OKI Semiconductor

This version: Jan. 1998
Previous version: Aug. 1996

MSM80C88A-10RS/GS/JS

8-Bit CMOS MICROPROCESSOR

GENERAL DESCRIPTION

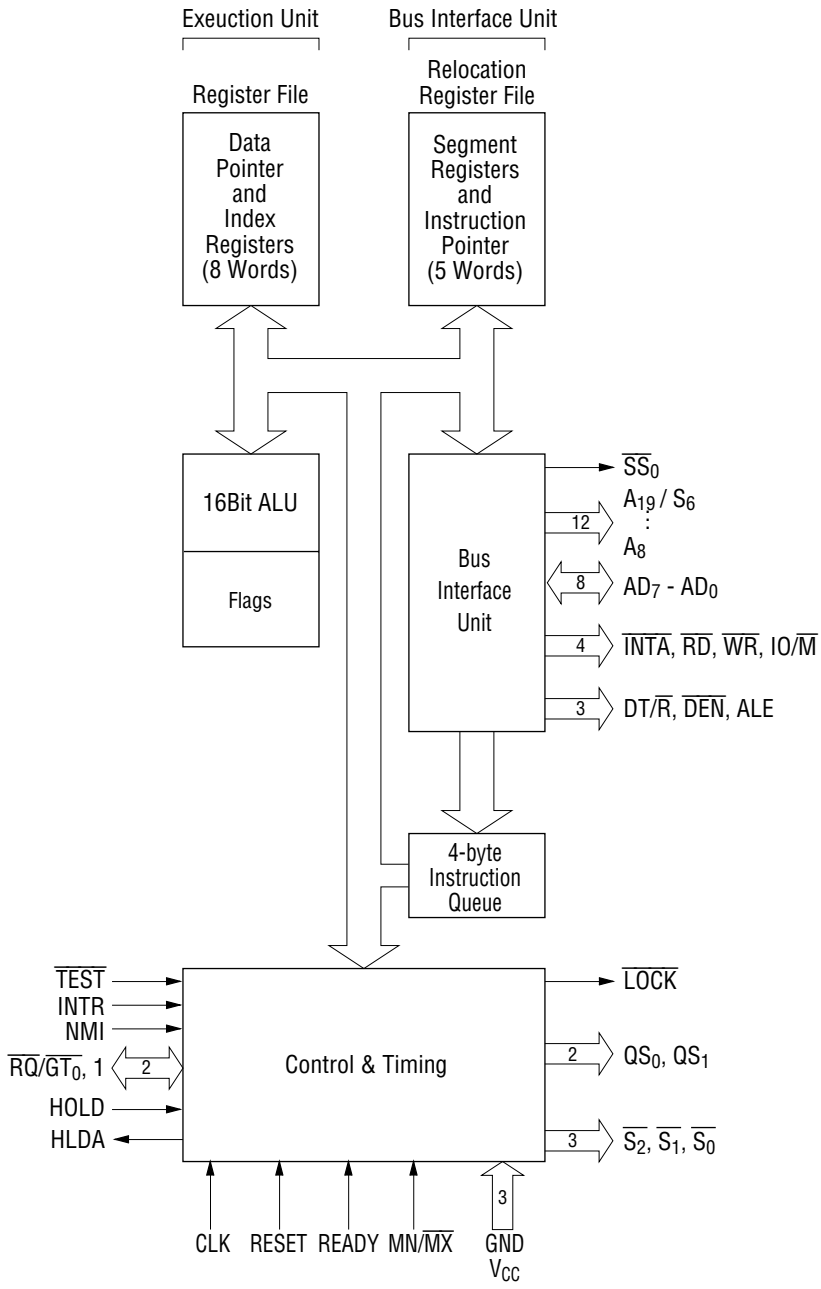
The MSM80C88A-10 is internal 16-bit CPUs with 8-bit interface implemented in Silicon Gate CMOS technology. It is designed with the same processing speed as the NMOS8088-1, but with considerably less power consumption.
The processor has attributes of both 8 and 16-bit microprocessor. It is directly compatible with MSM80C86A-10 software and MSM80C85AH hardware and peripherals.

FEATURES

- 8-Bit Data Bus interface
- 16-Bit Internal Architecture
- 1 Mbyte Direct Addressable Memory Space
- Software Compatible with MSM80C86A-10
- Internal 14-Word by 16-bit Register Set
- 24-Operand Addressing Modes
- Bit, Byte, Word and String Operations
- 8 and 16-bit Signed and Unsigned Arithmetic Operation
- From DC to 10 MHz Clock Rate (Note)
- Low Power Dissipation (10mA/MHz)
- Bus Hold Circuitry Eliminated Pull-Up Resistors
- 40-pin Plastic DIP (DIP 40-P-600-2.54): (Product name: MSM80C88A-10RS)
- 44-pin Plastic QFJ (QFJ44-P-S650-1.27): (Product name: MSM80C88A-10JS)
- 56-pin Plastic QFP (QFP56-P-1519-1.00-K): (Product name: MSM80C88A-10GS-K)

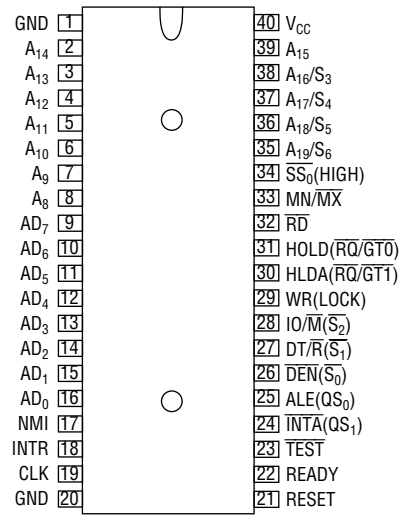
(Note) 10 MHz Spec. is not compatible with Intel 8088-1 spec.

FUNCTIONAL BLOCK DIAGRAM

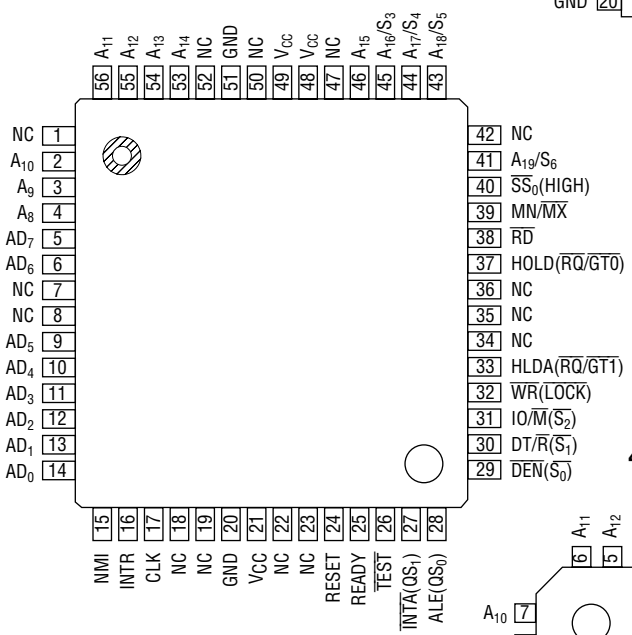


PIN CONFIGURATION (TOP VIEW)

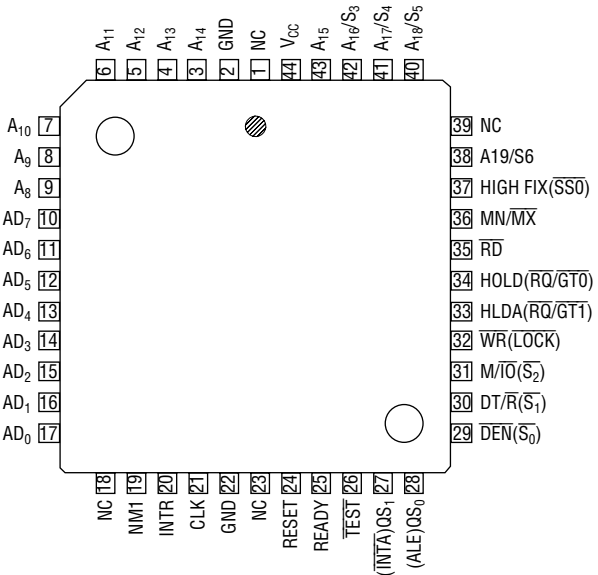
40 pin Plastic DIP



56 pin Plastic QFP



44 pin Plastic QFJ



ABSOLUTE MAXIMUM RATING

Parameter	Symbol	Rating			Units	Condition
		MSM80C88A-10RS	MSM80C88A-10GS	MSM80C88A-10JS		
Power Supply Voltage	V_{CC}	–0.5 to +7			V	With respect to GND
Input Voltage	V_{IN}	–0.5 to V_{CC} +0.5			V	
Output Voltage	V_{OUT}	–0.5 to V_{CC} +0.5			V	
Storage Temperature	T_{STG}	–65 to +150			°C	—
Power Dissipation	P_D	1.0	0.7		W	Ta = 25°C

OPERATING RANGE

Parameter	Symbol	Range	Unit
Power Supply Voltage	V_{CC}	4.75 to 5.25	V
Operating Temperature	T_{op}	0 to +70	°C

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power Supply Voltage	V_{CC}	4.75	5.0	5.25	V
Operating Temperature	T_{op}	0	+25	+70	°C
"L" Input Voltage	V_{IL}	–0.5	—	+0.8	V
"H" Input Voltage	V_{IL} *1	V_{CC} -0.8	—	V_{CC} +0.5	V
	V_{IL} *2	2.0	—	V_{CC} +0.5	V

*1 Only CLK
*2 Except CLK

DC CHARACTERISTICS

(V_{CC} = 4.5 to 5.5 V, Ta = –40°C to +85°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
"L" Output Voltage	V_{OL}	—	—	0.4	V	I_{OL} = 2.5 mA
"H" Output Voltage	V_{OH}	3.0	—	—	V	I_{OH} = –2.5 mA
		V_{CC} –0.4				I_{OH} = –100 µA
Input Leak Current	I_{LI}	–1.0	—	+1.0	µA	$0 \le V_{IN} \le V_{CC}$
Output Leak Current	I_{LO}	–10	—	+10	µA	$V_O = V_{CC}$ or GND
Input Leakage Current (Bus Hold Low)	I_{BHL}	50	—	400	µA	V_{IN} = 0.8 V *3
Input Leakage Current (Bus Hold High	I_{BHH}	–50	—	–400	µA	V_{IN} = 3.0 V *4
Bus Hold Low Overdrive	I_{BHLO}	—	—	600	µA	*5
Bus Hold High Overdrive	I_{BHHO}	—	—	–600	µA	*6
Operating Power Supply Current	I_{CCS}	—	—	10	mA/MHz	V_{IL} = GND $V_{IH} = V_{CC}$
Standby Power Current	I_{CC}	—	—	500	µA	$V_{IN} = V_{CC}$ or GND Outputs Unloaded CLK = GND or V_{CC}
Input Capacitance	C_{IN}	—	—	10	pF	*7
Output Capacitance	C_{OUT}	—	—	15	pF	*7
I/O Capacitance	$C_{I/O}$	—	—	20	pF	*7

*3 Test conditions are to lower V_{IN} to GND and then raise V_{IN} to 0.8 V on pins 2-16, and 35-39.

*4 Test conditions are to raise V_{IN} to V_{CC} and then lower V_{IN} to 3.0 V on pins 2-16, 26-32, and 34-39.

*5 An external driver must source at least I_{BHLO} to switch this node from LOW to HIGH.

*6 An external driver must sink at least I_{BHHO} to switch this node from HIGH to LOW.

*7 Test Conditions: a) Freq = 1 MHz.
b) Ummeasured Pins at GND.
c) V_{IN} at 5.0 V or GND.

AC CHARACTERISTICS

Minimum Mode System Timing Requirements

Parameter	Symbol	5 MHz Spec. V_{CC} = 4.5 V to 5.5 V Ta = -40 to +85°C		8 MHz Spec. V_{CC} = 4.75 V to 5.25 V Ta = 0 to +70°C		10 MHz Spec. V_{CC} = 4.75 V to 5.25 V Ta = 0 to +70°C		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	
CLK Cycle Period	T_{CLCL}	200	DC	125	DC	100	DC	ns
CLK Low Time	T_{CLCH}	118	—	68	—	46	—	ns
CLK High Time	T_{CHCL}	69	—	44	—	44	—	ns
CLK Rise Time (From 1.0 V to 3.5 V)	T_{CH1CH2}	—	10	—	10	—	10	ns
CLK Fall Time (From 3.5 V to 1.0 V)	T_{CL2CL1}	—	10	—	10	—	10	ns
Data in Setup Time	T_{DVCL}	30	—	20	—	20	—	ns
Data in Hold Time	T_{CLDX}	10	—	10	—	10	—	ns
RDY Setup Time into MSM 82C84A-2 (See Notes 1, 2)	T_{R1VCL}	35	—	35	—	35	—	ns
RDY Hold Time into MSM 82C84A-2 (See Notes 1, 2)	T_{CLR1X}	0	—	0	—	0	—	ns
READY Setup Time into MSM80C88A-10	T_{RYHCH}	118	—	68	—	46	—	ns
READY Hold Time into MSM80C88A-10	T_{CHRYX}	30	—	20	—	20	—	ns
READY inactive to CLK (See Note 3)	T_{RYLCL}	–8	—	–8	—	–8	—	ns
HOLD Setup Time	T_{HVCH}	35	—	20	—	20	—	ns
INTR, NMI, $\overline{TEST}$ Setup Time (See Note 2)	T_{INVCH}	30	—	15	—	15	—	ns
Input Rise Time (Except CLK) (From 0.8 V to 2.0 V)	T_{ILIH}	—	15	—	15	—	15	ns
Input Fall Time (Except CLK) (From 2.0 V to 0.8 V)	T_{IHIL}	—	15	—	15	—	15	ns

Timing Responses

Parameter	Symbol	5 MHz Spec. V_{CC} = 4.5 V to 5.5 V Ta = –40 to +85°C		8 MHz Spec. V_{CC} = 4.75 V to 5.25 V Ta = 0 to +70°C		10 MHz Spec. V_{CC} = 4.75 V to 5.25 V Ta = 0 to +70°C		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	
Address Valid Delay	t_{CLAV}	10	110	10	60	10	60	ns
Address Hold Time	t_{CLAX}	10	—	10	—	10	—	ns
Address Float Delay	t_{CLAZ}	t_{CLAX}	80	t_{CLAX}	50	t_{CLAX}	50	ns
ALE Width	t_{LHLL}	t_{CLCH}-20	—	t_{CLCH}-10	—	t_{CLCH}-10	—	ns
ALE Active Delay	t_{CLLH}	—	80	—	50	—	40	ns
ALE Inactive Delay	t_{CHLL}	—	85	—	55	—	45	ns
Address Hold Time to ALE Inactive	t_{LLAX}	t_{CLCH}-10	—	t_{CLCH}-10	—	t_{CLCH}-10	—	ns
Data Valid Delay	t_{CLDV}	10	110	—	60	10	60	ns
Data Hold Time	t_{CHDX}	10	—	—	—	10	—	ns
Data Hold Time after $\overline{WR}$	t_{WHDX}	t_{CLCH}-30	—	t_{CLCH}-30	—	t_{CLCH}-25	—	ns
Control Active Delay 1	t_{CVCTV}	10	110	10	70	10	55	ns
Control Active Delay 2	t_{CHCTV}	10	110	10	60	10	50	ns
Control Inactive Delay	t_{CVCTX}	10	110	10	70	10	55	ns
Address Float to $\overline{RD}$ Active	t_{AZRL}	0	—	0	—	0	—	ns
$\overline{RD}$ Active Delay	t_{CLRL}	10	165	10	100	10	70	ns
$\overline{RD}$ Inactive Delay	t_{CLRH}	10	150	10	80	10	60	ns
$\overline{RD}$ Inactive to Next Address Active	t_{RHAV}	t_{CLCH}-45	—	t_{CLCH}-40	—	t_{CLCL}-35	—	ns
HLDA Valid Delay	t_{CLHAV}	10	160	10	100	10	60	ns
$\overline{RD}$ Width	t_{RLRH}	$2t_{CLCL}$-75	—	$2t_{CLCL}$-50	—	$2t_{CLCL}$-40	—	ns
$\overline{WR}$ Width	t_{WLWH}	$2t_{CLCL}$-60	—	$2t_{CLCL}$-40	—	$2t_{CLCL}$-35	—	ns
Address Valid to ALE Low	t_{AVAL}	t_{CLCH}-60	—	t_{CLCH}-40	—	t_{CLCH}-35	—	ns
Ouput Rise Time (From 0.8 V to 2.0 V)	t_{OLOH}	—	15	—	15	—	15	ns
Output Fall Time (From 2.0 V to 0.8 V)	t_{OHOL}	—	15	—	15	—	15	ns

Notes: 1. Signals at MSM82C84A-2 shown for reference only.
2. Setup requirement for asynchronous signal only to guarantee recognition at next CLK.
3. Applies only to T_2 state. (8 ns into T_3)

Maximum Mode System (Using MSM82C88-2 Bus Controller) Timing Requirements

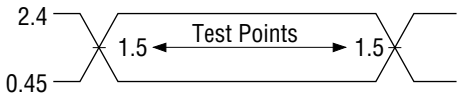
Parameter	Symbol	5 MHz Spec. V_{CC} = 4.5 V to 5.5 V Ta = –40 to +85°C		8 MHz Spec. V_{CC} = 4.75 V to 5.25 V Ta = 0 to +70°C		10 MHz Spec. V_{CC} = 4.75 V to 5.25 V Ta = 0 to +70°C		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	
CLK Cycle Period	t_{CLCL}	200	DC	125	DC	100	DC	ns
CLK Low Time	t_{CLCH}	118	—	68	—	46	—	ns
CLK High Time	t_{CHCL}	69	—	44	—	44	—	ns
CLK Rise Time (From 1.0 V to 3.5 V)	t_{CH1CH2}	—	10	—	10	—	10	ns
CLK Fall Time (From 3.5 V to 1.0 V)	t_{CL2CL1}	—	10	—	10	—	10	ns
Data in Setup Time	t_{DVCL}	30	—	20	—	20	—	ns
Data in Hold Time	t_{CLDX}	10	—	10	—	10	—	ns
RDY Setup Time into MSM 82C84A-2 (See Notes 1, 2)	t_{R1VCL}	35	—	35	—	35	—	ns
RDY Hold Time into MSM82C84A-2 (See Notes 1, 2)	t_{CLR1X}	0	—	0	—	0	—	ns
READY Setup Time into MSM80C88A-10	t_{RYHCH}	118	—	68	—	46	—	ns
READY Hold Time into MSM80C88A-10	t_{CHRYX}	30	—	20	—	20	—	ns
READY inactive to CLK (See Note 3)	t_{RYLCL}	–8	—	–8	—	–8	—	ns
Setup Time for Recognition (NMI, INTR, $\overline{TEST}$) (See Note 2)	t_{INVCH}	30	—	15	—	15	—	ns
$\overline{RQ}$/GT Setup Time	t_{GVCH}	30	—	15	—	15	—	ns
$\overline{RQ}$ Hold Time into MSM80C88A-10	t_{CHGX}	40	—	30	—	20	—	ns
Input Rise Time (Except CLK) (From 0.8 V to 2.0 V)	t_{ILIH}	—	15	—	15	—	15	ns
Input Fall Time (Except CLK) (From 2.0 V to 0.8 V)	t_{IHIL}	—	15	—	15	—	15	ns

Timing Responses

Parameter	Symbol	5 MHz Spec. V_{CC} = 4.5 V to 5.5 V Ta = –40 to +85°C		8 MHz Spec. V_{CC} = 4.75 V to 5.25 V Ta = 0 to +70°C		10 MHz Spec. V_{CC} = 4.75 V to 5.25 V Ta = 0 to +70°C		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	
Command Active Delay (See Note 1)	t_{CLML}	5	45	5	35	5	35	ns
Command Inactive Delay (See Note 1)	t_{CLMH}	5	45	5	45	5	45	ns
READY Active to Status Passive (See Note 4)	t_{RYHSH}	—	110	—	65	—	45	ns
Status Active Delay	t_{CHSV}	10	110	10	60	10	45	ns
Status Inactive Delay	t_{CLSH}	10	130	10	70	10	60	ns
Address Valid Delay	t_{CLAV}	10	110	10	60	10	60	ns
Address Hold Time	t_{CLAX}	10	—	10	—	10	—	ns
Address Float Delay	t_{CLAZ}	t_{CLAX}	80	t_{CLAX}	50	t_{CLAX}	50	ns
Status Valid to ALE High (See Note 1)	t_{SVLH}	—	35	—	25	—	25	ns
Status Valid to MCE High (See Note 1)	t_{SVMCH}	—	35	—	30	—	30	ns
CLK Low to ALE Valid (See Note 1)	t_{CLLH}	—	35	—	25	—	25	ns
CLK Low to MCE High (See Note 1)	t_{CLMCH}	—	35	—	25	—	25	ns
ALE Inactive Delay (See Note 1)	t_{CHLL}	4	35	4	25	4	25	ns
Data Valid Delay	t_{CLDV}	10	110	10	60	10	60	ns
Data Hold Time	t_{CHDX}	10	—	10	—	10	—	ns
Control Active Delay (See Note 1)	t_{CVNV}	5	45	5	45	5	45	ns
Control Inactive Delay (See Note 1)	t_{CVNX}	5	45	5	45	5	45	ns
Address Float to $\overline{RD}$ Active	t_{AZRL}	0	—	0	—	0	—	ns
$\overline{RD}$ Active Delay	t_{CLRL}	10	165	10	100	10	70	ns
$\overline{RD}$ Inactive Delay	t_{CLRH}	10	150	10	80	10	60	ns
$\overline{RD}$ Inactive to Next Address Active	t_{RHAV}	t_{CLCL}-45	—	t_{CLCL}-40	—	t_{CLCL}-35	—	ns
Direction Control Active Delay (See Note 1)	t_{CHDTL}	—	50	—	50	—	50	ns
Direction Control Inactive Delay (See Note 1)	t_{CHDTH}	—	35	—	30	—	30	ns
$\overline{GT}$ Active Delay (See Note 5)	t_{CLGL}	0	85	0	50	0	45	ns
$\overline{GT}$ Inactive Delay	t_{CLGH}	0	85	0	50	0	45	ns
$\overline{RD}$ Width	t_{RLRH}	$2t_{CLCL}$-75	—	$2t_{CLCL}$-50	—	$2t_{CLCL}$-40	—	ns
Output Rise Time (From 0.8 V to 2.0 V)	t_{OLOH}	—	15	—	15	—	15	ns
Output Fall Time (From 2.0 V to 0.8 V)	t_{OHOL}	—	15	—	15	—	15	ns

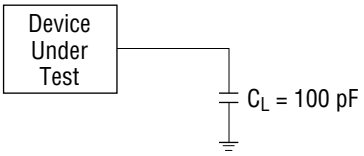
Notes: 1. Signals at MSM82C84A-2 or MSM82C88-2 are shown for reference only.
2. Setup requirement for asynchronous signal only to guarantee recognition at next CLK.
3. Applies only to T_2 state (8 ns into T_3)
4. Applies only to T_3 and wait states.
5. C_L = 40 pF ($\overline{RQ}/\overline{GT}_0$, $\overline{RQ}/\overline{GT}_1$)

A.C. Testing Input, Output Waveform



A.C. Testing: Inputs are driven at 2.4 V for a logic "1" and 0.45 V for a logic "0" timing measurements are 1.5 V for both a logic "1" and "0".

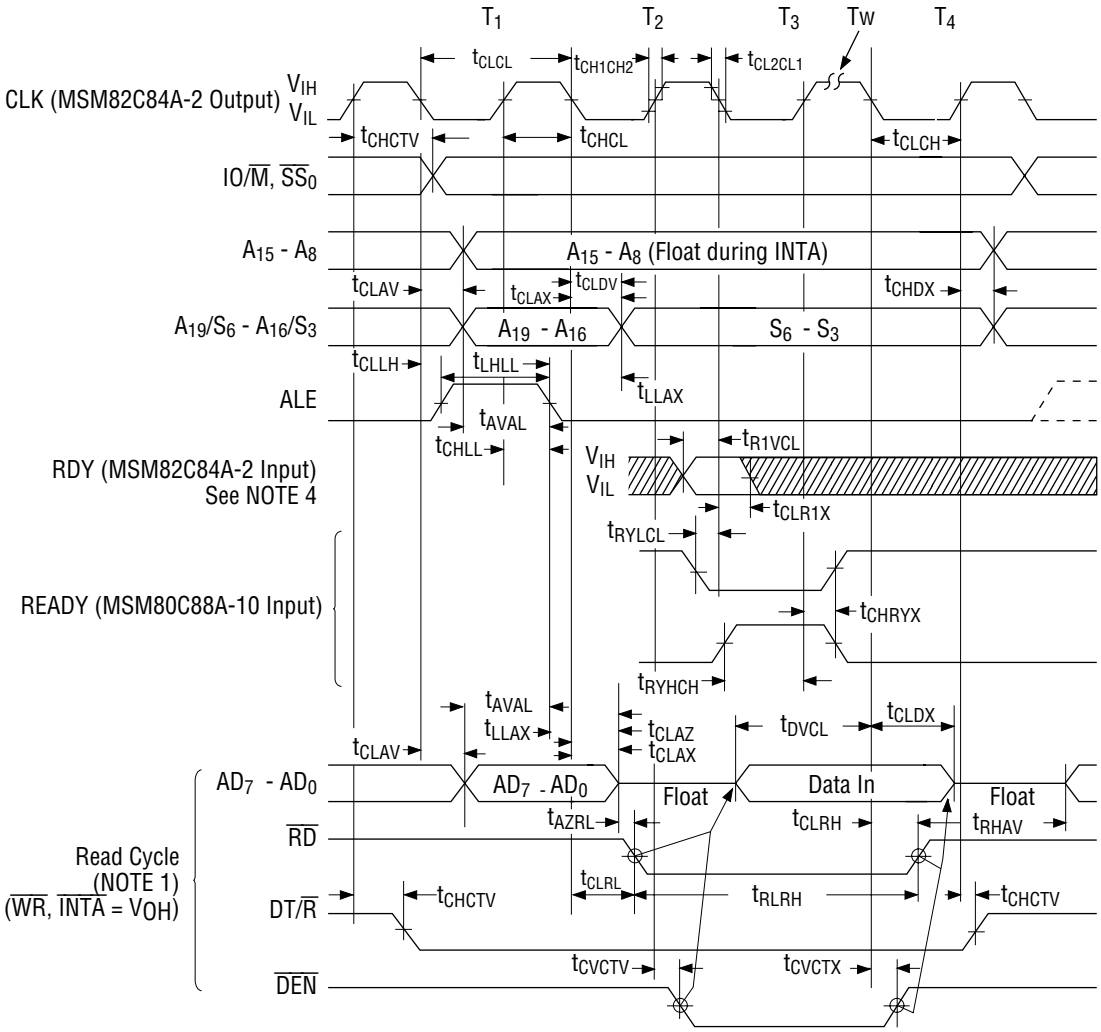
A.C. Testing Load Circuit



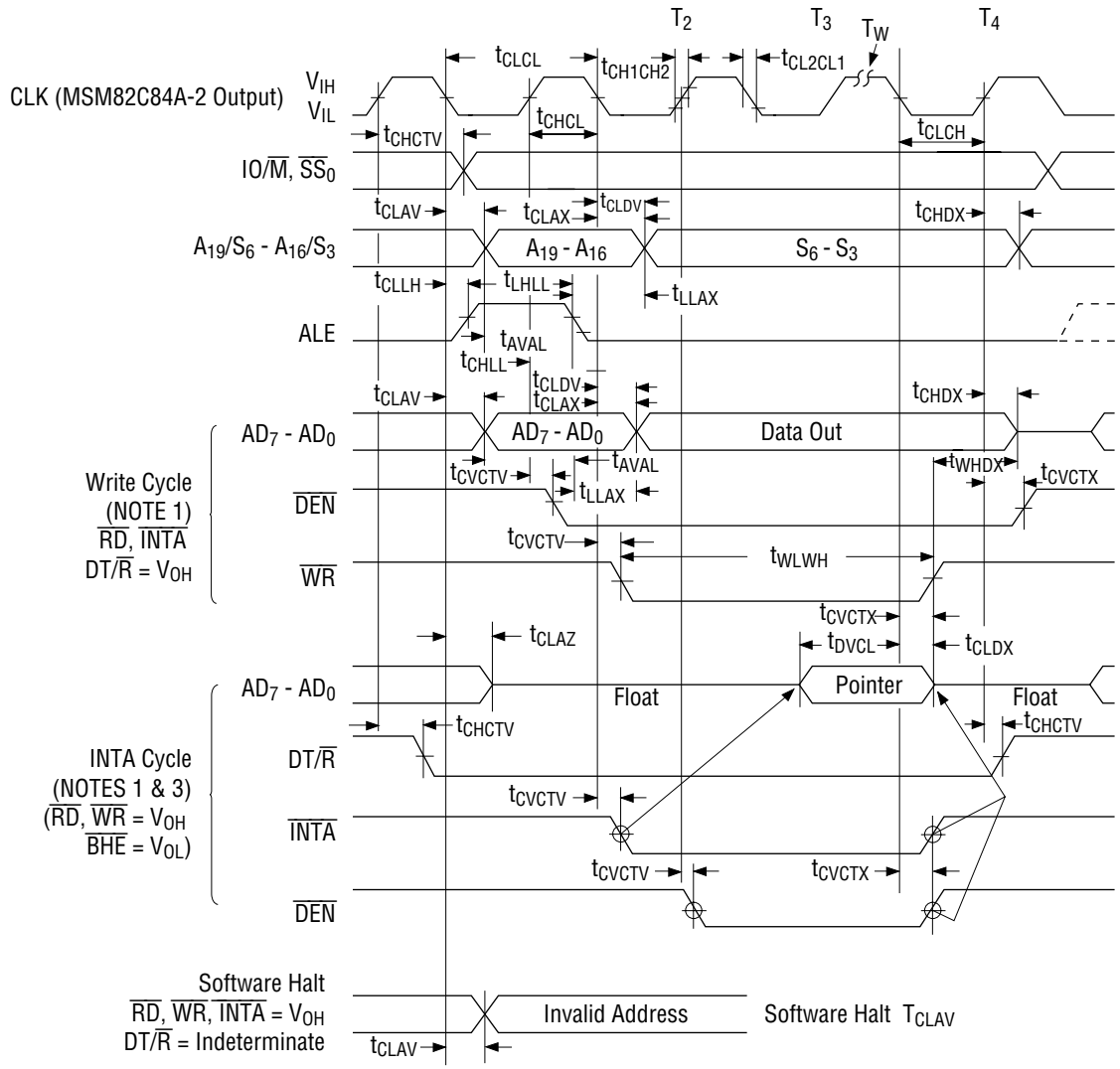
C_L includes jig capacitance.

TIMING CHART

Minimum Mode

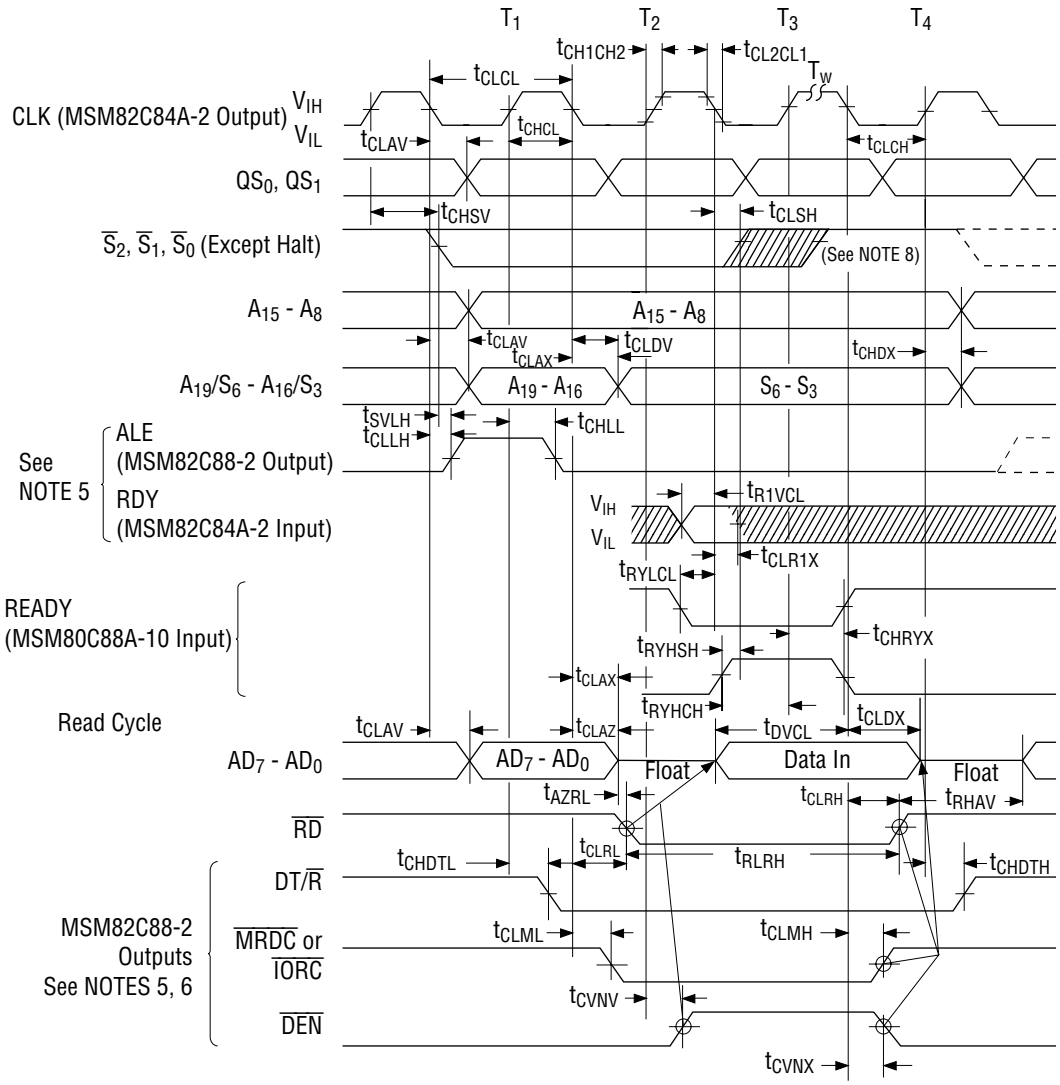


Minimum Mode (continued)

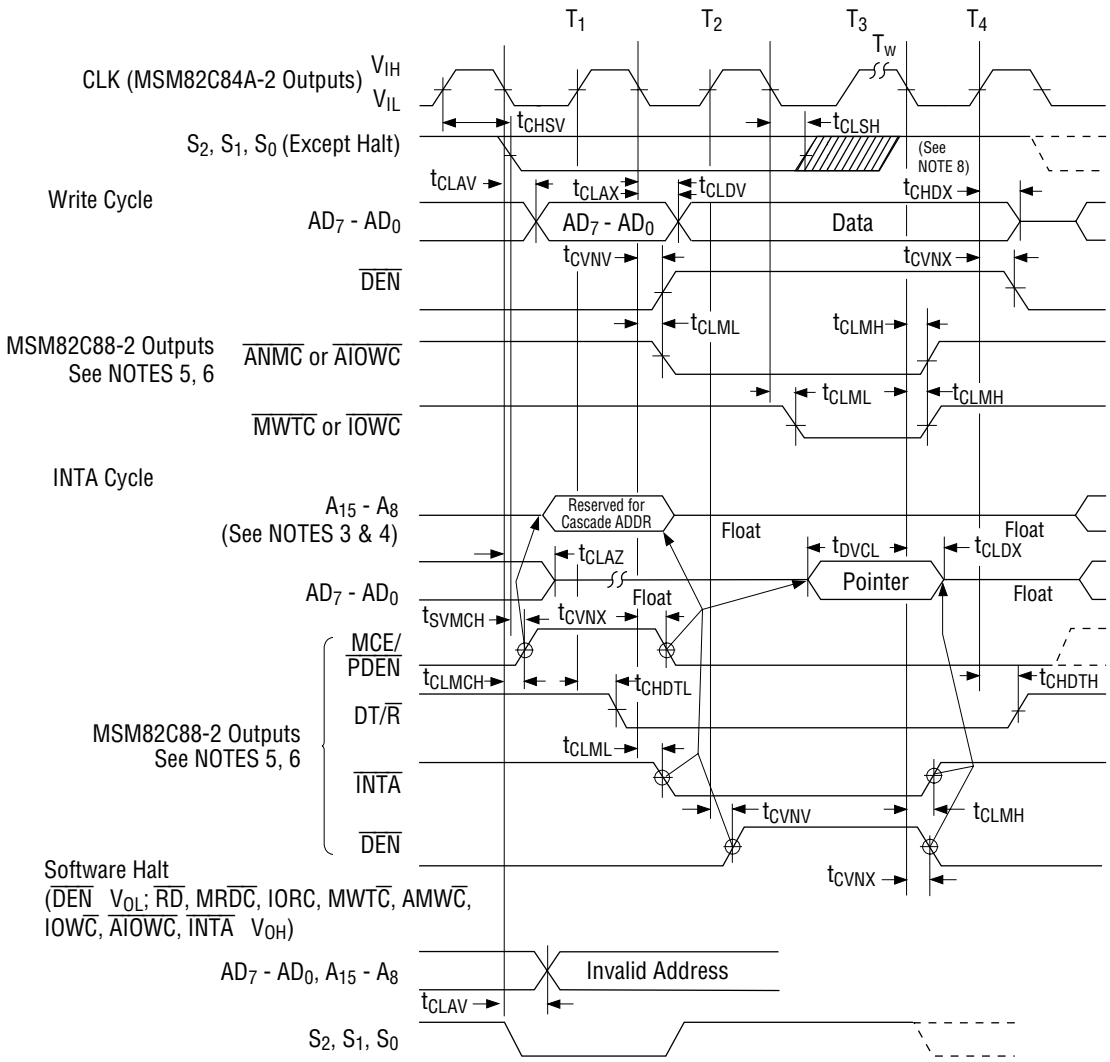


Notes: 1. All signals switch between V_{OH} and V_{OL} unless otherwise specified.
2. RDY is sampled near the end of T_2, T_3, TW to determine if TW machines states are to be inserted.
3. Two $\overline{INTA}$ cycles run back-to-back. The MSM80C88A-10 LOCAL ADDR/DATA BUS is floating during both $\overline{INTA}$ cycles. Control signals shown for second $\overline{INTA}$ cycle.
4. Signals at MSM82C84A-2 shown for reference only.
5. All timing measurements are made at 1.5 V unless otherwise noted.

Maximum Mode

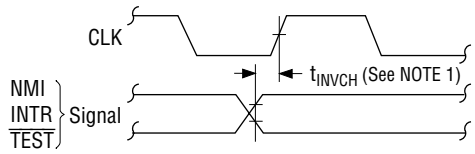


Maximum Mode (continued)



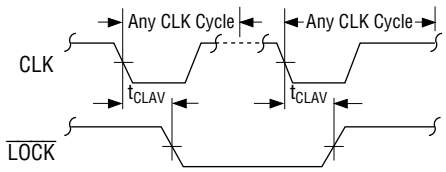
Notes: 1. All signals switch between V_{OH} and V_{OL} unless otherwise specified.
2. RDY is sampled near the end of T_2, T_3, T_W to determine if T_W machines states are to be inserted.
3. Cascade address is valid between first and second $\overline{INTA}$ cycle.
4. Two $\overline{INTA}$ cycles run back-to-back. The MSM80C86A-10 LOCAL ADDR/DATA BUS is floating during both $\overline{INTA}$ cycles. Control for pointer address is shown for second $\overline{INTA}$ cycle.
5. Signal at MSM82C84A-2 or MSM82C88-2 shown for reference only.
The issuance of the MSM82C88-2 command and control signals ($\overline{MRDC}$, $\overline{MWTC}$, $\overline{AMWC}$, $\overline{IORC}$, $\overline{IOWC}$, $\overline{AIOWC}$, $\overline{INTA}$ and $\overline{DEN}$) lags the active high MSM82C88-2 CEN.
7. All timing measurements are made at 1.5 V unless otherwise noted.
8. Status inactive in state just prior to T_4.

Asynchronous Signal Recognition

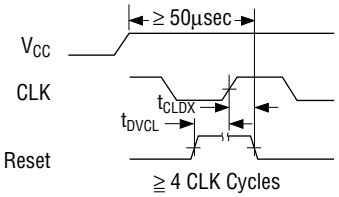


NOTE: 1 Setup requirements for asynchronous signals only to guarantee recognition at next CLK

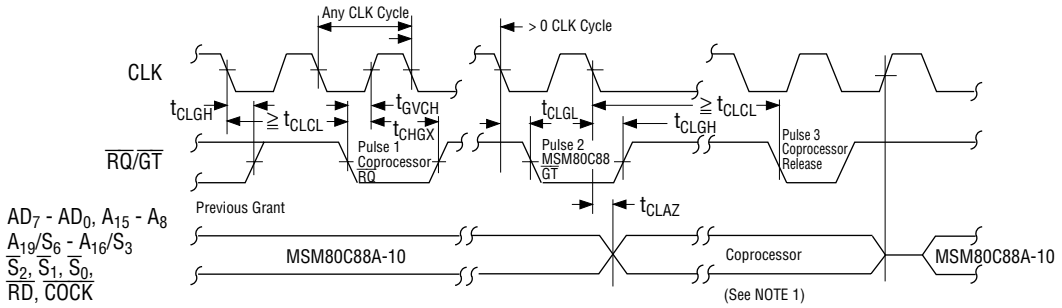
Bus Lock Signal Timing (Maximum Mode Only)



Reset Timing

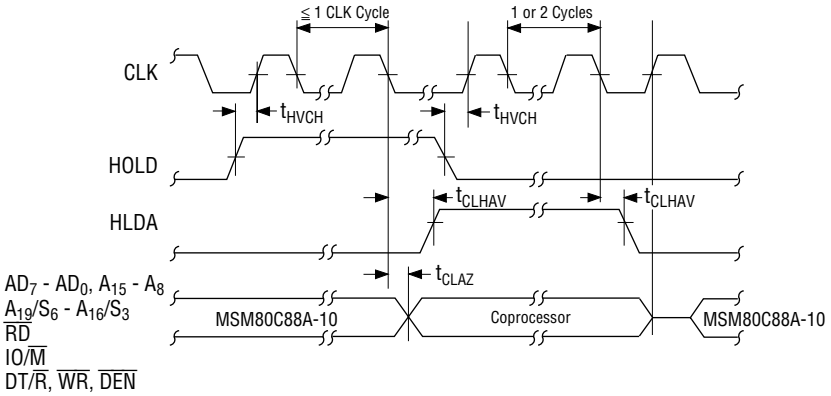


Request/Grant Sequence Timing (Maximum Mode Only)



NOTE: 1 The coprocessor may not drive the busses outside the region shown without risking contention

Hold/Hold Acknowledge Timing (Minimum Mode Only)



PIN DESCRIPTION

AD_0 - AD_7
ADDRESS DATA BUS: Input/Output
These lines are the multiplexed address and data bus.
These are the address bus at T_1 cycle and the data bus at T_2, T_3, T_W and T_4 cycle.
T_2, T_3, T_W and T_4 cycle.
These lines are high impedance during interrupt acknowledge and hold acknowledge.

A_8 - A_{15}
ADDRESS BUS: Output
These lines are the address bus bits 8 thru 15 at all cycles.
These lines do not have to be latched by an ALE signal.
These lines are high impedance during interrupt acknowledge and hold acknowledge.

A_{16}/S_3, A_{17}/S_4, A_{18}/S_5, A_{19}/S_6
ADDRES/STATUS : Output
These are the four most significant address as at the T_1, cycle.
Accessing I/O port address, these are low at T_1 Cycle.
These lines are Status lines at the T_2, T_3, T_W and T_4 Cycles.
S_5 indicates interrupt enable Flag.
S_3 and S_4 are encoded as shown below.

S_3	S_4	Characteristics
0	0	Alternate Data
1	0	Stack
0	1	Code or None
1	1	Data

These lines are high impedance during hold acknowledge.

$\overline{RD}$
READ: Output
This line indicates that CPU is in a memory or I/O read cycle.
This line is the read strobe signal when CPU reads data from a memory or I/O device. This line is active low.
This line is high impedance during hold acknowledge.

READY
READY:Input
This line indicates to the CPU that the addressed memory or I/O device is ready to read or write.
This line is active high. If the setup and hold time are out of specification, an illegal operation will occur.

INTR
INTERRUPT REQUEST: Input
This line is the level triggered interrupt request signal which is sampled during the last clock cycle of instruction and string manipulations.
It can be internally masked by software.
This signal is active high and internally synchronized.

$\overline{TEST}$
TEST: Input
This line is examined by a "WAIT" instruction.
When $\overline{TEST}$ is high, the CPU enters an idle cycle.
When $\overline{TEST}$ is low, the CPU exits in an idle cycle.

NMI
NON MASKABLE INTERRUPT: Input
This line causes a type 2 interrupt.
NMI is not maskable.
This signal is internally synchronized and needs 2-clock cycle pulse width.

RESET
RESET:Input
This signal causes the CPU to initialize immediately.
This signal is active high and must be at least four clock cycles.

CLK
CLOCK: Input
This signal provides the basic timing for the internal circuit.

MN/$\overline{MX}$
MINIMUM/MAXIMUM: Input
This signal selects the CPU's operating mode.
When V_{CC} is connected, the CPU operates in minimum mode.
When GND is connected, the CPU operates in maximum mode.

V_{CC}
V_{CC}: +5V supplied.

GND
GROUND

The following pin function descriptions are for maximum mode only. Other pin functions are already described.

$\overline{S_0}$, $\overline{S_1}$, $\overline{S_2}$
STATUS: Output
These lines indicate bus status and they are used by the MSM82C88-2 Bus Controller to generate all memory and I/O access control signals. These lines are high impedance during hold acknowledge. These status lines are encoded as shown below.

$\overline{S_2}$	$\overline{S_1}$	$\overline{S_0}$	Characteristics
0 (LOW)	0	0	Interrupt acknowledge
0	0	1	Read I/O Port
0	1	0	Write I/O Port
0	1	1	Halt
1 (HIGH)	0	0	Code Access
1	0	1	Read Memory
1	1	0	Write Memory
1	1	1	Passive

$\overline{RQ}/\overline{GT_0}$
$\overline{RQ}/\overline{GT_1}$
REQUEST/GRANT:Input/Output
These lines are used for Bus Request from other devices and Bus GRANT to other devices. These lines are bidirectional and active low.

$\overline{LOCK}$
LOCK:Output
This line is active low.
When this line is low, other devices cannot gain control of the bus.
This line is high impedance hold acknowledge.

QS_0/QS_1
QUEUE STATUS: Output
These are Queue Status Lines that indicate internal instruction queue status.

QS_1	QS_0	Characteristics
0 (LOW)	0	No operation
0	1	First Byte of Op Code from Queue
1 (HIGH)	0	Empty the Queue
1	1	Subsequent Byte from Queue

The following pin function descriptions are minimum mode only. Other pin functions are already described.

IO/$\overline{M}$
STATUS: Output
This line selects memory address space or I/O address space.
When this line is low, the CPU selects memory address space and when it is high, the CPU selects I/O address space.
This line is high impedance during hold acknowledge.

$\overline{WR}$
WRITE: Output
This line indicates that the CPU is in a memory or I/O write cycle.
This line is a write strobe signal when the CPU writes data to memory or an I/O device.
This line is active low. This line is high impedance during hold acknowledge.

$\overline{INTA}$
INTERRUPT ACKNOWLEDGE: Output
This line is a read strobe signal for the interrupt acknowledge cycle.
This line is active low.

ALE
ADDRESS LATCH ENABLE: Output
This line is used for latching an address into the MSM82C12 address latch it is a positive pulse and the trailing edge is used to strobe the address. This line is never floated.

DT/$\overline{R}$
DATA TRANSMIT/RECEIVE: Output
This line is used to control the direction of the bus transceiver.
When this line is high, the CPU transmits data, and when it is low. the CPU receives data.
This line is high impedance during hold acknowledge.

$\overline{DEN}$
DATA ENABLE: Output
This line is used to control the output enable of the bus transceiver. This line is active low. This line is high impedance during hold acknowledge.

HOLD
HOLD REQUEST: Input
This line is used for a Bus Request from an other device.
This line is active high.

HLDA
HOLD ACKNOWLEDGE: Output
This line is used for a Bus Grant to an other device.
This line is active high.

$\overline{SS_0}$
STATUS: Output
This line is logically equivalent to $\overline{S}_0$ in the maximum mode.

STATIC OPERATION

The MSM80C88A-10 circuitry is of static design. Internal registers, counters and latches are static and require no refresh as with dynamic circuit design. This eliminates the minimum operating frequency restriction placed on other microprocessors. The MSM80C88A-10 can operate from DC to the appropriate upper frequency limit. The processor clock may be stopped in either state (high/low) and held there indefinitely. This type of operation is especially useful for system debug or power critical applications.

The MSM80C88A-10 can be signal stepped using only the CPU clock. This state can be maintained as long as is necessary. Signal step clock operation allows simple interface circuitry to provide critical information for bringing up your system.
Static design also allows very low frequency operation (down to DC). In a power critical situation, this can provide extremely low power operation since 80C88A power dissipation is directly related to operating frequency. As the system frequency is reduced, so is the operating power until, ultimately, at a DC input frequency, the MSM80C88A-10 power requirement is the standby current (500 µA maximum).

FUNCTIONAL DESCRIPTION

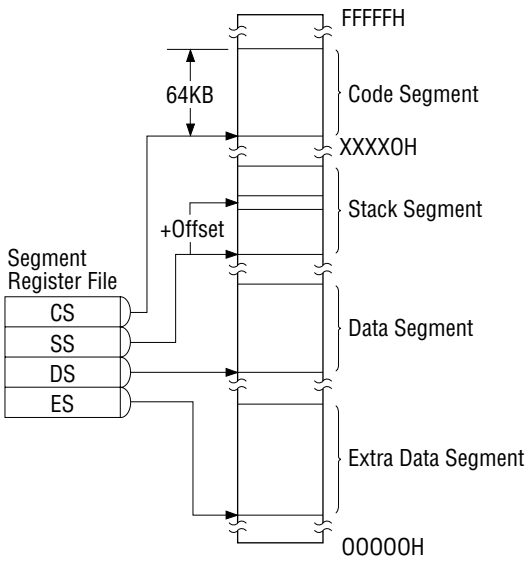
General Operation

The internal function of the MSM80C88A-10 consists of a Bus interface Unit (BIU) and an Execution Unit (EU). These units operate mutually but perform as separate processors.
The BIU performs instruction fetch and queueing, operand fetch, DATA read and write address relocation and basic bus control. By performing instruction prefetch while waiting for decoding and execution of instruction, the CPU's performance is increased. Up to 4-bytes for instruction stream can be queued.
EU receives pre-fetched instructions from the BIU queue, decodes and executes instructions and provides an un-relocated operand address to the BIU.

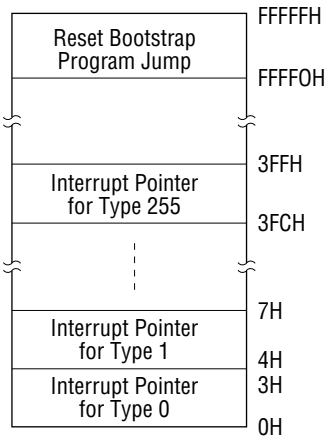
Memory Organization

The MSM80C88A-10 has a 20-bit address to memory. Each address has 8-bit data width. Memory is organized 00000H to FFFFFH and is logically divided into four segments: code, data, extra data and stack segment. Each segment contains up to 64 Kbytes and locates on a 16-byte boundary. (Fig. 3a)
All memory references are made relative to a segment register according to a select rule. Memory location FFFF0H is the start address after reset, and 00000H through 003FFH are reserved as an interrupt pointer. There are 256 types of interrupt pointer:
Each interrupt type has a 4-byte pointer element consisting of a 16-bit segment address and a 16-bit offset address.

Memory Organization



Reserved Memory Locations



Memory Reference Need	Segment Register Used	Segment Selection Rule
Instructions	CODE (CS)	Automatic with all instruction prefetch.
Stack	STACK (CS)	All stack pushes and pops. Memory references relative to BP base register except data references.
Local Data	DATA (DS)	Data references when relative to stack, destination of string operation, or explicitly overridden.
External (Global Data)	EXTRA (ES)	Destination of string operations: Explicitly selected using a segment override.

Minimum and Maximum Modes

The MSM80C88A-10 has two system modes: minimum and maximum. When using the maximum mode, it is easy to organize a multiple-CPU system with the MSM82C88-2 Bus Controller which generates the bus control signal.
When using the minimum mode, it is easy to organize a simple system by generating the bus control signal itself. MN/$\overline{MX}$ is the mode select pin. Definition of 24-31, 34 pin changes depends on the MN/$\overline{MX}$ pin.

Bus Operation

The MSM80C88A-10 has a time multiplexed address and data bus. If a non-multiplexed bus is desired for the system, it is only needed to add the address latch.
A CPU bus cycle consists of at least four clock cycles: T_1, T_2, T_3 and T_4. (Fig. 4)
The address output occurs during T_1, and data transfer occurs during T_3 and T_4. T_2 is used for changing the direction of the bus during read operation. When the device which is accessed by the CPU is not ready to data transfer and send to the CPU "NOT READY" is indicated T_W cycles are inserted between T_3 and T_4.
When a bus cycle is not needed, T_1 cycles are inserted between the bus cycles for internal execution. At the T_1 cycle an ALE signal is output from the CPU or the MSM82C88-2 depending in MN/$\overline{MX}$, at the trailing edge of an ALE, a valid address may be latched. Status bits S_0, S_1 and S_2 are used, in maximum mode, by the bus controller to recognize the type of bus operation according to the following table.

$\overline{S_2}$	$\overline{S_1}$	$\overline{S_0}$	Characteristics
0 (LOW)	0	0	Interrupt acknowledge
0	0	1	Read I/O
0	1	0	Write I/O
0	1	1	Halt
1 (HIGH)	0	0	Instruciton Fetch
1	0	1	Read Data from Memory
1	1	0	Write Data to Memory
1	1	1	Passive (no bus cycle)

Status bits S_3 through S_6 are multiplexed with A_{16}-A_{19}, and therefore they are valid during T_2 through T_4. S_3 and S_4 indicate which segment register was selected on the bus cycle, according to the following table.

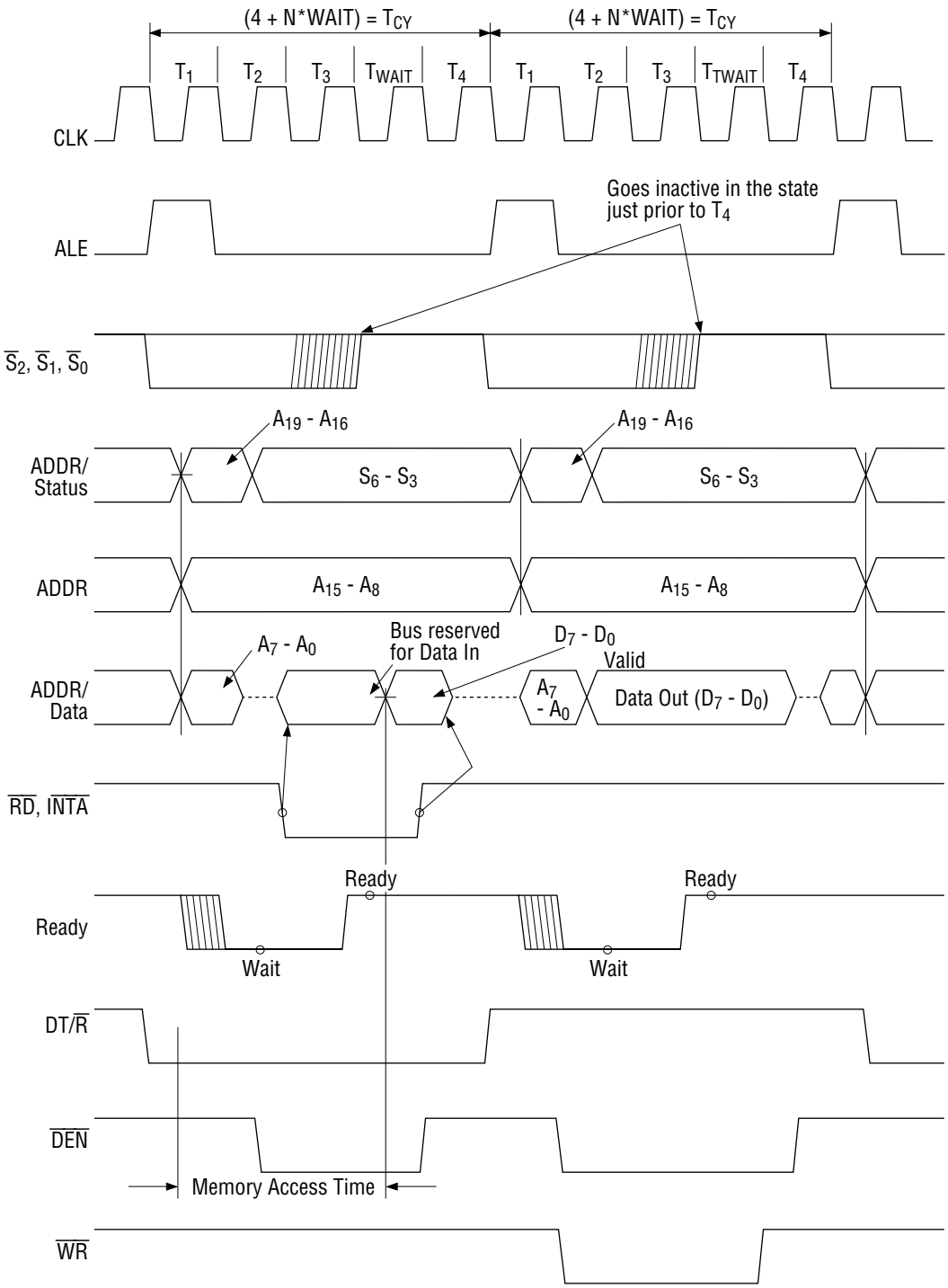
S_4	S_3	Characteristics
0 (LOW)	0	Alternate Data (Extra Segment)
0	1	Stack
1 (HIGH)	0	Code or None
1	1	Data

S_5 indicates interrupt enable Flag.

I/O Addressing

The MSM80C88A-10 has a 64 Kbyte I/O. When the CPU accesses an I/O device, addresses A_0-A_{15} are in same format as a memory access, and A_{16}-A_{19} are low.
I/O ports addresses are same as four memory.

Basic System Timing



EXTERNAL INTERFACE

Reset

CPU initialization is executed by the RESET pin. The MSM80C88A-10's RESET High signal is required for greater than 4 clock cycles.
The rising edge of RESET terminates the present operation immediately. The falling edge of RESET triggers an internal reset sequence for approximately 10 clock cycles. After internal reset sequence is finished, normal operation begins from absolute location FFFF0H.

Interrupt Operations

The interrupt operation is classified as software or hardware, and hardware interrupt is classified as non-markable or maskable.
An interrupt causes a new program location which is defined by the interrupt pointer table, according to the interrupt type. Absolute location 00000H through 003FFH is reserved for the interrupt pointer table. The interrupt pointer table consists of 256-elements. Each element is 4 bytes in size and corresponds to an 8-bit type number which is sent from an interrupt request device during the interrupt acknowledge cycle.

Non-maskable Interrupt (NMI)

The MSM80C88A-10 has a non-maskable interrupt (NMI) which is of higher priority than a maskable interrupt request (INTR).
An NMI request pulse width needs minimum of 2 clock cycles. The NMI will be serviced at the end of the current instruction or between string manipulations.

Maskable Interrupt (INTR)

The MSM80C88A-10 provides another interrupt request (INTR) which can be masked by software. INTR is level triggerd, so it must be held until interrupt request is acknowledged.
The INTR will be serviced at the end of the current instruction or between string manipulations.

Interrupt Acknowledge

During the interrupt acknowledge sequence, further interrupts are disabled. The interrupt enable bit is reset by any interrupt, after which the Flag register is automatically pushed onto the stack. During an acknowledge sequence, the CPU emits the lock signal from T_2 of first bus cycle to T_2 of second bus cycle. At the second bus cycle, a byte is fetched from the external device as a vector which identifies the type of interrupt. This vector is multiplied by four and used as an interrupt pointer address (INTR only).
The interrupt Return (IRET) instruction includes a Flag pop operation which returns the original interrupt enable bit when it restores the Flag.

HALT

When a Halt instruction is executed, the CPU enters Halt state. An interrupt request or RESET will force the MSM80C88A-10 out of the Halt state.

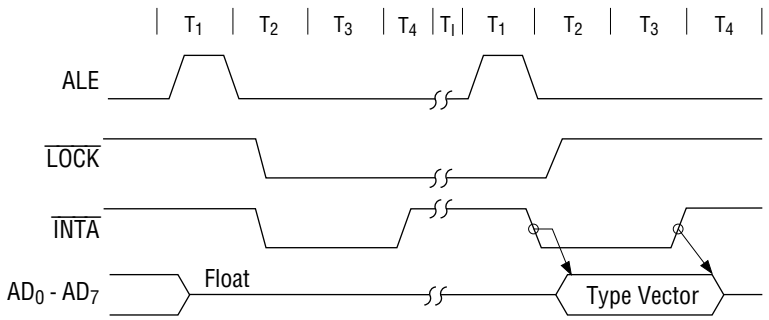
System Timing – Minimum Mode

A bus cycle begins at T_1 with an ALE signal. The trailing edge of ALE is used to latch the address. From T_1 to T_4 the IO/$\overline{M}$ signal indicates a memory or I/O operation. From T_2 to T_4, the address data bus changes the address but to the data bus.
The read ($\overline{RD}$), write ($\overline{WR}$), and interrupt acknowledge ($\overline{INTA}$) signals caused the addressed device to enable the data bus. These signals become active at the beginning of T_2 and inactive at the beginning of T_4.

System Timing – Maximum Mode

In maximum mode, the MSM82C88-2 Bus Controller is added to system. The CPU sends status information to the Bus Controller. Bus timing signals are generated by the Bus Controller. Bus timing is almost the same as in minimum mode.

Interrupt Acknowledge Sequence



BUS HOLD CIRCUITRY

To avoid high current conditions caused by floating inputs to CMOS devices, and to eliminate the need for pull-up/down resistors, "bus-hold" circuitry has been used on MSM80C88A-10 pins 2-16, 26-32, and 34-39 (Figures 6a, 6b). These circuits will maintain the last valid logic state if no driving source is present (i.e. an unconnected pin or a driving source which goes to a high impedance state). To overdrive the "bus hold" circuits, an external driver must be capable of supplying approximately 400 µA minimum sink or source current at valid input voltage levels. Since this "bus hold" circuitry is active and not a "resistive" type element, the associated power supply current is negligible and power dissipation is significantly reduced when compared to the use of passive pull-up resistors.

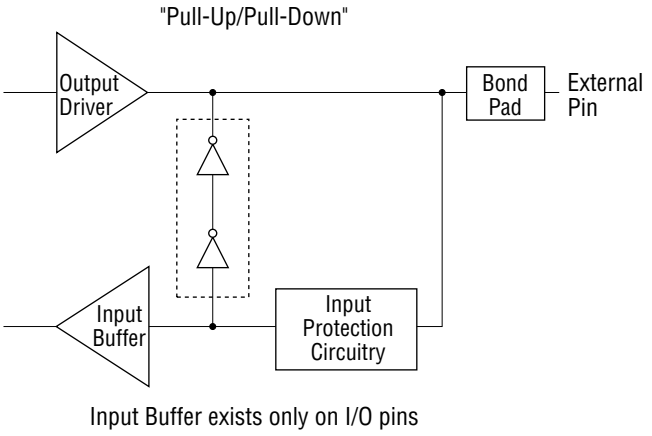


Figure 6a. Bus Hold Circuitry Pin 2-16, 35-39

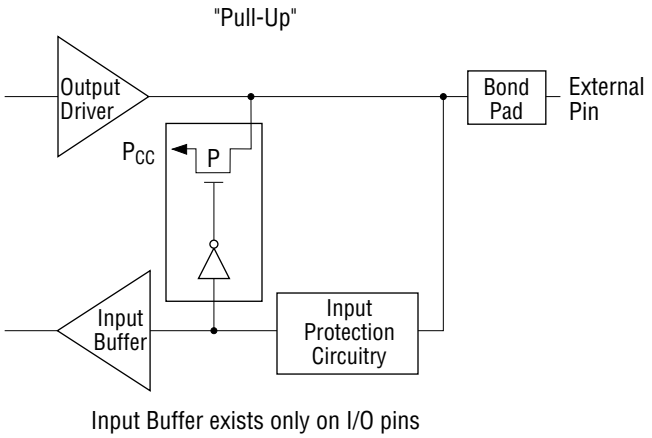


Figure 6b. Bus Hold Circuit Pin 26-32, 34

DATA TRANSFER

	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
MOV = Move:																																
Register/memory to/from register	1	0	0	0	1	0	d	w	mod			reg			r/m																	
Immediate to register/memory	1	1	0	0	0	1	1	w	mod		0	0	0		r/m					data								data if w = 1				
Immediatye to register	1	0	1	1	w		reg					data								data if w = 1												
Memory to accumulator	1	0	1	0	0	0	0	w				addr-low								addr-high												
Accumulator to memory	1	0	1	0	0	0	1	w				addr-low								addr-high												
Register/memory to segment register	1	0	0	0	1	1	1	0	mod		0	reg			r/m																	
Segment register to register/memory	1	0	0	0	1	1	0	0	mod		0	reg			r/m																	
PUSH = Push:																																
Register/memory	1	1	1	1	1	1	1	1	mod		1	1	0		r/m																	
Register	0	1	0	1	0		reg																									
Segment register	0	0	0	reg		1	1	0																								
POP = Pop:																																
Register/memory	1	0	0	0	1	1	1	1	mod		0	0	0		r/m																	
Register	0	1	0	1	1		reg																									
Segment register	0	0	0	reg		1	1	1																								
XCHG = Exchange:																																
Register/memory with register	1	0	0	0	0	1	1	w	mod			reg			r/m																	
Register with accumulator	1	0	0	1	0		reg																									
IN = Input from:																																
Fixed port	1	1	1	0	0	1	0	w				port																				
Variable port	1	1	1	0	1	1	0	w																								
OUT = Output to:																																
Fixed port	1	1	1	0	0	1	1	w				port																				
Variable port	1	1	1	0	1	1	1	w																								
XLAT = Translate byte to AL	1	1	0	1	0	1	1	1																								
LEA = Load EA to register	1	0	0	0	1	1	0	1	mod			reg			r/m																	
LDS = Load pointer to DS	1	1	0	0	0	1	0	1	mod			reg			r/m																	
LES = Load pointer to ES	1	1	0	0	0	1	0	0	mod			reg			r/m																	
LAHF = Load AH with flags	1	0	0	1	1	1	1	1																								
SAHF = Store AH into flags	1	0	0	1	1	1	1	0																								
PUSHF = Push flags	1	0	0	1	1	1	0	0																								
POPF = Pop flags	1	0	0	1	1	1	0	1																								

ARITHMETHIC

ADD = Add:															
Reg./memory with register to either	0	0	0	0	0	0	d	w	mod		reg		r/m		
Immediate to register/memory	1	0	0	0	0	0	s	w	mod	0	0	0	r/m	data	data if s:w = 01
Immediate to accumulator	0	0	0	0	0	1	0	w	data					data if w = 1	
ADC = Add with carry:															
Reg./memory with register to either	0	0	0	1	0	0	d	w	mod		reg		r/m		
Immediate to register/memory	1	0	0	0	0	0	s	w	mod	0	1	0	r/m	data	data if s:w = 01
Immediate to accumulator	0	0	0	1	0	1	0	w	data					data if w = 1	
INC = Increment:															
Register/memory	1	1	1	1	1	1	1	w	mod	0	0	0	r/m		
Register	0	1	0	0	0		reg								
AAA = ASCII adjust for add	0	0	1	1	0	1	1	1							
DAA = Decimal adjust for add	0	0	1	0	0	1	1	1							
SUB = Subtract:															
Reg./memory with register to either	0	0	1	0	1	0	d	w	mod		reg		r/m		
Immediate from register/memory	1	0	0	0	0	0	s	w	mod	1	0	1	r/m	data	data if s:w = 01
Immediate from accumulator	0	0	1	0	1	1	0	w	data					data if w = 1	
SBB = Subtract with borrow:															
Reg./memory and register to either	0	0	0	1	1	0	d	w	mod		reg		r/m		
Immediate from register/memory	1	0	0	0	0	0	s	w	mod	0	1	1	r/m	data	data if s:w = 01
Immediate from accumulator	0	0	0	1	1	1	0	w	data					data if w = 1	
DEC = Decrement:															
Register/memory	1	1	1	1	1	1	1	w	mod	0	0	1	r/m		
Register	0	1	0	0	1		reg								
NEG = Change sign	1	1	1	1	0	1	1	w	mod	0	1	1	r/m		
CMP = Compare:															
Register/memory and register	0	0	1	1	1	0	d	w	mod		reg		r/m		
Immediate with register/memory	1	0	0	0	0	0	s	w	mod	1	1	1	r/m	data	data if s:w = 01
Immediate from accumulator	0	0	1	1	1	1	0	w	data					data if w = 1	
AAS = ASCII adjust for subtract	0	0	1	1	1	1	1	1							

DAS = Decimal adjust for subtract	0	0	1	0	1	1	1	1																	
MUL = Multiply (unsigned)	1	1	1	1	0	1	1	w	mod		1	0	0	r/m											
IMUL = Integer multiply (signed)	1	1	1	1	0	1	1	w	mod		1	0	1	r/m											
AAM = ASCII adjust for multiply	1	1	0	1	0	1	0	0	0	0	0	0	1	0	1	0									
DIV = Divide (unsigned)	1	1	1	1	0	1	1	w	mod		1	1	0	r/m											
IDIV = Integer divide (signed)	1	1	1	1	0	1	1	w	mod		1	1	1	r/m											
AAD = ASCII adjust for divide	1	1	0	1	0	1	0	1	0	0	0	0	1	0	1	0									
CBW = Convert byte to word	1	0	0	1	1	0	0	0																	
CWD = Convert word to double word	1	0	0	1	1	0	0	1																	

LOGIC

NOT = Invert	1	1	1	1	0	1	1	w	mod	0	1	0	r/m		
SHL/SAL = Shift logical/arithmetic left	1	1	0	1	0	0	v	w	mod	1	0	0	r/m		
SHR = Shift logical right	1	1	0	1	0	0	v	w	mod	1	0	1	r/m		
SAR = Shift arithmetic right	1	1	0	1	0	0	v	w	mod	1	1	1	r/m		
ROL = Rotate left	1	1	0	1	0	0	v	w	mod	0	0	0	r/m		
ROR = Rotate right	1	1	0	1	0	0	v	w	mod	0	0	1	r/m		
RCL = Rotate left through carry	1	1	0	1	0	0	v	w	mod	0	1	0	r/m		
RCR = Rotate right through carry	1	1	0	1	0	0	v	w	mod	0	1	1	r/m		
AND = And:															
Reg./memory with register to either	0	0	1	0	0	0	d	w	mod			reg	r/m		
Immediate to register/memory	1	0	0	0	0	0	0	w	mod	1	0	0	r/m	data	data if w = 1
Immediate to accumulator	0	0	1	0	0	1	0	w			data			data if w = 1	
TEST = And function to flags, no result:															
Register/memory and register	1	0	0	0	0	1	0	w	mod			reg	r/m		
Immediate data and register/memory	1	1	1	1	0	1	1	w	mod	0	0	0	r/m	data	data if w = 1
Immediate data and accumulator	1	0	1	0	1	0	0	w			data			data if w = 1	
OR = Or:															
Reg./memory and register to either	0	0	0	0	1	0	d	w	mod			reg	r/m		
Immediate to register/memory	1	0	0	0	0	0	0	w	mod	0	0	1	r/m	data	data if w = 1
Immediate to accumulator	0	0	0	0	1	1	0	w			data			data if w = 1	
XOR = Exclusive or:															
Reg./memory and register to either	0	0	1	1	0	0	d	w	mod			reg	r/m		
Immediate to register/memory	1	0	0	0	0	0	0	w	mod	1	1	0	r/m	data	data if w = 1
Immediate to accumulator	0	0	1	1	0	1	0	w			data			data if w = 1	

STRING MANIPULATION

REP = Repeat	1	1	1	1	0	0	1	z			
MOVS = Move byte/word	1	0	1	0	0	1	0	w			
CMPS = Compare byte/word	1	0	1	0	0	1	1	w			
SCAS = Scan byte/word	1	0	1	0	1	1	1	w			
LODS = Load byte/word to AL/AX	1	0	1	0	1	1	0	w			
STOS = Store byte/word from AL/AX	1	0	1	0	1	0	1	w			
CJMP = Conditional JMP											
JE/JZ = Jump on equal/zero	0	1	1	1	0	1	0	0	disp		
JZ/JNGE = Jump on less/not greater or equal	0	1	1	1	1	1	0	0	disp		
JLE/JNG = Jump on less or equal/not greater	0	1	1	1	1	1	1	0	disp		
JB/JNAE = Jump on below/not above or equal	0	1	1	1	0	0	1	0	disp		
JBE/JNA = Jump on below or equal/not above	0	1	1	1	0	1	1	0	disp		
JP/JPE = Jump on parity/parity even	0	1	1	1	1	0	1	0	disp		
JO = Jump on over flow	0	1	1	1	0	0	0	0	disp		
JS = Jump on sign	0	1	1	1	1	0	0	0	disp		
JNE/JNZ = Jump on not equal/not zero	0	1	1	1	0	1	0	1	disp		
JNL/JGE = Jump on not less/greater or equal	0	1	1	1	1	1	0	1	disp		
JNLE/JG = Jump on not less or equal/greater	0	1	1	1	1	1	1	1	disp		
JNB/JAE = Jump on not below/above or equal	0	1	1	1	0	0	1	1	disp		
JNBE/JA = Jump on not below or equal/above	0	1	1	1	0	1	1	1	disp		
JNP/JPO = Jump on not parity/parity odd	0	1	1	1	1	0	1	1	disp		
JNO = Jump on not overflow	0	1	1	1	0	0	0	1	disp		
JNS = Jump on not sigh	0	1	1	1	1	0	0	1	disp		
LOOP = Loop CX times	1	1	0	1	0	0	1	0	disp		
LOOPZ/LOOPE = Loop while zero/equal	1	1	1	0	0	0	0	1	disp		
LOOPNZ/LOOPNE = Loop while not zero equal	1	1	1	0	0	0	0	0	disp		
JCXZ = Jump on CX zero	1	1	1	0	0	0	1	1	disp		
INT = Interrupt											
Type specified	1	1	0	0	1	1	0	1	type		
Type 3	1	1	0	0	1	1	0	0			
INTO = Interrupt on overflow	1	1	0	0	1	1	1	0			
IRET = Interrupt return	1	1	0	0	1	1	1	1			

PROCESSOR CONTROL

CLC = Clear carry	1	1	1	1	1	0	0	0																						
CMC = Complementary carry	1	1	1	1	0	1	0	1																						
STC = Set carry	1	1	1	1	1	0	0	1																						
CLD = Clear direction	1	1	1	1	1	1	0	0																						
STD = Set direction	1	1	1	1	1	1	0	1																						
CLI = Clear interrupt	1	1	1	1	1	0	1	0																						
STI = Set interrupt	1	1	1	1	1	0	1	1																						
HLT = Halt	1	1	1	1	0	1	0	0																						
WAIT = Wait	1	0	0	1	1	0	1	1																						
ESC = Escape (to external device)	1	1	0	1	1	x	x	x	mod		x	x	x		r/m															
LOCK = Bus lock prefix	1	1	1	1	0	0	0	0																						

CONTROL TRANSFER

	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
CALL = Call:																																
Direct within segment	1	1	1	0	1	0	0	0				disp-low							disp-high													
Indirect within segment	1	1	1	1	1	1	1	1	mod		0	1	0		r/m																	
Direct intersegment	1	0	0	1	1	0	1	0				offset-low							offset-high													
												seg-low							seg-high													
Indirect intersegment	1	1	1	1	1	1	1	1	mod		0	1	1		r/m																	
JMP = Unconditional Jump:																																
Direct within segment	1	1	1	0	1	0	0	1				disp-low							disp-high													
Direct within segment-short	1	1	1	0	1	0	1	1				disp																				
Indirect within segment	1	1	1	1	1	1	1	1	mod		1	0	0		r/m																	
Direct intersegment	1	1	1	0	1	0	1	0				offset-low							offset-high													
												seg-low							seg-high													
Indirect intersegment	1	1	1	1	1	1	1	0	mod		1	0	1		r/m																	
RET = Return from CALL:																																
Within segment	1	1	0	0	0	0	1	1																								
Within seg. adding immediate to SP	1	1	0	0	0	0	1	0				data-low							data-high													
Intersegment	1	1	0	0	1	0	1	1																								
Intersegment adding immediate to SP	1	1	0	0	1	0	1	0				data-low							dat-high													

Notes: AL = 8-bit accumulator
AX = 18-bit accumulator
CX = Count register
DS = Data segment
EX = Extra segment
Above/below refers to unsigned value
Greater=more positive
Less=less positive (more negative) signed value
If d=1 then "to" reg: If d=0 then "from" reg.
If w=1 then word instruction: If w=0 then byte instruction

If mod=11 then r/m is treated as a REG field
If mod=00 then DISP=0*, disp-low and disp-high are absent
If mod=01 then DISP=disp-low sign-extended to 16 bits, disp-high is absent
If mod=10 then DISP=disp-high: disp-low
If r/m=000 then EA=(BX)+(SI)+DISP
If r/m=001 then EA=(BX)+(DI)+DISP
If r/m=010 then EA=(BP)+(SI)+DISP
If r/m=011 then EA=(BP)+(DI)+DISP
If r/m=100 then EA=(SI)+DISP
If r/m=101 then EA=(DI)+DISP
If r/m=110 then EA=(BP)+DISP*
If r/m=111 then EA=(BX)+DISP
DISP follows 2nd byte of instruction (before data if required)
* except if mod=00 and r/m=110 then EA-disp-high: disp-low

If s:w=01 then 16 bits of immediate data form the operand
If s:w=11 then an immediate data byte is sign extended to form the 16-bit operand
If v=0 then "count"=1:if v=1 then "count" in (CL)
x=don' t care
z is used for string primitives for comparison with ZF FLAG

SEGMENT OVERRIDE PREFIX
001 reg 110

REG is assigned according to the following table:

16-Bit	(w=1)	8-Bit	(w=0)	Segment	
000	AX	000	AL	00	ES
001	CX	001	CL	01	CS
010	DX	010	DL	10	SS
011	BX	011	BL	11	DS
100	SP	100	AH		
101	BP	101	CH		
110	SI	110	DH		
111	DI	111	BH		

Instructions which reference the flag register file as a 16-bit object use the symbol FLAGS to represent the file:

FLAGS=x:x:x:x:(OF):(DF):(IF):(TF):(SF):(ZF):X:(AF):X:(PF):X:(CF)

NOTICE ON REPLACING LOW-SPEED DEVICES WITH HIGH-SPEED DEVICES

The conventional low speed devices are replaced by high-speed devices as shown below.
When you want to replace your low speed devices with high-speed devices, read the replacement notice given on the next pages.

High-speed device (New)	Low-speed device (Old)	Remarks
M80C85AH	M80C85A/M80C85A-2	8bit MPU
M80C86A-10	M80C86A/M80C86A-2	16bit MPU
M80C88A-10	M80C88A/M80C88A-2	8bit MPU
M82C84A-2	M82C84A/M82C84A-5	Clock generator
M81C55-5	M81C55	RAM.I/O, timer
M82C37B-5	M82C37A/M82C37A-5	DMA controller
M82C51A-2	M82C51A	USART
M82C53-2	M82C53-5	Timer
M82C55A-2	M82C55A-5	PPI

Differences between MSM80C88A-10 and MSM80C88A-2, MSM80C88A

1) Manufacturing Process
All devices use a 1.5 µ Si-CMOS process technology.

2) Design
Although circuit timings of these devices are a little different, these devices have the same chip size and logics.

3) Electrical Characteristics
Oki's '96 Data Book for MICROCONTROLLER describes that the MSM80C88A-10 satisfies the electrical characteristics of the MSM80C88A-2 and MSM80C88A.

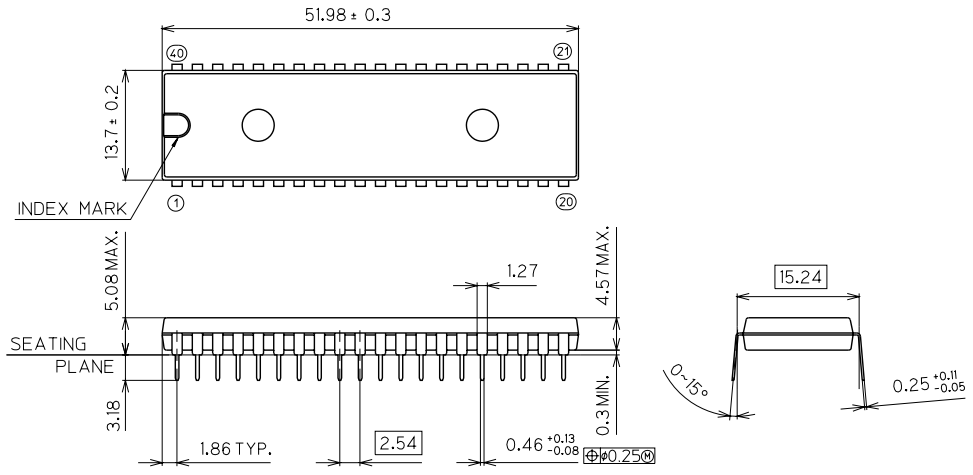
4) Other notices
1) The noise characteristics of the high-speed MSM80C88A-10 (for 10 MHz) are a little different from those of the MSM80C88A-2 and MSM80C88A. Therefore when devices are replaced for upgrading, it is recommended to perform noise evaluation.

2) The characteristics of the MSM80C88A-10 basically satisfy those of the MSM80C88A-2 and MSM80C88A but their timings are a little different. When critical timing is required in designing it is recommended to evaluate operating margins at various temperatures and voltages.

PACKAGE DIMENSIONS

(Unit : mm)

DIP40-P-600-2.54



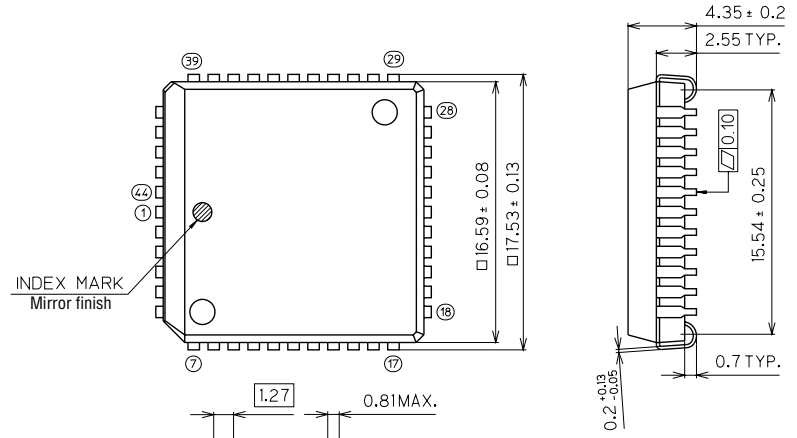
Package material	Epoxy resin
Lead frame material	42 alloy
Pin treatment	Solder plating
Solder plate thickness	5 μm or more
Package weight (g)	6.10 TYP.

Notes for Mounting the Surface Mount Type Package

The SOP, QFP, TSOP, SOJ, QFJ (PLCC), SHP and BGA are surface mount type packages, which are very susceptible to heat in reflow mounting and humidity absorbed in storage.
Therefore, before you perform reflow mounting, contact Oki's responsible sales person for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

(Unit : mm)

QFJ44-P-S650-1.27



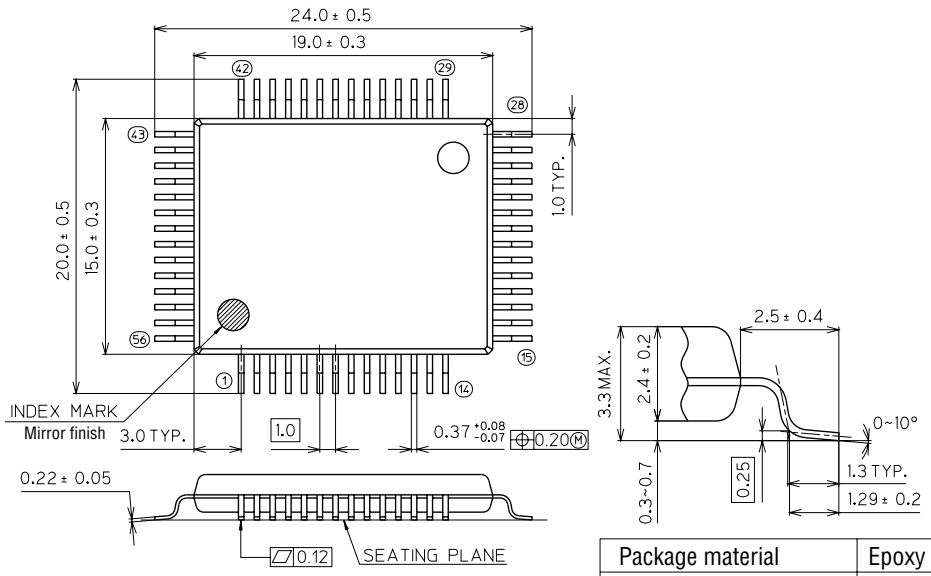
Package material	Epoxy resin
Lead frame material	Cu alloy
Pin treatment	Solder plating
Solder plate thickness	5 μm or more
Package weight (g)	2.00 TYP.

Notes for Mounting the Surface Mount Type Package

The SOP, QFP, TSOP, SOJ, QFJ (PLCC), SHP and BGA are surface mount type packages, which are very susceptible to heat in reflow mounting and humidity absorbed in storage.
Therefore, before you perform reflow mounting, contact Oki's responsible sales person for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

(Unit : mm)

QFP56-P-1519-1.00-K



Package material	Epoxy resin
Lead frame material	42 alloy
Pin treatment	Solder plating
Solder plate thickness	5 μm or more
Package weight (g)	1.46 TYP.

Notes for Mounting the Surface Mount Type Package

The SOP, QFP, TSOP, SOJ, QFJ (PLCC), SHP and BGA are surface mount type packages, which are very susceptible to heat in reflow mounting and humidity absorbed in storage.
Therefore, before you perform reflow mounting, contact Oki's responsible sales person for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).