P8052AH Microcontroller

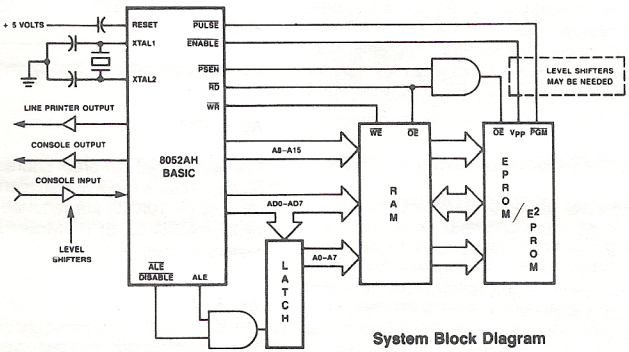
- **Full BASIC Interpreter in ROM on a Single Chip**
- **BCD Floating Point Math**
- **Generates All Timing Necessary to Program EPROMS and E²PROMS**
- **Fast Tokenized Interpreter**
- **"Stand Alone" Software Development**
- **All Arithmetic and Utility Routines Can Be Called From Assembly Language**
- **Interrupts Can Be Handled By BASIC or Assembly Language**
- **Built-In Accurate REAL TIME CLOCK**
- **Multiple User Programs**
- **Programs May Reside In RAM, EPROM or E²PROM**
- **Built In Radix Conversion — Hex to Decimal and Decimal to Hex**

8052AH-BASIC is an 8052AH microcontroller with a complete full-featured BASIC interpreter, MCS® BASIC-52, resident in the 8K of available ROM. This Software-On-Silicon product is specifically designed to address the needs of process control, measurement, and instrumentation applications. MCS BASIC-52 allows 8052AH users to write programs in the popular BASIC language, which is much simpler to write and easier to understand than assembly language.

In addition to the standard BASIC commands and functions, such as floating point arithmetic and transcendental operations, MCS BASIC-52 contains many unique features that allow the user to perform tasks that usually require assembly language. Bit-wise logical operators, such as AND, OR, and EXCLUSIVE-OR are supported as well as hexadecimal arithmetic.

A minimum amount of hardware is required to support MCS BASIC-52. Small systems can be constructed with only a latch, 1K bytes of external memory, and the appropriate serial port drivers. With the addition of a transistor, a gate, and a couple of passive components, MCS BASIC-52 can program EPROM or E²PROM devices with the users application program. Both the standard and the int$_e$ligent Programming™ algorithms are supported.

MCS BASIC-52 is an interpreted language. This allows the user to develop a program interactively without the cumbersome and repetitive process of editing, assembling, loading, and running which is required by assemblers and compilers. MCS BASIC-52 was designed to permit the programmer to develop resident high level language software using the high performance 8052AH device.



System Block Diagram

FEATURES

COMMAND SET

MCS BASIC-52 contains all standard BASIC commands, statements, and operators. Figure 1 list the software feature set of MCS BASIC-52.

DATA FORMAT

The range of numbers that can be represented in MCS BASIC-52 is:

$$\pm 1E-127 \text{ to } \pm .99999999E + 127$$

CONTROL ORIENTED FEATURES

MCS BASIC-52 contains many unique features to perform task that usually require assembly language programming. The XBY and DBY operators can read and/or write external and internal memory respectively. The CBY operator is used to read program memory. Additionally, virtually all of the special function registers on the 8052AH can be accessed with MCS BASIC-52. This allows the user to set the timer or interrupt modes within the constructs of a BASIC program. An accurate interrupt driven REAL TIME CLOCK that has a 5 millisecond resolution is also implemented in MCS BASIC-52. This clock can be enabled, disabled, and used to generate interrupts. Finally, a CALL statement that allows the programmer to CALL assembly language routines is available in MCS BASIC-52. Parameters can be passed in a number of different ways.

EPROM/E^{2}PROM FILE

Most Basic interpreters allow only one program to be resident in memory, and many require that the program reside in RAM. MCS BASIC-52 allows programs to reside in both RAM and EPROM/E^{2}PROM. Additionally, up to 255 programs may reside in EPROM/E^{2}PROM. Programs may also be transfered (XFER) from EPROM/E^{2}PROM to RAM for editing purposes.

EPROM/E^{2}PROM PROGRAMMING

A powerful feature of MCS BASIC-52 is that it generates all of the timing necessary to program any standard EPROM or E^{2}PROM device with the users' program (PROG/FPROG). Additionally, very little external hardware is required to implement this feature. Saving programs in EPROM/E^{2}PROM is much more attractive and reliable than other alternatives, such as cassette tape, especially in control and/or other noisy environments.

AUTOSTART

After the user programs an EPROM or E^{2}PROM with the desired BASIC program. The PROG2 or FPROG2 commands may be used to enable the unique AUTOSTART feature of MCS BASIC-52. When AUTOSTART is enabled, MCS BASIC-52 will execute the user program after RESET or a power-up condition. This permits the user to RUN a program without connecting the MCS BASIC-52 device to a console — a powerful feature for control environments.

USER ACCESSABLE FUNCTION LIBRARY

Another unique feature of MCS BASIC-52 is that it contains a complete library of functions that can be accessed with assembly language. All floating point, radix conversion, and I/O routines contained in MCS BASIC-52 can be accessed with assembly language CALL instructions. These complex arithmetic routines can be used by the programmer in applications requiring the speed of assembly language, but also the complex arithmetics offered by BASIC.

8052AH-BASIC PIN DESCRIPTION (FIGURE 2)

8052AH-BASIC is an 8052AH device, however, MCS BASIC-52 assumes a particular hardware configuration. The following pin description outlines the pin functions defined by MCS BASIC-52.

VSS

Circuit ground potential.

VCC

Circuit supply voltage. 5 volts ± 10% relative to VSS.

AD0–AD7

The multiplexed low-order address and data bus used during accesses to external memory. External pullup devices (~ 10K Ω) are required on these pins if the MCS BASIC-52 EPROM/E^{2}PROM programming feature is used.

A8–A15

The high order address bus used during accesses to external memory.

Commands	Statements	Operators
RUN	BAUD	ADD (+)
LIST	CALL	DIVIDE (/)
LIST#	CLEAR	EXPONENTIATION (**)
NEW	CLEARS	MULTIPLY (*)
NULL	CLEARI	SUBTRACT (–)
RAM	CLOCK0	LOGICAL AND (.AND.)
ROM	CLOCK1	LOGICAL OR (.OR.)
XFER	DATA	LOGICAL X-OR (.XOR.)
PROG	READ	LOGICAL NOT
PROG1	RESTORE	ABS ( )
PROG2	DIM	INT ( )
FPROG	DO-WHILE	SGN ( )
FPROG1	DO-UNTIL	SQR ( )
FPROG2	END	RND
	FOR-TO-STEP	LOG ( )
	NEXT	EXP ( )
	GOSUB	SIN ( )
	RETURN	COS ( )
	GOTO	TAN ( )
	ON-GOTO	ATN ( )
	ON-GOSUB	=, >, >=, <, <=, <>
	IF-THEN-ELSE	ASC ( )
	INPUT	CHR ( )
	LET	CBY ( )
	ONERR	DBY ( )
	ONEXT1	XBY ( )
	ONTIME	GET
	PRINT	IE
	PRINT#	IP
	PH0.	PORT1
	PH0.#	PCON
	PH1.	RCAP2
	PH1.#	T2CON
	PUSH	TCON
	POP	TMOD
	PWM	TIME
	REM	TIMER0
	RET1	TIMER1
	STOP	TIMER2
	STRING	TIME
	UI0	XTAL
	UI1	MTOP
	UO0	LEN
	UO1	FREE
		PI

Figure 1. MCS® BASIC-52 Software Feature Set

PORT 1

A general purpose quasi-bidirectional 8-bit input/output port. The individual pins on PORT 1 all have alternate functions which may or may not be implemented by the user. The alternate functions are as follows:

PORT 1.0 (T2)

Can be used as the trigger input to TIMER/COUNTER 2. A one (1) must be written to this port pin output latch in order for this function to operate. Details of the T2 trigger function are covered in the Microcontrollers Handbook. Order Number 210918-002.

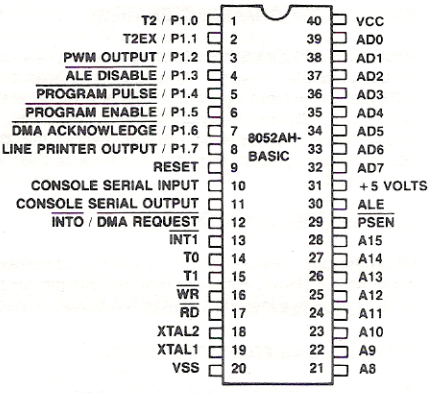


Figure 2. Configuration

PORT 1.1 (T2EX)

Can be used as the external input to TIMER/COUNTER 2. A one (1) must be written to this port pin output latch in order for this function to operate. Details of the T2 trigger function are covered in the Microcontroller Users Manual.

PORT 1.2 (PWM OUTPUT)

This pin is used as the PWM output port when the PWM statement is executed. PWM stands for Pulse Width Modulation and is used to generate pulses of varying duty cycle and frequency.

PORT 1.3 (ALE DISABLE)

This pin is used to disable the ALE signal to the external address latch when the EPROM/E^{2}PROM programming feature is used. In a system, this pin is logically anded with ALE.

PORT 1.4 (PROGRAMMING PULSE)

When the EPROM/E^{2}PROM programming feature is used, this pin provides the proper programming pulse width to program EPROM and INTELligent EPROM™ devices. MCS BASIC-52 actually calculates the proper programming pulse width from the system crystal value (XTAL) to assure the proper timing of this pulse. When used to program E^{2}PROM devices, the length of this pulse is not critical. This pin is active in the logical zero (0) state.

PORT 1.5 (PROGRAMMING ENABLE)

When the EPROM/E^{2}PROM programming feature is implemented, this pin is used to enable the EPROM programming voltage. This pin remains active (logically low (0)) during the entire EPROM programming process. On E^{2}PROM devices that do not require any special programming voltage, this pin is not used.

PORT 1.6 ($\overline{\text{DMA ACKNOWLEDGE}}$)

When the DMA feature is implemented as described in the MCS® BASIC-52 users manual, this pin functions as an active low DMA ACKNOWLEDGE output.

PORT 1.7 (LINE PRINTER OUTPUT)

This pin functions as a serial output port when the LIST# or PRINT# command and/or statement is used. This enables the user to make a "hard copy" of a program or to print out results of a calculation.

RESET

A high (2.5 volts) on this pin for two machine cycles while the oscillator is running resets the device. An external pulldown resistor (~8.2K) from RESET to VSS permits power-on reset when a capacitor (~10 uf) is connected from this pin to VCC.

ALE

ALE (address latch enable) is an output pin that is used to latch the low order address byte during Read, Write, or program fetch operations to external memory.

$\overline{\text{PSEN}}$

This pin (Program Store ENable) is a control signal that is used to enable external program memory. In MCS® BASIC-52, this pin will always remain inactive (logically high (1)) unless the user is running an assembly language program in external memory.

XTAL1

Input to the inverting amplifier that forms the oscillator.

XTAL2

Output of the inverting amplifier that forms the oscillator, and input to the internal clock generator. Receives the external oscillator signal when an external oscillator is used.

$\overline{\text{RD}}$

A control signal that is used to enable READ operations to external data memory. This pin is active low (0).

$\overline{\text{WR}}$

A control signal that is used to enable WRITE operations to external data memory. This pin is active low (0).

T1

This pin can be programmed to be an external input to TIMER/COUNTER 1.

T0

This pin can be programmed to be an external input to TIMER/COUNTER 0.

$\overline{\text{INT1}}$

This pin is the external interrupt 1 pin. It is active low and interrupts on this pin may be handled in either BASIC or in assembly language.

$\overline{\text{INT0}}$/DMA REQUEST

This is the external interrupt 0 pin. It is active low and may be optionally programmed to function as a DMA request input pin. The DMA REQUEST pin is used by E^{2}PROM devices during programming.

CONSOLE SERIAL OUTPUT

This is the serial output pin to the console device. Standard ASCII codes are used as well as a standard asynchronous frame.

CONSOLE SERIAL INPUT

This is the serial input pin that receives data from the console device. Standard ASCII codes are assumed to be the input and the data is assumed to be transmitted using a standard asynchronous frame.

NOTES

If pin 31 is grounded the 8052AH-BASIC will operate as a standard 8032AH. The tolerances on this pin are described under DC characteristics.

For detailed information concerning this product please refer to the MCS BASIC-52 Users Manual (Order Number 210918-002).

ABSOLUTE MAXIMUM RATINGS*

Ambient Temperature Under Bias . . . 0°C to 70°C

Storage Temperature . . . . . −65°C to +150°C

Voltage on Any Pin With Respect to Ground (V_{SS}) . . . . −0.5V to +7V

Power Dissipation . . . . . 2 Watts

**NOTICE: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

DC CHARACTERISTICS (T_A = 0°C to 70°C, V_{CC} = 4.5V to 5.5V, V_{SS} = 0V)

Symbol	Parameter	Min	Max	Unit	Test Conditions
VIL	Input Low Voltage	−0.5	0.8	V	
VIH	Input High Voltage (Except RST and XTAL2)	2.0	V_{CC} + 0.5	V	
VIH1	Input High Voltage to RST for Reset, XTAL2	2.5	V_{CC} + 0.5	V	XTAL1 to V_{SS}
VOL	Output Low Voltage Port 1, A8–15, Control Functions		0.45	V	IOL = 1.6mA
VOL1	Output Low Voltage ALE, PSEN (Note 1)		0.45	V	IOL = 3.2mA
VOH	Output High Voltage Port 1, A8–15, Control Functions	2.4		V	IOH = −80μA
VOH1	Output High Voltage AD0–7, ALE, $\overline{PSEN}$	2.4		V	IOH = −400μA
IIL	Logical 0 Input Current Port 1, A8–15 Control Functions		−800	μA	Vin = 0.45V
IIL2	Logical 0 Input Current XTAL2		−2.5	mA	XTAL1 at V_{SS}, Vin = 0.45V
IL1	Input Leakage Current To AD0–7 EA		±10	μA	0.45V<Vin<V_{CC}
IIH1	Input High Current to RST/VPD For Reset		500	μA	Vin = V_{CC} − 1.5V
ICC	Power Supply Current		175	mA	All outputs disconnected
CIO	Capacitance of I/O Buffer		10	pF	f_c = 1MHz, T_A = 25°C

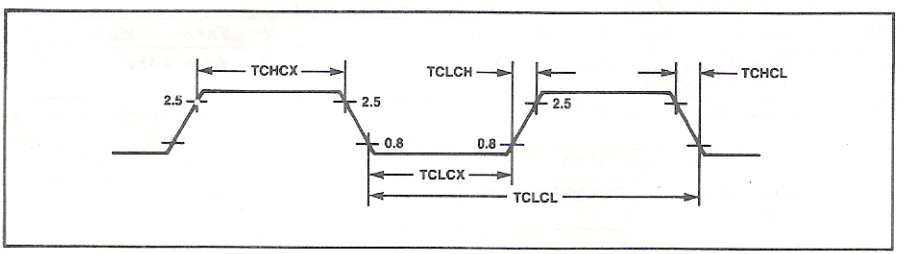
See page 6 for Notes.

Note 1: Vol is degraded when the 8032AH/8052AH rapidly discharges external capacitance. This AC noise is most pronounced during emission of address data. When using external memory, locate the latch or buffer as close to the 8032AH/8052AH as possible.

Datum	Emitting Ports	Degraded I/O Lines	VOL (peak) (max)
Address	A8–15, AD0–7	P1, Control Functions	0.8V
Write Data	AD0–7	P1, Control Functions, ALE	0.8v

EXTERNAL CLOCK DRIVE CHARACTERISTICS (XTAL2)

Symbol	Parameter	Variable Clock f = 3.5 MHz to 12 MHz		Unit
		Min	Max	
TCLCL	Oscillator Period	83.3	286	ns
TCHCX	High Time	20		ns
TCLCX	Low Time	20		ns
TCLCH	Rise Time		20	ns
TCHCL	Fall Time		20	ns



AC CHARACTERISTICS T_A = 0°C to 70°C, V_{CC} = 5V ± 10%, V_{SS} = 0V, C_L for AD0–7, ALE and $\overline{PSEN}$ Outputs = 100 pF, C_L for all other outputs = 80 pF)

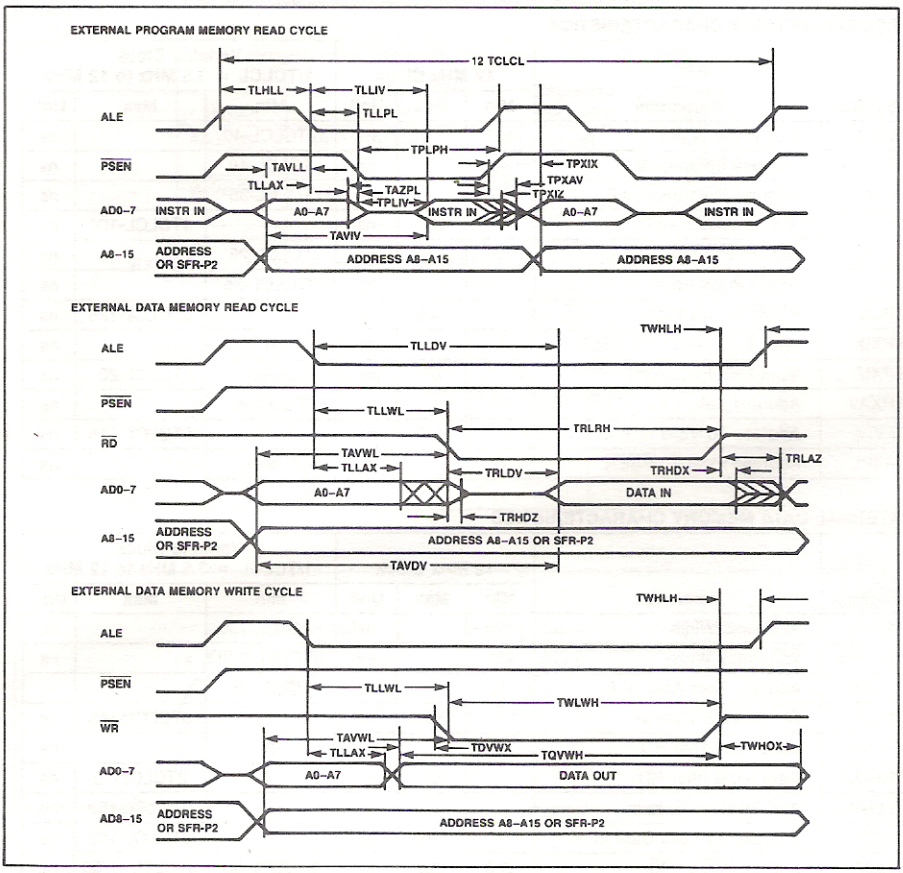
PROGRAM MEMORY CHARACTERISTICS

		12 MHz Clock			Variable Clock 1/TCLCL = 3.5 MHz to 12 MHz		
Symbol	Parameter	Min	Max	Unit	Min	Max	Unit
TLHLL	ALE Pulse Width	127		ns	2TCLCL-40		ns
TAVLL	Address Setup to ALE	43		ns	TCLCL-40		ns
TLLAX	Address Hold After ALE	48		ns	TCLCL-35		ns
TLLIV	ALE to Valid Instr In		233	ns		4TCLCL-100	ns
TLLPL	ALE To $\overline{PSEN}$	58		ns	TCLCL-25		ns
TPLPH	$\overline{PSEN}$ Pulse Width	215		ns	3TCLCL-35		ns
TPLIV	$\overline{PSEN}$ To Valid Instr In		125	ns		3TCLCL-125	ns
TPXIX	Input Instr Hold After $\overline{PSEN}$	0		ns	0		ns
TPXIZ	Input Instr Float After $\overline{PSEN}$		63	ns		TCLCL-20	ns
TPXAV	Address Valid After $\overline{PSEN}$	75		ns	TCLCL-8		ns
TAVIV	Address To Valid Instr In		302	ns		5TCLCL-115	ns
TAZPL	Address Float To $\overline{PSEN}$	0		ns	0		ns

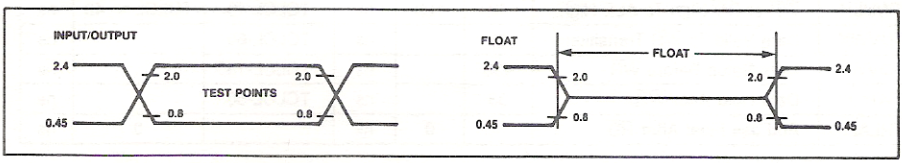
EXTERNAL DATA MEMORY CHARACTERISTICS

		12 MHz Clock			Variable Clock 1/TCLCL = 3.5 MHz to 12 MHz		
Symbol	Parameter	Min	Max	Unit	Min	Max	Unit
TRLRH	$\overline{RD}$ Pulse Width	400		ns	6TCLCL-100		ns
TWLWH	$\overline{WR}$ Pulse Width	400		ns	6TCLCL-100		ns
TLLAX	Address Hold After ALE	48		ns	TCLCL-35		
TRLDV	$\overline{RD}$ To Valid Data In		250	ns		5TCLCL-165	ns
TRHDX	Data Hold After $\overline{RD}$	0		ns	0		ns
TRHDZ	Data Float After $\overline{RD}$		97	ns		2TCLCL-70	ns
TLLDV	ALE To Valid Data In		517	ns		8TCLCL-150	ns
TAVDV	Address To Valid Data In		585	ns		9TCLCL-165	ns
TLLWL	ALE To $\overline{WR}$ or $\overline{RD}$	200	300	ns	3TCLCL-50	3TCLCL + 50	ns
TAVWL	Address To $\overline{SR}$ or $\overline{RD}$	203		ns	4TCLCL-130		ns
TWHLH	$\overline{WR}$ or $\overline{RD}$ High To ALE High	43	123	ns	TCLCL-40	TCLCL + 40	ns
TDVWX	Data Valid To $\overline{WR}$ Transition	23		ns	TCLCL-60		ns
TQVWH	Data Setup Before $\overline{WR}$	433		ns	7TCLCL-150		ns
TWHQX	Data Hold After $\overline{WR}$	33		ns	TCLCL-50		ns
TRLAZ	Address Float After $\overline{RD}$		0	ns		0	ns

AC TIMING DIAGRAMS

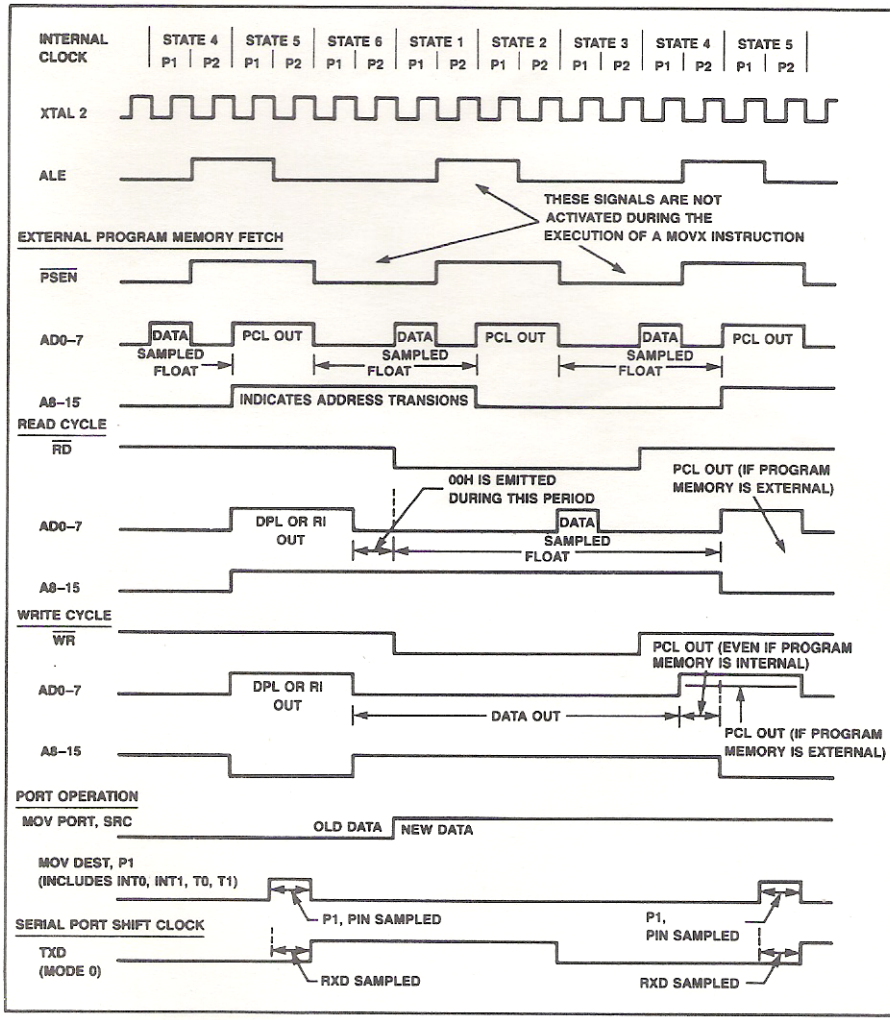


AC TESTING INPUT/OUTPUT, FLOAT WAVEFORMS



AC inputs during testing are driven at 2.4V for a logic "1" and 0.45V for a logic "0". Timing measurements are made at 2.0V for a logic "1" and 0.8V for a logic "0". For timing purposes, the float state is defined as the point at which an AD0–7 pin sinks 2.4mA or sources 400μA at the voltage test levels.

CLOCK WAVEFORMS



This diagram indicates when signals are clocked internally. The time it takes the signals to propagate to the pins, however, ranges from 25 to 125 ns. This propagation delay is dependent on variables such as temperature and pin loading. Propagation also varies from output to output and component to component. Typically though, (T_A = 25°C, fully loaded) RD and WR propagation delays are approximately 50 ns. The other signals are typically 85 ns. Propagation delays are incorporated in the AC specifications.

NOTES