MB89550A Series Electrical Specification

(Target Spec Version 10)

■ Electrical Specification

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■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Rating

$(AV_{SS} = V_{SS} = 0V)$

Parameter	Symbol	Value Min.	Value Max.	Unit	Remarks
Power supply voltage	V_{CC1}	V_{SS}-0.3	V_{SS}+4.0	V	Should not exceed V_{CC1} and V_{CC2} *1
	V_{CC2}	V_{SS}-0.3	V_{SS}+6.0	V	
A/D converter reference input voltage	AVR	V_{SS}-0.3	V_{SS}+6.0	V	
D/A converter reference input voltage	DVR	V_{SS}-0.3	V_{SS}+6.0	V	
LCD power supply voltage	V0-V3	V_{SS}-0.3	V_{SS}+6.0	V	V0 to V3 of non booster version should not exceed V_{CC2}
Input voltage	V_{I1}	V_{SS}-0.3	Vcc2+0.3	V	Except P50-P57, P60-P67, P70-P77, P46, P47, P30, and P31
	V_{I2}	V_{SS}-0.3	V3	V	P50-P57, P60-P67, and P70-P77
	V_{I3}	V_{SS}-0.3	V_{SS}+6.0	V	P46, P47, P30, and P31
Output voltage	V_{O1}	V_{SS}-0.3	Vcc2	V	Except P50-P57, P60-P67, P70-P77, P46, P47, P30, and P31
	V_{O2}	V_{SS}-0.3	V3	V	P50-P57, P60-P67, and P70-P77
	V_{O3}	V_{SS}-0.3	V_{SS}+6.0	V	P46, P47, P30, and P31
"L" level maximum output current	I_{OL1}	-	15	mA	Except P22/UCK and P23/PPG1
	I_{OL2}	-	15	mA	P22/UCK, P23/PPG1
"L" level average output current	I_{OLAV1}	-	4	mA	Except P22/UCK, P23/PPG1 Average value (operating current x operating rate)
	I_{OLAV2}	-	4	mA	P22/UCK, P23/PPG1 Average value (operating current x operating rate)
"L" level total maximum output current	ΣI_{OL}	-	100	mA	
"L" level total average output current	ΣI_{OLAV}	-	40	mA	Average value (operating current x operating rate)
"H" level maximum output current	I_{OH1}	-	-15	mA	Except P22/UCK, P23/PPG1
	I_{OH2}	-	-15	mA	P22/UCK, P23/PPG1
"H" level average output current	I_{OHAV}	-	-4	mA	Except P22/UCK, P23/PPG1 Average value (operating current x operating rate)
	I_{OHAV}	-	-4	mA	P22/UCK, P23/PPG1 Average value (operating current x operating rate)
"H" level maximum output current	ΣI_{OH}	-	-50	mA	
"H" level total average maximum output current	ΣI_{OHAV}	-	-20	mA	Average value (operating current x operating rate)
Power consumption	P_D	-	300	mW	
Operating temperature	T_A	-40	+85	°C	
Storage temperature	Tstg	-55	+150	°C	

*1: Use AV_{CC} and V_{CC2} set at the same voltage.
Take care so that AVR and DVR does not exceed AV_{CC} + 0.3V, such as when the power is turned on.

<Precaution> Permanent device damage may occur if the above "Absolute Maximum Ratings" are exceeded. Functional operation should be restricted to the conditions as detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

2. Recommended Operating Condition

$(AV_{SS} = V_{SS} = 0V)$

Parameter	Symbol	Value		Unit	Remarks
		Min.	Max.		
Power supply voltage *3	V_{CC1}	2.2[*1]	3.6	V	Normal operation assurance range * MB89557A/558A
	V_{CC2}	2.2[*1]	5.5	V	
	V_{CC1}	-	-	V	Normal operation assurance range * MB89P558A
	V_{CC2}	2.7[*2]	5.5	V	
	$V_{CC1,}V_{CC2}$	1.5	3.6	V	Retains the RAM state in stop mode
A/D converter reference input voltage *4	AVR	V_{CC1}	AV_{CC}	V	Normal operation assurance range *
D/A converter reference input voltage *4	DVR	V_{CC1}	AV_{CC}	V	Normal operation assurance range *
LCD power supply voltage	V0-V3	V_{SS}	V_{CC2}	V	V0-V3 pin in non-booster circuit version (The optimum value is dependent on the LCD element in use.)
Operating temperature	T_a	-40	+85	°C	

*1: The operating voltage vary with the instruction execution time (instruction cycle time) of clock frequency. See figure 1 in details.

*2: The operating voltage vary with the instruction execution time (instruction cycle time) of clock frequency. See figure 2 in details. Also, the V_{CC1} pin of the MB89PV550A has no internal connection circuit, and the V_{CC1} pin of the MB89P558A is used for the V_{PP} pin for the on-board programming. Please take a notice to use the V_{CC2}.

*3: Please uses the AV_{CC} and V_{CC2} set as the same voltage. Also, voltage of the V_{CC1} should not exceed the V_{CC2}.

*4: AVR and DVR must keep the "$V_{CC1} \leq AVR(DVR) \leq AV_{CC}+0.3V$"
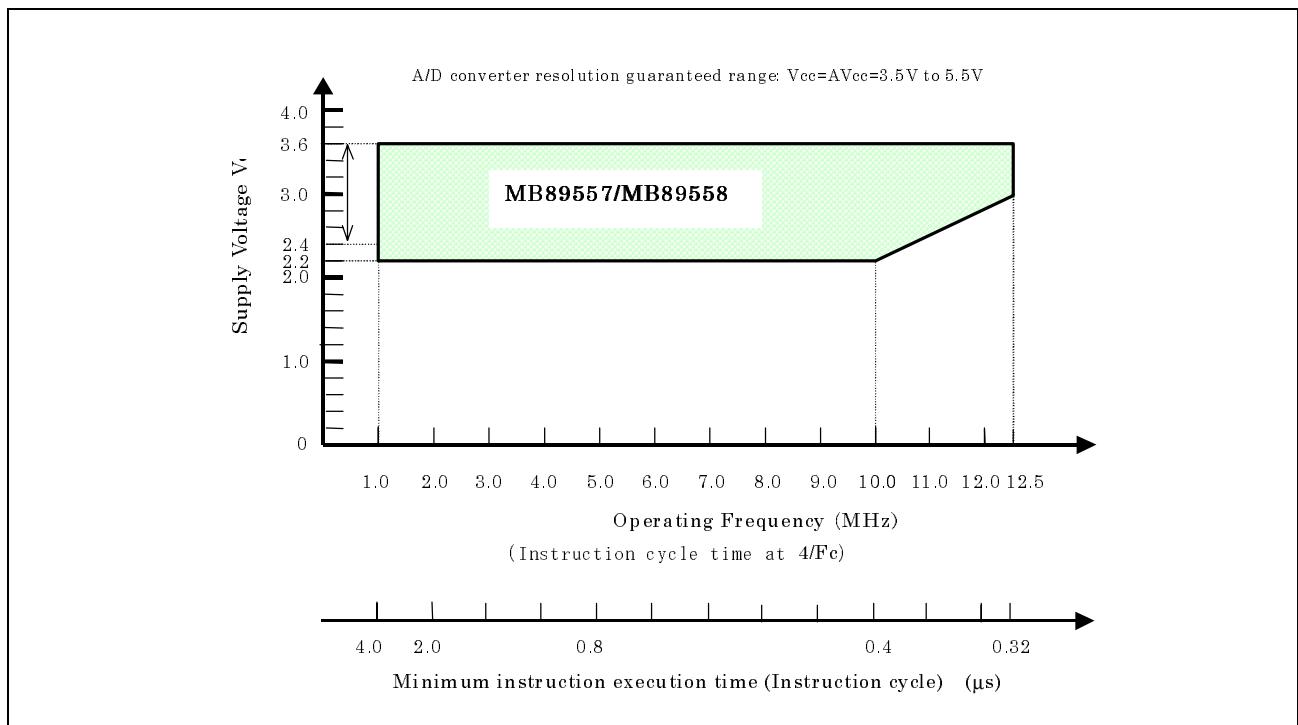
Figure 1: Operating Voltage vs. Main Clock Operating Frequency (MB89558A/557A)
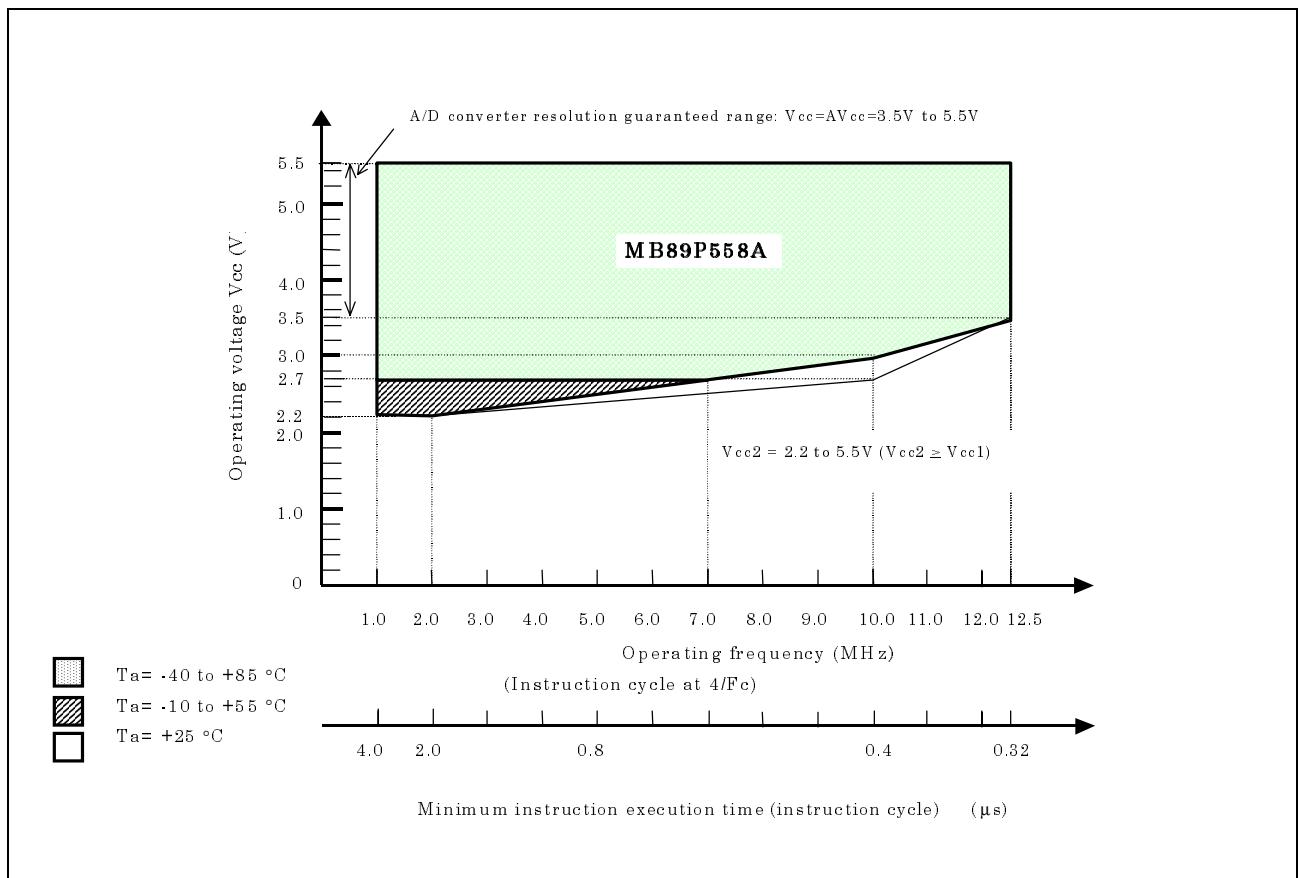
Figure 2: Operating Voltage vs. Main Clock Operating Frequency (MB89P558A)

3. DC Characteristic

$(AV_{CC}=AVR=DVR=V_{CC2}=5V, AV_{SS}=V_{SS}=0V, Ta= -40°C$ to $+85°C)$

Parameter	Symbol	Pin	Condition	Value Min.	Value Typ.	Value Max.	Unit	Remarks
"H" level input voltage	V_{IH1}	P00-P07, P10-P17, P20-P27, P40-P45, P80-P87	-	$0.7V_{CC2}$	-	$V_{CC2}+0.3$	V	
	V_{IH2}	P50-P57, P60-P67, P70-P77	-	$0.7V_{CC2}$	-	V3	V	V3 should not exceed V_{IH2}
	V_{IH3}	P46, P47, P30, P31	-	$0.7V_{CC2}$	-	$V_{SS}+5.5$	V	
	V_{IHS1}	INT10-INT17, UI, UCK, INT20-INT27, SCK, EC1, EC2, EC3, RSTX, MODA	-	$0.8V_{CC2}$	-	$V_{CC2}+0.3$	V	Hysteresis input
	V_{IHS2}	SI, PWC	-	$0.8 V_{CC2}$	-	$V_{SS}+5.5$	V	Hysteresis input
"L" level input voltage	V_{IL1}	P00-P07, P10-P17, P20-P27, P30,P31 P40-P47, P80-P87	-	$V_{SS}-0.3$	-	$0.3V_{CC2}$	V	
	V_{IL2}	P50-P57, P60-P67, P70-P77,	-	$V_{SS}-0.3$	-	$0.3V_{CC2}$	V	V3 should not exceed V_{IL2}
	V_{IS}	INT10-INT17, UI, UCK, INT20-INT27, SCK, EC1, EC2, EC3, RSTX, MODA, SI, PWC	-	$V_{SS}-0.3$	-	$0.2V_{CC2}$	V	Hysteresis input
Open-drain output pin application voltage	V_{D1}	P46, P47, P30, P31	-	$V_{SS}-0.3$	-	$V_{SS}+5.5$	V	
	V_{D2}	P50-P57, P60-P67, P70-P77	-	$V_{SS}-0.3$	-	V3	V	V3 should not exceed V_{D2}
"H" level output voltage	V_{OH}	P00-P07, P10-P17, P20,P21, P24-P27 P40-P45, P80-P87	$I_{OH}=-2.0mA$	4.0	-	-	V	
		P22, P23	$I_{OH}=-4.0mA$	4.0	-	-	V	
"L" level output voltage	V_{OL}	P00-P07, P10-P17, P20,P21, P24-P27, P30,P31, P40-P47, P50-P57, P60-P67, P70-P77, P80-P87	$I_{OL}=4.0mA$	-	-	0.4	V	
		P22, P23	$I_{OL}=12mA$	-	-	0.4	V	
Input leakage current (Hi-Z output leakage current)	I_{LI}	P00-P07, P10-P17, P20-P27, P30,P31 P40-P47, P50-P57, P60-P67, P70-P77, P80-P87, MODA	$0.0V<V_I<V_{CC2}$	-	-	±5	μA	Without pull-up resistor
Pull-up resistance	R_{PULL}	P00-P07, P10-P17, P20-P27, P40-P45, P80-P87, RSTX	$V_I=0.0V$	25	50	100	KΩ	With pull-up resistor

Parameter	Symbol	Pin	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
Supply current	I_{CC1}	V_{CC1}	$V_{CC1}=3.0V$ $V_{CC2}=5.0V$ $F_{CH}=12.5MHz$	-	4.5	6	mA	$t_{inst}=0.32\mu s$ MB89557A/558A
		V_{CC2}	$V_{CC2}=5.0V$ $F_{CH}=12.5MHz$	-	22	25	mA	$t_{inst}=0.32\mu s$ MB89P558A
	I_{CC2}	V_{CC1}	$V_{CC1}=3.0V,$ $V_{CC2}=5.0V$ $F_{CH}=10.0MHz$	-	1.4	2.1	mA	$t_{inst}=6.4\mu s$ MB89557A/558A
		V_{CC2}	$V_{CC2}=3.0V$ $F_{CH}=10.0Hz$	-	5.3	9	mA	$t_{inst}=6.4\mu s$ MB89P558A
	I_{CCS1}	V_{CC1}	$V_{CC1}=3.0V,$ $V_{CC2}=3.0V$ $F_{CH}=12.5MHz$	-	2	3	mA	at sleep mode $T_{inst}=0.32\mu s$ MB89557A/558A
		V_{CC2}	$V_{CC2}=5.0V$ $F_{CH}=12.5MHz$	-	6.2	10	mA	at sleep mode $t_{inst}=0.32\mu s$ MB89P558A
	I_{CCS2}	V_{CC1}	$V_{CC1}=3.0V$ $V_{CC2}=3.0V$ $F_{CH}=10.0MHz$	-	1.2	1.8	mA	at sleep mode $t_{inst}=6.4\mu s$ MB89557A/558A
		V_{CC2}	$V_{CC2}=3.0V$ $F_{CH}=10.0Hz$	-	0.47	1	mA	at sleep mode $t_{inst}=6.4\mu s$ MB89P558A
	I_{CCL}	V_{CC1}	$V_{CC1}=3.0V$ $V_{CC2}=5.0V$ $F_{CL}=32kHz$	-	30	50	μA	at sub-clock mode MB89557A/558A
		V_{CC2}	$V_{CC2}=3.0V$ $F_{CL}=32kHz$	-	4	8	mA	at sub-clock mode MB89P558A
	I_{CCLS}	V_{CC1}	$V_{CC1}=3.0V$ $V_{CC2}=3.0V$ $F_{CL}=32kHz$	-	10	20	μA	at sub-clock sleep mode MB89557A/558A
		V_{CC2}	$V_{CC2}=3.0V$ $F_{CL}=32kHz$	-	20	50	μA	at sub-clock sleep mode MB89P558A
	I_{CCT}	V_{CC1}	$V_{CC1}=3.0V$ $V_{CC2}=3.0V$ $F_{CL}=32kHz$	-	5	15	μA	Watch mode, at main-clock stop mode MB89557A/558A
		V_{CC2}	$V_{CC2}=3.0V$ $F_{CL}=32kHz$ at Ta=25°C	-	12	25	μA	Watch mode, at main-clock stop mode MB89P558A
	I_{CCH}	V_{CC1}	$V_{CC1}=3.0V$ $V_{CC2}=3.0V$ $F_{CL}=32kHz$ at Ta=25°C	-	5	10	μA	Ta=25°C, at sub-clock stop mode MB89557A/558A
		V_{CC2}	$V_{CC2}=3.0V$ $F_{CL}=32kHz$ at a=25°C	-	5	10	μA	Ta=25°C, at sub-clock stop mode MB89P558A

Parameter	Symbol	Pin	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
Supply current	I$_A$	AV$_{CC}$	V$_{CC1}$=3.0V AV$_{CC}$=V$_{CC2}$=5.0V F$_{CH}$=12.5MHz	-	2	5	mA	A/D conversion active MB89557A/558A
		AV$_{CC}$	V$_{CC2}$=5.0V F$_{CH}$=12.5MHz	-	3	6	μA	A/D conversion active MB89P558A
	I$_{AH}$	AV$_{CC}$	V$_{CC1}$=3.0V, AV$_{CC}$=V$_{CC2}$=5.0V F$_{CH}$=12.5MHz	-	-	10	μA	Ta=25°C A/D stop MB89557A/558A
		AV$_{CC}$	V$_{CC2}$=5.0V F$_{CH}$=12.5MHz	-	-	10	μA	Ta=25°C A/D stop MB89P558A
LCD divided resistance	R$_{LCD}$	-	Between V$_{CC}$-V$_0$ at V$_{CC}$=5V	-	500	-	kΩ	
COM0-COM3 output impedance	R$_{VCOM}$	COM0-COM3	V1-V3=5V	-	-	5	kΩ	
SEG0-SEG31 output impedance	R$_{VSEG}$	SEG0-SEG31		-	-	15	kΩ	
LCD leakage current	I$_{LCDL}$	V0-V3, COM0-COM3, SEG0-SEG31	-	-	-	±5	μA	
LCD booster output voltage	V$_{OV3}$	V3	V1=1.5V	-	4.5	-	V	With booster
	V$_{OV2}$	V2		-	3.0	-	V	
Reference input voltage impedance	R$_{RIN}$	V1	-	600	1000	1400	kΩ	With booster
Input capacitance	C$_{IN}$	except V$_{CC}$ and V$_{SS}$	F$_{CH}$=1MHz	-	10	-	pF	
V1 input voltage	V$_{I1}$	V1	I$_{IN}$=0μA	-	1.5	-	V	With booster

4. AC Characteristics

(1) Reset Timing

(DVR=V_{CC1}=3V, AV$_{SS}$=V$_{SS}$=0V, Ta= -40°C to +85°C)

Parameter	Symbol	Condition	Value		Unit	Remarks
			Min.	Max.		
RST "L" pulse width	t_{ZLZH}	-	48 t_{HCLY}	-	ns	

Note: t_{HCLY} is period of main clock frequency
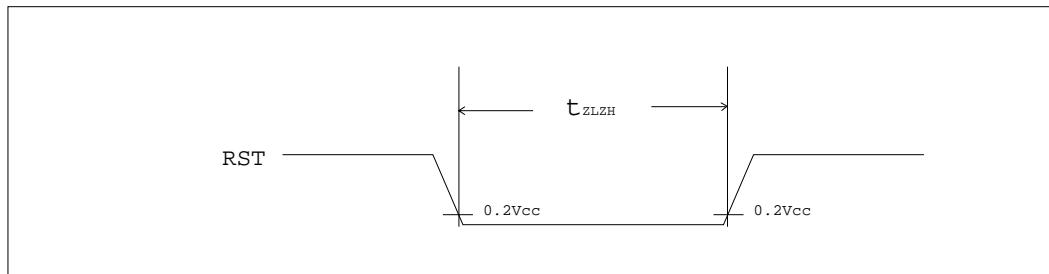
(2) Power-on Reset

(AV$_{SS}$=V$_{SS}$=0V, Ta= -40°C to +85°C)

Parameter	Symbol	Condition	Value		Unit	Remarks
			Min.	Max.		
Power supply rising time	t_R	-	0.05	50	Ms	
Power supply shut off time	t_{OFF}		1	-	Ms	Due to repeated operation

Note: Make sure that power supply rises within the selected oscillation stabilization time. If the power supply voltage needs to be varied in the course of operation, a smooth voltage rise is recommended.
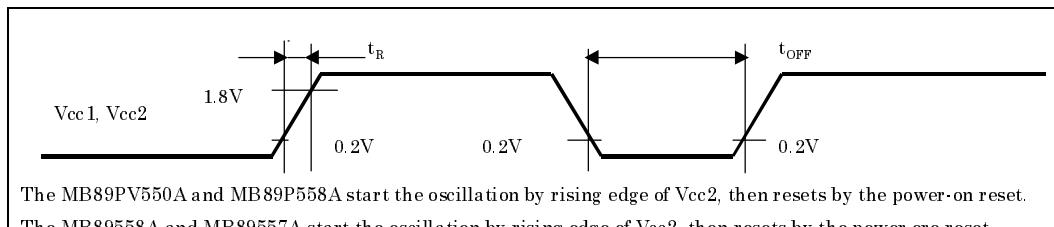
The MB89PV550A and MB89P558A start the oscillation by rising edge of Vcc2, then resets by the power-on reset.
The MB89558A and MB89557A start the oscillation by rising edge of Vcc2, then resets by the power ore reset

(3) Supply Voltage

The supply voltage should be Vcc2 > Vcc1.

The MB89PV550A and MB89P558A operate using only the Vcc2.

The MB89558A and MB89557A operate using Vcc1 = CPU internal voltage and Vcc2 = I/O voltage
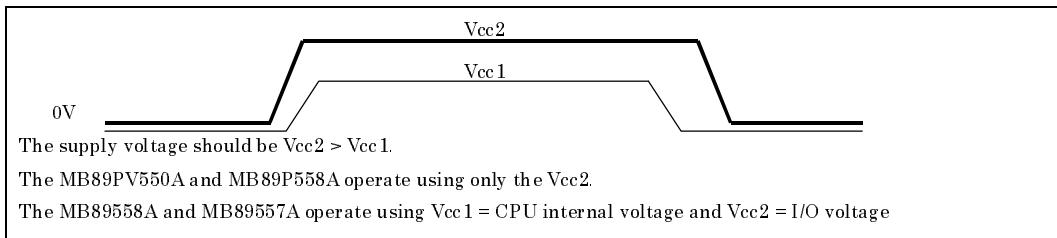
(4) Clock Timing

(AV$_{SS}$=V$_{SS}$=0V, Ta=- 40°C to +85°C)

Parameter	Symbol	Pin	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
Clock frequency	F$_{CH}$	X0, X1		1	-	12.5	MHz	
	F$_{CL}$	X0A, X1A		-	32.768	-	kHz	
Clock cycle time	t$_{CH}$	X0, X1		320	-	1000	ns	
	t$_{CL}$	X0A, X1A		-	30.5	-	µs	
Input clock pulse width	P$_{WH}$ P$_{WL}$	X0	-	20	-	-	ns	External clock
	P$_{WHL}$ P$_{WLL}$	X0A		-	15.2	-	µs	External clock
Input clock rising/falling time	t$_{CR}$ t$_{CF}$	X0		-	-	10	ns	External clock

(5) Instruction Cycle

(AV$_{SS}$=V$_{SS}$=0V, Ta= -40°C to +85°C)

Parameter	Symbol	Value (typical)	Unit	Remarks
Instruction cycle (minimum execution time)	t$_{inst}$	4/F$_{CH}$,8/F$_{CH}$, 16/F$_{CH}$, 64/F$_{CH}$,	ms	(4/F$_{CH}$) t$_{inst}$=0.32µs at F$_{CH}$=12.5MHz
		2/F$_{CL}$	ms	t$_{inst}$=61.036µs when operating at F$_{CL}$=32.768kHz

Note: When operating at 10MHz, the cycle varies with the set execution time.

(6) Serial I/O Timing

Parameter	Symbol	Pin	Condition	Value		Unit	Remarks
				Min.	Max.		
Serial clock cycle time	t_{SCYC}	SCK, UCK	Internal clock mode	2 t_{inst}	-	ns	
SCK ↓ → SO time UCK ↓ → UO time	t_{SLOV}	SCK, SO, UCK, UO		-200	200	ns	
Valid SI → SCK ↑ Valid UI → UCK ↑	t_{IVSH}	SI, SCK		1/2 t_{inst}	-	ns	
SCK ↑ → valid SI hold time UCK ↑ → valid UI hold time	t_{SHIX}	SCK, SI, UCK, UI		1/2 t_{inst}	-	ns	
Serial clock "H" pulse width	t_{SHSL}	SCK, UCK	External clock mode	1 t_{inst}	-	ns	
Serial clock "L" pulse width	t_{SLSH}			1 t_{inst}	-	ns	
SCK ↓ → SO time UCK ↓ → UO time	t_{SLOV}	SCK, SO, UCK, UO		0	200	ns	
valid SI → SCK ↑ valid UI → UCK ↑	t_{IVSH}	SI, SCK, UI, UCK		1/2 t_{inst}	-	ns	
SCK ↑ → valid SI hold time UCK ↑ → valid UI hold time	t_{SHIX2}	SCK, SI, UCK, UI		1/2 t_{inst}	-	ns	

* : For information on t_{inst} see "Instruction cycle"

(7) Peripheral Input Timing

<div align="right">(V_{CC1}=3V,AV_{CC}=AVR=DVR=V_{CC2}=5V, AV_{SS}=V_{SS}=0V, Ta= -40°C to +85°C)</div>

$(V_{CC1}=3V, AV_{CC}=AVR=DVR=V_{CC2}=5V, AV_{SS}=V_{SS}=0V, Ta= -40°C \text{ to } +85°C)$

Parameter	Symbol	Pin	Condition	Value		Unit	Remarks
				Min.	Max.		
Peripheral input "H" pulse width 1	t_{ILIH1}	EC1, EC2, EC3, INT10-INT17	-	1 t_{inst}	-	µs	
Peripheral input "L" pulse width 1	t_{IHIL1}	EC, EC2, EC3, INT10-INT17	-	1 t_{inst}	-	µs	
Peripheral input "H" pulse width 2	t_{ILIH2}	PWC, INT20-INT27	-	2 t_{inst}	-	µs	
Peripheral input "L" pulse width 2	t_{IHIL2}	PWC, INT20-INT27	-	2 t_{inst}	-	µs	

* : For information of t_{inst} see "Instruction cycle"

(8) A/D Converter Electrical Characteristics

$(V_{CC1}=3V, AV_{CC}=AVR=DVR=V_{CC2}=3.5\text{-}5.5V, AV_{SS}=V_{SS}=0V, Ta= -40°C \text{ to } +85°C)$

Parameter	Symbol	Pin	Condition	Min.	Typ.	Max.	Unit	Remarks
Resolution			-	-	10	-	bit	
Total error				-	-	±5.0	LSB	
Linearity error	-	-		-	-	±2.5	LSB	
Differential linearity error			AVR=AV$_{CC}$	-	-	±1.9	LSB	
Zero transition voltage	V$_{OT}$	AN0-AN7		AV$_{SS}$-3.5	+0.5	AV$_{SS}$+4.5	LSB	
Full-scale transition voltage	V$_{FST}$			AVR-6.5	AVR-1.5	AVR+1.5	LSB	
Interchannel disparity				-	-	4	LSB	
Conversion time	-	-		-	60tinst	-	µs	*1
Sampling time				-	16tinst	-	µs	
Analog port input current	I$_{AIN}$	AN0-AN7	-	-	-	10	µA	
Analog input voltage	V$_{AIN}$			AV$_{SS}$	-	AVR	V	
Reference voltage	-			AV$_{SS}$+2.7	-	AV$_{CC}$	V	
Reference voltage supply current	I$_R$	AVR	at A/D converter is active	-	400	-	µA	
	I$_{RH}$		at A/D converter is stopped	-	-	5	µA	

*1: including the sampling time

(9) D/A Converter Electrical Characteristics

$(V_{CC1}=3V, AV_{CC}=AVR=DVR=V_{CC2}=3.5 \text{ to } 5.5V, AV_{SS}=V_{SS}=0V, Ta= -40°C \text{ to } +85°C)$

Parameter	Symbol	Pin	Condition	Min.	Typ.	Max.	Unit	Remarks
Resolution			-	-	8	-	bit	
Differential linearity error				-	-	±0.9	LSB	
Absolute precision	-	-		-	-	±1.2	%	
Linearity error			AVR=AV$_{CC}$	-	-	±1.5	LSB	
Conversion time				-	10	20	µs	*1
Analog reference voltage				V$_{SS}$+3.0	-	AV$_{CC}$	V	
Reference voltage supply current	I$_{DVR}$	DV$_{CC}$	at D/A converter is active	-	120	300	µA	*2
	I$_{DVRS}$		at D/A converter is stopped	-	-	10	µA	*3
Analog output impedance	-	-	-	-	20	-	kΩ	MB89P558A
				-	20	-	kΩ	MB89558A/557A

*1: with load capacitance is 20pF

*2: without load

*3: at stop mode