National Semiconductor

MARCH 1978

INS8298/INS8298E 8080A LLL BASIC Interpreter

General Description

The INS8298/INS8298E is a 65k MAXI-ROM™*, organized into 8192 8-bit words, that is preprogrammed with the 8080A Lawrence Livermore Laboratory (LLL) BASIC Interpreter. Unprogrammed versions of the INS8298 and INS8298E are the MM5235 (28 pin, 800 ns access) and INS8364E/MM52164 (24 pin, 450 ns access), respectively. Both the INS8298 and INS8298E provide complete TTL compatibility and single 5V power supply. Three chip selects controlling TRI-STATE™ outputs allow for memory expansion.

The 8080A LLL BASIC Interpreter operates with the INS8080A microprocessor system to provide a high-level, easy-to-use language for performing both control and computation functions in the INS8080A. Designed for use in data acquisition and control applications, the LLL BASIC Interpreter enables the user to write and debug a program on-line. The interpreter executes source code statements directly, thus avoiding the need to translate into machine language. This approach has the advantage of easier source code manipulation (because the source is always available), and instant revision of the program when errors are detected.

Features

- Reduces software effort in microcomputer applications
- Provides easy source code manipulation and instant program revision
- Allows immediate-mode execution of program statements to assist program checkout
- Includes floating-point arithmetic package to provide full computational capability
- Readily adaptable to user-supplied I/O routines
- Allows calls to high-speed, machine-language subroutines
- Allows use of indestructible hexadecimal debugging package
- Available as INS8298 (28 pin, 800 ns access) and INS8298E (24 pin, 450 ns access)
- MICROBUS™* compatible

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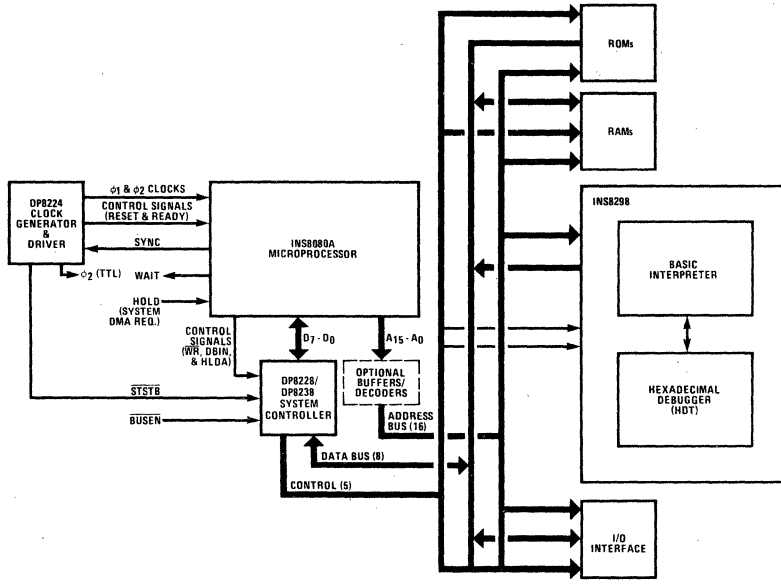
General System Configuration



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The LLL BASIC Interpreter is used to translate, debug, and execute user-written ASCII programs in read/write memory (RAM). Each statement is interpreted from its ASCII BASIC format, and then executed line-by-line. An LLL BASIC Compiler, written in FORTRAN, will soon be available in the public domain.* (See figure 1.)

The BASIC Interpreter accepts both program statements and control commands. Program statements describe (to the BASIC Interpreter) operations to be performed on program data. A program statement preceded by a line number is inserted into the program for later execution at a spot determined by the line number. If no line number precedes the statement, it is executed immediately and then discarded. This latter mode, known as "immediate" or "direct," is especially valuable during program checkout. Control commands specify actions that alter the status of the user's program; for example, they direct the execution, saving, and retrieval of programs. Program statements are summarized in table 1; control commands are summarized in table 2.

The BASIC Interpreter is located in ROM from 1000_{16} through $2FFF_{16}$. BASIC assumes that its RAM starts at location $3D00_{16}$. The memory map is shown in table 3. All I/O routines used by the INS8298 are located in the upper 256 bytes of the address space so that a simple address decoding circuit can allow the substitution of a special user-supplied I/O package, if necessary. As an alternative scheme for allowing the user to tailor I/O to his own needs, entry points to the interpreter are provided that allow the page zero initialization program to channel all BASIC I/O through its own routines.

A hexadecimal debugging routine (HDT) is also available on the INS8298 ROM. HDT allows the user to examine internal registers and memory locations and modify their contents. HDT is called from the BASIC Interpreter to help debug user-developed software. Input and output data representation is in hexadecimal format. In addition to the usual debugging capabilities, HDT also has commands to perform the following functions:

- Test a specified range of memory locations
- Load programs in hexadecimal, NSC, and LLL binary formats
- Save the contents of a specified range of memory locations

In addition to the features summarized previously, LLL BASIC has many capabilities found in other standard BASIC systems (see tables 1 and 2). However, LLL BASIC does not include built-in operations as intrinsic functions, e.g., trigonometric or string-manipulation functions. Also, LLL BASIC does not permit arbitrary arithmetic expressions beyond those of the form:

variable op variable

where the first variable in the expression may be preceded by a minus (–); op may be a plus (+), minus (–), asterisk (*) for multiplication, or slash (/) for division; and either variable can be an identifier, function, or number.

*For additional information, contact:

Argonne Code Center
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

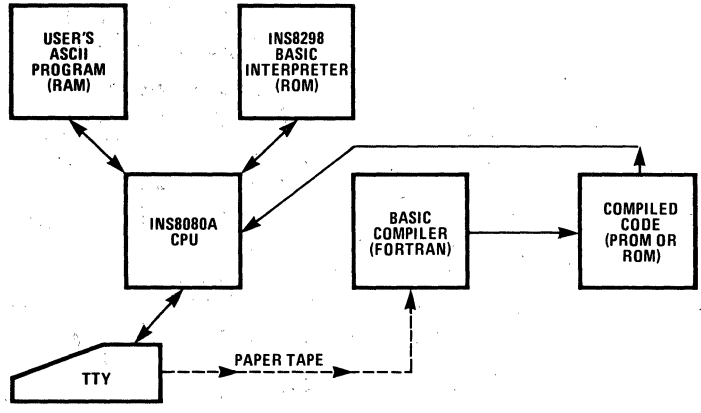


Figure 1. Operation of the LLL BASIC Interpreter and Compiler with the INS8080A

Table 1. BASIC Statements

Statement	Function
CALL	Calls user-written assembly-language routines.
DIM	Declares a one-dimensional array. (Indexing is from zero.)
END	Terminates a program and returns control to BASIC.
FOR	Causes program to iterate through a loop a designated number of times.
GET expression	Reads input data from a specified port.
GOSUB nn	Transfers control to a subroutine beginning at line nn.
GOTO nn	Transfers control to line nn.
IF expression THEN nn	Transfers to line nn if the condition of the expression is met.
INPUT list	Allows the user to supply numeric data to a program directly from the terminal.
LET identifier = expression	Assigns the value of an expression to the identifier on the left side of the equal sign.
NEXT	Signals the end of a loop.
PRINT	Allows numeric data and character strings to be printed on the terminal.
PUT expression	Writes output data to a specified port.
REM	Allows comments to be inserted in the program listing.
RETURN	Returns control to the line after the last GOSUB.
STOP	Suspends program execution and returns.

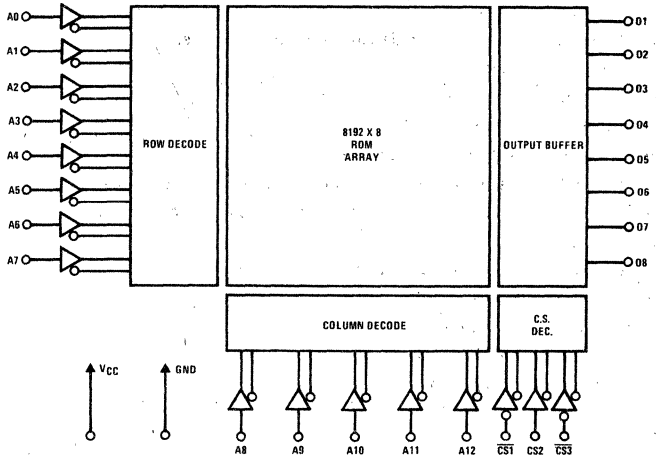
Table 2. BASIC Commands

Command	Function
CONTROL/H (backspace)	Deletes the previous character typed during input.
CONTROL/S	Interrupts program during execution and returns to immediate mode.
DEBUG	Transfers control to the Hexadecimal Debugger program (HDT).
LIST	Prints out all or part of a program at the terminal.
PACK	Frees memory locations in RAM to allow the user more working space.
PLIST	Punches paper-tape copy of a program.
PTAPE	Reads in paper-tape copy of program using high-speed reader.
RUN	Begins execution of the program currently in memory.
SCR	Erases the program in memory

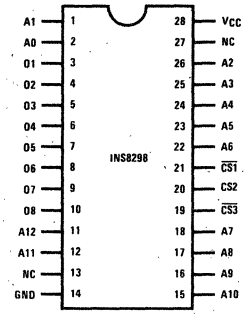
Table 3. Memory Map for BASIC Interpreter

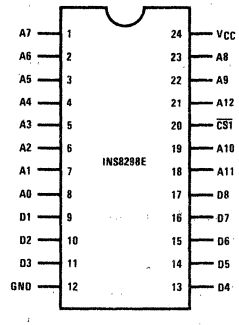
ROM Address (hex)	Function
1000 - 1008	BASIC entry points for initialization.
1009 - 27FF	BASIC Interpreter.
2800 - 2EFF	Hexadecimal Debugger (HDT) and loaders.
2F00 - 2FFF	System I/O routines for INS8251 USART (ports EC and ED).
RAM Address (hex)	**Function**
3D00 - 3DFF	BASIC RAM scratch area (buffers, variables, etc.).
3E00 upward	BASIC user program space.
Top of RAM downward	BASIC stack area.
Chip Selects	
$\overline{CS1}$	Active low (0).
CS2	Active high (1).
$\overline{CS3}$	Active low (0).

Block and Connection Diagrams



NOTE: CS2 AND $\overline{CS3}$ NOT AVAILABLE IN INS8298E.





Absolute Maximum Ratings (Note 1)

Voltage at Any Pin	−0.5V to +6.5V
Operating Temperature Range	0°C to +70°C
Storage Temperature Range	−65°C to +150°C
Power Dissipation	1 W
Lead Temperature (Soldering, 10 seconds)	+300°C

Chip Selects

CS No.	Pin No.	Active Level
INS8298		
1	21	0
2	20	1
3	19	0
INS8298E		
1	20	0

DC Electrical Characteristics

(T_A within operating temperature range, V_{CC} = +5V ± 5%, unless otherwise specified.) See AC test circuit and switching time waveforms.

Parameter (Note 3)		Conditions	Min.	Typ. (Note 4)	Max.	Units
I_{LI}	Input Current	V_{IN} = 0V to V_{CC}			10	μA
V_{IH}	Logical "1" Input Voltage		2.2		V_{CC}+1.0	V
V_{IL}	Logical "0" Input Voltage		−0.5		0.6	V
V_{OH}	Logical "1" Output Voltage	I_{OH} = −200 μA	2.4			V
V_{OL}	Logical "0" Output Voltage	I_{OL} = 3.2 mA			0.4	V
I_{LOH}	Output Leakage Current	V_{OUT} = 4 V, Chip Deselected			10	μA
I_{LOL}	Output Leakage Current	V_{OUT} = 0.45 V, Chip Deselected			−20	μA
I_{CC1}	Power Supply Current	All Inputs = 5.25 V, Data Output Open		100	130	mA

Capacitance

Parameter (Note 3)		Conditions	Min.	Typ. (Note 4)	Max.	Units
C_{IN}	Input Capacitance (All Inputs)	V_{IN} = 0V, T_A = 25°C, f = 1 MHz, (Note 2)			7.5	pF
C_{OUT}	Output Capacitance	V_{OUT} = 0V, T_A = 25°C, f = 1 MHz, (Note 2)			15.0	pF

AC Electrical Characteristics

(T_A within operating temperature range, V_{CC} = +5V ± 5%, unless otherwise specified.) See AC test circuit and switching time waveforms.

Parameter (Note 3)		Conditions	Limits						Units
			INS8298			INS8298E			
			Min.	Typ. (Note 4)	Max.	Min.	Typ. (Note 4)	Max.	
t_A	Address Access Time	See AC Load Circuit. All times except t_{OFF} measured to 1.5V level with t_r and t_f of input < 20 ns (figures 2 & 3), t_{OFF} TRI-STATE output level measured to less than ±20 μA output current.		450	800			450	ns
t_{AC}	Chip Select Access Time			150	250			150	ns
t_{OFF}	Output Turn OFF Delay			150	250			150	ns
t_C	Cycle Time		800	450					ns
t_{AS}	Address Set-Up Time Referenced to Chip Select		550						ns

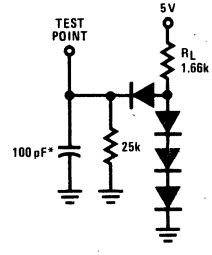
Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: Capacitance is guaranteed by periodic testing.

Note 3: Positive true logic notation is used: logical "1" = most positive voltage level, logical "0" = most negative voltage level.

Note 4: Typical values are for T_A = 25°C and nominal supply voltage.

AC Test Circuit and Switching Time Waveforms



*INCLUDES JIG CAPACITANCE.

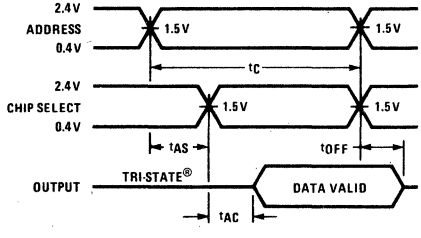


Figure 2. Address Precedes Chip Select

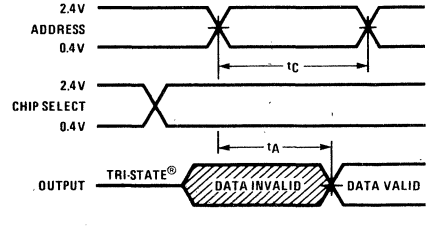


Figure 3. Address Follows Chip Select

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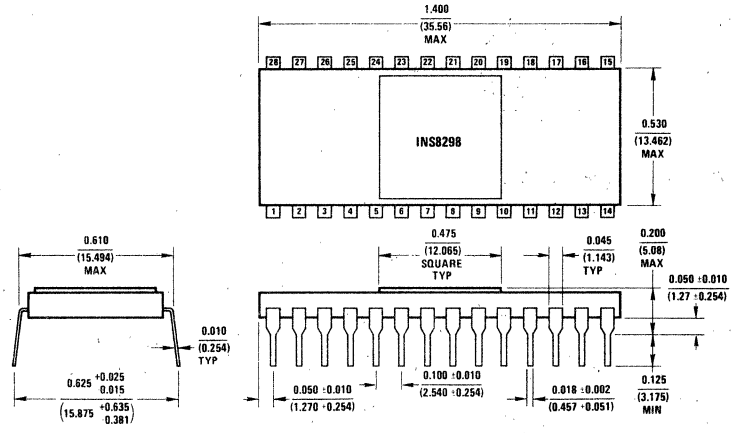
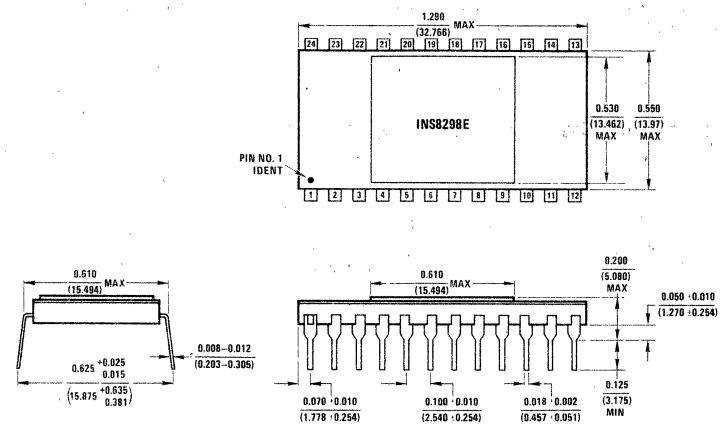
Physical Dimensions inches (millimeters)



28-Lead Cavity Dual-In-Line Package (D)
Order Number INS8298D
NS Package Number D28A



24-Lead Cavity Dual-In-Line Package (D)
Order Number INS8298ED
NS Package Number D24A

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