

MB88200 SERIES

CMOS Low-end Single-chip 4-bit Microprocessor

DESCRIPTION

The Fujitsu MB88200 series CMOS single-chip 4-bit microcomputer family is an economical low-end version of the conventional MB8850 series. It is designed based on the MB8850 series architecture, and its instruction set is a subset of the MB8850 series. But some of the on-chip resources available on the MB8850 series are eliminated for low-cost, high-volume applications, and a few new mask options are added for wider application.

The MB88200 series consists of the MB88201 and MB88202. Both devices contain a program memory (mask ROM: 512 x 8 bits for MB88201, 1K x 8 bits for MB88202), a data memory (static RAM: 16 x 4 bits for MB88201, 32 x 4 bits for MB88202), and I/O port (up to 12 lines), and a clock generator.

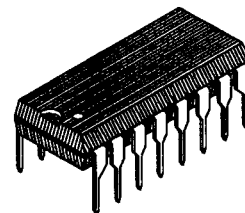
This series has two supply versions. One is standard version (4.5 V to 5.5 V), another is A-version (3.5 V to 6.0 V).

They are fabricated by the silicon-gate CMOS process and packaged in a 16-pin plastic DIP (suffix -P) or 16-pin plastic flat package (suffix -PF).

They operate with a single +5 V power supply and a 2 MHz clock without a prescaler (or 4MHz clock with prescaler) over the temperature range of -40 to +85 °C (standard version) or -30 to +70 °C (A-version).

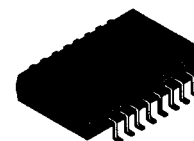
CMOS technology allows the device to operate with low power dissipation (1mA typ. at $V_{CC}=5$ V and $f_c=1$ MHz), and further the standby function (if implemented) enables data retention with lower current 10 μ A max. at $V_{CC}=3.5$ V).

For development of the MB88200 series-based system by the user, Fujitsu provides the MB88200 cross-assembler and host-emulator which run on the PC-DOS machines, the MB2115 series evaluation tool system. These development tools enable users to minimize their development time and cost.



16-Pin Plastic DIP
(DIP-16P-M04)

Order Nos:
MB88201-P
MB88202-P



16-Pin Plastic Flat Package
(FPT-16P-M03)

Order Nos:
MB88201-PF
MB88202-PF

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields. However, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit.

MB88200 Series

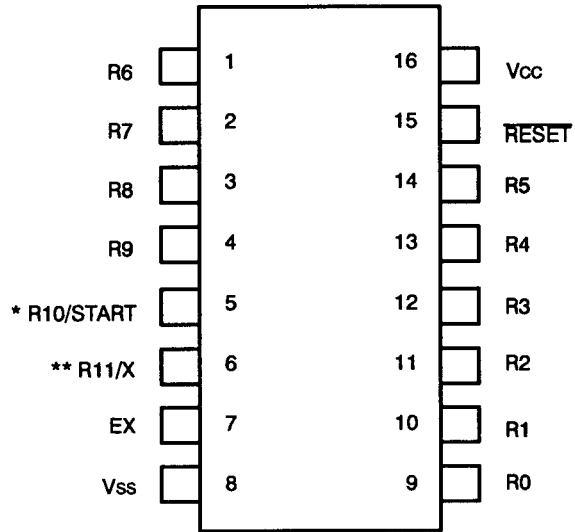
Features

- CMOS Low-end Single-chip 4-bit Microcomputer
- Program Memory:
 - MB88201: 512 x 8-bit mask ROM
 - MB88202: 1K x 8-bit mask ROM
- Data Memory:
 - MB88201: 16 x 4-bit static RAM
 - MB88202: 32 x 4-bit static RAM
- I/O Port: 10 to 12 Lines (depending on oscillator and standby function options)
 - R-Port : Up to three 4-bit parallel or 12 individual input/output ports
- Four Selectable Output Port Types for R-Port with Mask Option:
 - Standard pull-up
 - Standard open-drain
 - Middle-current open-drain
 - 12V-interface open-drain (R4 to R7)
- On-chip Clock Generator with Four Mask Options:
 - Crystal/ceramic resonator
 - RC-network
 - Capacitor
 - External clock drive
- Mask-option Divide-by-two Clock Prescaler for Expanding Clock Range
- Nesting Level:
 - MB88201: 2 levels
 - MB88202: 4 levels
- Instruction Set: Subset of MB8850 series
 - Number of instructions : 37 (MB88201) or 38 (MB88202)
 - Instruction length/cycle : 1 byte/1 cycle or 2 byte/2 cycle
 - Execution time : 3.0 μ s min. using 2MHz clock without prescaler(or 4MHz clock with prescaler)
- On-chip Power-on Reset Circuit
- Mask Option Standby Function: Software initiation & hardware release
- Mask Option Low-voltage Reset Function (Standard version only)
- Mask Option Output Port Level During Reset:
 - High Level
 - Low level (R0-R3, R5, R6, R10, R11)
- Low Power Dissipation:
 - 1mA typ. at Vcc=5.0V, fc=1MHz (Active mode)
 - 10 μ A max. at Vcc=3.5V, fc=0MHz (Standby mode)
- Single Power Supply:
 - Standard version:
 - 4.5V to 5.5V (Active mode)
 - 3.5V to 6.0V (Standby mode)
 - A-version:
 - 3.5V to 6.0V (Active mode)
 - 3.0V to 6.0V (Standby mode)

Features (continued)

- **Wide Operating Temperature Range:**
 - **Standard version:**
 - TA = -40°C to +85°C (without low-voltage reset function)
 - TA = -10°C to +70°C (with low-voltage reset function)
 - **A-version:**
 - TA = -30°C to +70°C
- **Silicon-gate CMOS Process**
- **Powerful Development Support:**
 - PC-DOS cross-assembler (SM07620-AXXX)
 - PC-DOS host emulator software for monitoring evaluation board and symbolic debugging (SM07620-GXXX)
 - MB2115 series evaluation tool (MB2115-01, -02, -04, and -33A) for software debugging
- **Package and Ordering Information**
 - 16-pin plastic DIP, order as MB8820XP, or
 - 16-pin plastic SOP, order as MB8820XPF

MB88200 Series



Notes:

- * When the standby function (mask option) is used, pin 5 functions as the START pin; otherwise as the R10 pin.
- ** When the crystal/ceramic or RC-network oscillator (mask-options) is used, pin 6 functions as the X pin; otherwise (i.e., when the capacitor or external oscillator is used) as the R11 pin.

Figure 1. Pin Assignment

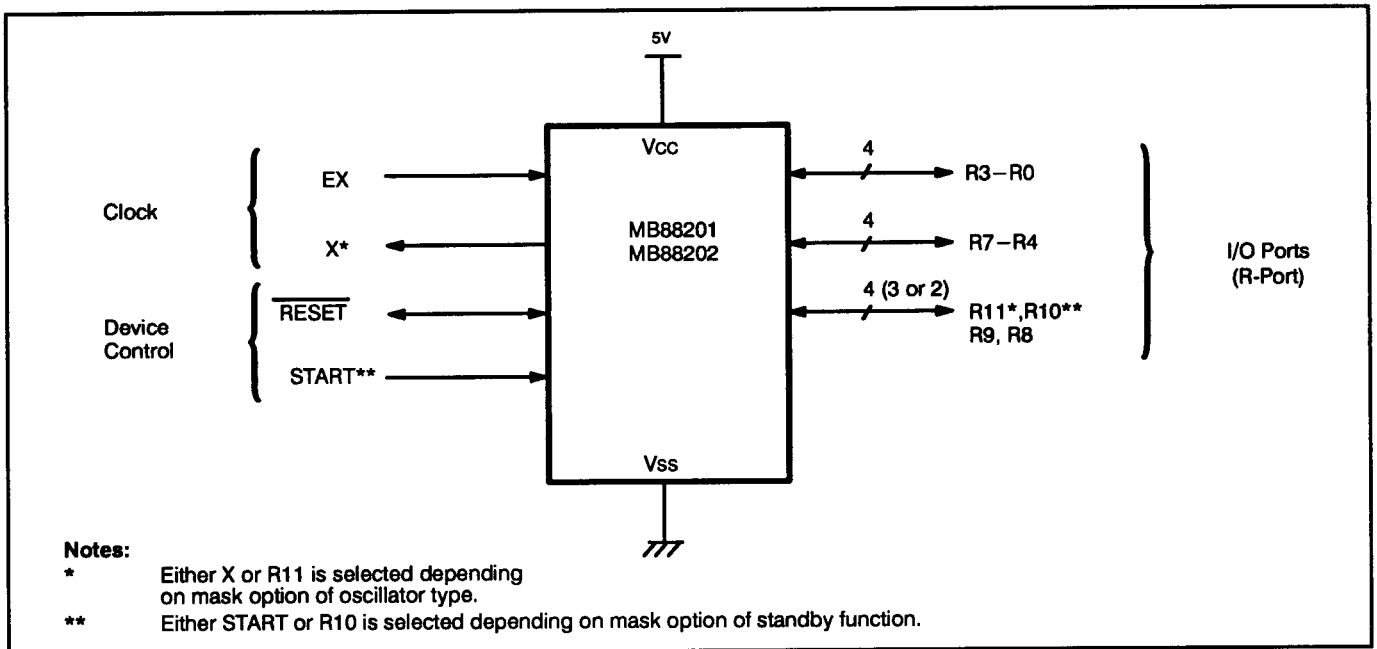


Figure 2. Logic Symbol

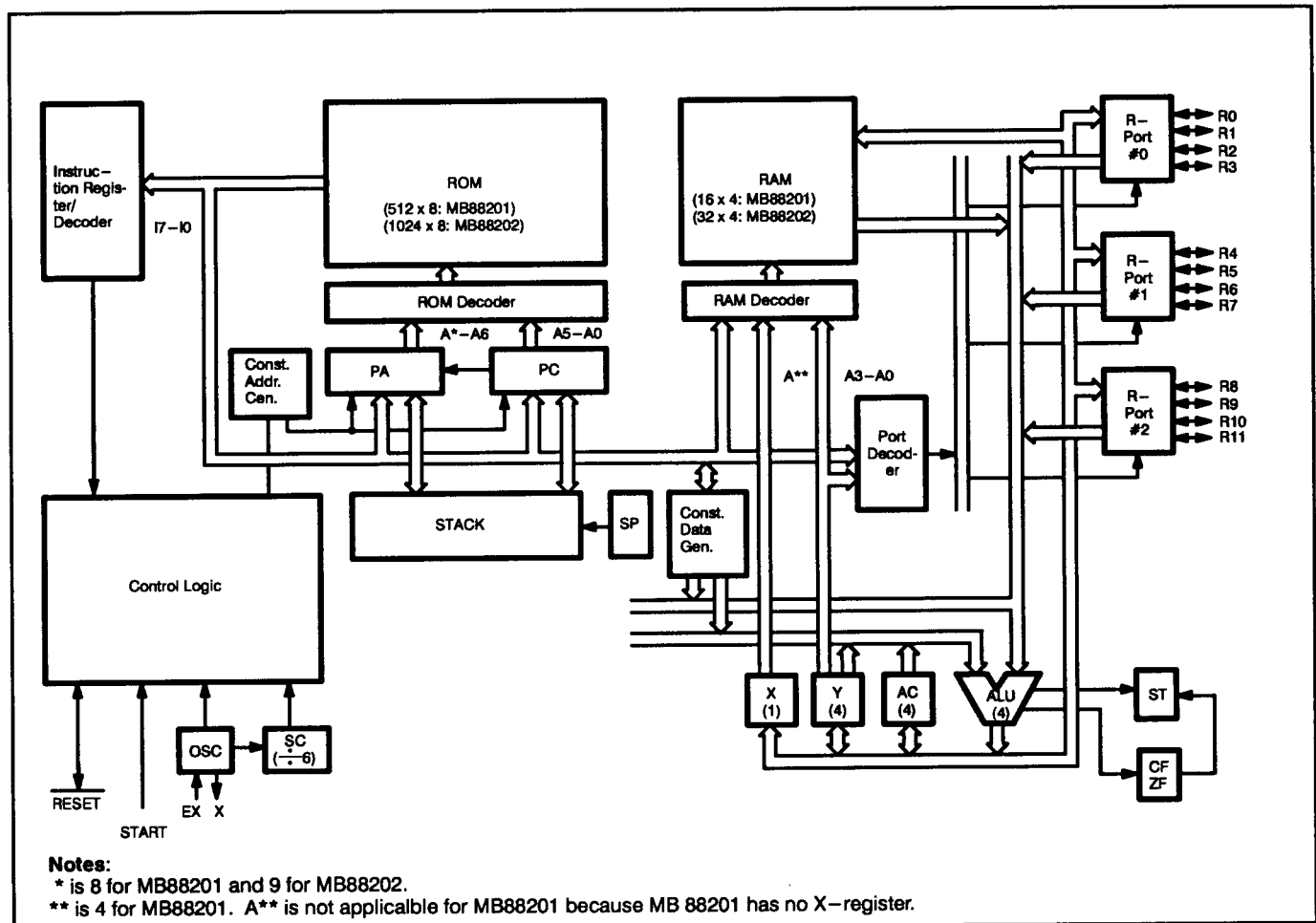


Figure 3. Block Diagram

MB88200 Series

Pin Description

Fig. 1 and Table 1 show the pin assignment and pin description of the MB88200 series.

Table 1 Pin Description

Symbol	Pin No.	Type	Name and Function
Power Supply			
Vcc	16	–	+5V DC power supply pin.
Vss	8	–	Ground pin.
Clock			
EX	7	I	<p>Oscillator Input: Input to the inverting amplifier that forms the on-chip oscillator. An external crystal/ceramic resonator or RC-network is connected between the EX and X pins, or an external capacitor or external oscillator is connected to the EX pin. One of these four oscillator types can be selected using mask option.</p> <p>This pin is a non-hysteresis input when the crystal/ceramic resonator or external oscillator is selected, or a hysteresis input when the RC-network or capacitor oscillator is selected.</p>
X	6	O	<p>Oscillator Output: Output of the inverting amplifier that forms the on-chip oscillator, and input to the internal clock generator. An external crystal/ceramic resonator or RC-network is connected between the EX and X pins.</p> <p>The X pin is common to the R11 pin. Either of them is selected using mask option. The X pin is selected when the crystal/ceramic resonator or RC-network oscillator is implemented.</p>
Device Control			
RESET	15	I/O	<p>Reset: This pin functions as an external reset input or power-on/low-voltage reset output.</p> <p>External reset input: A reset input to the internal reset circuit. A low level on the RESET pin forcibly stops the MCU's operations, and initializes its internal state. After the RESET pin returns high, the MCU restarts execution of program from address #0. The RESET pulse must be low for at least two instruction cycles (12 clock periods: approximately 6μs using a 2MHz crystal without a prescaler) while the oscillator is stably running after power on. An external capacitor (and an internal pull-up resistor) or RC-network, whose time constant should be greater than the reset time required (12 clock periods), composes the external reset circuit. This pin is active even in the standby mode.</p> <p>This pin is a hysteresis input with an internal pull-up resistor.</p> <p>Power-on/low-voltage reset output: A reset output from the on-chip reset control circuit. Normally this output is high during the active operation, except power-on/low-voltage reset.</p>

Table 1 Pin Description (continued)

Symbol	Pin No.	Type	Name and Function
Device Control (continued)			
RESET	15	I/O	<p>1) Power-on reset output: The rising of the Vcc voltage after power on outputs a negative pulse to the RESET pin. With an external RC-network at the RESET pin, whose time constant should be greater than the reset time required (the oscillator stabilization time, plus 12 clock periods), the power-on reset circuit is composed.</p> <p>2) Low-voltage reset output (Standard version only): The RESET pin outputs a low level when the Vcc voltage lowers below a threshold voltage during the active operating mode, and returns high when the Vcc voltage recovers above the threshold voltage. With an external RC-network at the RESET pin, whose time constant should be greater than the reset time required (the oscillator stabilization time, plus 12 clock periods), the low-voltage reset circuit is provided. (The low-voltage reset function is mask optional, and is disabled during the standby mode).</p>
START	5	I	<p>Start: A standby release input to the on-chip standby control circuit. A high level on the START pin triggers the standby release sequence to release the MCU from the standby mode. Before applying START pulse, the Vcc voltage must return to the active operation range (4.5V to 5.5V) when the battery backup is used. The START pin must remain high until the oscillation becomes stable after the oscillator restarts. An external RC-network at the START pin, whose time constant should be greater than the oscillator stabilization time, composes the external standby release circuit. This pin is inactive during reset and for two instruction cycles after the standby initiation.</p> <p>This pin is a hysteresis input with an internal pull-down resistor.</p> <p>The START pin is common to the R10 pin. Either of them is selected using mask option. The START pin is selected when the standby function is implemented. Even in that case, the "output" port of R10 is internally still alive, and is connected to the internal standby control circuit. The falling edge on the "internal" R10 output, which is given by software (OUT or SETR/RSTR instructions), triggers the standby initiation sequence.</p>

Continued on next page

MB88200 Series

Table 1 Pin Description (continued)

Symbol	Pin No.	Type	Name and Function
I/O Port			
R3-R0, R7-R4, R11-R8	12-9 2,1,14,13 6-3	I/O	<p>R-Port: This port functions as three 4-bit parallel input (non-latched)/output (latched) ports, or 12 individual input (non-latched)/output (latched) lines, depending on instructions.</p> <p>Parallel I/O: Each 4-bit port is named R-Port #0 (R3-R0), R-Port #1 (R7-R4), and R-Port #2 (R11-R8), and is indirectly addressed by the Y-register (Port #). 4-bit data in the accumulator is output to an addressed port of R-Ports #0 to #2 by OUT instruction. 4-bit data on the addressed port is input into the accumulator by IN instruction. (Before IN instruction, the port to be addressed must be set up to "1" (input mode)).</p> <p>Individual I/O: Each line from R11 to R0 is indirectly addressed by the Y-register (Bit #). An addressed line is individually set/reset by SETR/RSTR instruction, and is individually testable using TSTR instruction. (Before TSTR instruction, the line to be addressed must be set up to "1" (input mode)).</p> <p>Refer to Table 3 User mask options for available making options.</p> <p>The R10 pin is common to the START pin. Either of them is selected using mask option. When no standby function is implemented, the R10 pin is selected.</p> <p>The R11 pin is common to the X pin. Either of them is selected using mask option. When the capacitor oscillator is implemented or when the external oscillator is used, the R11 pin is selected.</p>

Input/Output Circuits

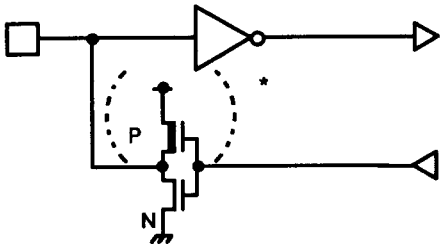
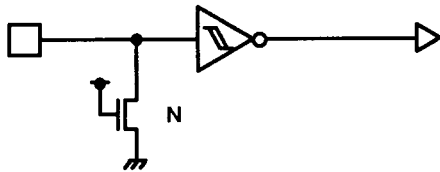
All input-only pins are internally pulled up, and R-Port can have push-pull (standard pull-up) or open-drain (standard, middle-current, 12V-interface) buffer using mask option.

Table 2 Input/Output Circuits

Pin	Circuit	Remarks
EX, X	<p>Crystal/Ceramic Oscillation</p>	<ul style="list-style-type: none"> • Non-hysteresis inverter • Feedback resistor: Approx. $2M\Omega$ typ. (at $V_{cc} = 5V$) • Pin 6 = X (not R11)
	<p>RC-Network Oscillation</p>	<ul style="list-style-type: none"> • Hysteresis inverter • Without feedback resistor • Pin 6 = X (not R11)
	<p>C-Network Oscillation</p>	<ul style="list-style-type: none"> • Hysteresis inverter • Feedback resistor: Approx. $5k\Omega$ typ. (at $V_{cc} = 5V$) • Pin 6 = R11 (not X)
	<p>External Clock Drive</p>	<ul style="list-style-type: none"> • Non-Hysteresis inverter • Without feedback resistor • Pin 6 = R11 (not X)
<p>RESET</p>	<p>Input/Output Pin</p>	<ul style="list-style-type: none"> • Hysteresis inverter • Output pull-up resistor (P-ch. Tr.): Approx. $300k\Omega$ typ. (at $V_{cc} = 5V$)

MB88200 Series

Table 2 Input/Output Circuits (Continued)

Pin	Circuit	Note
R-Port	<p>Input/Output Pin</p> 	<ul style="list-style-type: none"> • Non-hysteresis inverter • Output port option <ul style="list-style-type: none"> 1: Standard pull-up: Output pull-up resistor (P-ch. Tr.): Approx. 10kΩ typ. (at Vcc = 5V) *2: Standard open-drain: Without P-ch. pull-up resistor *3: Middle-current open-drain: Without P-ch. pull-up resistor *4: 12V-interface open-drain: Without P-ch. pull-up resistor. (R4-R7)
START	<p>Input Only Pin</p> 	<ul style="list-style-type: none"> • Hysteresis inverter • Input pull-down resistor (N-ch. Tr.) : A pprox. 300kΩ typ. (at Vcc = 5V)

User Mask Options

The MB88200 series has the following mask options, which must be specified by the customer on the attached data release form when devices are ordered.

Table 3 User Mask Options

Optional Feature	Symbol	Option	Option No.	Note
Program ROM	—	User program	—	1. MB88201: 512 x 8 bits 2. MB88202: 1024 x 8 bits
Clock Prescaler	CLK	No	0	$f_c = 0.5\text{MHz to } 2\text{MHz}$
		Yes	1	$f_c = 1\text{ MHz to } 4\text{MHz}$
Oscillator Type	OSC	Crystal/Ceramic oscillation	0	Pin 6 functions as X.
		RC-network oscillation	1	Pin 6 functions as X.
		Capacitor oscillation	2	Pin 6 functions as R11.
		External clock drive	3	Pin 6 functions as R11.
Output Port Type*	PORT	Standard pull-up	3/M	Pull-up resistor is approx. $10\text{k}\Omega$. R0 to R3, and R9 are standard open-drain.
		Standard open-drain	2/L	
		Middle-current open-drain	1/K	10mA
		12V-interface open-drain	4/G	1. For R4–R7 only, and R4–R7 are output only. 2. Other R-Ports are standard open-drain.
Output Port Level During Reset **	RST	High level	0	
		Low level	1	Except R4, R8, and R9: R4, R8, and R9 are fixed high.
Low-Voltage Reset Function	PWR	No	1	$T_A = -40^\circ\text{C to } +85^\circ\text{C}$
		Yes	2	$T_A = -10^\circ\text{C to } +70^\circ\text{C}$
Standby Function	STBY	No	0	Pin 5 functions as R10.
		Yes	1	Pin 5 functions as START.

Notes:

* Only one of the four options can be selected. Mixed options are not permitted.

** Either "high level" or "low level" is applied to all R-Ports in a clump. Mixed options are not permitted.

MB88200 Series

Instruction Set Description

The MB88200 series instruction set includes 37 (MB88201) or 38 (MB88202) instructions, 95% of which are single-byte and single-cycle, and 5% two-byte and two-cycle. The MB88200 series instruction set is a subset of the MB8850 series. It is divided into eight functional groups:

- Register-to-register transfer
- Register-to-memory transfer
- Constant transfer
- Arithmetic and logical operations
- Bit manipulation
- Input/Output
- Branch
- Flag manipulation

Tables 4 and 5 summarize the MB88200 series instruction set.

Table 4 Instruction Set Summary

	Mnemonic +Operand	Code (Hex.)	Flag/Status			Byte/ Cycle	Operation
			ZF	CF	ST		
Register-to- Register Transfer	TAY	04	•	•	•	1/1	$Y \leftarrow (AC)$
	TYA	14	↓	•	•	1/1	$AC \leftarrow (Y)$
Register-to- Memory Transfer	L	0D	↓	•	•	1/1	$AC \leftarrow \{M(X,Y)\}$
	ST	1D	•	•	•	1/1	$M(X,Y) \leftarrow (AC)$
	XD D XYD D	50-53* 54-57*	↓*1 ↓*2	•	•	1/1	$(AC) \pm \{M(0,D)\}; D=0 \text{ to } 3$ $(Y) \pm \{M(0,D)\}; D=4 \text{ to } 7$
Constant Transfer	CLA	90	↓	•	•	1/1	$AC \leftarrow 0$ (Included in LI instruction)
	LI imm	90-9F*	↓	•	•	1/1	$AC \leftarrow \text{imm}; \text{imm}=0 \text{ to } 15$
	LXI imm	58-59*	↓	•	•	1/1	$X3 \text{ to } X1 \leftarrow 0, X0 \leftarrow \text{imm}; \text{imm}=0 \text{ or } 1 *3$
	LYI imm	80-8F*	↓	•	•	1/1	$Y \leftarrow \text{imm}; \text{imm}=0 \text{ to } 15$
Arithmetic & Logical Operations	ADC	0E	↓	↓	↓C	1/1	$AC \leftarrow (AC) + \{M(X,Y)\} + (CF)$
	AI imm	70-7F*	↓	↓	↓C	1/1	$AC \leftarrow (AC) + \text{imm}; \text{imm}=0 \text{ to } 15$
	C	2E	↓	↓	↓Z	1/1	$\{M(X,Y)\} - (AC)$
	CI imm	B0-BF*	↓	↓	↓Z	1/1	$\text{imm} - (AC); \text{imm}=0 \text{ to } 15$
	CYI imm	A0-AF*	↓	↓	↓Z	1/1	$\text{imm} - (Y); \text{imm}=0 \text{ to } 15$
	DCA	7F	↓	↓	↓C	1/1	$AC \leftarrow (AC) + 15$ (Included in AI instruction)
	DCM	19	↓	•	↓C	1/1	$M(X,Y) \leftarrow \{M(X,Y)\} - 1$
	DCY	18	↓	•	↓C	1/1	$Y \leftarrow (Y) - 1$
	ICA	71	↓	↓	↓C	1/1	$AC \leftarrow (AC) + 1$ (Included in AI instruction)
	ICM	09	↓	•	↓C	1/1	$M(X,Y) \leftarrow \{M(X,Y)\} + 1$
	ICY	08	↓	•	↓C	1/1	$Y \leftarrow (Y) + 1$
	NEG	2D	•	•	↓Z	1/1	$AC \leftarrow \overline{(AC)} + 1$
	SBC	1E	↓	↓	↓C	1/1	$AC \leftarrow \{M(X,Y)\} - (AC) - (CF)$
Bit Manipulation	RBIT bp	34-37*	•	•	•	1/1	$\{M(X,Y)\} \text{bp} \leftarrow 0; \text{bp}=0 \text{ to } 3$
	SBIT bp	30-33*	•	•	•	1/1	$\{M(X,Y)\} \text{bp} \leftarrow 1; \text{bp}=0 \text{ to } 3$
	TBA bp	4C-4F*	•	•	↓C	1/1	$(AC) \text{bp} \leftarrow 1; \text{bp}=0 \text{ to } 3$
	TBIT bp	38-3B*	•	•	↓C	1/1	$\{M(X,Y)\} \text{bp} \leftarrow 1; \text{bp}=0 \text{ to } 3$
Input/ Output	IN	13	↓	•	•	1/1	$AC \leftarrow (R)Y; Y=0 \text{ to } 2 \text{ (Port \#)}$
	OUT	03	•	•	•	1/1	$(R)Y \leftarrow (AC); Y=0 \text{ to } 2 \text{ (Port \#)}$
	RSTR	22	•	•	•	1/1	$(R)Y \leftarrow 0; Y=0 \text{ to } 11$
	SETR	20	•	•	•	1/1	$(R)Y \leftarrow 1; Y=0 \text{ to } 11$
	TSTR	24	•	•	↓C	1/1	$(R)Y \leftarrow 1; Y=0 \text{ to } 11$

Table 4 Instruction Set Summary (continued)

	Mnemonic +Operand	Code (Hex.)	Flag/Status			Byte/ Cycle	Operation
			ZF	CF	ST		
Branch	CALL addr	6000– 63FF*	•	•	•	2/2	If ST=1, Subroutine Call for addr; addr=0 to 1023 ST=0, Not Subroutine Call.
	NOP	00	•	•	•	1/1	No operation
	JMP addr	C0–FF*	•	•	•	1/1	If ST=1, Branch to addr; addr=0 to 63 ST=0, Not Branch
	JPL addr	6800– 6BFF*	•	•	•	2/2	If ST=1, Branch to addr; addr=0 to 1023 ST=0, Not Branch;
	RTS	2C	•	•	•	1/1	Return From Subroutine
Flag Manipulations	RSTC	23	•	↓	•	1/1	CF←0
	SETC	21	•	↑	•	1/1	CF←1
	TSTC	28	•	•	↓CF	1/1	(CF)–1
	TSTZ	29	•	•	↓ZF	1/1	(ZF)–1

Notes:

- * Code is variable depending on the operand.
- *1: ZF is set or reset depending on contents of AC after instruction execution.
- *2: ZF is set or reset depending on contents of Y after instruction execution.
- *3: This instruction is available for MB88202 only because MB88201 has no X–register.

MB88200 Series**Symbols and Abbreviations****Symbols****Meaning**

←	Is transferred to
↔	Is exchanged with
+	Arithmetic plus
-	Arithmetic minus
— (Overline)	Negation
()	Contents of parenthesis
↑	Set to "1" always
↓	Set to "0" always
↕	Affected (set or reset) by operation results
↓C	Set to "0" due to carry (not carry flag)
↓CF	Set to "0" due to carry flag
↓Z	Set to "0" due to zero (not zero flag)
↓ZF	Set to "0" due to zero flag
•	Not affected

Abbreviations**Meaning**

AC	Accumulator
addr	Jump address
bp	Bit pointer (that is part of the instruction code)
C	Carry
CF	Carry flag
D	Direct data memory address (that is part of the instruction code)
imm	Immediate data
LSB	Least significant bit
M(X,Y)	Data memory (RAM) location indirectly addressed by data pointer (X- and Y-registers)
M(0,D)	Data memory (RAM) location directly addressed by "D" bits in the instruction code, in page #0 (X=0)
MSB	Most significant bit
R	R-Port (#0: R3-R0, #1: R7-R4, #2: R11-R8)
(R)Y; Y=n	(1) R-Port #n specified by Y-register (Y=0 to 3) (2) R-Port bit n specified by Y-register (Y=0 to 11)
ST	Status flag
X	X-register (that indicates page # in data memory RAM)
Xn	The n-th bit of X-register
Y	Y-register
Z	Zero
ZF	Zero Flag

Table 5 Instruction Code Summary

L H	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NOP			OUT	TAY				ICY	ICM				L	ADC	
1				IN	TYA				DCY	DCM				ST	SBC	
2	SETR	SETC	RSTR	RSTC	TSTR				TSTC	TSTZ			RTS	NEG	C	
3	SBIT bp			RBIT bp			TBIT bp									
4													TBA bp			
5	XD D			XYD D			LXI* imm									
6	CALL addr								JPL addr							
7		(ICA)	AI imm										(DCA)			
8	LYI imm															
9	(CLA)	LI imm														
A	CYI imm															
B	CI imm															
C	JMP addr															
D																
E																
F																

Notes:



: 1-byte/1-cycle instruction



: 2-byte/2-cycle instruction

* : For MB88202 only because MB88201 has no X-register.

MB88200 Series

Notes on Operation

● Prevention Latch-up Against

Latch-up may occur in CMOS devices when a voltage higher than V_{cc} or lower than V_{ss} is applied to input or output pin, or when a voltage exceeding the absolute maximum ratings is applied between V_{cc} and V_{ss} pins. If latch-up occurs, the supply current increases greatly, and the device may be thermally destroyed. Therefore, applied voltages should not exceed the maximum ratings.

● Treatment of Unused Pins

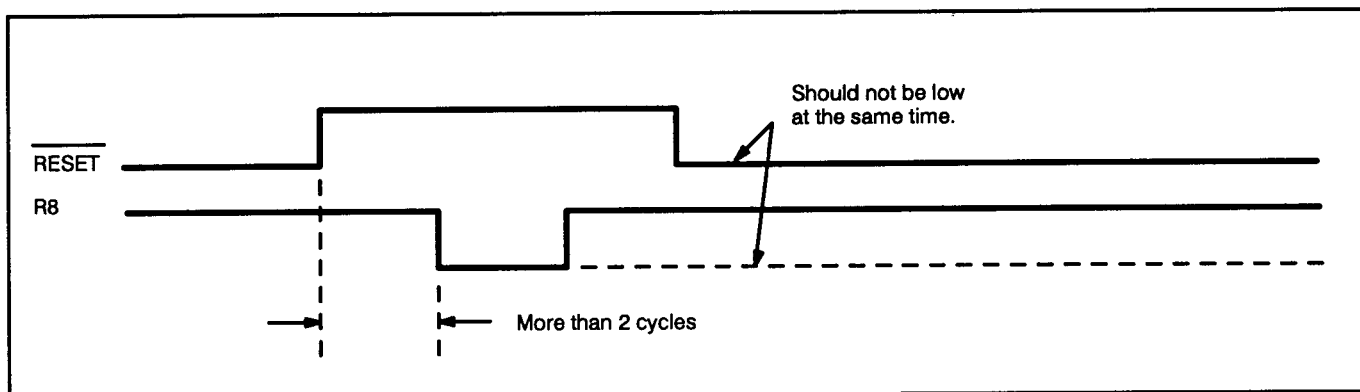
Unused input pins should be externally pulled up or down with resistors because such unused input pins may cause some malfunction if they are left open. (However, the X pin should be open when an external clock oscillator is used.)

● Special Function of R8 Pin

The R8 pin has another function as a test terminal, in addition to its normal function R-Port. If the R8 pin is forced low while the $\overline{\text{RESET}}$ pin is low, the MCU is placed in the test mode.

Especially when the open-drain is selected for the output port option, the R8 pin should be externally pulled up because such open-drain outputs are left floating and subject to noise disturbance.

At least 2 instruction cycles are required to change R8 pin from high to low after releasing reset ($\overline{\text{RESET}}$: Low→High)



● Externally Capacitance for Crystal Oscillation

The external capacitors should be adjusted to individual crystal resonators when precise oscillation frequency is required. It is recommended to use a crystal with a frequency higher than the required oscillation frequency, with the divide-by-two prescaler, because crystal resonators with lower oscillation frequency generally tend to have longer stabilization time and wider characteristic variation.

● Supply Voltage

Malfunction may occur even within the recommended operating supply voltage if the supply voltage changes rapidly. Therefore, the supply voltage should be regulated as well as possible. The following conditions are recommended for the power supply:

- (1) V_{cc} ripple (peak-to-peak value) at commercial frequency (50Hz to 60Hz): Less than 10% of typical V_{cc} value.
- (2) V_{cc} transient change rate (such as a switching of power supply): Less than 0.1V/ms.

Comparison of the MB8850 Series and MB88200 Series

Table 6 Comparison of the MB8850 Series and MB88200 Series

Item \ Device	MB8850 Series	MB88200 Series
ROM Size	<ul style="list-style-type: none"> • 2048 x 8: MB8851/5, MB8852/6 • 1024 x 8: MB8854/8 	<ul style="list-style-type: none"> • 1024 x 8: MB88202 • 512 x 8: MB88201
RAM Size	<ul style="list-style-type: none"> • 128 x 4: MB8851/5, MB8852/6 • 64 x 4: MB8854/8 	<ul style="list-style-type: none"> • 32 x 4: MB88202 • 16 x 4: MB88201
Register	<ul style="list-style-type: none"> • Total 6: AC, X, Y, SB, TH, TL 	<ul style="list-style-type: none"> • Total 2: AC, Y : MB88201 • Total 3: AC, X, Y: MB88202
I/O Port	<ul style="list-style-type: none"> • 37 lines: MB8851/5 • 23 lines: MB8852/6, MB8854/8 	12–10 lines (Depending on oscillator and standby function options)
Output Port Type	<ul style="list-style-type: none"> • Standard open–drain output • Standard pull–up output (Mask Option) 	<ul style="list-style-type: none"> • Standard open–drain • Standard pull–up output • Middle current open–drain output • 12V–interface open–drain output* (Mask option) (*R4–R7)
Output PLA	<ul style="list-style-type: none"> • Yes 	<ul style="list-style-type: none"> • No
Stack Depth (Nesting Level)	<ul style="list-style-type: none"> • 4 levels 	<ul style="list-style-type: none"> • 4 levels: MB88202 • 2 levels: MB88201
Timer/Counter	<ul style="list-style-type: none"> • Yes 	<ul style="list-style-type: none"> • No
Serial I/O	<ul style="list-style-type: none"> • Yes: MB8851/5 • No : MB8852/6, MB8854/8 	<ul style="list-style-type: none"> • No
Oscillator Type	<ul style="list-style-type: none"> • Crystal/ceramic oscillator or external clock drive 	<ul style="list-style-type: none"> • Crystal/Ceramic oscillator • RC–network oscillator • Capacitor oscillator • External clock drive (Mask option)
Interrupt Function	<ul style="list-style-type: none"> • Yes 	<ul style="list-style-type: none"> • No
Standby Function (Mask option)	<ul style="list-style-type: none"> • Yes(Hardware initiation) • No (Mask option) 	<ul style="list-style-type: none"> • Yes (Software initiation) • No
Low–Voltage Reset Function	<ul style="list-style-type: none"> • No (Mask option) 	<ul style="list-style-type: none"> • Yes (Standard version only) • No
Power–On Reset Function	<ul style="list-style-type: none"> • No 	<ul style="list-style-type: none"> • Yes
Output Port State During Reset	<ul style="list-style-type: none"> • High (Mask option) 	<ul style="list-style-type: none"> • High • Low (R0–R3, R5, R6, R10, R11)

MB88200 Series**Table 6 Comparison of the MB8850 Series and MB88200 Series (continued)**

Item / Device	MB8850 Series	MB88200 Series
Operating Ambient Temperature	<ul style="list-style-type: none"> • -40°C to +85°C 	<ul style="list-style-type: none"> • Standard version: <ul style="list-style-type: none"> * -40°C to +85°C (without low-voltage reset function) * -10°C to +70°C (with low-voltage reset function) • A-version: <ul style="list-style-type: none"> * -30°C to +70°C
Supply Current: -Active -Standby	<ul style="list-style-type: none"> • 6mA max. at Vcc=5V, fc=1MHz • 100µA max. at Vcc=3.5V, fc=0MHz 	<ul style="list-style-type: none"> • 1mA typ. at Vcc=5.0V, fc=1MHz • 10µA max. at Vcc=3.5V, fc=0MHz
Number of Instructions	<ul style="list-style-type: none"> • 70 	<ul style="list-style-type: none"> • 37 : MB88201 • 38 : MB88202
Package Type	<ul style="list-style-type: none"> • 42-pin plastic standard/shrink DIP: MB8851M/-PSH • 28-pin plastic standard/shrink DIP: MB8852M/-PSH MB8854M/-PSH • 48-pin plastic flat package: MB8855M/56M/58M 	<ul style="list-style-type: none"> • 16-pin plastic standard DIP: MB88201-P, MB88202-P • 16-pin plastic flat package: MB88201-PF, MB88202-PF
Members	<ul style="list-style-type: none"> • MB8851M/-PSH, MB8855M • MB8852M/-PSH, MB8856M • MB8854M/-PSH, MB8858M A- and L-versions are available for each part above.	<ul style="list-style-type: none"> • MB88201-P, MB88202-PF • MB88202-P, MB88202-PF A-version is available for each part above.

Product Lineup and Development Tools

The MB88200 series consists of the MB88201 and MB88202. See Table 7.

Table 7 MB88200 Series Product Line-Up and Development Tools

	MB88201-P/-PF	MB88202-P/-PF
ROM Size	512 x 8 bits (On-chip mask ROM)	1024 x 8 bits (On-chip mask ROM)
RAM Size (Directly addressed locations)	16 x 4 bits (0-7)	32 x 4 bits (0-7)
Register	Total 2: AC, Y	Total 3: AC, X, Y
I/O Port:	Total 12-10 lines	Total 12-10 lines
- Input only port	0	0
- Output only port	0	0
- I/O port	12-10	12-10
- Control port	0	0
Output Port Type	<ul style="list-style-type: none"> • Standard pull-up • Standard open-drain • Middle-current open-drain • 12V-interface open-drain (R4-R7 only) (Mask option) 	<ul style="list-style-type: none"> • Standard pull-up • Standard open-drain • Middle-current open-drain • 12V-interface open-drain (R4-R7 only) (Mask option)
Stack Depth (Nesting Level)	2 levels	4 levels
Clock Generator: - Oscillator type	Yes <ul style="list-style-type: none"> • Crystal • RC-network • Capacitor • External (Mask option) 	Yes <ul style="list-style-type: none"> • Crystal • RC-network • Capacitor • External (Mask option)
- Clock frequency (With prescaler)	0.5MHz-2MHz (1MHz-4MHz)	0.5MHz-2MHz (1MHz-4MHz)
Clock Prescaler (Divide-by-two)	Yes/No (Mask option)	Yes/No (Mask option)
Reset Function: - External reset	Yes	Yes
- Power-on reset function	Yes	Yes
- Low-voltage reset function	Yes/No (Mask option)	Yes/No (Mask option)
- Output port level during reset	High/Low (Mask option)	High/Low (Mask option)
Standby Function: - Initiation method	Yes/No (Mask option) Software	Yes/No (Mask option) Software
- Oscillator state during standby	Stop/Stop	
- Output state during standby	Hold	Hold
- Standby off reset function	No	No

MB88200 Series**Table 7 MB88200 Series Product Line-Up and Development Tools (Continued)**

	MB88201-P/-PF	MB88202-P/-PF
Instruction Set: -No. of Instruction -Length/Cycle	37 1/1 or 2/2	38 1/1 or 2/2
Min. Instruction Execution Time	3.0μs min. at 2MHz (Without prescaler)	3.0μs min. at 2MHz (Without prescaler)
Power Supply -Standard version -A-version	Single +5V • 4.5V to 5.5V (Active) 3.5V to 6.0V (Standby) • 3.5V to 5.5V (Active) 3.0V to 6.0V (Standby)	Single +5V • 4.5V to 5.5V (Active) 3.5V to 6.0V (Standby) • 3.5V to 5.5V (Active) 3.0V to 6.0V (Standby)
Operating Ambient Temperature Range	• Standard version: -40°C to +85°C • A-version -30°C to +70°C	• Standard version: -40°C to +85°C • A-version -30°C to +70°C
Process	CMOS	CMOS
Package	• 16-pin DIP • 16-pin flat package	• 16-pin DIP • 16-pin flat package
Development Tools: -Hardware -Software	MB2115-01 : CRT unit (Common) MB2115-02 : Monitor board with keyboard (Common) MB2115-04 : EPROM writer and RS-232C interface (Common) MB2115-33A : DUE board SM07620-AXXX : PC-DOS cross assembler SM07620-GXXX : PC-DOS host emulator	

Electrical Characteristics

Absolute Maximum Ratings†

Parameter	Symbol	Rating			Unit	Remarks
		Min	Typ	Max		
Supply Voltage		V _{CC}	V _{SS} -0.3		V _{SS} +7.0	V
Input Voltage	V _{IN}	V _{SS} -0.3		V _{SS} +7.0		V
Output Voltage	V _{OUT}	V _{SS} -0.3		V _{SS} +7.0		V
		V _{SS} -0.3		V _{SS} +15		V
Power Dissipation	P _D			200		mW
Operating Ambient Temperature	T _A	-40		+85		°C
		-30		+70		°C
Storage Temperature	T _{STG}	-55		+150		°C

† 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.

Recommended Operating Conditions

Parameter	Symbol	Value			Unit	Remarks
		Min	Typ	Max		
Supply Voltage tion range	V _{CC}	4.5	5.0	5.5	V	Active opera-
		3.5	5.0	6.0	V	Standard version Active operation range
		3.5		6.0	V	A-Version Standby operation range
		3.0		6.0	V	Standard version Standby operation range
	V _{SS}		0		V	A-version
Input High Voltage	V _{IH}	0.7•V _{CC}		V _{CC} +0.3	V	R-Port
	V _{IHS}	0.8•V _{CC}		V _{CC} +0.3	V	EX,RESET,START
Input Low Voltage	V _{IL}	V _{SS} -0.3		0.3•V _{CC}	V	R-Port
	V _{ILS}	V _{SS} -0.3		0.2•V _{CC}	V	EX,RESET,START
Operating Ambient Temperature	T _A	-40		+85	°C	Standard version, without low-voltage reset function
		-30		+70	°C	A-version without low-voltage reset function
		-10		+70	°C	With low-voltage reset function

MB88200 Series**DC Characteristics** (Recommended operating conditions unless otherwise noted.)

Parameter	Symbol	Pin/Port	Condition	Value			Unit	
				Min	Typ	Max		
Output High Voltage	V _{OH}	R-Port (Standard pull-up)	V _{CC} =4.5V I _{OH} =-200μA	2.4			V	
			V _{CC} =4.5V I _{OH} =-10μA	4.0			V	
Output Low Voltage	V _{OL}	R-Port (All output options)	V _{CC} =4.5V I _{OL} =1.8mA			0.4	V	
			V _{CC} =4.5V I _{OL} =3.2mA			0.6	V	
		R-Port (Middle-current open-drain)	V _{CC} =4.5V I _{OL} =10mA			2.0	V	
		$\overline{\text{RESET}}$	V _{CC} =4.5V I _{OL} =3.6mA			0.6	V	
Input Leakage I _{IH} Current	START	V _{CC} =5.5V	V _{IH} =5.5V			μA 60		
	I _{IL}	R-Port (Standard pull-up)	V _{CC} =5.5V V _{IL} =0.4V		-0.6	-1.6	mA	
			EX	Crystal/ceramic oscillation		-10	-20	μA
		RC-network/Capacitor oscillation		V _{CC} =5.5V V _{IL} =0.4V		-10	-20	μA
		External clock drive					-10	μA
	$\overline{\text{RESET}}$	V _{CC} =5.5V V _{IL} =0.4V			-20	-60	μA	
Output Leakage Current (For Open-Drain Output)	I _{LEAK}	R-Port (All open-drains)	V _{CC} =5.5V V _{OH} =5.5V Output in high-Z		0.1	10	μA	
	R-Port	V _{CC} =5.5V (12V-interface open-drain)	V _{OH} =13.2V Output in high-Z			40	μA	
Supply Current	I _{CC}	V _{CC}	V _{CC} =5.0V(Typ.) f _c =1MHz (Active) Reset state All outputs open		1	3	mA	
	I _{CCH}	V _{CC} (With standby function)	V _{CC} =3.5V (Min.) f _c =0MHz (Standby) Standby state All outputs open			10	μA	

Note : The "all outputs" include not only "output-only port pins", but also "I/O port pins".

AC Characteristics (Recommended operating conditions unless otherwise noted.)

Clock Timing							
Parameter	Symbol	Pin	Condition	Value		Unit	Remarks
				Min	Max		
Clock Frequency	f_c	EX, X	Crystal/ceramic, RC-network, C OSC or external clock drive: Figures 4 and 5	0.5	2.0	MHz	Without prescaler
				1.0	4.0		With prescaler
Clock Cycle Time	t_{cyc}	EX, X	Figures 4 and 5	0.5	2.0	μs	
Input Clock Pulse Width	PwCH, PwCL	EX	External clock drive: Figures 4 and 5	225		ns	Without prescaler
				100			With prescaler
Input Clock Rise/Fall Time	t_{cr} , t_{cf}	EX	External clock drive: Figures 4 and 5	5	100	ns	

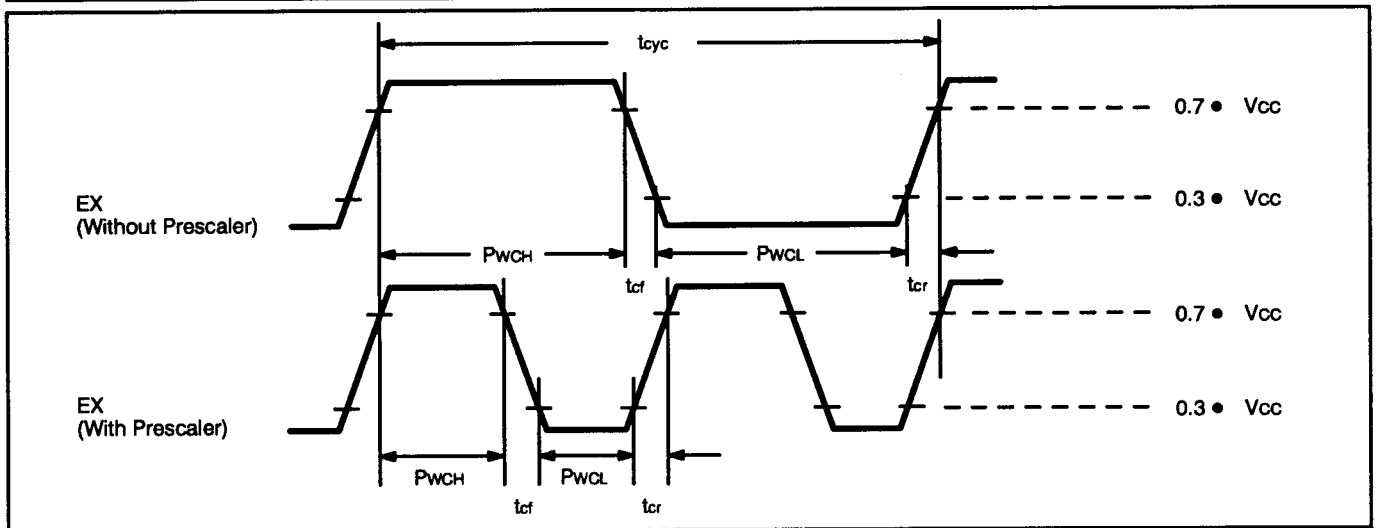


Figure 4. Clock Timing

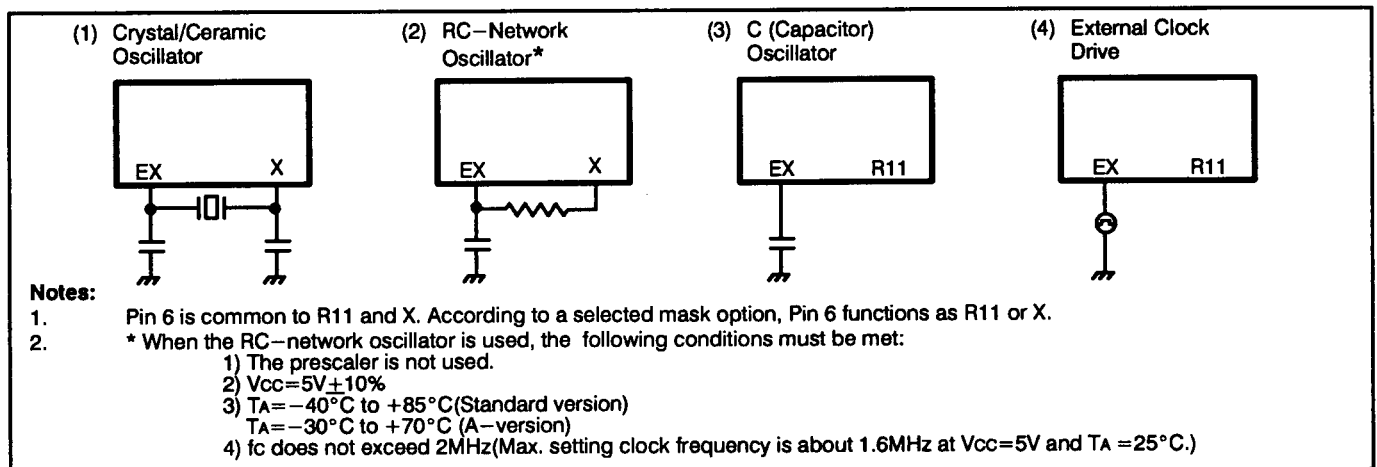
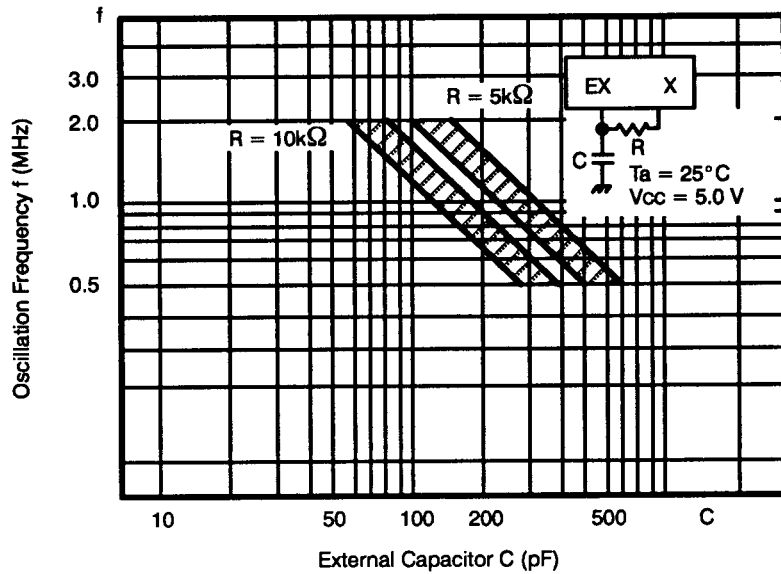


Figure 5. Clock Circuit Configurations

MB88200 Series

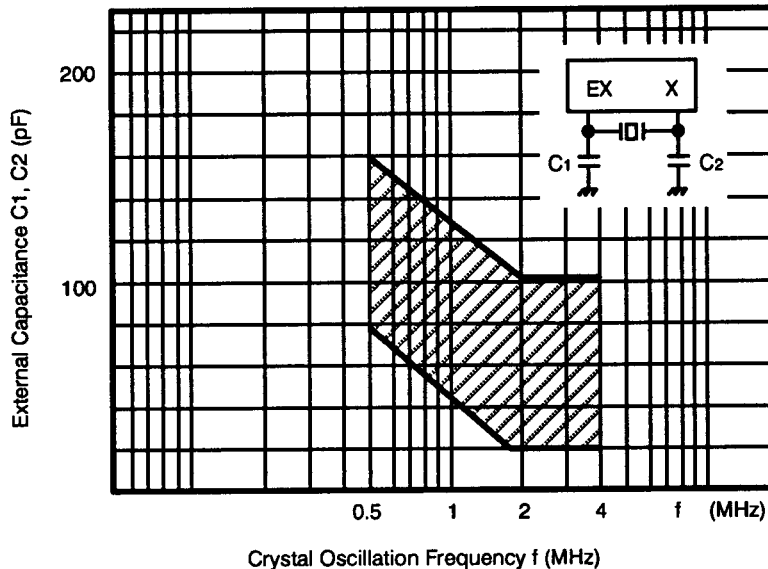


Notes:

When the RC-network oscillator is used, the following conditions must be met:

- 1) The prescaler is not used.
- 2) $V_{cc} = 5V \pm 10\%$
- 3) $T_A = -40^\circ C$ to $+85^\circ C$ (standard version), $T_A = -30^\circ C$ to $+70^\circ C$ (A-version)
- 4) f_c does not exceed 2MHz. (Max. setting clock frequency is about 1.6MHz at $V_{cc} = 5V$ and $T_A = 25^\circ C$.)

Figure 6. RC-Network Oscillator Characteristics (Example)



Notes:

- 1) The cross-hatched portion is an area where the on-chip oscillator has stable characteristics and short stabilization time when an average crystal resonator is used. This chart gives a target value of the external capacitor to realize a desired oscillation frequency. When an exact frequency is needed, capacitor value should be determined, adjusting to individual crystal resonator characteristics.
- 2) Generally speaking, crystal resonators with lower oscillation frequency tend to have longer oscillation stabilization time and wider characteristic variations which affect on-chip oscillator characteristics. So, we recommend a high-frequency crystal resonator with on-chip 1/2 prescaler.

Figure 7. Crystal Oscillator Characteristics (Example)

Power-on Reset (Built-in) Characteristics (Recommended operating conditions otherwise noted)

Parameter	Symbol	Conditions	Values		Unit	Remarks
			Min	Max		
Power Supply Rise Time	t_r	Figure 8	0.05	50	ms	Required for operation of the power-on reset circuit
Power Supply Shout-off Time	t_{off}	Figure 8	1		ms	Required for accurate circuit operation repeatability

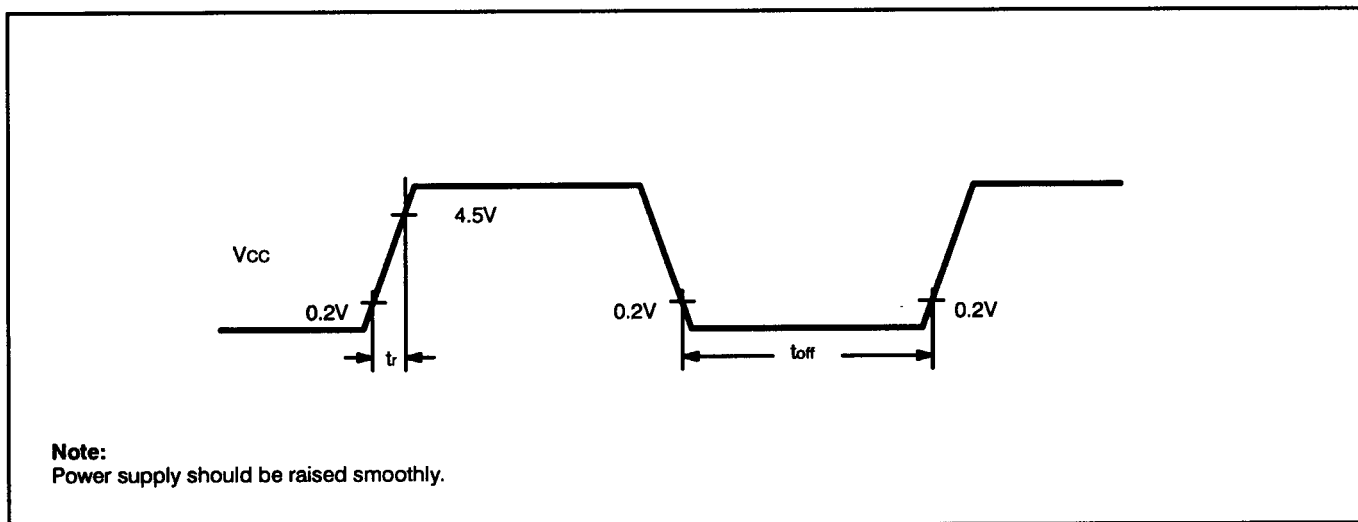


Figure 8. Power-On Reset Timing

MB88200 Series

Low Voltage Reset (Mask Option) Characteristics (Standard version only)

(Vcc=+5V±10%, Vss=0V, TA=-10°C to +70°C)

Parameter	Symbol	Pin	Value			Unit	Remarks
			Max	Typ	Max		
Detection Voltage	V_T	Vcc	2.0		4.5	V	Reset is operational at less than V_T .
Supply Voltage Rise/Fall Slope	$\Delta t/\Delta V$	Vcc	0.01			ms/V	

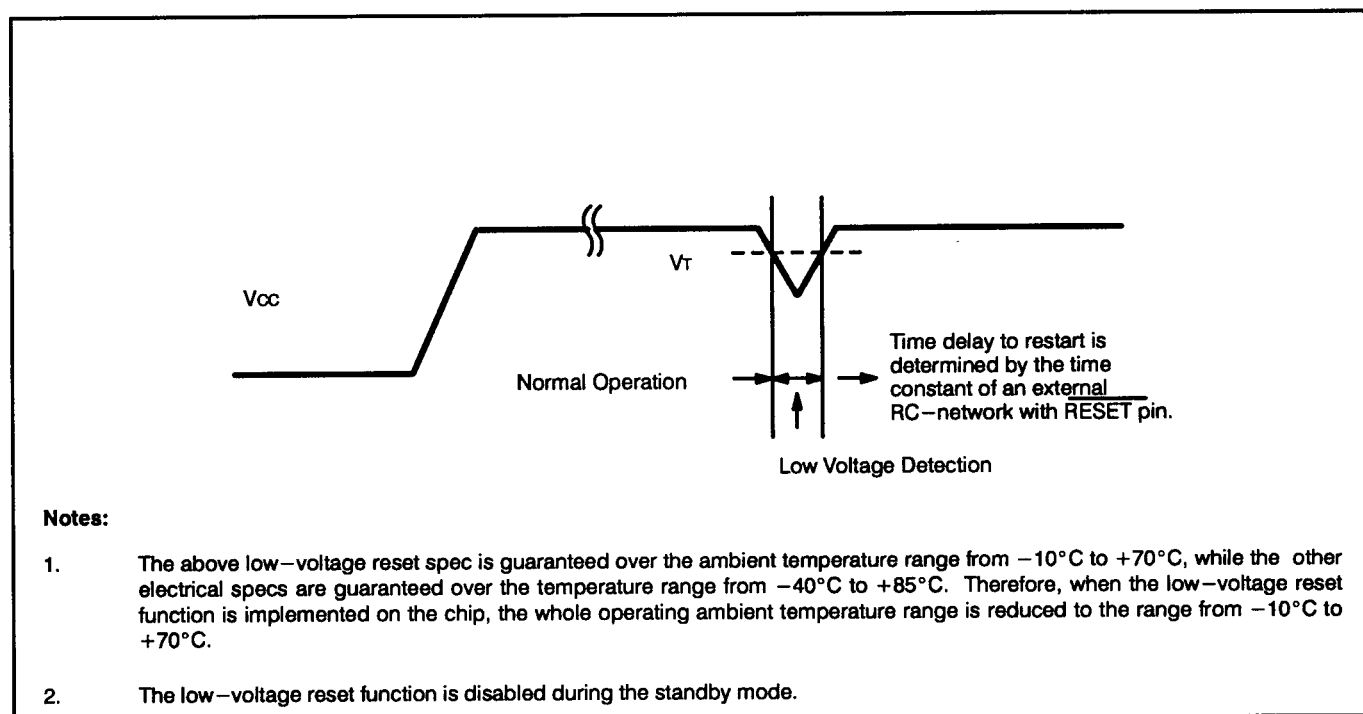
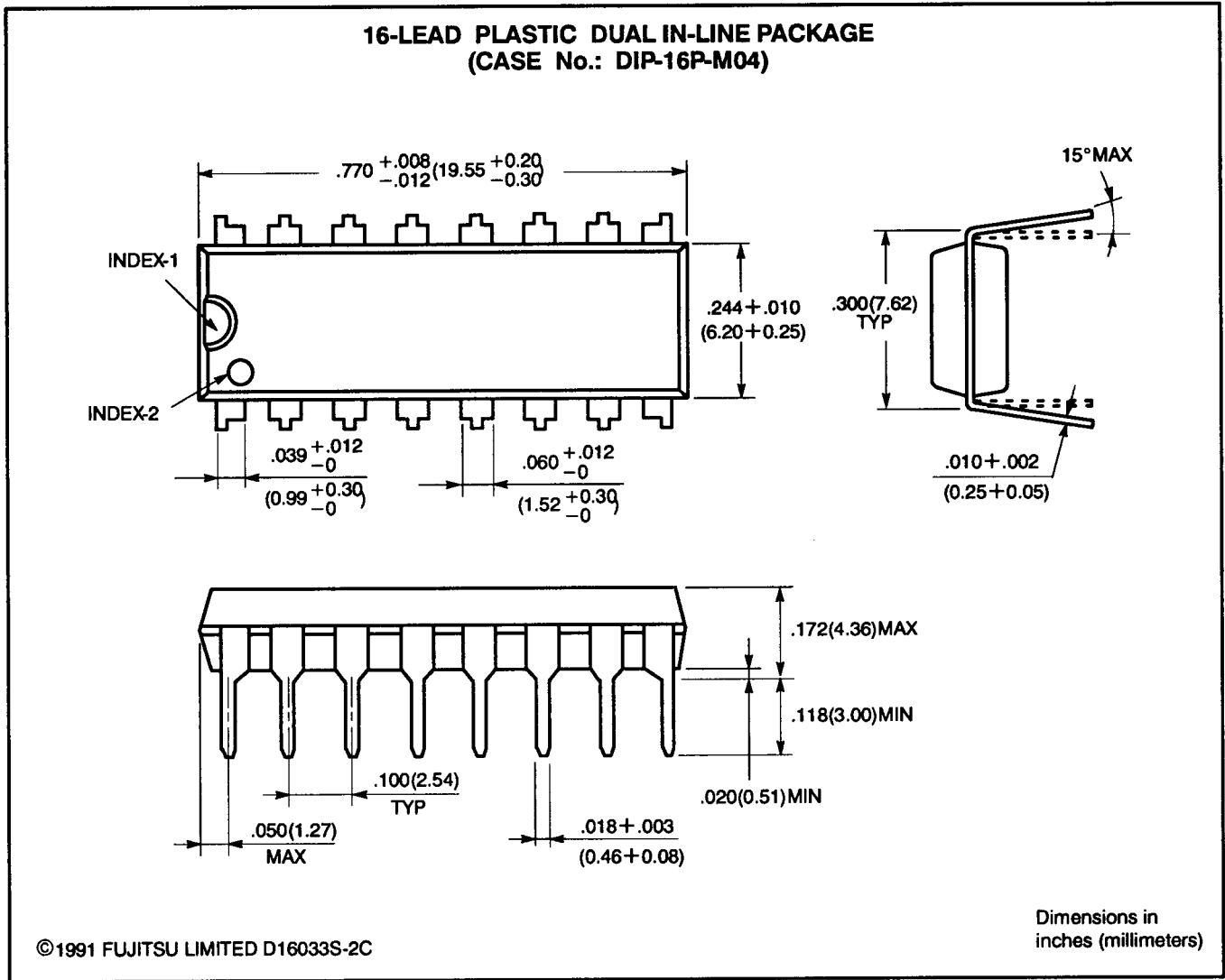


Figure 8. Low-Voltage Reset Characteristics

Package Dimensions

MB88201-P/MB88202-P: 16-PIN PLASTIC DIP

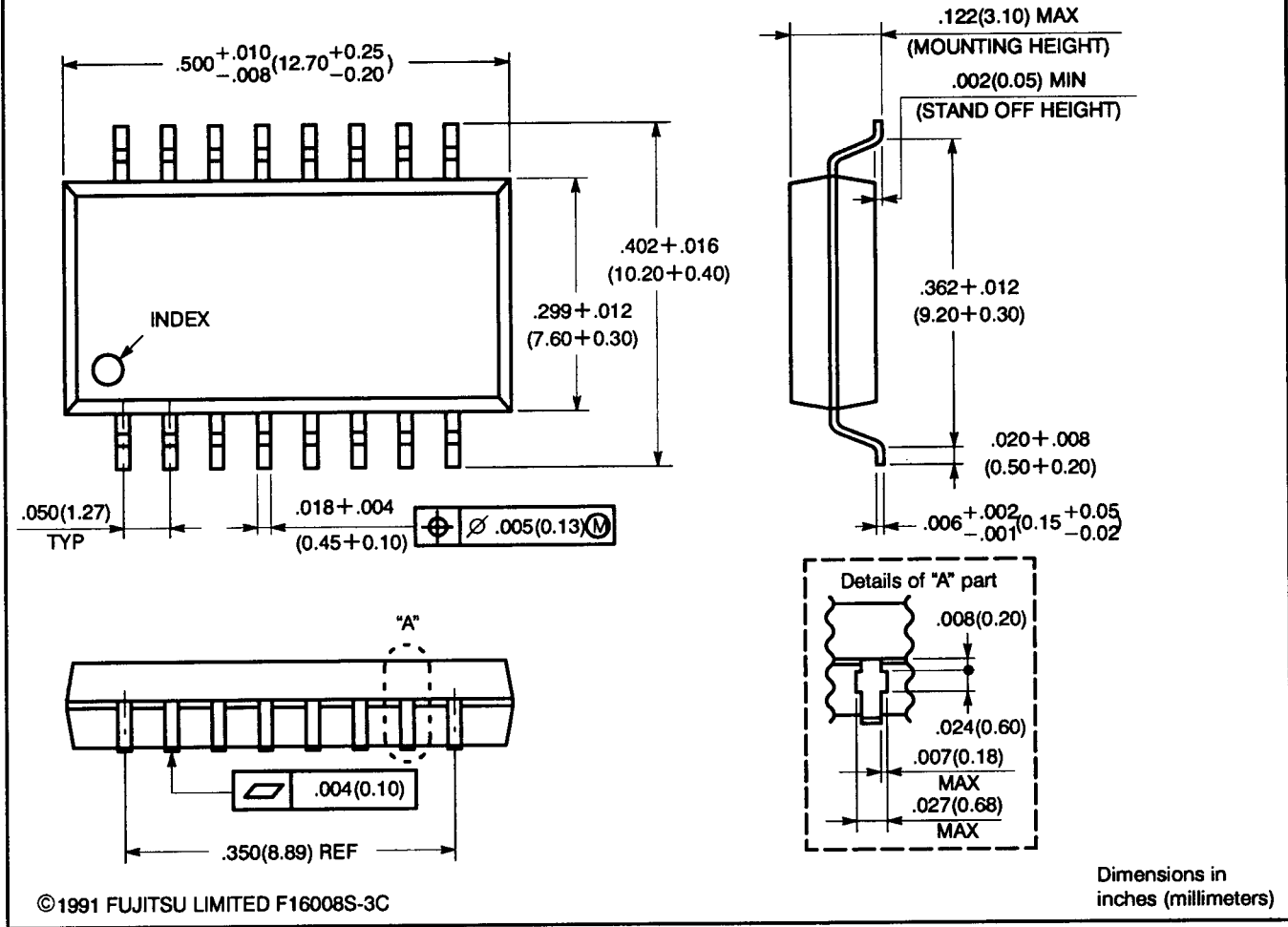


MB88200 Series

Package Dimensions

MB88201-PF/MB88202-PF: 16-PIN PLASTIC FLAT PACKAGE

16-LEAD PLASTIC FLAT PACKAGE
(CASE No.: FPT-16P-M03)



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