R/W] 00000000	BGR004 [R/W] 00000000	BGR105 [R/W] 00000000	BGR005 [R/W] 00000000	
$00008C_H$	BGR106 [R/W] 00000000	BGR006 [R/W] 00000000	BGR107 [R/W] 00000000	BGR007 [R/W] 00000000	
000090_H	PWC20 [R/W] - - - - - - XX XXXXXXXX		PWC10 [R/W] - - - - - - XX XXXXXXXX		Stepper Motor 0
000094_H	Reserved	Reserved	PWS20 [R/W] -0000000	PWS10 [R/W] - -000000	
000098_H	PWC21 [R/W] - - - - - - XX XXXXXXXX		PWC11 [R/W] - - - - - - XX XXXXXXXX		Stepper Motor 1
$00009C_H$	Reserved	Reserved	PWS21 [R/W] -0000000	PWS11 [R/W] - -000000	
$0000A0_H$	PWC22 [R/W] - - - - - - XX XXXXXXXX		PWC12 [R/W] - - - - - - XX XXXXXXXX		Stepper Motor 2
$0000A4_H$	Reserved	Reserved	PWS22 [R/W] -0000000	PWS12 [R/W] - -000000	
$0000A8_H$	PWC23 [R/W] - - - - - - XX XXXXXXXX		PWC13 [R/W] - - - - - - XX XXXXXXXX		Stepper Motor 3
$0000AC_H$	Reserved	Reserved	PWS23 [R/W] -0000000	PWS13 [R/W] - -000000	
$0000B0_H$	PWC24 [R/W] - - - - - - XX XXXXXXXX		PWC14 [R/W] - - - - - - XX XXXXXXXX		Stepper Motor 4
$0000B4_H$	Reserved	Reserved	PWS24 [R/W] -0000000	PWS14 [R/W] - -000000	

Address	Register				Block
	+0	+1	+2	+3	
$0000B8_H$	PWC25 [R/W] - - - - - - XX XXXXXXXX		PWC15 [R/W] - - - - - - XX XXXXXXXX		Stepper Motor 5
$0000BC_H$	Reserved	Reserved	PWS25 [R/W] -0000000	PWS15 [R/W] - -000000	
$0000C0_H$	Reserved	PWC0 [R/W] -00000--	Reserved	PWC1 [R/W] -00000--	Stepper Motor Control 0 to 5
$0000C4_H$	Reserved	PWC2 [R/W] -00000--	Reserved	PWC3 [R/W] -00000--	
$0000C8_H$	Reserved	PWC4 [R/W] -00000--	Reserved	PWC5 [R/W] -00000--	
$0000CC_H$	Reserved				Reserved
0000D0H	IBCR0 [R/W] 00000000	IBSR0 [R] 00000000	ITBAH0 [R/W] - - - - - - 00	ITBAL0 [R/W] 00000000	I^2C 0
0000D4H	ITMKH0 [R/W] 00 - - - - 11	ITMKL0 [R/W] 11111111	ISMK0 [R/W] 01111111	ISBA0 [R/W] - 0000000	
0000D8H	Reserved	IDAR0 [R/W] 00000000	ICCR0 [R/W] - 0011111	Reserved	
$0000DC_H$ to 000100_H	Reserved				Reserved
000104_H	GCN11 [R/W] 00110010 00010000		Reserved	GCN21 [R/W] - - - - 0000	PPG Control 4 to 7
000108_H	GCN12 [R/W] 00110010 00010000		Reserved	GCN22 [R/W] - - - - 0000	PPG Control 8 to 11
000110_H to $00012C_H$	Reserved				Reserved
000130_H	PTMR04 [R] 11111111 11111111		PCSR04 [W] XXXXXXXX XXXXXXXX		PPG 4
000134_H	PDUT04 [W] XXXXXXXX XXXXXXXX		PCNH04 [R/W] 0000000 -	PCNL04 [R/W] 000000 - 0	
000138_H	PTMR05 [R] 11111111 11111111		PCSR05 [W] XXXXXXXX XXXXXXXX		PPG 5
$00013C_H$	PDUT05 [W] XXXXXXXX XXXXXXXX		PCNH05 [R/W] 0000000 -	PCNL05 [R/W] 000000 - 0	
000140_H	PTMR06 [R] 11111111 11111111		PCSR06 [W] XXXXXXXX XXXXXXXX		PPG 6
000144_H	PDUT06 [W] XXXXXXXX XXXXXXXX		PCNH06 [R/W] 0000000 -	PCNL06 [R/W] 000000 - 0	
000148_H	PTMR07 [R] 11111111 11111111		PCSR07 [W] XXXXXXXX XXXXXXXX		PPG 7
$00014C_H$	PDUT07 [W] XXXXXXXX XXXXXXXX		PCNH07 [R/W] 0000000 -	PCNL07 [R/W] 000000 - 0	

Address	Register				Block
	+0	+1	+2	+3	
000150_H	PTMR08 [R] 11111111 11111111		PCSR08 [W] XXXXXXXX XXXXXXXX		PPG 8
000154_H	PDUT08 [W] XXXXXXXX XXXXXXXX		PCNH08 [R/W] 0000000 -	PCNL08 [R/W] 000000 - 0	
000158_H	PTMR09 [R] 11111111 11111111		PCSR09 [W] XXXXXXXX XXXXXXXX		PPG 9
$00015C_H$	PDUT09 [W] XXXXXXXX XXXXXXXX		PCNH09 [R/W] 0000000 -	PCNL09 [R/W] 000000 - 0	
000160_H	PTMR10 [R] 11111111 11111111		PCSR10 [W] XXXXXXXX XXXXXXXX		PPG 10
000164_H	PDUT10 [W] XXXXXXXX XXXXXXXX		PCNH10 [R/W] 0000000 -	PCNL10 [R/W] 000000 - 0	
000168_H	PTMR11 [R] 11111111 11111111		PCSR11 [W] XXXXXXXX XXXXXXXX		PPG 11
$00016C_H$	PDUT11 [W] XXXXXXXX XXXXXXXX		PCNH11 [R/W] 0000000 -	PCNL11 [R/W] 000000 - 0	
000170_H	P0TMCSRH [R/W] - 0-000-0	P0TMCSRL [R/W] - - -00000	P1TMCSRH [R/W] - 0000000	P1TMCSRL [R/W] 01000000	Pulse Frequency Modulator
000174_H	P0TMRLR [W] XXXXXXXX XXXXXXXX		P0TMR [R] XXXXXXXX XXXXXXXX		
000178_H	P1TMRLR [W] XXXXXXXX XXXXXXXX		P1TMR [R] XXXXXXXX XXXXXXXX		
$00017C_H$	Reserved				Reserved
000180_H	Reserved	ICS01 [R/W] 00000000	Reserved	ICS23 [R/W] 00000000	Input Capture 0 to 3
000184_H	IPCP0 [R] XXXXXXXX XXXXXXXX		IPCP1 [R] XXXXXXXX XXXXXXXX		
000188_H	IPCP2 [R] XXXXXXXX XXXXXXXX		IPCP3 [R] XXXXXXXX XXXXXXXX		
$00018C_H$	OCS01 [R/W] - - - 0 - - 00 0000 - - 00		OCS23 [R/W] - - - 0 - - 00 0000 - - 00		Output Compare 0 to 3
000190_H	OCCP0 [R/W] XXXXXXXX XXXXXXXX		OCCP1 [R/W] XXXXXXXX XXXXXXXX		
000194_H	OCCP2 [R/W] XXXXXXXX XXXXXXXX		OCCP3 [R/W] XXXXXXXX XXXXXXXX		
000198_H	SGCRH [R/W] 0000 - - 00	SGCRL [R/W] - - 0 - - 000	SGFR [R/W, R] XXXXXXXX XXXXXXXX		Sound Generator
$00019C_H$	SGAR [R/W] 00000000	Reserved	SGTR [R/W] XXXXXXXX	SGDR [R/W] XXXXXXXX	

Address	Register				Block
	+0	+1	+2	+3	
$0001A0_H$	ADERH [R/W] 00000000 00000000		ADERL [R/W] 00000000 00000000		A/D Converter
0001A4	ADCS1 [R/W] 00000000	ADCS0 [R/W] 00000000	ADCR1 [R] 000000XX	ADCR0 [R] XXXXXXXX	
$0001A8_H$	ADCT1 [R/W] 00010000	ADCT0 [R/W] 00101100	ADSCH [R/W] - - - 00000	ADECH [R/W] - - - 00000	
$0001AC_H$	Reserved	ACSR0 [R/W] - 11XXX00	Reserved	Reserved	Alarm Comparator 0
$0001B0_H$	TMRLR0 [W] XXXXXXXX XXXXXXX		TMR0 [R] XXXXXXXX XXXXXXXX		Reload Timer 0
$0001B4_H$	Reserved		TMCSRH0 [R/W] - - - 00000	TMCSRL0 [R/W] 0 - 000000	
$0001B8_H$	TMRLR1 [W] XXXXXXXX XXXXXXXX		TMR1 [R] XXXXXXXX XXXXXXXX		Reload Timer 1
$0001BC_H$	Reserved		TMCSRH1 [R/W] - - - 00000	TMCSRL1 [R/W] 0 - 000000	
$0001C0_H$	TMRLR2 [W] XXXXXXXX XXXXXXXX		TMR2 [R] XXXXXXXX XXXXXXXX		Reload Timer 2 (PPG 4, PPG 5)
$0001C4_H$	Reserved		TMCSRH2 [R/W] - - - 00000	TMCSRL2 [R/W] 0 - 000000	
$0001C8_H$	TMRLR3 [W] XXXXXXXX XXXXXXXX		TMR3 [R] XXXXXXXX XXXXXXXX		Reload Timer 3 (PPG 6, PPG 7)
$0001CC_H$	Reserved		TMCSRH3 [R/W] - - - 00000	TMCSRL3 [R/W] 0 - 000000	
$0001D0_H$	TMRLR4 [W] XXXXXXXX XXXXXXXX		TMR4 [R] XXXXXXXX XXXXXXXX		Reload Timer 4 (PPG 8, PPG 9)
$0001D4_H$	Reserved		TMCSRH4 [R/W] - - - 00000	TMCSRL4 [R/W] 0 - 000000	
$0001D8_H$	TMRLR5 [W] XXXXXXXX XXXXXXXX		TMR5 [R] XXXXXXXX XXXXXXXX		Reload Timer 5 (PPG 10, PPG 11)
$0001DC_H$	Reserved		TMCSRH5 [R/W] - - - 00000	TMCSRL5 [R/W] 0 - 000000	
$0001E0_H$	TMRLR6 [W] XXXXXXXX XXXXXXXX		TMR6 [R] XXXXXXXX XXXXXXXX		Reload Timer 6 (PPG 12, PPG 13)
$0001E4_H$	Reserved		TMCSRH6 [R/W] - - - 00000	TMCSRL6 [R/W] 0 - 000000	

Address	Register				Block
	+0	+1	+2	+3	
$0001E8_H$	TMRLR7 [W] XXXXXXXX XXXXXXXX		TMR7 [R] XXXXXXXX XXXXXXXX		Reload Timer 7 (PPG 14, PPG 15) (A/D Converter)
$0001EC_H$	Reserved		TMCSRH7 [R/W] - - - 00000	TMCSRL7 [R/W] 0 - 000000	
$0001F0_H$	TCDT0 [R/W] XXXXXXXX XXXXXXXX		Reserved	TCCS0 [R/W] 00000000	Free Running Timer 0 (ICU 0, ICU 1)
$0001F4_H$	TCDT1 [R/W] XXXXXXXX XXXXXXXX		Reserved	TCCS1 [R/W] 00000000	Free Running Timer 1 (ICU 2, ICU 3)
$0001F8_H$	TCDT2 [R/W] XXXXXXXX XXXXXXXX		Reserved	TCCS2 [R/W] 00000000	Free Running Timer 2 (OCU 0, OCU 1)
$0001FC_H$	TCDT3 [R/W] XXXXXXXX XXXXXXXX		Reserved	TCCS3 [R/W] 00000000	Free Running Timer 3 (OCU 2, OCU 3)
000200_H	DMACA0 [R/W] 00000000 0000XXXX XXXXXXXX XXXXXXXX				DMAC
000204_H	DMACB0 [R/W] 00000000 00000000 XXXXXXXX XXXXXXXX				
000208_H	DMACA1 [R/W] 00000000 0000XXXX XXXXXXXX XXXXXXXX				
$00020C_H$	DMACB1 [R/W] 00000000 00000000 XXXXXXXX XXXXXXXX				
000210_H	DMACA2 [R/W] 00000000 0000XXXX XXXXXXXX XXXXXXXX				
000214_H	DMACB2 [R/W] 00000000 00000000 XXXXXXXX XXXXXXXX				
000218_H	DMACA3 [R/W] 00000000 0000XXXX XXXXXXXX XXXXXXXX				
$00021C_H$	DMACB3 [R/W] 00000000 00000000 XXXXXXXX XXXXXXXX				
000220_H	DMACA4 [R/W] 00000000 0000XXXX XXXXXXXX XXXXXXXX				
000224_H	DMACB4 [R/W] 00000000 00000000 XXXXXXXX XXXXXXXX				
000228_H to $00023C_H$	Reserved				Reserved
000240_H	DMACR [R/W] 0 - -0 0000	Reserved			

Address	Register				Block
	+0	+1	+2	+3	
000244_H to $0002CC_H$	Reserved				Reserved
$0002D0_H$	Reserved	ICS045 [R/W] 00000000	Reserved	ICS67 [R/W] 00000000	Input Capture 4 to 7
$0002D4_H$	IPCP4 [R] XXXXXXXX XXXXXXXX		IPCP5 [R] XXXXXXXX XXXXXXXX		
$0002D8_H$	IPCP6 [R] XXXXXXXX XXXXXXXX		IPCP7 [R] XXXXXXXX XXXXXXXX		
$0002DC_H$ to $0002EC_H$	Reserved				Reserved
$0002F0_H$	TCDT4 [R/W] XXXXXXXX XXXXXXXX		Reserved	TCCS4 [R/W] 00000000	Free Running Timer 4 (ICU 4, ICU 5)
$0002F4_H$	TCDT5 [R/W] XXXXXXXX XXXXXXXX		Reserved	TCCS5 [R/W] 00000000	Free Running Timer 5 (ICU 6, ICU 7)
$0002F8_H$	TCDT6 [R/W] XXXXXXXX XXXXXXXX		Reserved	TCCS6 [R/W] 00000000	Free Running Timer 6
$0002FC_H$	TCDT7 [R/W] XXXXXXXX XXXXXXXX		Reserved	TCCS7 [R/W] 00000000	Free Running Timer 7
000300_H	UDRC1 [W] 00000000	UDRC0 [W] 00000000	UDCR1 [R] 00000000	UDCR0 [R] 00000000	Up/Down Counter 0
000304_H	UDCCH0 [R/W] 00000000	UDCCL0 [R/W] 00000000	Reserved	UDCS0 [R/W] 00000000	
000308_H to $00030C_H$	Reserved				Reserved
000310_H	UDRC3 [W] 00000000	UDRC2 [W] 00000000	UDCR3 [R] 00000000	UDCR2 [R] 00000000	Up/Down Counter 2 to 3
000314_H	UDCCH2 [R/W] 00000000	UDCCL2 [R/W] 00000000	Reserved	UDCS2 [R/W] 00000000	
000318_H	UDCCH3 [R/W] 00000000	UDCCL3 [R/W] 00000000	Reserved	UDCS3 [R/W] 00000000	
$00031C_H$	Reserved				Reserved
000320_H	GCN13 [R/W] 00110010 00010000		Reserved	GCN23 [R/W] - - - - 0000	PPG Control 12 to 15
000324_H to $00032C_H$	Reserved				Reserved
000330_H	PTMR12 [R] 11111111 11111111		PCSR12 [W] XXXXXXXX XXXXXXXX		PPG 12
000334_H	PDUT12 [W] XXXXXXXX XXXXXXXX		PCNH12 [R/W] 0000000 -	PCNL12 [R/W] 000000 - 0	

Address	Register				Block
	+0	+1	+2	+3	
000338_H	PTMR13 [R] 11111111 11111111		PCSR13 [W] XXXXXXXX XXXXXXXX		PPG 13
$00033C_H$	PDUT13 [W] XXXXXXXX XXXXXXXX		PCNH13 [R/W] 0000000 -	PCNL13 [R/W] 000000 - 0	
000340_H	PTMR14 [R] 11111111 11111111		PCSR14 [W] XXXXXXXX XXXXXXXX		PPG 14
000344_H	PDUT14 [W] XXXXXXXX XXXXXXXX		PCNH14 [R/W] 0000000 -	PCNL14 [R/W] 000000 - 0	
000348_H	PTMR15 [R] 11111111 11111111		PCSR15 [W] XXXXXXXX XXXXXXXX		PPG 15
$00034C_H$	PDUT15 [W] XXXXXXXX XXXXXXXX		PCNH15 [R/W] 0000000 -	PCNL15 [R/W] 000000 - 0	
000350_H to 000364_H	Reserved				Reserved
000368_H	IBCR2 [R/W] 00000000	IBSR2 [R] 00000000	ITBAH2 [R/W] - - - - - - 00	ITBAL2 [R/W] 00000000	I^2C 2
$00036C_H$	ITMKH2 [R/W] 00 - - - - 11	ITMKL2 [R/W] 11111111	ISMK2 [R/W] 01111111	ISBA2 [R/W] - 0000000	
000370_H	Reserved	IDAR2 [R/W] 00000000	ICCR2 [R/W] - 0011111	Reserved	
00374H	IBCR3 [R/W] 00000000	IBSR3 [R] 00000000	ITBAH3 [R/W] - - - - - - 00	ITBAL3 [R/W] 00000000	I^2C 3
000378_H	ITMKH3 [R/W] 00 - - - - 11	ITMKL3 [R/W] 11111111	ISMK3 [R/W] 01111111	ISBA3 [R/W] - 0000000	
$00037C_H$	Reserved	IDAR3 [R/W] 00000000	ICCR3 [R/W] - 0011111	Reserved	
000380_H to $00038C_H$	Reserved				Reserved
000390_H	ROMS [R] 11111111 00000000		Reserved		ROM Select Register
000394_H to $0003EC_H$	Reserved				Reserved
$0003F0_H$	BSD0 [W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				Bit Search Module
$0003F4_H$	BSD1 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
$0003F8_H$	BSDC [W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
$0003FC_H$	BSRR [R] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
000400_H to $00043C_H$	Reserved				Reserved

Address	Register				Block
	+0	+1	+2	+3	
000440_H	ICR00 [R/W] ---11111	ICR01 [R/W] ---11111	ICR02 [R/W] ---11111	ICR03 [R/W] ---11111	Interrupt Controller
000444_H	ICR04 [R/W] ---11111	ICR05 [R/W] ---11111	ICR06 [R/W] ---11111	ICR07 [R/W] ---11111	
000448_H	ICR08 [R/W] ---11111	ICR09 [R/W] ---11111	ICR10 [R/W] ---11111	ICR11 [R/W] ---11111	
$00044C_H$	ICR12 [R/W] ---11111	ICR13 [R/W] ---11111	ICR14 [R/W] ---11111	ICR15 [R/W] ---11111	
000450_H	ICR16 [R/W] ---11111	ICR17 [R/W] ---11111	ICR18 [R/W] ---11111	ICR19 [R/W] ---11111	
000454_H	ICR20 [R/W] ---11111	ICR21 [R/W] ---11111	ICR22 [R/W] ---11111	ICR23 [R/W] ---11111	
000458_H	ICR24 [R/W] ---11111	ICR25 [R/W] ---11111	ICR26 [R/W] ---11111	ICR27 [R/W] ---11111	
$00045C_H$	ICR28 [R/W] ---11111	ICR29 [R/W] ---11111	ICR30 [R/W] ---11111	ICR31 [R/W] ---11111	
000460_H	ICR32 [R/W] ---11111	ICR33 [R/W] ---11111	ICR34 [R/W] ---11111	ICR35 [R/W] ---11111	
000464_H	ICR36 [R/W] ---11111	ICR37 [R/W] ---11111	ICR38 [R/W] ---11111	ICR39 [R/W] ---11111	
000468_H	ICR40 [R/W] ---11111	ICR41 [R/W] ---11111	ICR42 [R/W] ---11111	ICR43 [R/W] ---11111	
$00046C_H$	ICR44 [R/W] ---11111	ICR45 [R/W] ---11111	ICR46 [R/W] ---11111	ICR47 [R/W] ---11111	
000470_H	ICR48 [R/W] ---11111	ICR49 [R/W] ---11111	ICR50 [R/W] ---11111	ICR51 [R/W] ---11111	
000474_H	ICR52 [R/W] ---11111	ICR53 [R/W] ---11111	ICR54 [R/W] ---11111	ICR55 [R/W] ---11111	
000478_H	ICR56 [R/W] ---11111	ICR57 [R/W] ---11111	ICR58 [R/W] ---11111	ICR59 [R/W] ---11111	
$00047C_H$	ICR60 [R/W] ---11111	ICR61 [R/W] ---11111	ICR62 [R/W] ---11111	ICR63 [R/W] ---11111	
000480_H	RSRR [R/W] 10000000	STCR [R/W] 00110011	TBCR [R/W] 00XXX – 00	CTBR [W] XXXXXXXX	Clock Controller
000484_H	CLKR [R/W] ---- 0000	WPR [W] XXXXXXXX	DIVR0 [R/W] 00000011	DIVR1 [R/W] 00000000	
000488_H	CTEST [R/W] XXXX00XX	Reserved	Reserved	Reserved	C-Unit Test (hidden)
$00048C_H$	PLLDIVM [R/W] - - - - 0000	PLLDIVN [R/W] - - 000000	PLLDIVG [R/W] - - - - 0000	PLLMULG [W] 00000000	PLL Interface
000490_H	PLLCTRL [R/W] - - - - 0000	Reserved	Reserved	Reserved	

Address	Register				Block
	+0	+1	+2	+3	
000494_H	OSCC1 [R/W] - - - - - 010	OSCS1 [R/W] 00001111	OSCC2 [R/W] - - - - - 010	OSCS2 [R/W] 00001111	Main/Sub Oscillator Control
000498_H	PORTEN [R/W] - - - - - - 00	Reserved	Reserved	Reserved	Port Input Enable Control
$00049C_H$	Reserved				Reserved
$0004A0_H$	Reserved	WTCER [R/W] - - - - - - 00	WTCR [R/W] 00000000 000 – 00 – 0		Real Time Clock (Watch Timer)
$0004A4_H$	Reserved	WTBR [R/W] - - - XXXXX XXXXXXXX XXXXXXXX			
$0004A8_H$	WTHR [R/W] - - - 00000	WTMR [R/W] - - 000000	WTSR [R/W] - - 000000	Reserved	
$0004AC_H$	CSVTR [R/W] - - - 00010	CSVCR [R/W] 00011100	CSCFG [R/W] 0X000000	CMCFG [R/W] 00000000	Clock-Supervisor / Selector / Monitor
$0004B0_H$	CUCR [R/W] - - - - - - - - - - - - 0 - - 00		CUTD [R/W] 10000000 00000000		Calibration of Sub Clock
$0004B4_H$	CUTR1 [R] - - - - - - - - 00000000		CUTR2 [R] 00000000 00000000		
$0004B8_H$	CMPR [R/W] - - 000010 11111101		Reserved	CMCR [R/W] - 001 - - 00	Clock Modulator
$0004BC_H$	CMT1 [R/W] 00000000 1 - - - 0000		CMT2 [R/W] - - 000000 - - 000000		
$0004C0_H$	CANPRE [R/W] 0 - - - 0000	CANCKD [R/W] - - - - - 000*1	Reserved	Reserved	CAN Clock Control
$0004C4_H$	LVSEL [R/W] 00000111	LVDET [R/W] 0000 0 – 00	HWWDE [R/W] - - - - - - 00	HWWD [R/W,W] 00011000	Low Voltage Detection/ Hardware Watchdog
$0004C8_H$	OSCRH [R/W] 000 - - 001	OSCRL [R/W] - - - - - 000	WPCRH [R/W] 00 - - - 000	WPCRL [R/W] - - - - - - 00	Main-/Sub-Oscillation Stabilisation Timer
$0004CC_H$	OSCCR [R/W] - - - - - - 00	Reserved	REGSEL [R/W] - - 000110	REGCTR [R/W] - - - 0 - - 00	Main- Oscillation Standby Control Main/Subregulator Control
$0004D0_H$ to $0007F8_H$	Reserved				Reserved
$0007FC_H$	Reserved	MODR [W] XXXXXXXX	Reserved	Reserved	Mode Register
000800_H to $000BFC_H$	Reserved				Reserved
$000C00_H$	TVCTW [W] XXXXXXXX	TVCTR [R] - - XXXXXX	Reserved	IOS [R/W] 00000000	I-Unit Test (hidden)
$000C04_H$ to $000CFC_H$	Reserved				Reserved

Address	Register				Block
	+0	+1	+2	+3	
$000D00_H$	Reserved	Reserved	PDRD02 [R] XXXXXXXX	Reserved	R-bus Port Data Direct Read Register
$000D04_H$	Reserved	Reserved	Reserved	Reserved	
$000D08_H$	Reserved	Reserved	Reserved	Reserved	
$000D0C_H$	Reserved	Reserved	PDRD14 [R] XXXXXXXX	PDRD15 [R] - - - - XXXX	
$000D10_H$	PDRD16 [R] XXXXXXXX	PDRD17 [R] XXXX - - - -	PDRD18 [R] - XXX - XXX	PDRD19 [R] - XXX - XXX	
$000D14_H$	PDRD20 [R] - - - - - XXX	Reserved	PDRD22 [R] - - XX - X - X	PDRD23 [R] - XXXXXXX	
$000D18_H$	PDRD24 [R] XXXXXXXX	PDRD25 [R] XXXXXXXX	PDRD26 [R] XXXXXXXX	PDRD27 [R] XXXXXXXX	
$000D1C_H$	PDRD28 [R] - - XXXXX	PDRD29 [R] XXXXXXXX	Reserved	Reserved	
$000D20_H$ to $000D3C_H$	Reserved				Reserved
$000D40_H$	Reserved	Reserved	DDR02 [R/W] 00000000	Reserved	R-bus Port Direction Register
$000D44_H$	Reserved	Reserved	Reserved	Reserved	
$000D48_H$	Reserved	Reserved	Reserved	Reserved	
$000D4C_H$	Reserved	Reserved	DDR14 [R/W] 00000000	DDR15 [R/W] - - - - 0000	
$000D50_H$	DDR16 [R/W] 00000000	DDR17 [R/W] 0000 - - - -	DDR18 [R/W] - 000 - 000	DDR19 [R/W] - 000 - 000	
$000D54_H$	DDR20 [R/W] - - - - - 000	Reserved	DDR22 [R/W] - - 00 - 0 - 0	DDR23 [R/W] - 0000000	
$000D58_H$	DDR24 [R/W] 00000000	DDR25 [R/W] 00000000	DDR26 [R/W] 00000000	DDR27 [R/W] 00000000	
$000D5C_H$	DDR28 [R/W] - - 00000	DDR29 [R/W] 00000000	Reserved	Reserved	
$000D60_H$ to $000D7C_H$	Reserved				Reserved

Address	Register				Block
	+0	+1	+2	+3	
$000D80_H$	Reserved	Reserved	Reserved	Reserved	R-bus Port Function Register
$000D84_H$	Reserved	Reserved	Reserved	Reserved	
$000D88_H$	Reserved	Reserved	Reserved	Reserved	
$000D8C_H$	Reserved	Reserved	PFR14 [R/W] 00000000	PFR15 [R/W] - - - - 0000	
$000D90_H$	PFR16 [R/W] 00000000	PFR17 [R/W] 0000 - - - -	PFR18 [R/W] - 000 - 000	PFR19 [R/W] - 000 - 000	
$000D94_H$	PFR20 [R/W] - - - - - 000	Reserved	PFR22 [R/W] - - 00 - 0 - 0	PFR23 [R/W] - 000000	
$000D98_H$	PFR24 [R/W] 00000000	PFR25 [R/W] 00000000	PFR26 [R/W] 00000000	PFR27 [R/W] 00000000	
$000D9C_H$	PFR28 [R/w] - - 00000	PFR29 [R/W] 00000000	Reserved	Reserved	
$000DA0_H$ to $000DBC_H$	Reserved				Reserved
$000DC0_H$	Reserved	Reserved	Reserved	Reserved	R-bus Extra Port Function Register
$000DC4_H$	Reserved	Reserved	Reserved	Reserved	
$000DC8_H$	Reserved	Reserved	Reserved	Reserved	
$000DCC_H$	Reserved	Reserved	EPFR14 [R/W] 00000000	EPFR15 [R/W] - - - - 0000	
$000DD0_H$	EPFR16 [R/W] 0000 - - - -	Reserved	EPFR18 [R/W] - 000 - 000	EPFR19 [R/W] - 0 - - - 0 - -	
$000DD4_H$	EPFR20 [R/W] - - - - - 000	Reserved	Reserved	Reserved	
$000DD8_H$	Reserved	Reserved	EPFR26 [R/W] 00000000	EPFR27 [R/W] 00000000	
$000DDC_H$	Reserved	Reserved	Reserved	Reserved	
$000DE0_H$ to $000DFC_H$	Reserved				Reserved

Address	Register				Block
	+0	+1	+2	+3	
$000E00_H$	Reserved	Reserved	PODR02 [R/W] 00000000	Reserved	R-bus Port Output Drive Select Register
$000E04_H$	Reserved	Reserved	Reserved	Reserved	
$000E08_H$	Reserved	Reserved	Reserved	Reserved	
$000E0C_H$	Reserved	Reserved	PODR14 [R/W] 00000000	PODR15 [R/W] - - - - 0000	
$000E10_H$	PODR16 [R/W] 00000000	PODR17 [R/W] 0000 - - - -	PODR18 [R/W] - 000 - 000	PODR19 [R/W] - 000 - 000	
$000E14_H$	PODR20 [R/W] - - - - - 000	Reserved	PODR22 [R/W] - - 00 - 0 - 0	PODR23 [R/W] - 0000000	
$000E18_H$	PODR24 [R/W] 00000000	PODR25 [R/W] 00000000	PODR26 [R/W] 00000000	PODR27 [R/W] 00000000	
$000E1C_H$	PODR28 [R/W] - - 00000	PODR29 [R/W] 00000000	Reserved	Reserved	
$000E20_H$ to $000E3C_H$	Reserved				Reserved
$000E40_H$	Reserved	Reserved	PILR02 [R/W] 00000000	Reserved	R-bus Port Input Level Select Register
$000E44_H$	Reserved	Reserved	Reserved	Reserved	
$000E48_H$	Reserved	Reserved	Reserved	Reserved	
$000E4C_H$	Reserved	Reserved	PILR14 [R/W] 00000000	PILR15 [R/W] - - - - 0000	
$000E50_H$	PILR16 [R/W] 00000000	PILR17 [R/W] 0000 - - - -	PILR18 [R/W] - 000 - 000	PILR19 [R/W] - 000 - 000	
$000E54_H$	PILR20 [R/W] - - - - - 000	Reserved	PILR22 [R/W] - - 00 - 0 - 0	PILR23 [R/W] - 0000000	
$000E58_H$	PILR24 [R/W] 00000000	PILR25 [R/W] 00000000	PILR26 [R/W] 00000000	PILR27 [R/W] 00000000	
$000E5C_H$	PILR28 [R/W] - - 000000	PILR29 [R/W] 00000000	Reserved	Reserved	
$000E60_H$ to $000E7C_H$	Reserved				Reserved

Address	Register				Block
	+0	+1	+2	+3	
$000E80_H$	Reserved	Reserved	EPILR02 [R/W] 00000000	Reserved	R-bus Extra Port Input Level Select Register
$000E84_H$	Reserved	Reserved	Reserved	Reserved	
$000E88_H$	Reserved	Reserved	Reserved	Reserved	
$000E8C_H$	Reserved	Reserved	EPILR14 [R/W] 00000000	EPILR15 [R/W] - - - - 0000	
$000E90_H$	EPILR16 [R/W] 00000000	EPILR17 [R/W] 0000 - - - -	EPILR18 [R/W] - 000 - 000	EPILR19 [R/W] - 000 - 000	
$000E94_H$	EPILR20 [R/W] - - - - - 000	Reserved	EPILR22 [R/W] - - 00 - 0 - 0	EPILR23 [R/W] - 0000000	
$000E98_H$	EPILR24 [R/W] 00000000	EPILR25 [R/W] 00000000	EPILR26 [R/W] 00000000	EPILR27 [R/W] 00000000	
$000E9C_H$	EPILR28 [R/W] - - 00000	EPILR29 [R/W] 00000000	Reserved	Reserved	
$000EA0_H$ to $000EBC_H$	Reserved				Reserved
$000EC0_H$	Reserved	Reserved	PPER02 [R/W] 00000000	Reserved	R-bus Port Pull-Up/Down Enable Register
$000EC4_H$	Reserved	Reserved	Reserved	Reserved	
$000EC8_H$	Reserved	Reserved	Reserved	Reserved	
$000ECC_H$	Reserved	Reserved	PPER14 [R/W] 00000000	PPER15 [R/W] - - - - 0000	
$000ED0_H$	PPER16 [R/W] 00000000	PPER17 [R/W] 0000 - - - -	PPER18 [R/W] - 000 - 000	PPER19 [R/W] - 000 - 000	
$000ED4_H$	PPER20 [R/W] - - - - - 000	Reserved	PPER22 [R/W] - - 00 - 0 - 0	PPER23 [R/W] - 0000000	
$000ED8_H$	PPER24 [R/W] 00000000	PPER25 [R/W] 00000000	PPER26 [R/W] 00000000	PPER27 [R/W] 00000000	
$000EDC_H$	PPER28 [R/W] - - 00000	PPER29 [R/W] 00000000	Reserved	Reserved	
$000EE0_H$ to $000EFC_H$	Reserved				Reserved

Address	Register				Block
	+0	+1	+2	+3	
$000F00_H$	Reserved	Reserved	PPCR02 [R/W] 11111111	Reserved	R-bus Port Pull-Up/Down Control Register
$000F04_H$	Reserved	Reserved	Reserved	Reserved	
$000F08_H$	Reserved	Reserved	Reserved	Reserved	
$000F0C_H$	Reserved	Reserved	PPCR14 [R/W] 11111111	PPCR15 [R/W] - - - - 1111	
$000F10_H$	PPCR16 [R/W] 11111111	PPCR17 [R/W] 1111 - - - -	PPCR18 [R/W] - 111 - 111	PPCR19 [R/W] - 111 - 111	
$000F14_H$	PPCR20 [R/W] - - - - - 111	Reserved	PPCR22 [R/W] - - 11 - 1 - 1	PPCR23 [R/W] -1111111	
$000F18_H$	PPCR24 [R/W] 11111111	PPCR25 [R/W] 11111111	PPCR26 [R/W] 11111111	PPCR27 [R/W] 11111111	
$000F1C_H$	PPCR28 [R/W] - - 11111	PPCR29 [R/W] 11111111	Reserved	Reserved	
$000F20_H$ to $000F3C_H$	Reserved				Reserved
001000_H	DMASA0 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				DMAC
001004_H	DMADA0 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
001008_H	DMASA1 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
$00100C_H$	DMADA1 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
001010_H	DMASA2 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
001014_H	DMADA2 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
001018_H	DMASA3 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
$00101C_H$	DMADA3 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
001020_H	DMASA4 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
001024_H	DMADA4 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
001028_H to $001FFC_H$	Reserved				Reserved
002000_H to $006FFC_H$	MB91F467Cx Flash-cache size is 8 Kbytes : 004000_H to $005FFC_H$ MB91F465CA Flash-cache size is 8 Kbytes : 004000_H to $005FFC_H$ MB91F463CA Flash-cache size is 4 Kbytes : 005000_H to $005FFC_H$				Flash-cache / I-RAM area

Address	Register				Block
	+0	+1	+2	+3	
007000_H	FMCS [R/W] 01101000	FMCR [R] - - - 00000	FCHCR [R/W] - - - - - - 00 10000011		Flash Memory/ Flash-cache/ I-RAM Control Register
007004_H	FMWT [R/W] 11111111 11111111		FMWT2 [R] - 001 - - - -	FMPS [R/W] - - - - - 000	
007008_H	FMAC [R] 00000000 00000000 00000000 00000000				
$00700C_H$	FCHA0 [R/W] - - - - - - - - - - - 00000 00000000 00000000				Flash-cache Non-cacheable area setting Register
007010_H	FCHA1 [R/W] - - - - - - - - - - - 00000 00000000 00000000				
007014_H to 007FFCH	Reserved				Reserved
008000H to $00BFFC_H$	MB91F467Cx Boot-ROM size is 4 Kbytes : $00B000_H$ to $00BFFC_H$ MB91F465CA Boot-ROM size is 4 Kbytes : $00B000_H$ to $00BFFC_H$ MB91F463CA Boot-ROM size is 4 Kbytes : $00B000_H$ to $00BFFC_H$ (instruction access is 1 wait cycle, data access is 1 wait cycle)				Boot ROM area
$00C000_H$	CTRLR0 [R/W] 00000000 00000001		STATR0 [R/W] 00000000 00000000		CAN 0 Control Register
$00C004_H$	ERRCNT0 [R] 00000000 00000000		BTR0 [R/W] 00100011 00000001		
$00C008_H$	INTR0 [R] 00000000 00000000		TESTR0 [R/W] 00000000 X0000000		
$00C00C_H$	BRPE0 [R/W] 00000000 00000000		Reserved		
$00C010_H$	IF1CREQ0 [R/W] 00000000 00000001		IF1CMSK0 [R/W] 00000000 00000000		CAN 0 IF 1 Register
$00C014_H$	IF1MSK20 [R/W] 11111111 11111111		IF1MSK10 [R/W] 11111111 11111111		
$00C018_H$	IF1ARB20 [R/W] 00000000 00000000		IF1ARB10 [R/W] 00000000 00000000		
$00C01C_H$	IF1MCTR0 [R/W] 00000000 00000000		Reserved		
$00C020_H$	IF1DTA10 [R/W] 00000000 00000000		IF1DTA20 [R/W] 00000000 00000000		
$00C024_H$	IF1DTB10 [R/W] 00000000 00000000		IF1DTB20 [R/W] 00000000 00000000		
$00C028_H$ to $00C02C_H$	Reserved				
$00C030_H$	IF1DTA20 [R/W] 00000000 00000000		IF1DTA10 [R/W] 00000000 00000000		
$00C034_H$	IF1DTB20 [R/W] 00000000 00000000		IF1DTB10 [R/W] 00000000 00000000		

Address	Register				Block
	+0	+1	+2	+3	
$00C038_H$ to $00C03C_H$	Reserved				
$00C040_H$	IF2CREQ0 [R/W] 00000000 00000001		IF2CMSK0 [R/W] 00000000 00000000		CAN 0 IF 2 Register
$00C044_H$	IF2MSK20 [R/W] 11111111 11111111		IF2MSK10 [R/W] 11111111 11111111		
$00C048_H$	IF2ARB20 [R/W] 00000000 00000000		IF2ARB10 [R/W] 00000000 00000000		
$00C04C_H$	IF2MCTR0 [R/W] 00000000 00000000		Reserved		
$00C050_H$	IF2DTA10 [R/W] 00000000 00000000		IF2DTA20 [R/W] 00000000 00000000		
$00C054_H$	IF2DTB10 [R/W] 00000000 00000000		IF2DTB20 [R/W] 00000000 00000000		
$00C058_H$ to $00C05C_H$	Reserved				
$00C060_H$	IF2DTA20 [R/W] 00000000 00000000		IF2DTA10 [R/W] 00000000 00000000		
$00C064_H$	IF2DTB20 [R/W] 00000000 00000000		IF2DTB10 [R/W] 00000000 00000000		
$00C068_H$ to $00C07C_H$	Reserved				
$00C080_H$	TREQR20 [R] 00000000 00000000		TREQR10 [R] 00000000 00000000		CAN 0 Status Flags
$00C084_H$ to $00C08C_H$	Reserved				
$00C090_H$	NEWDT20 [R] 00000000 00000000		NEWDT10 [R] 00000000 00000000		
$00C094_H$ to $00C09C_H$	Reserved				
$00C0A0_H$	INTPND20 [R] 00000000 00000000		INTPND10 [R] 00000000 00000000		
$00C0A4_H$ to $00C0AC_H$	Reserved				
$00C0B0_H$	MSGVAL20 [R] 00000000 00000000		MSGVAL10 [R] 00000000 00000000		
$00C0B4_H$ to $00C0FC_H$	Reserved				Reserved

Address	Register				Block
	+0	+1	+2	+3	
$00C100_H$	CTRLR1 [R/W] 00000000 00000001		STATR1 [R/W] 00000000 00000000		CAN 1 Control Register
$00C104_H$	ERRCNT1 [R] 00000000 00000000		BTR1 [R/W] 00100011 00000001		
$00C108_H$	INTR1 [R] 00000000 00000000		TESTR1 [R/W] 00000000 X0000000		
$00C10C_H$	BRPE1 [R/W] 00000000 00000000		Reserved		
$00C110_H$	IF1CREQ1 [R/W] 00000000 00000001		IF1CMSK1 [R/W] 00000000 00000000		CAN 1 IF 1 Register
$00C114_H$	IF1MSK21 [R/W] 11111111 11111111		IF1MSK11 [R/W] 11111111 11111111		
$00C118_H$	IF1ARB21 [R/W] 00000000 00000000		IF1ARB11 [R/W] 00000000 00000000		
$00C11C_H$	IF1MCTR1 [R/W] 00000000 00000000		Reserved		
$00C120_H$	IF1DTA11 [R/W] 00000000 00000000		IF1DTA21 [R/W] 00000000 00000000		
$00C124_H$	IF1DTB11 [R/W] 00000000 00000000		IF1DTB21 [R/W] 00000000 00000000		
$00C128_H$ to $00C12C_H$	Reserved				
$00C130_H$	IF1DTA21 [R/W] 00000000 00000000		IF1DTA11 [R/W] 00000000 00000000		
$00C134_H$	IF1DTB21 [R/W] 00000000 00000000		IF1DTB11 [R/W] 00000000 00000000		
$00C138_H$ to $00C13C_H$	Reserved				Reserved

Address	Register				Block
	+0	+1	+2	+3	
$00C140_H$	IF2CREQ1 [R/W] 00000000 00000001		IF2CMSK1 [R/W] 00000000 00000000		CAN 1 IF 2 Register
$00C144_H$	IF2MSK21 [R/W] 11111111 11111111		IF2MSK11 [R/W] 11111111 11111111		
$00C148_H$	IF2ARB21 [R/W] 00000000 00000000		IF2ARB11 [R/W] 00000000 00000000		
$00C14C_H$	IF2MCTR1 [R/W] 00000000 00000000		Reserved		
$00C150_H$	IF2DTA11 [R/W] 00000000 00000000		IF2DTA21 [R/W] 00000000 00000000		
$00C154_H$	IF2DTB11 [R/W] 00000000 00000000		IF2DTB21 [R/W] 00000000 00000000		
$00C158_H$ to $00C15C_H$	Reserved				
$00C160_H$	IF2DTA21 [R/W] 00000000 00000000		IF2DTA11 [R/W] 00000000 00000000		
$00C164_H$	IF2DTB21 [R/W] 00000000 00000000		IF2DTB11 [R/W] 00000000 00000000		
$00C168_H$ to $00C17C_H$	Reserved				
$00C180_H$	TREQR21 [R] 00000000 00000000		TREQR11 [R] 00000000 00000000		CAN 1 Status Flags
$00C184_H$ to $00C18C_H$	Reserved				
$00C190_H$	NEWDT21 [R] 00000000 00000000		NEWDT11 [R] 00000000 00000000		
$00C194_H$ to $00C19C_H$	Reserved				
$00C1A0_H$	INTPND21 [R] 00000000 00000000		INTPND11 [R] 00000000 00000000		
$00C1A4_H$ to $00C1AC_H$	Reserved				Reserved
$00C1B0_H$	MSGVAL21 [R] 00000000 00000000		MSGVAL11 [R] 00000000 00000000		CAN 1 Status Flags
$00C1B4_H$ to $00C1FC_H$	Reserved				Reserved
$00C200_H$	CTRLR2 [R/W] 00000000 00000001		STATR2 [R/W] 00000000 00000000		CAN 2 Control Register
$00C204_H$	ERRCNT2 [R] 00000000 00000000		BTR2 [R/W] 00100011 00000001		
$00C208_H$	INTR2 [R] 00000000 00000000		TESTR2 [R/W] 00000000 X0000000		
$00C20C_H$	BRPE2 [R/W] 00000000 00000000		Reserved		

Address	Register				Block
	+0	+1	+2	+3	
$00C210_H$	IF1CREQ2 [R/W] 00000000 00000001		IF1CMSK2 [R/W] 00000000 00000000		CAN 2 IF 1 Register
$00C214_H$	IF1MSK22 [R/W] 11111111 11111111		IF1MSK12 [R/W] 11111111 11111111		
$00C218_H$	IF1ARB22 [R/W] 00000000 00000000		IF1ARB12 [R/W] 00000000 00000000		
$00C21C_H$	IF1MCTR2 [R/W] 00000000 00000000		Reserved		
$00C220_H$	IF1DTA12 [R/W] 00000000 00000000		IF1DTA22 [R/W] 00000000 00000000		
$00C224_H$	IF1DTB12 [R/W] 00000000 00000000		IF1DTB22 [R/W] 00000000 00000000		
$00C228_H$ to $00C22C_H$	Reserved				
$00C230_H$	IF1DTA22 [R/W] 00000000 00000000		IF1DTA12 [R/W] 00000000 00000000		
$00C234_H$	IF1DTB22 [R/W] 00000000 00000000		IF1DTB12 [R/W] 00000000 00000000		
$00C238_H$ to $00C23C_H$	Reserved				Reserved
$00C240_H$	IF2CREQ2 [R/W] 00000000 00000001		IF2CMSK2 [R/W] 00000000 00000000		CAN 2 IF 2 Register
$00C244_H$	IF2MSK22 [R/W] 11111111 11111111		IF2MSK12 [R/W] 11111111 11111111		
$00C248_H$	IF2ARB22 [R/W] 00000000 00000000		IF2ARB12 [R/W] 00000000 00000000		
$00C24C_H$	IF2MCTR2 [R/W] 00000000 00000000		Reserved		
$00C250_H$	IF2DTA12 [R/W] 00000000 00000000		IF2DTA22 [R/W] 00000000 00000000		
$00C254_H$	IF2DTB12 [R/W] 00000000 00000000		IF2DTB22 [R/W] 00000000 00000000		
$00C258_H$ to $00C25C_H$	Reserved				
$00C260_H$	IF2DTA22 [R/W] 00000000 00000000		IF2DTA12 [R/W] 00000000 00000000		
$00C264_H$	IF2DTB22 [R/W] 00000000 00000000		IF2DTB12 [R/W] 00000000 00000000		
$00C268_H$ to $00C27C_H$	Reserved				Reserved

Address	Register				Block
	+0	+1	+2	+3	
$00C280_H$	TREQR22 [R] 00000000 00000000		TREQR12 [R] 00000000 00000000		CAN 2 Status Flags
$00C284_H$ to $00C28C_H$	Reserved				
$00C290_H$	NEWDT22 [R] 00000000 00000000		NEWDT12 [R] 00000000 00000000		
$00C294_H$ to $00C29C_H$	Reserved				
$00C2A0_H$	INTPND22 [R] 00000000 00000000		INTPND12 [R] 00000000 00000000		
$00C2A4_H$ to $00C2AC_H$	Reserved				
$00C2B0_H$	MSGVAL22 [R] 00000000 00000000		MSGVAL12 [R] 00000000 00000000		CAN 2 Status Flags
$00C2B4_H$ to $00EFFC_H$	Reserved				Reserved
$00F000_H$	BCTRL [R/W] -------- -------- 11111100 00000000				EDSU / MPU
$00F004_H$	BSTAT [R/W] -------- -----000 00000000 10--0000				
$00F008_H$	BIAC [R] -------- -------- 00000000 00000000				
$00F00C_H$	BOAC [R] -------- -------- 00000000 00000000				
$00F010_H$	BIRQ [R/W] -------- -------- 00000000 00000000				
$00F014_H$ to $00F01C_H$	Reserved				
$00F020_H$	BCR0 [R/W] -------- 00000000 00000000 00000000				
$00F024_H$	BCR1 [R/W] -------- 00000000 00000000 00000000				
$00F028_H$	BCR2 [R/W] -------- 00000000 00000000 00000000				
$00F02C_H$	BCR3 [R/W] -------- 00000000 00000000 00000000				
$00F030_H$ to $00F07C_H$	Reserved				Reserved

Address	Register				Block
	+0	+1	+2	+3	
$00F080_H$	BAD0 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				EDSU / MPU
$00F084_H$	BAD1 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
$00F088_H$	BAD2 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
$00F08C_H$	BAD3 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
$00F090_H$	BAD4 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
$00F094_H$	BAD5 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
$00F098_H$	BAD6 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
$00F09C_H$	BAD7 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				EDSU / MPU
$00F0A0_H$	BAD8 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
$00F0A4_H$	BAD9 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
$00F0A8_H$	BAD10 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
$00F0AC_H$	BAD11 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
$00F0B0_H$	BAD12 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
$00F0B4_H$	BAD13 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
$00F0B8_H$	BAD14 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
$00F0BC_H$	BAD15 [R/W] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
$00F0C0_H$ to $01FFFC_H$	Reserved				Reserved
020000_H to $02FFFC_H$	MB91F467Cx D-RAM size is 32 Kbytes : 028000_H to $02FFFC_H$ MB91F465CA D-RAM size is 16 Kbytes : $02C000_H$ to $02FFFC_H$ MB91F463CA D-RAM size is 16 Kbytes : $02C000_H$ to $02FFFC_H$ (data access is 0 wait cycles)				D-RAM area
030000_H to $03FFFC_H$	MB91F467Cx ID-RAM size is 32 Kbytes : 030000_H to $037FFC_H$ MB91F465CA ID-RAM size is 16 Kbytes : 030000_H to $033FFC_H$ MB91F463CA ID-RAM size is 8 Kbytes : 030000_H to $031FFC_H$ (instruction access is 0 wait cycles, data access is 1 wait cycle)				ID-RAM area

*1 : depends on the number of available CAN channels

12.2 Flash memory and external bus area

32bit read/write	dat[31:0]				dat[31:0]				
16bit read/write	dat[31:16]		dat[15:0]		dat[31:16]		dat[15:0]		
Address	Register								Block
	+0	+1	+2	+3	+4	+5	+6	+7	
040000_H to $05FFF8_H$	SA8 (64KB, MB91F467Cx); Reserved (MB91F465CA, MB91F463CA)				SA9 (64KB, MB91F467Cx); Reserved (MB91F465CA, MB91F463CA)				ROMS0
060000_H to $07FFF8_H$	SA10 (64KB, MB91F467Cx); Reserved (MB91F465CA, MB91F463CA)				SA11 (64KB, MB91F467Cx); Reserved (MB91F465CA, MB91F463CA)				ROMS1
080000_H to $09FFF8_H$	SA12 (64KB, MB91F467Cx, MB91F465CA); Reserved (MB91F463CA)				SA13 (64KB, MB91F467Cx, MB91F465CA); Reserved (MB91F463CA)				ROMS2
$0A0000_H$ to $0BFFF8_H$	SA14 (64KB, MB91F467Cx, MB91F465CA); Reserved (MB91F463CA)				SA15 (64KB, MB91F467Cx, MB91F465CA); Reserved (MB91F463CA)				ROMS3
$0C0000_H$ to $0DFFF8_H$	SA16 (64KB)				SA17 (64KB)				ROMS4
$0E0000_H$ to $0FFFF0_H$	SA18 (64KB)				SA19 (64KB)				ROMS5
$0FFFF8_H$	FMV [R] 06 00 00 00H				FRV [R] 00 00 BF F8H				
100000_H to $11FFF8_H$	SA20 (64KB, MB91F467Cx); Reserved (MB91F465CA, MB91F463CA)				SA21 (64KB, MB91F467Cx); Reserved (MB91F465CA, MB91F463CA)				ROMS6
120000_H to $13FFF8_H$	SA22 (64KB, MB91F467Cx); Reserved (MB91F465CA, MB91F463CA)				SA23 (64KB, MB91F467Cx); Reserved (MB91F465CA, MB91F463CA)				
140000_H to $143FF8_H$	SA0 (8KB, MB91F467Cx); Reserved (MB91F465CA, MB91F463CA)				SA1 (8KB, MB91F467Cx); Reserved (MB91F465CA, MB91F463CA)				ROMS7
144000_H to $17FF8_H$	SA2 (8KB, MB91F467Cx); Reserved (MB91F465CA, MB91F463CA)				SA3 (8KB, MB91F467Cx); Reserved (MB91F465CA, MB91F463CA)				
148000_H to $14BFF8_H$	SA4 (8KB)				SA5 (8KB)				
$14C000_H$ to $14FFF8_H$	SA6 (8KB)				SA7 (8KB)				
150000_H to $17FFF8_H$	Reserved								

32bit read/write	dat[31:0]				dat[31:0]				
16bit read/write	dat[31:16]		dat[15:0]		dat[31:16]		dat[15:0]		
Address	Register								Block
	+0	+1	+2	+3	+4	+5	+6	+7	
180000_H to $1BFFF8_H$	Reserved								ROMS8
$1C0000_H$ to $1FFFF8_H$									ROMS9
200000_H to $27FFF8_H$									ROMS10
280000_H to $2FFFF8_H$									ROMS11
300000_H to $37FFF8_H$									ROMS12
380000_H to $3FFFF8_H$									ROMS13
400000_H to $47FFF8_H$									ROMS14
480000_H to $4FFFF8_H$									ROMS15

Notes: Write operations to address $0FFFF8_H$ and $0FFFFC_H$ are not possible. When reading these addresses, the values shown above will be read.

On MB91F465CA and MB91F463CA, write access to the flash is only possible in 16-bit mode.

13. Interrupt Vector Table

Interrupt	Interrupt number		Interrupt level *1		Interrupt vector *2		DMA Resource number
	Decimal	Hexa-decimal	Setting Register	Register address	Offset	Default Vector address	
Reset	0	00	-	-	0x3FC	0x000FFFFC	
Mode vector	1	01	-	-	0x3F8	0x000FFFF8	
System reserved	2	02	-	-	0x3F4	0x000FFFF4	
System reserved	3	03	-	-	0x3F0	0x000FFFF0	
System reserved	4	04	-	-	0x3EC	0x000FFFEC	
CPU supervisor mode (INT #5 instruction) *6	5	05	-	-	0x3E8	0x000FFFE8	
Memory Protection exception *6	6	06	-	-	0x3E4	0x000FFFE4	
Co-processor fault trap *5	7	07	-	-	0x3E0	0x000FFFE0	
Co-processor error trap *5	8	08	-	-	0x3DC	0x000FFFDC	
INTE instruction *5	9	09	-	-	0x3D8	0x000FFFD8	
Instruction break exception *5	10	0A	-	-	0x3D4	0x000FFFD4	
Operand break trap *5	11	0B	-	-	0x3D0	0x000FFFD0	
Step trace trap *5	12	0C	-	-	0x3CC	0x000FFFCC	
NMI interrupt (tool)*5	13	0D	-	-	0x3C8	0x000FFFC8	
Undefined instruction exception	14	0E	-	-	0x3C4	0x000FFFC4	
NMI request	15	0F	F_H fixed		0x3C0	0x000FFFC0	
External Interrupt 0	16	10	ICR00	0x440	0x3BC	0x000FFFBC	0, 16
External Interrupt 1	17	11			0x3B8	0x000FFFB8	1, 17
External Interrupt 2	18	12	ICR01	0x441	0x3B4	0x000FFFB4	2, 18
External Interrupt 3	19	13			0x3B0	0x000FFFB0	3, 19
External Interrupt 4	20	14	ICR02	0x442	0x3AC	0x000FFFAC	20
External Interrupt 5	21	15			0x3A8	0x000FFFA8	21
External Interrupt 6	22	16	ICR03	0x443	0x3A4	0x000FFFA4	22
External Interrupt 7	23	17			0x3A0	0x000FFFA0	23
External Interrupt 8	24	18	ICR04	0x444	0x39C	0x000FFF9C	
External Interrupt 9	25	19			0x398	0x000FFF98	
External Interrupt 10	26	1A	ICR05	0x445	0x394	0x000FFF94	
External Interrupt 11	27	1B			0x390	0x000FFF90	
External Interrupt 12	28	1C	ICR06	0x446	0x38C	0x000FFF8C	
External Interrupt 13	29	1D			0x388	0x000FFF88	

Interrupt	Interrupt number		Interrupt level *1		Interrupt vector *2		DMA Resource number
	Decimal	Hexa-decimal	Setting Register	Register address	Offset	Default Vector address	
External Interrupt 14	30	1E	ICR07	0x447	0x384	0x000FFF84	
Reserved	31	1F			0x380	0x000FFF80	
Reload Timer 0	32	20	ICR08	0x448	0x37C	0x000FFF7C	4, 32
Reload Timer 1	33	21			0x378	0x000FFF78	5, 33
Reload Timer 2	34	22	ICR09	0x449	0x374	0x000FFF74	34
Reload Timer 3	35	23			0x370	0x000FFF70	35
Reload Timer 4	36	24	ICR10	0x44A	0x36C	0x000FFF6C	36
Reload Timer 5	37	25			0x368	0x000FFF68	37
Reload Timer 6	38	26	ICR11	0x44B	0x364	0x000FFF64	38
Reload Timer 7	39	27			0x360	0x000FFF60	39
Free Run Timer 0	40	28	ICR12	0x44C	0x35C	0x000FFF5C	40
Free Run Timer 1	41	29			0x358	0x000FFF58	41
Free Run Timer 2	42	2A	ICR13	0x44D	0x354	0x000FFF54	42
Free Run Timer 3	43	2B			0x350	0x000FFF50	43
Free Run Timer 4	44	2C	ICR14	0x44E	0x34C	0x000FFF4C	44
Free Run Timer 5	45	2D			0x348	0x000FFF48	45
Free Run Timer 6	46	2E	ICR15	0x44F	0x344	0x000FFF44	46
Free Run Timer 7	47	2F			0x340	0x000FFF40	47
CAN 0	48	30	ICR16	0x450	0x33C	0x000FFF3C	
CAN 1	49	31			0x338	0x000FFF38	
CAN 2	50	32	ICR17	0x451	0x334	0x000FFF34	
Reserved	51	33			0x330	0x000FFF30	
Reserved	52	34	ICR18	0x452	0x32C	0x000FFF2C	
Reserved	53	35			0x328	0x000FFF28	
Reserved	54	36	ICR19	0x453	0x324	0x000FFF24	6, 48
Reserved	55	37			0x320	0x000FFF20	7, 49
Reserved	56	38	ICR20	0x454	0x31C	0x000FFF1C	8, 50
Reserved	57	39			0x318	0x000FFF18	9, 51
USART (LIN) 2 RX	58	3A	ICR21	0x455	0x314	0x000FFF14	52
USART (LIN) 2 TX	59	3B			0x310	0x000FFF10	53
Reserved	60	3C	ICR22	0x456	0x30C	0x000FFF0C	54
Reserved	61	3D			0x308	0x000FFF08	55
System reserved	62	3E	ICR23 *4	0x457	0x304	0x000FFF04	
Delayed Interrupt	63	3F			0x300	0x000FFF00	
System reserved *3	64	40	(ICR24)	(0x458)	0x2FC	0x000FFEFC	
System reserved *3	65	41			0x2F8	0x000FFEF8	

Interrupt	Interrupt number		Interrupt level *1		Interrupt vector *2		DMA Resource number
	Decimal	Hexa-decimal	Setting Register	Register address	Offset	Default Vector address	
USART (LIN, FIFO) 4 RX	66	42	ICR25	0x459	0x2F4	0x000FFEF4	10, 56
USART (LIN, FIFO) 4 TX	67	43			0x2F0	0x000FFEF0	11, 57
USART (LIN, FIFO) 5 RX	68	44	ICR26	0x45A	0x2EC	0x000FFEEC	12, 58
USART (LIN, FIFO) 5 TX	69	45			0x2E8	0x000FFEE8	13, 59
USART (LIN, FIFO) 6 RX	70	46	ICR27	0x45B	0x2E4	0x000FFEE4	60
USART (LIN, FIFO) 6 TX	71	47			0x2E0	0x000FFEE0	61
USART (LIN, FIFO) 7 RX	72	48	ICR28	0x45C	0x2DC	0x000FFEDC	62
USART (LIN, FIFO) 7 TX	73	49			0x2D8	0x000FFED8	63
I^2C 0 / I^2C 2	74	4A	ICR29	0x45D	0x2D4	0x000FFED4	
I^2C 3	75	4B			0x2D0	0x000FFED0	
Reserved	76	4C	ICR30	0x45E	0x2CC	0x000FFECC	64
Reserved	77	4D			0x2C8	0x000FFEC8	65
Reserved	78	4E	ICR31	0x45F	0x2C4	0x000FFEC4	66
Reserved	79	4F			0x2C0	0x000FFEC0	67
Reserved	80	50	ICR32	0x460	0x2BC	0x000FFEBC	68
Reserved	81	51			0x2B8	0x000FFEB8	69
Reserved	82	52	ICR33	0x461	0x2B4	0x000FFEB4	70
Reserved	83	53			0x2B0	0x000FFEB0	71
Reserved	84	54	ICR34	0x462	0x2AC	0x000FFEAC	72
Reserved	85	55			0x2A8	0x000FFEA8	73
Reserved	86	56	ICR35	0x463	0x2A4	0x000FFEA4	74
Reserved	87	57			0x2A0	0x000FFEA0	75
Reserved	88	58	ICR36	0x464	0x29C	0x000FFE9C	76
Reserved	89	59			0x298	0x000FFE98	77
Reserved	90	5A	ICR37	0x465	0x294	0x000FFE94	78
Reserved	91	5B			0x290	0x000FFE90	79
Input Capture 0	92	5C	ICR38	0x466	0x28C	0x000FFE8C	80
Input Capture 1	93	5D			0x288	0x000FFE88	81
Input Capture 2	94	5E	ICR39	0x467	0x284	0x000FFE84	82
Input Capture 3	95	5F			0x280	0x000FFE80	83
Input Capture 4	96	60	ICR40	0x468	0x27C	0x000FFE7C	84
Input Capture 5	97	61			0x278	0x000FFE78	85
Input Capture 6	98	62	ICR41	0x469	0x274	0x000FFE74	86
Input Capture 7	99	63			0x270	0x000FFE70	87
Output Compare 0	100	64	ICR42	0x46A	0x26C	0x000FFE6C	88
Output Compare 1	101	65			0x268	0x000FFE68	89

Interrupt	Interrupt number		Interrupt level *1		Interrupt vector *2		DMA Resource number
	Decimal	Hexa-decimal	Setting Register	Register address	Offset	Default Vector address	
Output Compare 2	102	66	ICR43	0x46B	0x264	0x000FFE64	90
Output Compare 3	103	67			0x260	0x000FFE60	91
Reserved	104	68	ICR44	0x46C	0x25C	0x000FFE5C	92
Reserved	105	69			0x258	0x000FFE58	93
Reserved	106	6A	ICR45	0x46D	0x254	0x000FFE54	94
Reserved	107	6B			0x250	0x000FFE50	95
Sound Generator	108	6C	ICR46	0x46E	0x24C	0x000FFE4C	
Phase Frequ. Modulator	109	6D			0x248	0x000FFE48	
System reserved	110	6E	ICR47 *4	0x46F	0x244	0x000FFE44	
System reserved	111	6F			0x240	0x000FFE40	
Reserved	112	70	ICR48	0x470	0x23C	0x000FFE3C	15, 96
Reserved	113	71			0x238	0x000FFE38	97
Reserved	114	72	ICR49	0x471	0x234	0x000FFE34	98
Reserved	115	73			0x230	0x000FFE30	99
Prog. Pulse Gen. 4	116	74	ICR50	0x472	0x22C	0x000FFE2C	100
Prog. Pulse Gen. 5	117	75			0x228	0x000FFE28	101
Prog. Pulse Gen. 6	118	76	ICR51	0x473	0x224	0x000FFE24	102
Prog. Pulse Gen. 7	119	77			0x220	0x000FFE20	103
Prog. Pulse Gen. 8	120	78	ICR52	0x474	0x21C	0x000FFE1C	104
Prog. Pulse Gen. 9	121	79			0x218	0x000FFE18	105
Prog. Pulse Gen. 10	122	7A	ICR53	0x475	0x214	0x000FFE14	106
Prog. Pulse Gen. 11	123	7B			0x210	0x000FFE10	107
Prog. Pulse Gen. 12	124	7C	ICR54	0x476	0x20C	0x000FFE0C	108
Prog. Pulse Gen. 13	125	7D			0x208	0x000FFE08	109
Prog. Pulse Gen. 14	126	7E	ICR55	0x477	0x204	0x000FFE04	110
Prog. Pulse Gen. 15	127	7F			0x200	0x000FFE00	111
Up/Down Counter 0	128	80	ICR56	0x478	0x1FC	0x000FFDFC	
Reserved	129	81			0x1F8	0x000FFDF8	
Up/Down Counter 2	130	82	ICR57	0x479	0x1F4	0x000FFDF4	
Up/Down Counter 3	131	83			0x1F0	0x000FFDF0	
Real Time Clock	132	84	ICR58	0x47A	0x1EC	0x000FFDEC	
Calibration Unit	133	85			0x1E8	0x000FFDE8	
A/D Converter 0	134	86	ICR59	0x47B	0x1E4	0x000FFDE4	14, 112
Reserved	135	87			0x1E0	0x000FFDE0	
Alarm Comparator 0	136	88	ICR60	0x47C	0x1DC	0x000FFDDC	
Reserved	137	89			0x1D8	0x000FFDD8	

Interrupt	Interrupt number		Interrupt level *1		Interrupt vector *2		DMA Resource number
	Decimal	Hexa-decimal	Setting Register	Register address	Offset	Default Vector address	
Low Voltage Detection	138	8A	ICR61	0x47D	0x1D4	0x000FFDD4	
Reserved	139	8B			0x1D0	0x000FFDD0	
Timebase Overflow	140	8C	ICR62	0x47E	0x1CC	0x000FFDCC	
PLL Clock Gear	141	8D			0x1C8	0x000FFDC8	
DMA Controller	142	8E	ICR63	0x47F	0x1C4	0x000FFDC4	
Main/Sub OSC stability wait	143	8F			0x1C0	0x000FFDC0	
Security vector	144	90	-	-	0x1BC	0x000FFDBC	
Used by the INT instruction.	145 to 255	91 to FF	-	-	0x1B8 to 0x000	0x000FFDB8 to 0x000FFC00	

Notes:

*1: The Interrupt Control Registers (ICRs) are located in the interrupt controller and set the interrupt level for each interrupt request. An ICR is provided for each interrupt request.
*2:The vector address for each EIT (exception, interrupt or trap) is calculated by adding the listed offset to the table base register value (TBR). The TBR specifies the top of the EIT vector table. The addresses listed in the table are for the default TBR value (0x000FFC00). The TBR is initialized to this value by a reset. After execution of the internal boot ROM TBR is set to 0x000FFC00.
*3: Used by REALOS
*4: ICR23 and ICR47 can be exchanged by setting the REALOS compatibility bit (addr 0x0C03 : IOS[0])
*5: System reserved
*6: Memory Protection Unit (MPU) support

14. Recommended Settings

14.1 PLL and Clockgear settings

Please note that for MB91F460C series the core base clock frequencies are valid in the 1.8V operation mode of the Main regulator and Flash.

Recommended PLL divider and clockgear settings

PLL Input (CLK) [MHz]	Frequency Parameter		Clockgear Parameter		PLL Output (X) [MHz]	Core Base Clock [MHz]	Remarks
	DIVM	DIVN	DIVG	MULG	MULG		
4	2	25	16	24	200	100	
4	2	24	16	24	192	96	
4	2	23	16	24	184	92	
4	2	22	16	24	176	88	
4	2	21	16	20	168	84	
4	2	20	16	20	160	80	
4	2	19	16	20	152	76	
4	2	18	16	20	144	72	
4	2	17	16	16	136	68	
4	2	16	16	16	128	64	
4	2	15	16	16	120	60	
4	2	14	16	16	112	56	
4	2	13	16	12	104	52	
4	2	12	16	12	96	48	
4	2	11	16	12	88	44	
4	4	10	16	24	160	40	
4	4	9	16	24	144	36	
4	4	8	16	24	128	32	
4	4	7	16	24	112	28	
4	6	6	16	24	144	24	
4	8	5	16	28	160	20	
4	10	4	16	32	160	16	
4	12	3	16	32	144	12	

14.2 Clock Modulator settings

The following table shows all possible settings for the Clock Modulator in a base clock frequency range from 32MHz up to 88MHz.

The Flash access time settings need to be adjusted according to Fmax while the PLL and clockgear settings should be set according to base clock frequency.

Clock Modulator settings, frequency range and supported supply voltage

Modulation Degree (k)	Random No (N)	CMPR [hex]	Baseclk [MHz]	Fmin [MHz]	Fmax [MHz]
1	3	026F	88	79.5	98.5
1	3	026F	84	76.1	93.8
1	3	026F	80	72.6	89.1
1	5	02AE	80	68.7	95.8
2	3	046E	80	68.7	95.8
1	3	026F	76	69.1	84.5
1	5	02AE	76	65.3	90.8
1	7	02ED	76	62	98.1
2	3	046E	76	65.3	90.8
3	3	066D	76	62	98.1
1	3	026F	72	65.5	79.9
1	5	02AE	72	62	85.8
1	7	02ED	72	58.8	92.7
2	3	046E	72	62	85.8
3	3	066D	72	58.8	92.7
1	3	026F	68	62	75.3
1	5	02AE	68	58.7	80.9
1	7	02ED	68	55.7	87.3
1	9	032C	68	53	95
2	3	046E	68	58.7	80.9
2	5	04AC	68	53	95
3	3	066D	68	55.7	87.3
4	3	086C	68	53	95
1	3	026F	64	58.5	70.7
1	5	02AE	64	55.3	75.9
1	7	02ED	64	52.5	82
1	9	032C	64	49.9	89.1
1	11	036B	64	47.6	97.6
2	3	046E	64	55.3	75.9
2	5	04AC	64	49.9	89.1
3	3	066D	64	52.5	82
4	3	086C	64	49.9	89.1
5	3	0A6B	64	47.6	97.6

Modulation Degree (k)	Random No (N)	CMPR [hex]	Baseclk [MHz]	Fmin [MHz]	Fmax [MHz]
1	3	026F	60	54.9	66.1
1	5	02AE	60	51.9	71
1	7	02ED	60	49.3	76.7
1	9	032C	60	46.9	83.3
1	11	036B	60	44.7	91.3
2	3	046E	60	51.9	71
2	5	04AC	60	46.9	83.3
3	3	066D	60	49.3	76.7
4	3	086C	60	46.9	83.3
5	3	0A6B	60	44.7	91.3
1	3	026F	56	51.4	61.6
1	5	02AE	56	48.6	66.1
1	7	02ED	56	46.1	71.4
1	9	032C	56	43.8	77.6
1	11	036B	56	41.8	84.9
1	13	03AA	56	39.9	93.8
2	3	046E	56	48.6	66.1
2	5	04AC	56	43.8	77.6
2	7	04EA	56	39.9	93.8
3	3	066D	56	46.1	71.4
3	5	06AA	56	39.9	93.8
4	3	086C	56	43.8	77.6
5	3	0A6B	56	41.8	84.9
6	3	0C6A	56	39.9	93.8
1	3	026F	52	47.8	57
1	5	02AE	52	45.2	61.2
1	7	02ED	52	42.9	66.1
1	9	032C	52	40.8	71.8
1	11	036B	52	38.8	78.6
1	13	03AA	52	37.1	86.8
1	15	03E9	52	35.5	96.9
2	3	046E	52	45.2	61.2
2	5	04AC	52	40.8	71.8
2	7	04EA	52	37.1	86.8
3	3	066D	52	42.9	66.1
3	5	06AA	52	37.1	86.8
4	3	086C	52	40.8	71.8

Modulation Degree (k)	Random No (N)	CMPR [hex]	Baseclk [MHz]	Fmin [MHz]	Fmax [MHz]
5	3	0A6B	52	38.8	78.6
6	3	0C6A	52	37.1	86.8
7	3	0E69	52	35.5	96.9
1	3	026F	48	44.2	52.5
1	5	02AE	48	41.8	56.4
1	7	02ED	48	39.6	60.9
1	9	032C	48	37.7	66.1
1	11	036B	48	35.9	72.3
1	13	03AA	48	34.3	79.9
1	15	03E9	48	32.8	89.1
2	3	046E	48	41.8	56.4
2	5	04AC	48	37.7	66.1
2	7	04EA	48	34.3	79.9
3	3	066D	48	39.6	60.9
3	5	06AA	48	34.3	79.9
4	3	086C	48	37.7	66.1
5	3	0A6B	48	35.9	72.3
6	3	0C6A	48	34.3	79.9
7	3	0E69	48	32.8	89.1
1	3	026F	44	40.6	48.1
1	5	02AE	44	38.4	51.6
1	7	02ED	44	36.4	55.7
1	9	032C	44	34.6	60.4
1	11	036B	44	33	66.1
1	13	03AA	44	31.5	73
1	15	03E9	44	30.1	81.4
2	3	046E	44	38.4	51.6
2	5	04AC	44	34.6	60.4
2	7	04EA	44	31.5	73
2	9	0528	44	28.9	92.1
3	3	066D	44	36.4	55.7
3	5	06AA	44	31.5	73
4	3	086C	44	34.6	60.4
4	5	08A8	44	28.9	92.1
5	3	0A6B	44	33	66.1
6	3	0C6A	44	31.5	73
7	3	0E69	44	30.1	81.4

Modulation Degree (k)	Random No (N)	CMPR [hex]	Baseclk [MHz]	Fmin [MHz]	Fmax [MHz]
8	3	1068	44	28.9	92.1
1	3	026F	40	37	43.6
1	5	02AE	40	34.9	46.8
1	7	02ED	40	33.1	50.5
1	9	032C	40	31.5	54.8
1	11	036B	40	30	59.9
1	13	03AA	40	28.7	66.1
1	15	03E9	40	27.4	73.7
2	3	046E	40	34.9	46.8
2	5	04AC	40	31.5	54.8
2	7	04EA	40	28.7	66.1
2	9	0528	40	26.3	83.3
3	3	066D	40	33.1	50.5
3	5	06AA	40	28.7	66.1
3	7	06E7	40	25.3	95.8
4	3	086C	40	31.5	54.8
4	5	08A8	40	26.3	83.3
5	3	0A6B	40	30	59.9
6	3	0C6A	40	28.7	66.1
7	3	0E69	40	27.4	73.7
8	3	1068	40	26.3	83.3
9	3	1267	40	25.3	95.8
1	3	026F	36	33.3	39.2
1	5	02AE	36	31.5	42
1	7	02ED	36	29.9	45.3
1	9	032C	36	28.4	49.2
1	11	036B	36	27.1	53.8
1	13	03AA	36	25.8	59.3
1	15	03E9	36	24.7	66.1
2	3	046E	36	31.5	42
2	5	04AC	36	28.4	49.2
2	7	04EA	36	25.8	59.3
2	9	0528	36	23.7	74.7
3	3	066D	36	29.9	45.3
3	5	06AA	36	25.8	59.3
3	7	06E7	36	22.8	85.8
4	3	086C	36	28.4	49.2

Modulation Degree (k)	Random No (N)	CMPR [hex]	Baseclk [MHz]	Fmin [MHz]	Fmax [MHz]
4	5	08A8	36	23.7	74.7
5	3	0A6B	36	27.1	53.8
6	3	0C6A	36	25.8	59.3
7	3	0E69	36	24.7	66.1
8	3	1068	36	23.7	74.7
9	3	1267	36	22.8	85.8
1	3	026F	32	29.7	34.7
1	5	02AE	32	28	37.3
1	7	02ED	32	26.6	40.2
1	9	032C	32	25.3	43.6
1	11	036B	32	24.1	47.7
1	13	03AA	32	23	52.5
1	15	03E9	32	22	58.6
2	3	046E	32	28	37.3
2	5	04AC	32	25.3	43.6
2	7	04EA	32	23	52.5
2	9	0528	32	21.1	66.1
2	11	0566	32	19.5	89.1
3	3	066D	32	26.6	40.2
3	5	06AA	32	23	52.5
3	7	06E7	32	20.3	75.9
4	3	086C	32	25.3	43.6
4	5	08A8	32	21.1	66.1
5	3	0A6B	32	24.1	47.7
5	5	0AA6	32	19.5	89.1
6	3	0C6A	32	23	52.5
7	3	0E69	32	22	58.6
8	3	1068	32	21.1	66.1
9	3	1267	32	20.3	75.9
10	3	1466	32	19.5	89.1

15. Electrical Characteristics

15.1 Absolute maximum ratings

Parameter	Symbol	Rating		Unit	Remarks
		Min	Max		
Power supply slew rate	—	—	50	V/ms	
Power supply voltage 1*1	$V_{DD}5R$	− 0.3	+ 6.0	V	
Power supply voltage 2*1	$V_{DD}5$	− 0.3	+ 6.0	V	
Power supply voltage 3*1	$HV_{DD}5$	− 0.3	+ 6.0	V	
Relationship of the supply voltages	$HV_{DD}5$	$V_{DD}5$-0.3	$V_{DD}5$+0.3	V	SMC mode
		$V_{SS}5$-0.3	$V_{DD}5$+0.3	V	General purpose port mode
	$AV_{CC}5$	$V_{DD}5$-0.3	$V_{DD}5$+0.3	V	At least one pin of the Ports 25 to 29 (SMC, ANn) is used as digital input or output.
		$V_{SS}5$-0.3	$V_{DD}5$+0.3	V	All pins of the Ports 25 to 29 (SMC, ANn) follow the condition of V_{IA}
Analog power supply voltage*1	$AV_{CC}5$	− 0.3	+ 6.0	V	*2
Analog reference power supply voltage*1	AVRH	− 0.3	+ 6.0	V	*2
Input voltage 1*1	V_{I1}	Vss5 − 0.3	$V_{DD}5$ + 0.3	V	
Input voltage 3*1	V_{I3}	HVss5 − 0.3	$HV_{DD}5$ + 0.3	V	Stepper motor controller
Analog pin input voltage*1	V_{IA}	AVss5 − 0.3	AVcc5 + 0.3	V	
Output voltage 1*1	V_{O1}	Vss5 − 0.3	$V_{DD}5$ + 0.3	V	
Output voltage 3*1	V_{O3}	HVss5 − 0.3	$HV_{DD}5$ + 0.3	V	Stepper motor controller
Maximum clamp current	I_{CLAMP}	− 4.0	+ 4.0	mA	*3
Total maximum clamp current	$\Sigma \lvert I_{CLAMP} \rvert$	—	20	mA	*3
“L” level maximum output current*4	I_{OL}	—	10	mA	
		—	40	mA	Stepper motor controller
“L” level average output current*5	I_{OLAV}	—	8	mA	
		—	30	mA	Stepper motor controller
“L” level total maximum output current	ΣI_{OL}	—	100	mA	
		—	360	mA	Stepper motor controller
“L” level total average output current*6	ΣI_{OLAV}	—	50	mA	
		—	230	mA	Stepper motor controller
“H” level maximum output current*4	I_{OH}	—	− 10	mA	
		—	− 40	mA	Stepper motor controller
“H” level average output current*5	I_{OHAV}	—	− 4	mA	
		—	− 30	mA	Stepper motor controller
“H” level total maximum output current	ΣI_{OH}	—	− 100	mA	
		—	− 360	mA	Stepper motor controller

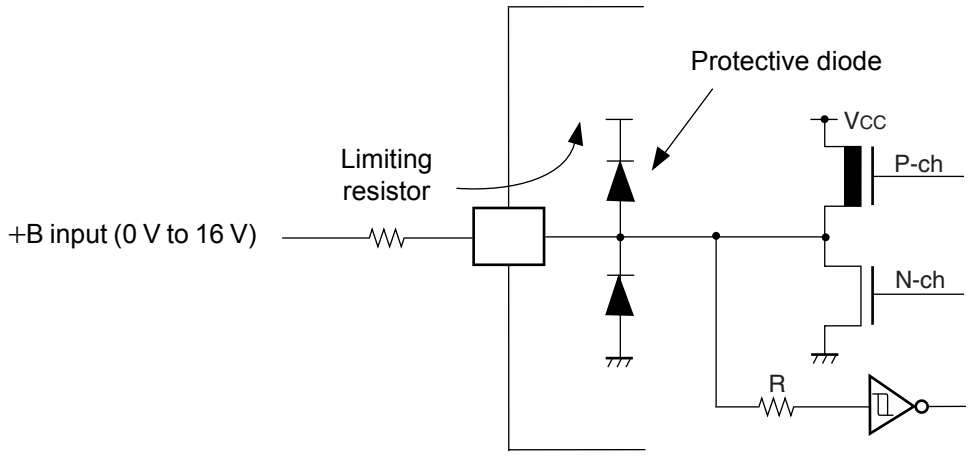
Parameter	Symbol	Rating		Unit	Remarks
		Min	Max		
"H" level total average output current*6	ΣI_{OHAV}	—	− 25	mA	
		—	− 230	mA	Stepper motor controller
Power consumption	P_D	—	1000	mW	
Operating temperature	T_A	− 40	+ 105	°C	
Storage temperature	Tstg	− 55	+ 150	°C	

*1 : The parameter is based on $V_{SS}5 = HV_{SS}5 = AV_{SS}5 = 0.0$ V.

*2 : $AV_{CC}5$ and AVRH5 must not exceed $V_{DD}5 + 0.3$ V.

*3 :
- Use within recommended operating conditions.
- Use with DC voltage (current).
- +B signals are input signals that exceed the $V_{DD}5$ voltage. +B signals should always be applied by connecting a limiting resistor between the +B signal and the microcontroller.
- The value of the limiting resistor should be set so that the current input to the microcontroller pin does not exceed the rated value at any time , either instantaneously or for an extended period, when the +B signal is input.
- Note that when the microcontroller drive current is low, such as in the low power consumption modes, the +B input potential can increase the potential at the power supply pin via a protective diode, possibly affecting other devices.
- Note that if the +B signal is input when the microcontroller is off (not fixed at 0 V), power is supplied through the +B input pin; therefore, the microcontroller may partially operate.
- Note that if the +B signal is input at power-on, since the power is supplied through the pin, the power-on reset may not function in the power supply voltage.
- Do not leave +B input pins open.
- Example of recommended circuit :

Input/output equivalent circuit



*4 : Maximum output current is defined as the value of the peak current flowing through any one of the corresponding pins.

*5 : Average output current is defined as the value of the average current flowing through any one of the corresponding pins for a 100 ms period.

*6 : Total average output current is defined as the value of the average current flowing through all of the corresponding pins for a 100 ms period.

WARNING:Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

15.2 Recommended operating conditions

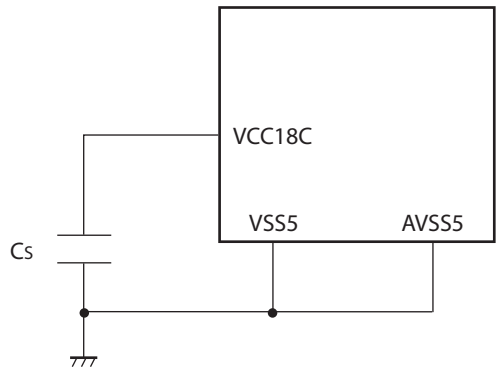
($V_{SS}5 = AV_{SS}5 = 0.0$ V)

Parameter	Symbol	Value			Unit	Remarks
		Min	Typ	Max		
Power supply voltage	$V_{DD}5$	3.0	—	5.5	V	
	$V_{DD}5R$	3.0	—	5.5	V	Internal regulator
	$HV_{DD}5$	4.5	—	5.5	V	Stepper motor controller
		3.0	—	5.5	V	Stepper motor controller (when all pins are used as general-purpose ports)
	$AV_{CC}5$	3.0	—	5.5	V	A/D converter
Smoothing capacitor at VCC18C pin	C_S	—	4.7	—	µF	Use a X7R ceramic capacitor or a capacitor that has similar frequency characteristics.
Power supply slew rate		—	—	50	V/ms	
Operating temperature	T_A	− 40	—	+ 105	°C	
Stepper motor control slew rate			40		ns	Cload = 0 pF
Main Oscillation stabilisation time		10			ms	
Lock-up time PLL (4 MHz ->16 ...100MHz)				0.6	ms	
ESD Protection (Human body model)	V_{surge}	2			kV	$R_{discharge}$ = 1.5kΩ $C_{discharge}$ = 100pF
RC Oscillator	$f_{RC100kHz}$ f_{RC2MHz}	50 1	100 2	200 4	kHz MHz	VDD_{CORE}≥1.65V

WARNING: The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device's electrical characteristics are warranted when the device is operated within these ranges.

Always use semiconductor devices within their recommended operating condition ranges. Operation outside these ranges may adversely affect reliability and could result in device failure.

No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet. Users considering application outside the listed conditions are advised to contact their Cypress representatives beforehand.



15.3 DC characteristics

Note: In the following tables, "V_{DD}" means $HV_{DD}5$ for SMC pins or $V_{DD}5$ for other pins.
In the following tables, "V_{SS}" means Hvss5 for ground Pins of the stepper motor and $V_{SS}5$ for the other pins.

($V_{DD}5 = AV_{CC}5 = 3.0$ V to 5.5 V, $V_{SS}5 = AV_{SS}5 = 0$ V, $T_A = -40$ °C to $+105$ °C)

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min	Typ	Max		
Input "H" voltage	V_{IH}	—	Port inputs if CMOS Hysteresis 0.8/0.2 input is selected	$0.8 \times V_{DD}$	—	$V_{DD} + 0.3$	V	CMOS hysteresis input
		—	Port inputs if CMOS Hysteresis 0.7/0.3 input is selected	$0.7 \times V_{DD}$	—	$V_{DD} + 0.3$	V	$4.5\ V \le V_{DD} \le 5.5\ V$
				$0.74 \times V_{DD}$	—	$V_{DD} + 0.3$	V	$3\ V \le V_{DD} \le 4.5\ V$
		—	AUTOMOTIVE Hysteresis input is selected	$0.8 \times V_{DD}$	—	$V_{DD} + 0.3$	V	
		—	Port inputs if TTL input is selected	2.0	—	$V_{DD} + 0.3$	V	
	V_{IHR}	INITX	—	$0.8 \times V_{DD}$	—	$V_{DD} + 0.3$	V	INITX input pin (CMOS Hysteresis)
	V_{IHM}	MD_3 to MD_0	—	$V_{DD} - 0.3$	—	$V_{DD} + 0.3$	V	Mode input pins
	V_{IHX0S}	X0, X0A	—	2.5	—	$V_{DD} + 0.3$	V	External clock in "Oscillation mode"
	V_{IHX0F}	X0	—	$0.8 \times V_{DD}$	—	$V_{DD} + 0.3$	V	External clock in "Fast Clock Input mode"
Input "L" voltage	V_{IL}	—	Port inputs if CMOS Hysteresis 0.8/0.2 input is selected	$V_{SS} - 0.3$	—	$0.2 \times V_{DD}$	V	
		—	Port inputs if CMOS Hysteresis 0.7/0.3 input is selected	$V_{SS} - 0.3$	—	$0.3 \times V_{DD}$	V	
		—	Port inputs if AUTOMOTIVE Hysteresis input is selected	$V_{SS} - 0.3$	—	$0.5 \times V_{DD}$	V	$4.5\ V \le V_{DD} \le 5.5\ V$
				$V_{SS} - 0.3$	—	$0.46 \times V_{DD}$	V	$3\ V \le V_{DD} \le 4.5\ V$
		—	Port inputs if TTL input is selected	$V_{SS} - 0.3$	—	0.8	V	
	V_{ILR}	INITX	—	$V_{SS} - 0.3$	—	$0.2 \times V_{DD}$	V	INITX input pin (CMOS Hysteresis)
	V_{ILM}	MD_3 to MD_0	—	$V_{SS} - 0.3$	—	$V_{SS} + 0.3$	V	Mode input pins
	V_{ILXDS}	X0, X0A	—	$V_{SS} - 0.3$	—	0.5	V	External clock in "Oscillation mode"

($V_{DD}5 = AV_{CC}5 = 3.0$ V to 5.5 V, $V_{SS}5 = AV_{SS}5 = 0$ V, $T_A = -40$ °C to $+105$ °C)

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min	Typ	Max		
Input “L” voltage	V_{ILXDF}	X0	—	$V_{SS} - 0.3$	—	$0.2 \times V_{DD}$	V	External clock in “Fast Clock Input mode”
Output “H” voltage	V_{OH2}	Normal outputs	$4.5V \le V_{DD} \le 5.5V$, $I_{OH} = -2mA$ $3.0V \le V_{DD} \le 4.5V$, $I_{OH} = -1.6mA$	$V_{DD} - 0.5$	—	—	V	Driving strength set to 2 mA
	V_{OH5}	Normal outputs	$4.5V \le V_{DD} \le 5.5V$, $I_{OH} = -5mA$ $3.0V \le V_{DD} \le 4.5V$, $I_{OH} = -3mA$	$V_{DD} - 0.5$	—	—	V	Driving strength set to 5 mA
	V_{OH3}	I^2C outputs	$3.0V \le V_{DD} \le 5.5V$, $I_{OH} = -3mA$	$V_{DD} - 0.5$	—	—	V	
	V_{OH30}	High current outputs	$4.5V \le V_{DD} \le 5.5V$, T_A = -40°C, I_{OH} = -40mA $4.5V \le V_{DD} \le 5.5V$, I_{OH} = -30mA $3.0V \le V_{DD} \le 4.5V$, I_{OH} = -20mA	$V_{DD} - 0.5$			V	Driving strength set to 30mA
Output “L” voltage	V_{OL2}	Normal outputs	$4.5V \le V_{DD} \le 5.5V$, $I_{OH} = +2mA$ $3.0V \le V_{DD} \le 4.5V$, $I_{OH} = +1.6mA$	—	—	0.4	V	Driving strength set to 2 mA
	V_{OL5}	Normal outputs	$4.5V \le V_{DD} \le 5.5V$, $I_{OH} = +5mA$ $3.0V \le V_{DD} \le 4.5V$, $I_{OH} = +3mA$	—	—	0.4	V	Driving strength set to 5 mA
	V_{OL3}	I^2C outputs	$3.0V \le V_{DD} \le 5.5V$, $I_{OH} = +3mA$	—	—	0.4	V	
	V_{OL30}	High current outputs	$4.5V \le V_{DD} \le 5.5V$, T_A = -40°C, I_{OH} = +40mA $4.5V \le V_{DD} \le 5.5V$, I_{OH} = +30mA $3.0V \le V_{DD} \le 4.5V$, I_{OH} = +20mA			0.5	V	Driving strength set to 30mA
Input leakage current	I_{IL}	Pnn_m *1	$3.0V \le V_{DD} \le 5.5V$ $V_{SS}5 < V_I < V_{DD}$ T_A=25 °C	-1	—	$+1$	µA	
			$3.0V \le V_{DD} \le 5.5V$ $V_{SS}5 < V_I < V_{DD}$ T_A=105 °C	-3	—	$+3$		

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min	Typ	Max		
Analog input leakage current	I_{AIN}	ANn *2	$3.0V \le V_{DD} \le 5.5V$ T_A=25 °C	− 1	—	+ 1	µA	
			$3.0V \le V_{DD} \le 5.5V$ T_A=105 °C	− 3	—	+ 3	µA	
Pull-up resistance	R_{UP}	Pnn_m*3 , INITX	$3.0V \le V_{DD} \le 3.6V$	40	100	160	kΩ	
			$4.5V \le V_{DD} \le 5.5V$	25	50	100		
Pull-down resistance	R_{DOWN}	Pnn_m*4	$3.0V \le V_{DD} \le 3.6V$	40	100	180	kΩ	
			$4.5V \le V_{DD} \le 5.5V$	25	50	100		
Input capacitance	C_{IN}	All except $V_{DD}5$, $V_{DD}5R$, $V_{SS}5$, $AV_{CC}5$, AV_{SS}, AVRH5	f = 1 MHz	—	5	15	pF	
Power supply current MB91-F467Cx	I_{CC}	$V_{DD}5R$	MB91F467Cx: CLKB: 100 MHz CLKP: 50 MHz CLKT: 50 MHz CLKCAN: 50 MHz	—	120	150	mA	Code fetch from Flash
	I_{CCH}	$V_{DD}5R$	T_A = + 25 °C	—	30	150	µA	At stop mode *5
			T_A = + 105 °C	—	400	2000	µA	
			T_A = + 25 °C	—	100	500	µA	RTC : 4 MHz mode *5
			T_A = + 105 °C	—	500	2400	µA	
			T_A = + 25 °C	—	50	250	µA	RTC : 100 kHz mode *5 32 kHz mode *6
			T_A = + 105 °C	—	450	2200	µA	
	I_{LVE}	$V_{DD}5$	—	—	70	150	µA	External low voltage detection
	I_{LVI}	$V_{DD}5R$	—	—	50	100	µA	Internal low voltage detection
	I_{OSC}	$V_{DD}5$	—	—	250	500	µA	Main clock (4 MHz)
			—	—	20	40	µA	Sub clock (32 kHz)

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min	Typ	Max		
Power supply current MB91-F465CA	I_{CC}	$V_{DD}5R$	MB91F465CA: CLKB: 100 MHz CLKP: 50 MHz CLKT: 50 MHz CLKCAN: 50 MHz	—	110	140	mA	Code fetch from Flash
	I_{CCH}	$V_{DD}5R$	T_A = + 25 °C	—	30	150	µA	At stop mode *5
			T_A = + 105 °C	—	300	2000	µA	
			T_A = + 25 °C	—	100	500	µA	RTC : 4 MHz mode *5
			T_A = + 105 °C	—	500	2400	µA	
			T_A = + 25 °C	—	50	250	µA	RTC : 100 kHz mode *5 32 kHz mode *6
			T_A = + 105 °C	—	400	2200	µA	
	I_{LVE}	$V_{DD}5$	—	—	70	150	µA	External low voltage detection
	I_{LVI}	$V_{DD}5R$	—	—	50	100	µA	Internal low voltage detection
	I_{OSC}	$V_{DD}5$	—	—	250	500	µA	Main clock (4 MHz)
			—	—	20	40	µA	Sub clock (32 kHz)
Power supply current MB91-F463CA (target data)	I_{CC}	$V_{DD}5R$	MB91F463CA: CLKB: 100 MHz CLKP: 50 MHz CLKT: 50 MHz CLKCAN: 50 MHz	—	100	130	mA	Code fetch from Flash
	I_{CCH}	$V_{DD}5R$	T_A = + 25 °C	—	30	150	µA	At stop mode *5
			T_A = + 105 °C	—	300	2000	µA	
			T_A = + 25 °C	—	100	500	µA	RTC : 4 MHz mode *5
			T_A = + 105 °C	—	500	2400	µA	
			T_A = + 25 °C	—	50	250	µA	RTC : 100 kHz mode *5 32 kHz mode *6
			T_A = + 105 °C	—	400	2200	µA	
	I_{LVE}	$V_{DD}5$	—	—	70	150	µA	External low voltage detection
	I_{LVI}	$V_{DD}5R$	—	—	50	100	µA	Internal low voltage detection
	I_{OSC}	$V_{DD}5$	—	—	250	500	µA	Main clock (4 MHz)
			—	—	20	40	µA	Sub clock (32 kHz)

1. Pnn_m includes all GPIO pins. Analog (AN) channels and PullUp/PullDown are disabled.
2. ANn includes all pins where AN channels are enabled.
3. Pnn_m includes all GPIO pins. The pull up resistors must be enabled by PPER/PPCR setting and the pins must be in input direction.

4. Pnn_m includes all GPIO pins. The pull down resistors must be enabled by PPER/PPCR setting and the pins must be in input direction.
5. Main regulator OFF, sub regulator set to 1.2 V, Low voltage detection disabled.
6. Main regulator OFF, sub regulator set 1.2 V, Low voltage detection disabled, RC oscillator enabled.
   Additional current consumption of Sub oscillator I_{OSC} has to be taken into account.

15.4 A/D converter characteristics

($V_{DD}5 = AV_{CC}5 = 3.0$ V to 5.5 V, $V_{SS}5 = AV_{SS}5 = 0$ V, $T_A = -40$ °C to $+105$ °C)

Parameter	Symbol	Pin name	Value			Unit	Remarks
			Min	Typ	Max		
Resolution	—	—	—	—	10	bit	
Total error	—	—	− 3	—	+ 3	LSB	
Nonlinearity error	—	—	− 2.5	—	+ 2.5	LSB	
Differential nonlinearity error	—	—	− 1.9	—	+ 1.9	LSB	
Zero reading voltage	V_{OT}	ANn	AVRL − 1.5 LSB	AVRL + 0.5 LSB	AVRL + 2.5 LSB	V	
Full scale reading voltage	V_{FST}	ANn	AVRH − 3.5 LSB	AVRH − 1.5 LSB	AVRH + 0.5 LSB	V	
Compare time	T_{comp}	—	0.6	—	16,500	µs	4.5 V ≤ $AV_{CC}5$ ≤ 5.5 V
			2.0	—	—	µs	3.0 V ≤ $AV_{CC}5$ ≤ 4.5 V
Sampling time	T_{samp}	—	0.4	—	—	µs	4.5 V ≤ $AV_{CC}5$ ≤ 5.5 V, R_{EXT} < 2 kΩ
			1.0	—	—	µs	3.0 V ≤ $AV_{CC}5$ ≤ 4.5 V, R_{EXT} < 1 kΩ
Conversion time	T_{conv}	—	1.0	—	—	µs	4.5 V ≤ $AV_{CC}5$ ≤ 5.5 V
			3.0	—	—	µs	3.0 V ≤ $AV_{CC}5$ ≤ 4.5 V
Input capacitance	C_{IN}	ANn	—	—	11	pF	
Input resistance	R_{IN}	ANn	—	—	2.6	kΩ	4.5 V ≤ $AV_{CC}5$ ≤ 5.5 V
			—	—	12.1	kΩ	3.0 V ≤ $AV_{CC}5$ ≤ 4.5 V
Analog input leakage current	I_{AIN}	ANn	− 1	—	+ 1	µA	T_A = + 25 °C
			− 3	—	+ 3	µA	T_A = + 105 °C
Analog input voltage range	V_{AIN}	ANn	AVRL	—	AVRH	V	
Offset between input channels	—	ANn	—	—	4	LSB	

(Continued)

Note : The accuracy gets worse as AVRH - AVRL becomes smaller

(Continued)

Parameter	Symbol	Pin name	Value			Unit	Remarks
			Min	Typ	Max		
Reference voltage range	AVRH	AVRH5	0.75 × $AV_{CC}5$	—	$AV_{CC}5$	V	
	AVRL	$AV_{SS}5$	$AV_{SS}5$	—	$AV_{CC}5$ × 0.25	V	
Power supply current per ADC macro *3	I_A	$AV_{CC}5$	—	2.5	5	mA	A/D Converter active
	I_{AH}	$AV_{CC}5$	—	—	5	µA	A/D Converter not operated *1
Reference voltage current per ADC macro *3	I_R	AVRH5	—	0.7	1	mA	A/D Converter active
	I_{RH}	AVRH5	—	—	5	µA	A/D Converter not operated *2

*1 : Supply current at $AV_{CC}5$, if A/D converter and ALARM comparator are not operating, ($V_{DD}5 = AV_{CC}5 = AVRH = 5.0$ V)

*2 : Input current at AVRH5, if A/D converter is not operating, ($V_{DD}5 = AV_{CC}5 = AVRH = 5.0$ V)

*3 : The current consumption per ADC macro is given here. On devices having more then one A/D converter, the current values have to be multiplied by the number of macros.

Sampling Time Calculation

$T_{samp} = (2.6\ kOhm + R_{EXT}) \cdot 11pF \cdot 7$; for $4.5V \leq AV_{CC}5 \leq 5.5V$

$T_{samp} = (12.1\ kOhm + R_{EXT}) \cdot 11pF \cdot 7$; for $3.0V \leq AV_{CC}5 \leq 4.5V$

Conversion Time Calculation

$T_{conv} = T_{samp} + T_{comp}$

Definition of A/D converter terms

■ Resolution

Analog variation that is recognizable by the A/D converter.

■ Nonlinearity error

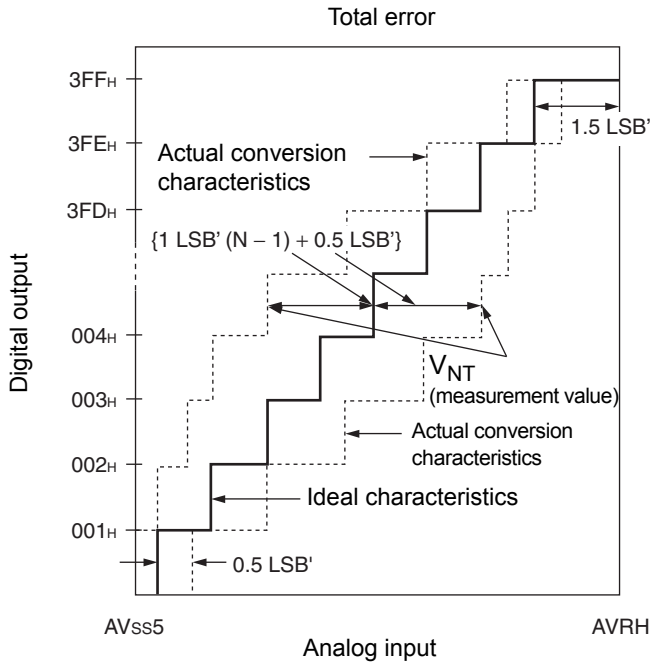
Deviation between actual conversion characteristics and a straight line connecting the zero transition point ($00\ 0000\ 0000_B \leftrightarrow 00\ 0000\ 0001_B$) and the full scale transition point ($11\ 1111\ 1110_B \leftrightarrow 11\ 1111\ 1111_B$).

■ Differential nonlinearity error

Deviation of the input voltage from the ideal value that is required to change the output code by 1 LSB.

■ Total error

This error indicates the difference between actual and theoretical values, including the zero transition error, full scale transition error, and nonlinearity error.



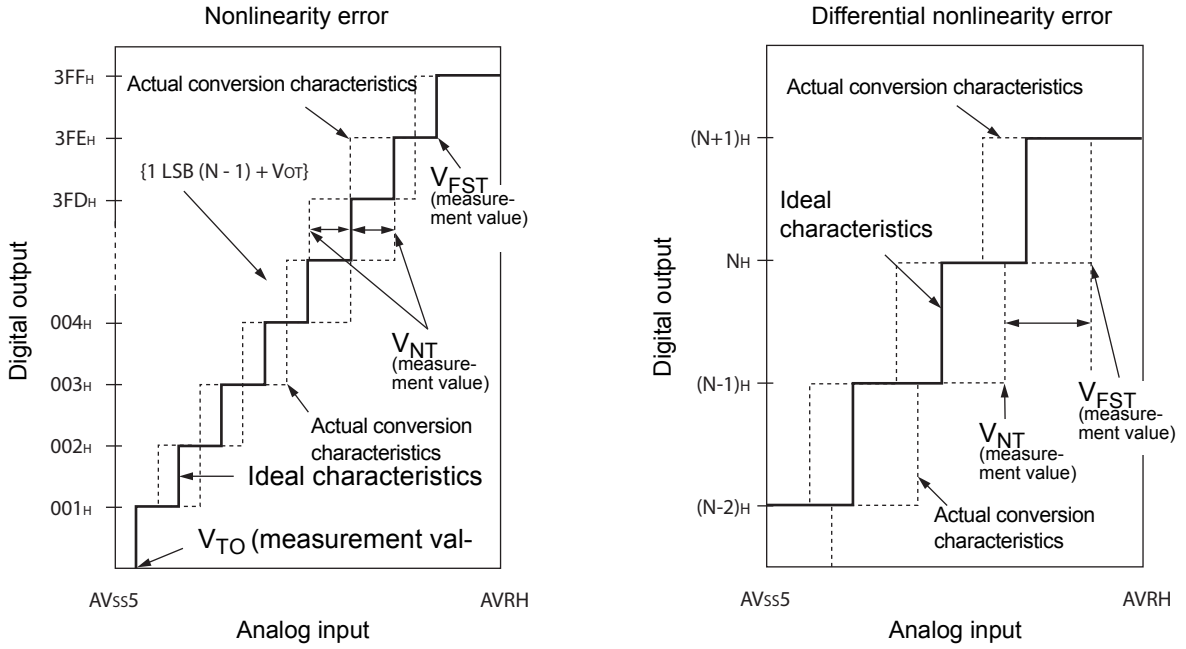
$$1LSB' \text{ (ideal value)} = \frac{AVRH - AV_{SS}5}{1024} \text{ [V]}$$

$$\text{Total error of digital output N} = \frac{V_{NT} - \{1\ LSB' \cdot (N - 1) + 0.5\ LSB'\}}{1\ LSB'}$$

N : A/D converter digital output value
V_{OT}' (ideal value) = $AV_{SS}5 + 0.5$ LSB' [V]
V_{FST}' (ideal value) = AVRH − 1.5 LSB' [V]
V_{NT} : Voltage at which the digital output changes from $(N + 1)_H$ to N_H

(Continued)

(Continued)



$$\text{Nonlinearity error of digital output N} = \frac{V_{NT} - \{1LSB \cdot (N - 1) + V_{OT}\}}{1LSB} \text{ [LSB]}$$

$$\text{Differential nonlinearity error of digital output N} = \frac{V_{(N+1)T} - V_{NT}}{1LSB} - 1 \text{ [LSB]}$$

$$1LSB = \frac{V_{FST} - V_{OT}}{1022} \text{ [V]}$$

N : A/D converter digital output value
V_{OT} : Voltage at which the digital output changes from 000_H to 001_H.
V_{FST} : Voltage at which the digital output changes from $3FE_H$ to $3FF_H$.

15.5 Alarm comparator characteristics

Parameter	Symbol	Pin name	Value			Unit	Remarks
			Min	Typ	Max		
Power supply current	I_{A5ALMF}	$AV_{CC}5$	—	25	40	µA	Alarm comparator enabled in fast mode (per channel) *1
	I_{A5ALMS}		—	7	10	µA	Alarm comparator enabled in normal mode (per channel) *1
	I_{A5ALMH}		—	—	5	µA	Alarm comparator disabled
ALARM pin input current	I_{ALIN}	ALARM_n	− 1	—	+ 1	µA	T_A=25 °C
			− 3	—	+ 3	µA	T_A=105 °C
ALARM pin input voltage range	V_{ALIN}		0	—	$AV_{CC}5$	V	
Alarm upper limit voltage	V_{IAH}		$AV_{CC}5 \times 0.78$ − 3%	$AV_{CC}5 \times 0.78$	$AV_{CC}5 \times 0.78$ + 3%	V	
Alarm lower limit voltage	V_{IAL}		$AV_{CC}5 \times 0.36$ − 5%	$AV_{CC}5 \times 0.36$	$AV_{CC}5 \times 0.36$ + 5%	V	
Alarm hysteresis voltage	V_{IAHYS}		50	—	250	mV	
Alarm input resistance	R_{IN}		5	—	—	MΩ	
Comparion time	t_{COMPF}		—	0.1	0.2	µA	Alarm comparator enabled in fast mode *1
	t_{COMPS}		—	1	2	µA	Alarm comparator enabled in normal mode *1

Note: *1 : The fast Alarm Comparator mode is enabled by setting ACSR.MD=1
Setting ACSR.MD=0 sets the normal mode.

15.6 FLASH memory program/erase characteristics

15.6.1 MB91F463CA, MB91F465CA

(T_A = 25°C, Vcc = 5.0V)

Parameter	Value			Unit	Remarks
	Min	Typ	Max		
Sector erase time	-	0.9	3.6	s	Erasure programming time not included
Chip erase time	-	n*0.9	n*3.6	s	n is the number of Flash sector of the device
Word (16-bit width) programming time	-	23	370	µs	System overhead time not included
Programme/Erase cycle	10 000			cycle	
Flash data retention time	20			year	*1

*1: This value was converted from the results of evaluating the reliability of the technology (using Arrhenius equation to convert high temperature measurements into normalized value at 85°C)

15.6.2 MB91F467Cx

(T_A = 25°C, Vcc = 5.0V)

Parameter	Value			Unit	Remarks
	Min	Typ	Max		
Sector erase time	-	0.5	2.0	s	Erasure programming time not included
Chip erase time	-	n*0.5	n*2.0	s	n is the number of Flash sector of the device
Word (16-bit or 32-bit width) programming time	-	6	100	µs	System overhead time not included
Programme/Erase cycle	10 000			cycle	
Flash data retention time	20			year	*1

*1: This value was converted from the results of evaluating the reliability of the technology (using Arrhenius equation to convert high temperature measurements into normalized value at 85°C)

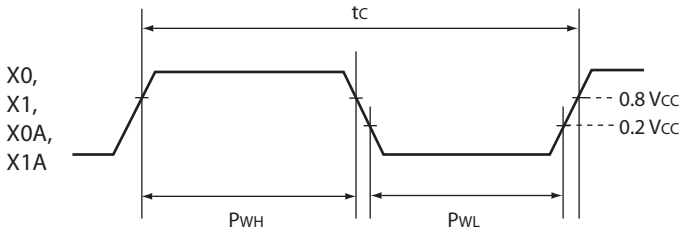
15.7 AC characteristics

15.7.1 Clock timing

($V_{DD}5 = 3.0$ V to 5.5 V, Vss5 = AVss5 = 0 V, $T_A = -40$ °C to + 105 °C)

Parameter	Symbol	Pin name	Value			Unit	Condition
			Min	Typ	Max		
Clock frequency	f_C	X0 X1	3.5	4	16	MHz	Opposite phase external supply or crystal
		X0A X1A	32	32.768	100	kHz	

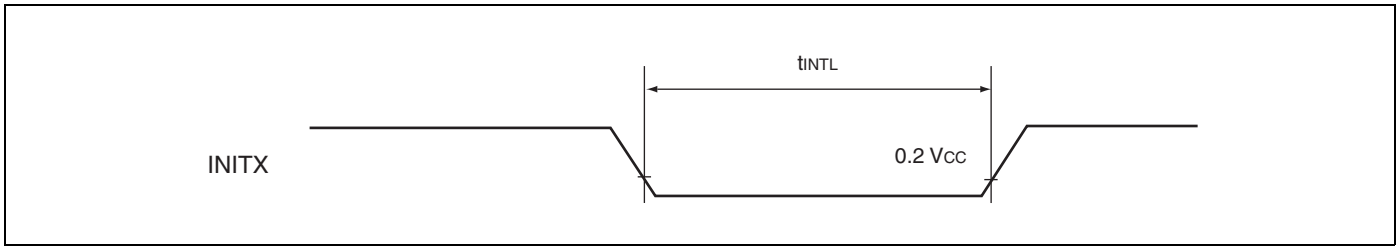
Clock timing condition



15.7.2 Reset input ratings

($V_{DD}5 = 3.0$ V to 5.5 V, $V_{SS}5 = AV_{SS}5 = 0$ V, $T_A = -40$ °C to $+105$ °C)

Parameter	Symbol	Pin name	Condition	Value		Unit
				Min	Max	
INITX input time (at power-on)	t_{INTL}	INITX	—	10	—	ms
INITX input time (other than the above)				20	—	µs



15.7.3 LIN-USART Timings at $V_{DD}5$ = 3.0 to 5.5 V

- Conditions during AC measurements
- All AC tests were measured under the following conditions:
- - IO_{drive} = 5 mA
- - $V_{DD}5$ = 3.0 V to 5.5 V, I_{load} = 3 mA
- - $V_{SS}5$ = 0 V
- - T_a = -40°C to +105°C
- - C_l = 50 pF (load capacity value of pins when testing)
- - VOL = 0.2 x $V_{DD}5$
- - VOH = 0.8 x $V_{DD}5$
- - EPILR = 0, PILR = 1 (Automotive Level = worst case)

($V_{DD}5 = 3.0$ V to 5.5 V, $V_{SS}5 = AV_{SS}5 = 0$ V, $T_A = -40$ °C to + 105 °C)

Parameter	Symbol	Pin name	Condition	$V_{DD}5 = 3.0$ V to 4.5 V		$V_{DD}5 = 4.5$ V to 5.5 V		Unit
				Min	Max	Min	Max	
Serial clock cycle time	t_{SCYCI}	SCKn	Internal clock operation (master mode)	4 t_{CLKP}	—	4 t_{CLKP}	—	ns
SCK ↓ → SOT delay time	t_{SLOVI}	SCKn SOTn		− 30	30	− 20	20	ns
SOT → SCK ↓ delay time	t_{OVSHI}	SCKn SOTn		m × t_{CLKP} − 30*	—	m × t_{CLKP} − 20*	—	ns
Valid SIN → SCK ↑ setup time	t_{IVSHI}	SCKn SINn		t_{CLKP} + 55	—	t_{CLKP} + 45	—	ns
SCK ↑ → valid SIN hold time	t_{SHIXI}	SCKn SINn		0	—	0	—	ns
Serial clock “H” pulse width	t_{SHSLE}	SCKn	External clock operation (slave mode)	t_{CLKP} + 10	—	t_{CLKP} + 10	—	ns
Serial clock “L” pulse width	t_{SLSHE}	SCKn		t_{CLKP} + 10	—	t_{CLKP} + 10	—	ns
SCK ↓ → SOT delay time	t_{SLOVE}	SCKn SOTn		—	2 t_{CLKP} + 55	—	2 t_{CLKP} + 45	ns
Valid SIN → SCK ↑ setup time	t_{IVSHE}	SCKn SINn		10	—	10	—	ns
SCK ↑ → valid SIN hold time	t_{SHIXE}	SCKn SINn		t_{CLKP} + 10	—	t_{CLKP} + 10	—	ns
SCK rising time	t_{FE}	SCKn		—	20	—	20	ns
SCK falling time	t_{RE}	SCKn		—	20	—	20	ns

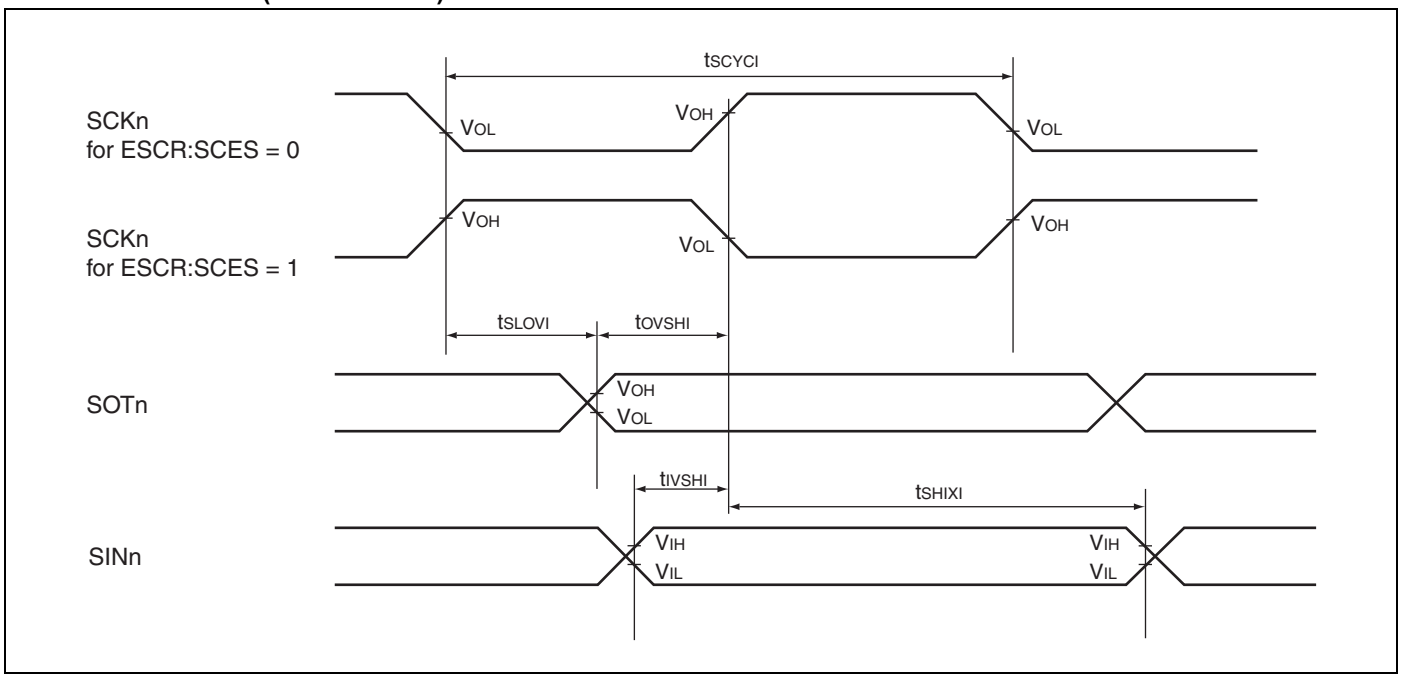
* : Parameter m depends on t_{SCYCI} and can be calculated as :

- if $t_{SCYCI} = 2*k*t_{CLKP}$, then m = k, where k is an integer > 2
- if $t_{SCYCI} = (2*k + 1)*t_{CLKP}$, then m = k + 1, where k is an integer > 1

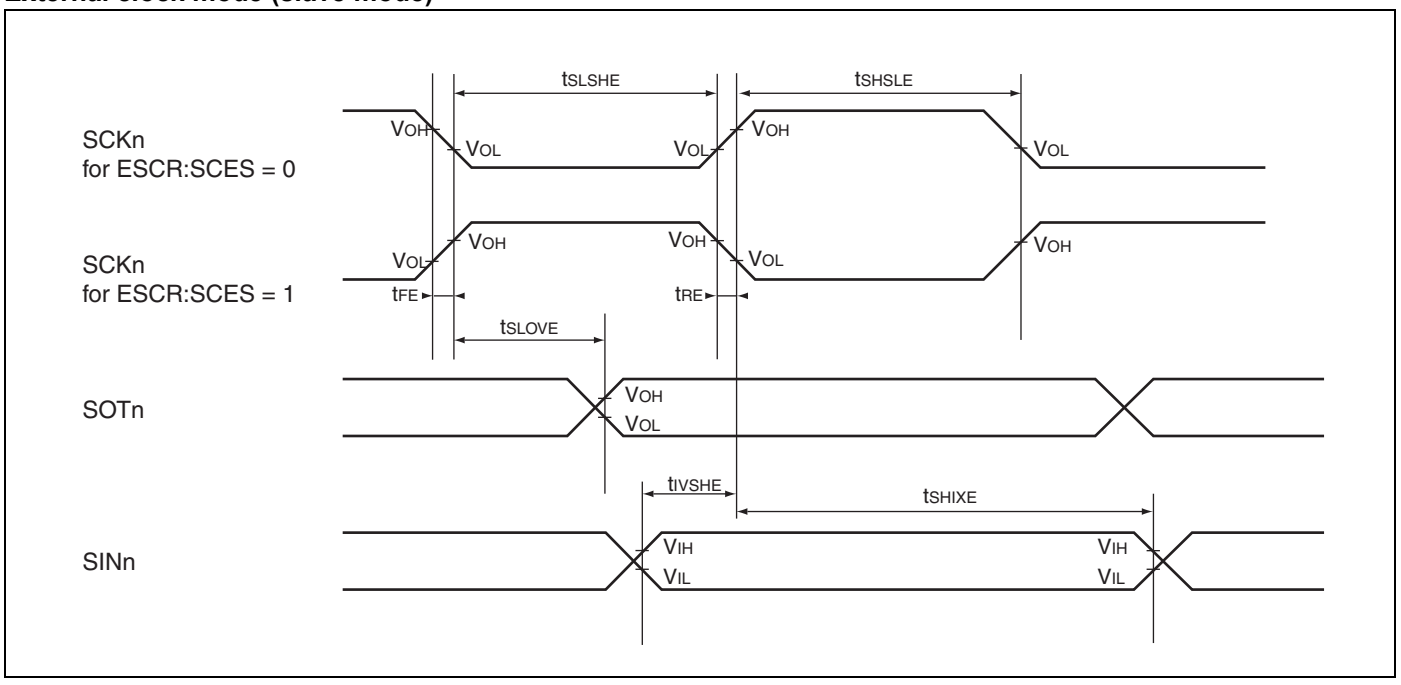
Notes :

- The above values are AC characteristics for CLK synchronous mode.
- t_{CLKP} is the cycle time of the peripheral clock.

Internal clock mode (master mode)



External clock mode (slave mode)



15.7.4 I^2C AC Timings at $V_{DD}5$ = 3.0 to 5.5 V

- Conditions during AC measurements
  All AC tests were measured under the following conditions:
  - IO_{drive} = 3 mA
  - $V_{DD}5$ = 3.0 V to 5.5 V, I_{load} = 3 mA (V_{DD} = 4.5 V to 5.5 V for MB91F467Cx)
  - $V_{SS}5$ = 0 V
  - Ta = −40 °C to +105 °C
  - C_l = 50 pF
  - VOL = 0.3 × $V_{DD}5$
  - VOH = 0.7 × $V_{DD}5$
  - EPILR = 0, PILR = 0 (CMOS Hysteresis 0.3 × $V_{DD}5$/0.7 × $V_{DD}5$)

Fast mode:

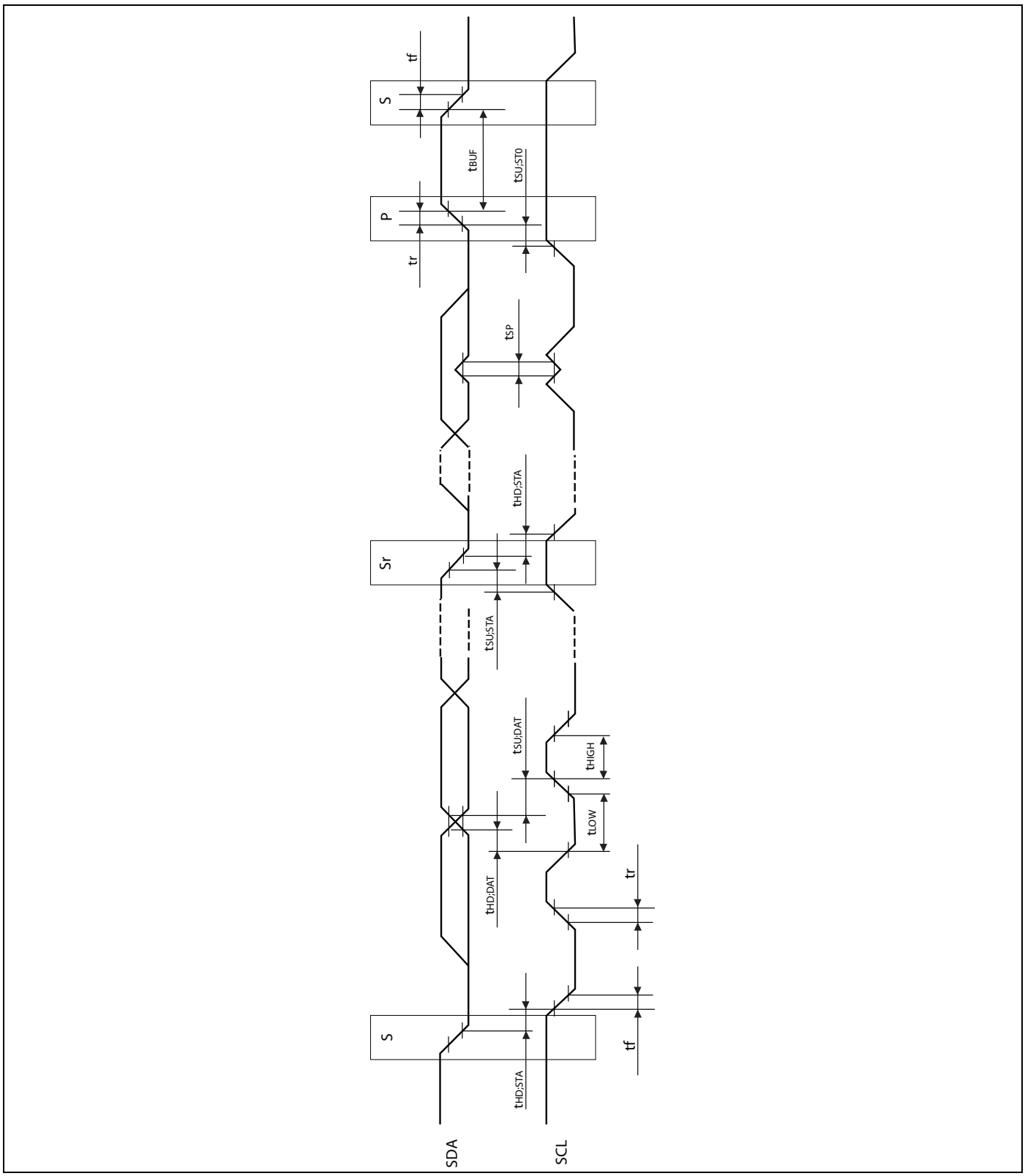
($V_{DD}5$ = 3.5 V to 5.5 V, $V_{SS}5$ = $AV_{SS}5$ = 0 V, T_A = −40 °C to +105 °C)

Parameter	Symbol	Pin name	Value		Unit	Remark
			Min	Max		
SCL clock frequency	f_{SCL}	SCLn	0	400	kHz	
Hold time (repeated) START condition. After this period, the first clock pulse is generated	$t_{HD;STA}$	SCLn, SDAn	0.6	—	µs	
LOW period of the SCL clock	t_{LOW}	SCLn	1.3	—	µs	
HIGH period of the SCL clock	t_{HIGH}	SCLn	0.6	—	µs	
Setup time for a repeated START condition	$t_{SU;STA}$	SCLn, SDAn	0.6	—	µs	
Data hold time for I^2C-bus devices	$t_{HD;DAT}$	SCLn, SDAn	0	0.9	µs	
Data setup time	$t_{SU;DAT}$	SCLn SDAn	100	—	ns	
Rise time of both SDA and SCL signals	t_r	SCLn, SDAn	20 + 0.1Cb	300	ns	*1
Fall time of both SDA and SCL signals	t_f	SCLn, SDAn	20 + 0.1Cb	300	ns	*1
Setup time for STOP condition	$t_{SU;STO}$	SCLn, SDAn	0.6	—	µs	
Bus free time between a STOP and START condition	t_{BUF}	SCLn, SDAn	1.3	—	µs	
Capacitive load for each bus line	C_b	SCLn, SDAn	—	400	pF	
Pulse width of spike suppressed by input filter	t_{SP}	SCLn, SDAn	0	(1.1.5) × t_{CLKP}	ns	*2

*1: On MB91F467Cx only guaranteed for 4.5 V < $V_{DD}5$ < 5.5 V.

*2: The noise filter will suppress single spikes with a pulse width of 0ns and between (1 to 1.5) cycles of peripheral clock, depending on the phase relationship between I^2C signals (SDA, SCL) and peripheral clock.

Note: t_{CLKP} is the cycle time of the peripheral clock.

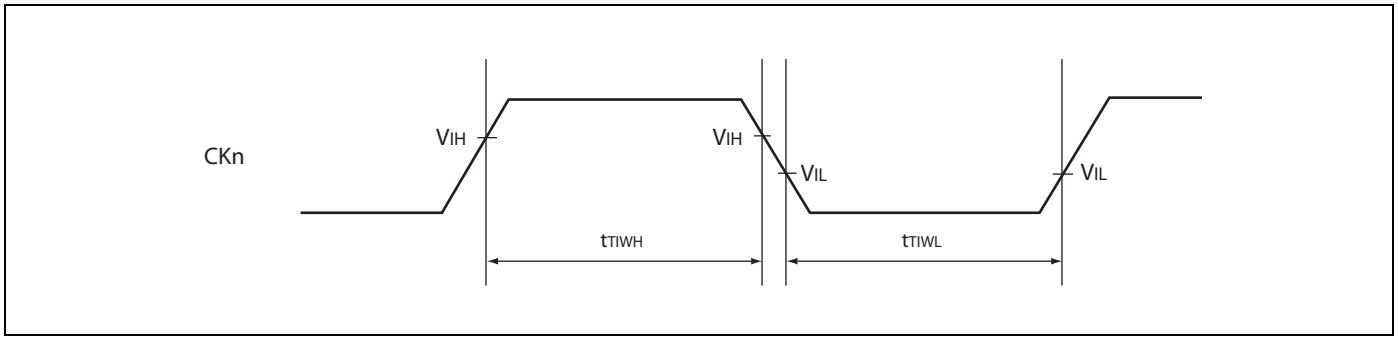

tf
S
tBUF
tSU;STO
P
tr
tSP
tHD;STA
Sr
tSU;STA
tSU;DAT
tHIGH
tLOW
tHD;DAT
tr
tf
S
tHD;STA
SDA
SCL

15.7.5 Free-run timer clock

($V_{DD}5 = 3.0$ V to 5.5 V, $V_{SS}5 = AV_{SS}5 = 0$ V, $T_A = -40$ °C to $+105$ °C)

Parameter	Symbol	Pin name	Condition	Value		Unit
				Min	Max	
Input pulse width	t_{TIWH} t_{TIWL}	CKn	—	$4t_{CLKP}$	—	ns

Note : t_{CLKP} is the cycle time of the peripheral clock.

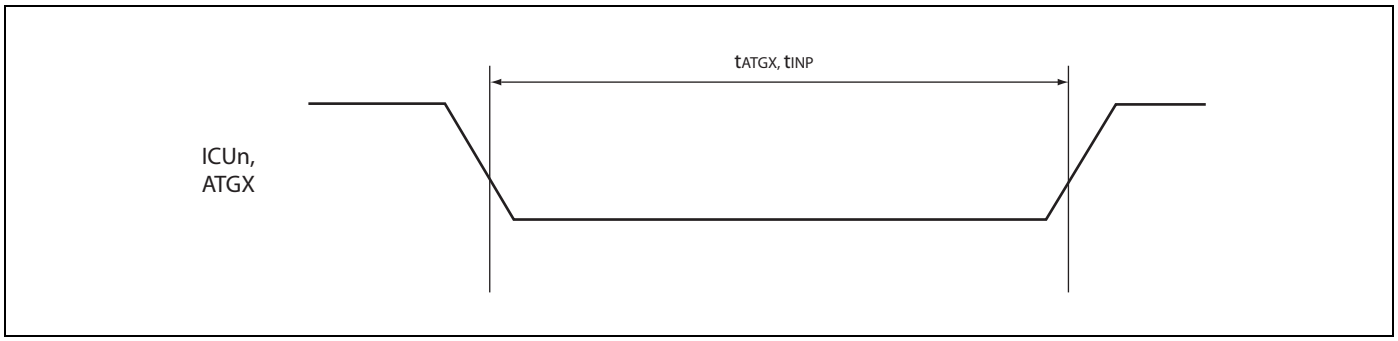


15.7.6 Trigger input timing

($V_{DD}5 = 3.0$ V to 5.5 V, $V_{SS}5 = AV_{SS}5 = 0$ V, $T_A = -40$ °C to $+105$ °C)

Parameter	Symbol	Pin name	Condition	Value		Unit
				Min	Max	
Input capture input trigger	t_{INP}	ICUn	—	$5t_{CLKP}$	—	ns
A/D converter trigger	t_{ATGX}	ATGX	—	$5t_{CLKP}$	—	ns

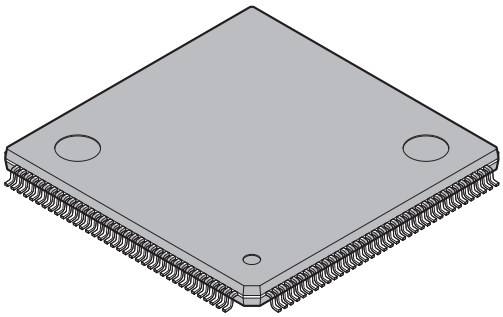
Note : t_{CLKP} is the cycle time of the peripheral clock.



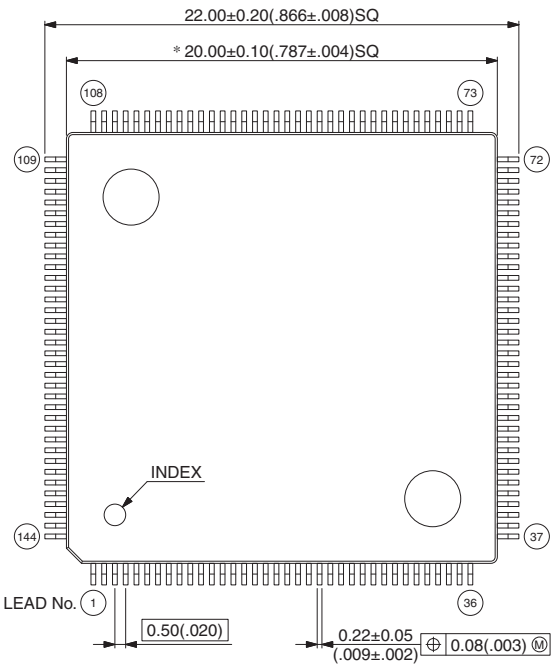
16. Ordering Information

Part number	Package	Remarks
MB91F467CAPMC-GSE2	144-pin plastic LQFP (FPT-144P-M08)	not recommended
MB91F467CBPMC-GSE2		Lead-free package
MB91F465CAPMC-GSE2		Lead-free package
MB91F463CAPMC-GSE2		Lead-free package

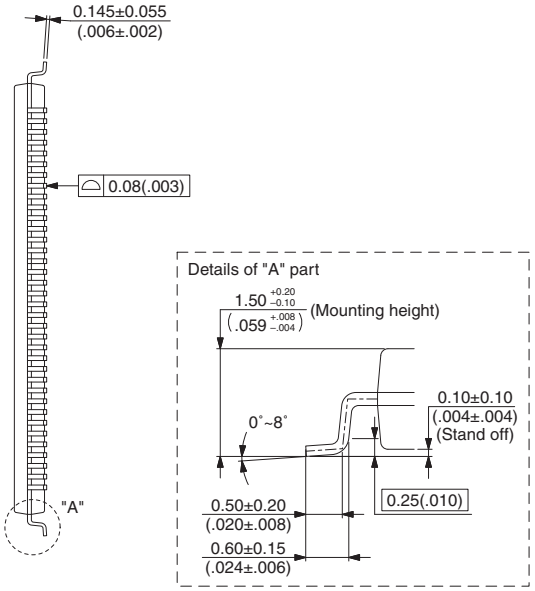
17. Package Dimension

144-pin plastic LQFP		
	Lead pitch	0.50 mm
	Package width × package length	20.0 × 20.0 mm
	Lead shape	Gullwing
	Sealing method	Plastic mold
	Mounting height	1.70 mm MAX
	Weight	1.20g
(FPT-144P-M08)	Code (Reference)	P-LFQFP144-20×20-0.50

144-pin plastic LQFP
(FPT-144P-M08)



Note 1) *:Values do not include resin protrusion.
Resin protrusion is +0.25(.010)Max(each side).
Note 2) Pins width and pins thickness include plating thickness.
Note 3) Pins width do not include tie bar cutting remainder.



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

18. Revision History

Version	Date	Remark
2.0	2008-04-16	Initial Version
2.1	2008-08-15	Handling devices: Section Notes on PS Register changed for better understanding; Interrupt Vector Table: corrected the footnotes FLASH: Added note about the flash operation mode switching; added section "Poweron Sequence in parallel programming mode"; FLASH Security: Corrected sector assignments FSV1,FSV2 Absolute maximum ratings: Removed the note that analog input/output pins cannot accept +B signal input. DC Characteristics: Updated PullUp/Down resistors and the footnotes, splitted I_{LV} into external and internal LV detection AD Converter characteristics updated (complete section); Ordering information updated; Company name updated
2.2	2008-11-24	Flash: Added MB91F463CA to all sections Memory maps: Removed external bus areas (no ext. bus available) IO-Map: Added/corrected MB91F463CA Ordering Information: Added MB91F463CA

19. Main Changes

Spansion Publication Number: DS07-16610-2E

Page	Section	Change Results
2	Features 2. Internal peripheral resources	Deleted following description: Fly-by transfer support (between external I/O and memory)
29	Embedded Program / Data Memory (Flash)	Corrected the Note: The operation mode of the flash memory → The operation mode of the MCU
49	I/O Map	Added Reload Timer 0 and 1 on address $0001B0_H$ to $0001BC_H$
89, 90	Electrical Characteristics 3. DC characteristics	Corrected the Remarks column of Parameter: Power supply current RTC: 100 kHz mode*5 → RTC: 100 kHz mode*5, 32 kHz mode*6
91		Added Footnote 6:
99	Electrical Characteristics 7.2. Reset input ratings	Corrected the spec value of INITX input time (at power-on) Min: 8 ms → 10 ms

NOTE: Please see “Document History” about later revised information.

Document History

Document Title: MB91460C Series FR60 32-bit Microcontroller Document Number: 002-04609				
Revision	**ECN**	**Orig. of Change**	**Submission Date**	**Description of Change**
**	—	TORS	04/28/2010	Migrated to Cypress and assigned document number 002-04609. No change to document contents or format.
*A	5200971	TORS	04/12/2016	Updated to Cypress format.

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