Table 1. Pin Description

Symbol	Pin No.	Type	Name and Function
PFEED	1	I	**Paper Feed:** Paper feed input switch.
XTAL1 XTAL2	2 3	I	**Crystal:** Inputs for a crystal to set internal oscillator frequency. For proper operation use 6 MHz crystal.
$\overline{RESET}$	4	I	**Reset:** Reset input, active low. After reset the 8295 will be set for 12 characters/inch single width printing, solenoid strobe at 320 msec.
NC	5		**No Connection:** No connection or tied high.
$\overline{CS}$	6	I	**Chip Select:** Chip select input used to enable the RD and WR inputs except during DMA.
GND	7		**Ground:** This pin must be tied to ground.
$\overline{RD}$	8	I	**Read:** Read input which enables the master CPU to read data and status. In the serial mode this pin must be tied to V_{CC}.
V_{CC}	9		**Power:** +5 volt power input: +5V ± 10%.
$\overline{WR}$	10	I	**Write:** Write input which enables the master CPU to write data and commands to the 8295. In the serial mode this pin must be tied to V_{SS}.
SYNC	11	O	**Sync:** 2.5 μs clock output. Can be used as a strobe for external circuitry.
D_0 D_1 D_2 D_3 D_4 D_5 D_6 D_7	12 13 14 15 16 17 18 19	I/O	**Data Bus:** Three-state bidirectional data bus buffer lines used to interface the 8295 to the host processor in the parallel mode. In the serial mode D_0—D_2 sets up the baud rate.
GND	20		**Ground:** This pin must be tied to ground.
V_{CC}	40		**Power:** +5 volt power input: +5 ± 10%.

Symbol	Pin No.	Type	Name and Function
HOME	39	I	**Home:** Home input switch, used by the 8295 to detect that the print head is in the home position.
$\overline{DACK}$/SIN	38	I	**DMA Acknowledge/Serial Input:** In the parallel mode used as DMA acknowledgment; in the serial mode, used as input for data.
DRQ/$\overline{CTS}$	37	O	**DMA Request/Clear to Send:** In the parallel mode used as DMA request output pin to indicate to the 8257 that a DMA transfer is requested; in the serial mode used as clear-to-send signal.
IRQ/$\overline{SER}$	36	O	**Interrupt Request/Serial Mode:** In parallel mode it is an interrupt request input to the master CPU; in serial mode it should be strapped to V_{SS}.
$\overline{MOT}$	35	O	**Motor:** Main motor drive, active low.
STB	34	O	**Solenoid Strobe:** Solenoid strobe output. Used to determine duration of solenoids activation.
$\overline{S_7}$ $\overline{S_6}$ $\overline{S_5}$ $\overline{S_4}$ $\overline{S_3}$ $\overline{S_2}$ $\overline{S_1}$	33 32 31 30 29 28 27	O	**Solenoid:** Solenoid drive outputs; active low.
V_{DD}	26		**Power:** +5V power input (+5V ± 10%). Low power standby pin.
V_{CC}	25		**Power:** Tied high.
GP1 GP2	24 23	O O	**General Purpose:** General purpose output pins.
$\overline{TOF}$	22	I	**Top of Form:** Top of form input, used to sense top of form signal for type T printer.
$\overline{PFM}$	21	O	**Paper Feed Motor Drive:** Paper feed motor drive, active low.

8295
DOT MATRIX PRINTER CONTROLLER

- **Interfaces Dot Matrix Printers to MCS-48™, MCS-80/85™, MCS-86™ Systems**
- **40 Character Buffer On Chip**
- **Serial or Parallel Communication with Host**
- **DMA Transfer Capability**
- **Programmable Character Density (10 or 12 Chararcters/Inch)**
- **Programmable Print Intensity**
- **Single or Double Width Printing**
- **Programmable Multiple Line Feeds**
- **3 Tabulations**
- **2 General Purpose Outputs**

The Intel® 8295 Dot Matrix Printer Controller provides an interface for microprocessors to the LRC 7040 Series dot matrix impact printers. It may also be used as an interface to other similar printers.

The chip may be used in a serial or parallel communication mode with the host processor. In parallel mode, data transfers are based on polling, interrupts, or DMA. Furthermore, it provides internal buffering of up to 40 characters and contains a 7 x 7 matrix character generator accommodating 64 ASCII characters.

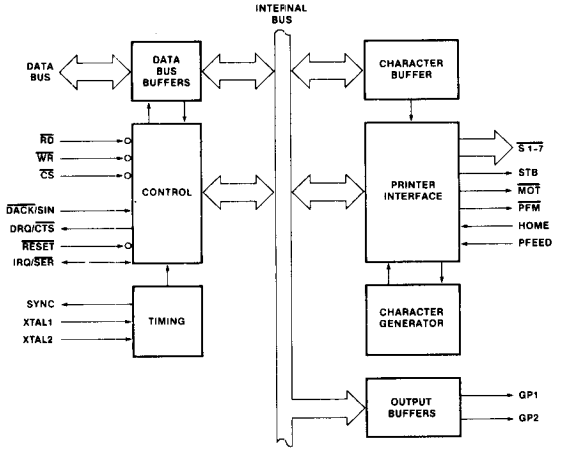


Figure 1. Block Diagram

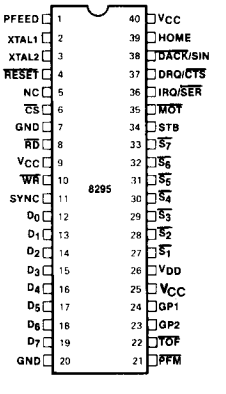


Figure 2. Pin Configuration

lowed by a byte specifying the column. The tab positions will then remain valid until new Set Tab commands are issued.

Sending a tab character (09H) will automatically fill the character buffer with blanks up to the next tab position. The character sent immediately after the tab character will thus be stored and printed at that position.

CPU TO 8295 INTERFACE

Communication between the CPU and the 8295 may take place in either a serial or parallel mode. However, the selection of modes is inherent in the system hardware; it is not software programmable. Thus, the two modes cannot be mixed in a single 8295 application.

PARALLEL INTERFACE

Two internal registers on the 8295 are addressable by the CPU: one for input, one for output. The following table describes how these registers are accessed.

$\overline{RD}$	$\overline{WR}$	$\overline{CS}$	Register
1	0	0	Input Data Register
0	1	0	Output Status Register

Input Data Register—Data written to this register is interpreted in one of two ways, depending on how the data is coded.

1. A command to be executed (0XH or 1XH).
2. A character to be stored in the character buffer for printing (2XH, 3XH, 4XH, or 5XH). See the character set, Table 2.

Output Status Register—8295 status is available in this register at all times.

STATUS BIT:	7	6	5	4	3	2	1	0
FUNCTION:	x	x	PA	DE	x	x	IBF	x

PA—Parameter Required; PA = 1 indicates that a command requiring a parameter has been received. After the necessary parameters have been received by the 8295, the PA flag is cleared.

DE—DMA Enabled; DE = 1 whenever the 8295 is in DMA mode. Upon completion of the required DMA transfers, the DE flag is cleared.

IBF—Input Buffer Full; IBF = 1 whenever data is written to the Input Data Register. No data should be written to the 8295 when IBF = 1.

A flow chart describing communication with the 8295 is shown in Figure 3.

The interrupt request output (IRQ, Pin 36) is available on the 8295 for interrupt driven systems. This output is asserted true whenever the 8295 is ready to receive data.

To improve bus efficiency and CPU overhead, data may be transferred from main memory to the 8295 via DMA cycles. Sending the Enable DMA command (08H) activates the DMA channel of the 8295. This command must be followed by two bytes specifying the length of the data string to be transferred (least significant byte first). The 8295 will then assert the required DMA requests to the 8257 DMA controller without further CPU intervention. Figure 4 shows a block diagram of the 8295 in DMA mode.

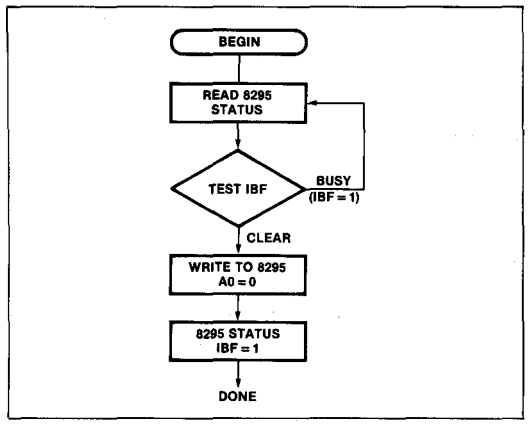


Figure 3. Host to 8295 Protocol Flowchart

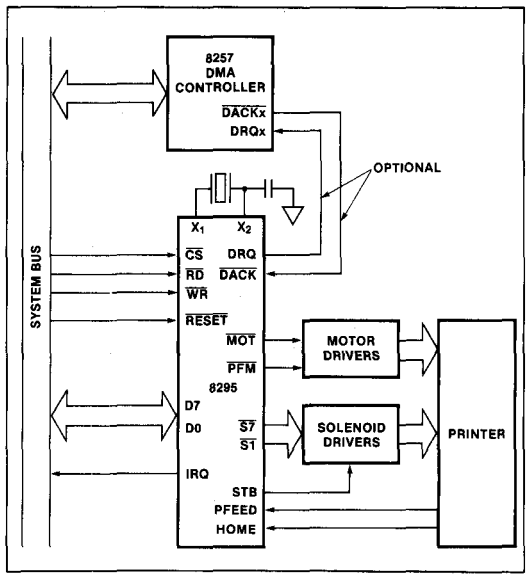


Figure 4. Parallel System Interface

Data transferred in the DMA mode may be either commands or characters or a mixture of both. The procedure is as follows:

1. Set up the 8257 DMA controller channel by sending a starting address and a block length.
2. Set up the 8295 by issuing the "Enable DMA" command (08H) followed by two bytes specifying the block length (least significant byte first).

The DMA enabled flag (DE) will be true until the assigned data transfer is completed. Upon completion of the transfer, the flag is cleared and the interrupt request (IRQ) signal is asserted. The 8295 then returns to the non-DMA mode of operation.

FUNCTIONAL DESCRIPTION

The 8295 interfaces microcomputers to the LRC 7040 Series dot matrix impact printers, and to other similar printers. It provides internal buffering of up to 40 characters. Printing begins automatically when the buffer is full or when a carriage return character is received. It provides a modified 7x7 matrix character generator. The character set includes 64 ASCII characters.

Communication between the 8295 and the host processor can be implemented in either a serial or parallel mode. The parallel mode allows for character transfers into the buffer via DMA cycles. The serial mode features selectable data rates from 110 to 4800 baud.

The 8295 also offers two general purpose output pins which can be set or cleared by the host processor. They can be used with various printers to implement such functions as ribbon color selection, enabling form release solenoid, and reverse document feed.

COMMAND SUMMARY

Hex Code	Description
00	Set GP1. This command brings the GP1 pin to a logic high state. After power on it is automatically set high.
01	Set GP2. Same as the above but for GP2.
02	Clear GP1. Sets GP1 pin to logic low state, inverse of command 00.
03	Clear GP2. Same as above but for GP2. Inverse command 01.
04	Software Reset. This is a pacify command. This command is not effective immediately after commands requiring a parameter, as the Reset command will be interpreted as a parameter.
05	Print 10 characters/in. density.
06	Print 12 characters/in. density.
07	Print double width characters. This command prints characters at twice the normal width, that is, at either 17 or 20 characters per line.
08	Enable DMA mode; must be followed by two bytes specifying the number of data characters to be fetched. Least significant byte accepted first.
09	Tab character.
0A	Line feed.
0B	Multiple Line Feed; must be followed by a byte specifying the number of line feeds.
0C	Top of Form. Enables the line feed output until the Top of Form input is activated.
0D	Carriage Return. Signifies end of a line and enables the printer to start printing.
0E	Set Tab #1, followed by tab position byte.
0F	Set Tab #2, followed by tab position byte. Should be greater than Tab #1.
10	Set Tab #3, followed by tab position byte. Should be greater than Tab #2.
11	Print Head Home on Right. On some printers the print head home position is on the right. This command would enable normal left to right printing with such printers.
12	Set Strobe Width; must be followed by strobe width selection byte. This command adjusts the duration of the strobe activation.

PROGRAMMABLE PRINTING OPTIONS

CHARACTER DENSITY

The character density is programmable at 10 or 12 characters/inch (32 or 40 characters/line). The 8295 is automatically set to 12 characters/inch at power-up. Invoking the Print Double-Width command halves the character density (5 or 6 characters/inch). The 10 char/in or 12 char/in command must be re-issued to cancel the Double-Width mode. Different character density modes may not be mixed within a single line of printing.

PRINT INTENSITY

The intensity of the printed characters is determined by the amount of time during which the solenoid is on. This on-time is programmable via the Set Strobe-Width command. A byte following this command sets the solenoid on-time according to Table 2. Note that only the three least significant bits of this byte are important.

Table 2. Solenoid On-Time

D7—D3	D2	D1	D0	Solenoid On (microsec)
x	0	0	0	200
x	0	0	1	240
x	0	1	0	280
x	0	1	1	320
x	1	0	0	360
x	1	0	1	400
x	1	1	0	440
x	1	1	1	480

TABULATIONS

Up to three tabulation positions may be specified with the 8295. The column position of each tabulation is selected by issuing the Set Tab commands, each fol-

8295 CHARACTER SET

Hex Code	Print Char.	Hex Code	Print Char.	Hex Code	Print Char.	Hex Code	Print Char.
20	space	30	0	40	@	50	P
21	!	31	1	41	A	51	Q
22	"	32	2	42	B	52	R
23	#	33	3	43	C	53	S
24	$	34	4	44	D	54	T
25	%	35	5	45	E	55	U
26	&	36	6	46	F	56	V
27	'	37	7	47	G	57	W
28	(	38	8	48	H	58	X
29	)	39	9	49	I	59	Y
2A	*	3A	:	5A	J	5A	Z
2B	+	3B	;	4B	K	5B	[
2C	,	3C	<	4C	L	5C	\
2D	-	3D	=	4D	M	5D	]
2E	.	3E	>	4E	N	5E	↑
2F	/	3F	?	4F	O	5F	—

ABSOLUTE MAXIMUM RATINGS*

Ambient Temperature Under Bias . . . . . 0°C to 70°C
Storage Temperature . . . . . −65° to +150°C
Voltage on Any Pin With
Respect to Ground . . . . . −0.5V to +7V
Power Dissipation . . . . . 1.5 Watt

**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.*

D.C. AND OPERATING CHARACTERISTICS (T_A = 0°C to 70°C, V_{CC} = V_{DD} = +5V ± 10%, V_{SS} = 0V)

Symbol	Parameter	Limits			Unit	Test Conditions
		Min.	Typ.	Max.		
V_{IL}	Input Low Voltage (All Except X_1, X_2, $\overline{RESET}$)	−0.5		0.8	V	
V_{IL1}	Input Low Voltage (X_1, X_2, $\overline{RESET}$)	−0.5		0.6	V	
V_{IH}	Input High Voltage (All Except X_1, X_2, $\overline{RESET}$)	2.2		V_{CC}	V	
V_{IH1}	Input High Voltage (X_1, X_2, $\overline{RESET}$)	3.8		V_{CC}	V	
V_{OL}	Output Low Voltage (D_0-D_7)			0.45	V	I_{OL} = 2.0 mA
V_{OL1}	Output Low Voltage (All Other Outputs)			0.45	V	I_{OL} = 1.6 mA
V_{OH}	Output High Voltage (D_0-D_7)	2.4			V	I_{OH} = −400 μA
V_{OH1}	Output High Voltage (All Other Outputs)	2.4			V	I_{OH} = −50 μA
I_{IL}	Input Leakage Current ($\overline{RD}$, $\overline{WR}$, $\overline{CS}$, $\overline{A_0}$)			±10	μA	$V_{SS} \leq V_{IN} \leq V_{CC}$
I_{OZ}	Output Leakage Current (D_0-D_7, High Z State)			±10	μA	V_{SS}+0.45 ≤ $V_{OUT} \leq V_{CC}$
I_{DD}	V_{DD} Supply Current		5	15	mA	
$I_{DD} + I_{CC}$	Total Supply Current		60	125	mA	
I_{LI}	Low Input Load Current (Pins 24, 27-38)			0.5	mA	V_{IL} = 0.8V
I_{LI1}	Low Input Load Current ($\overline{RESET}$)			0.2	mA	V_{IL} = 0.8V
I_{IH}	Input High Leakage Current (Pins 22, 38)			100	μA	V_{IN} = V_{CC}
C_{IN}	Input Capacitance			10	pF	
$C_{I/O}$	I/O Capacitance			20	pF	

SERIAL INTERFACE

The 8295 may be hardware programmed to operate in a serial mode of communication. By connecting the IRQ/$\overline{SER}$ pin (pin 36) to logic zero, the serial mode is enabled immediately upon power-up. The serial Baud rate is also hardware programmable; by strapping pins 14, 13, and 12 according to Table 3, the rate is selected. $\overline{CS}$, $\overline{RD}$, and $\overline{WR}$ must be strapped as shown in Figure 5.

Table 3. Serial Baud Rate

Pin 14	Pin 13	Pin 12	Baud Rate
0	0	0	110
0	0	1	150
0	1	0	300
0	1	1	600
1	0	0	1200
1	0	1	2400
1	1	0	4800
1	1	1	4800

The serial data format is shown in Figure 5. The CPU should wait for a clear to send signal ($\overline{CTS}$) from the 8295 before sending data.

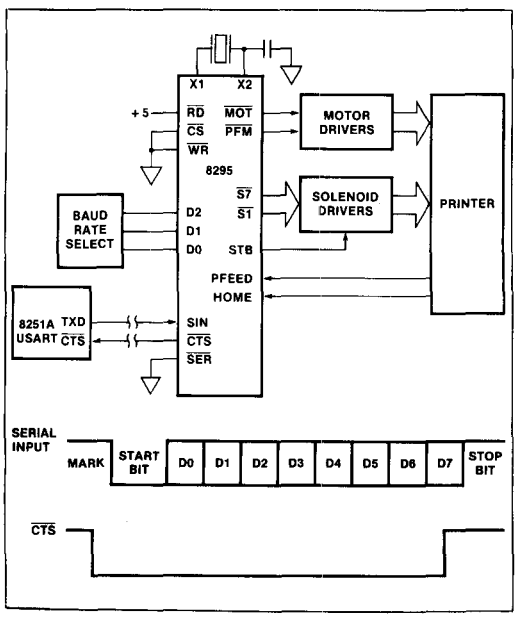


Figure 5. Serial Interface to UART (8251A)

8295 TO PRINTER INTERFACE

The strobe output signal of the 8295 determines the duration of the solenoid outputs, which hold the data to the printer. These solenoid outputs cannot drive the printer solenoids directly. They should be buffered through solenoid drivers as shown in Figure 6. Recommended solenoid and motor driver circuits may be found in the printer manufacturer's interface guide.

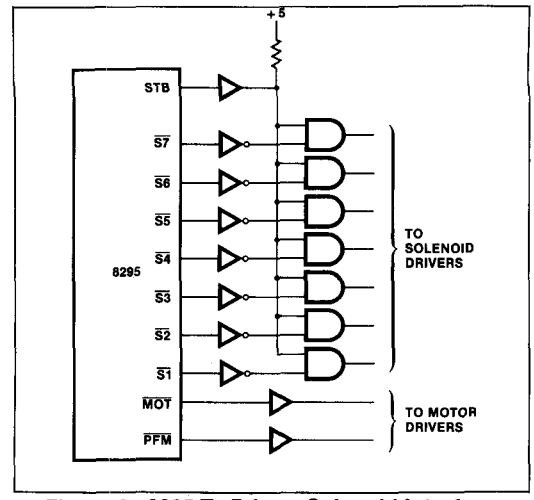


Figure 6. 8295 To Printer Solenoid Interface

OSCILLATOR AND TIMING CIRCUITS

The 8295's internal timing generation is controlled by a self-contained oscillator and timing circuit. A 6 MHz crystal is used to derive the basic oscillator frequency. The resident timing circuit consists of an oscillator, a state counter and a cycle counter as illustrated in Figure 7. The recommended crystal connection is shown in Figure 8.

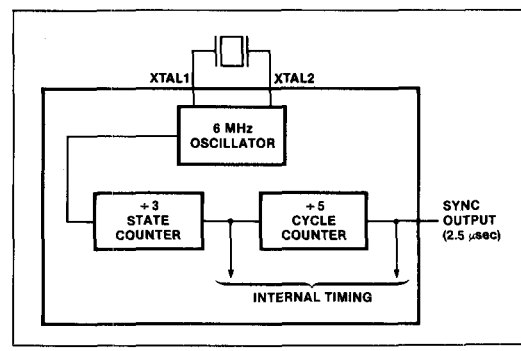


Figure 7. Oscillator Configuration

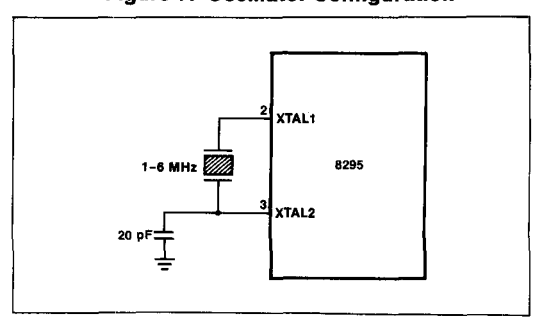
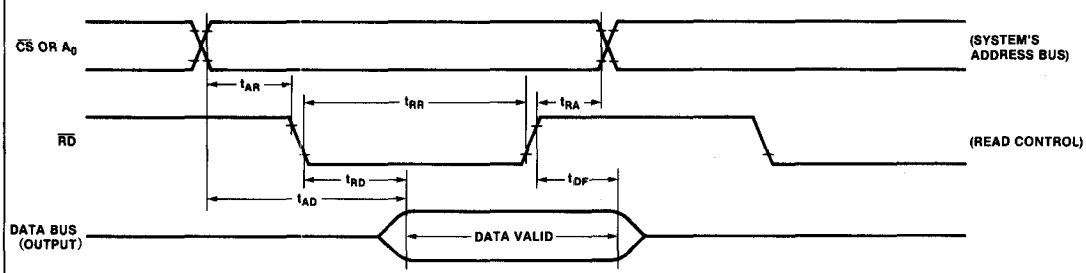


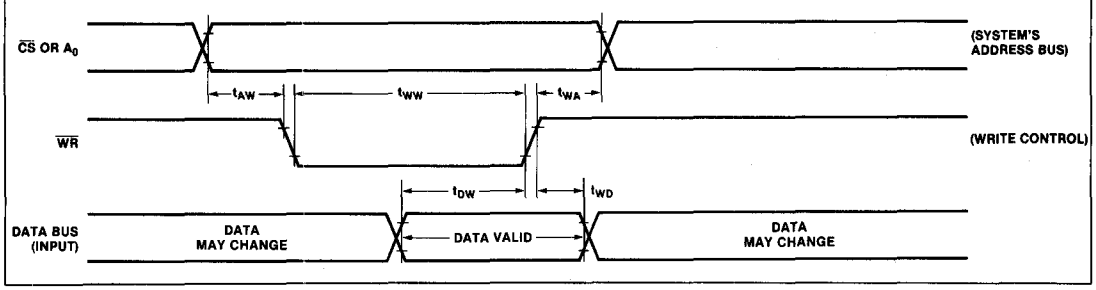
Figure 8. Recommended Crystal Connection

WAVEFORMS

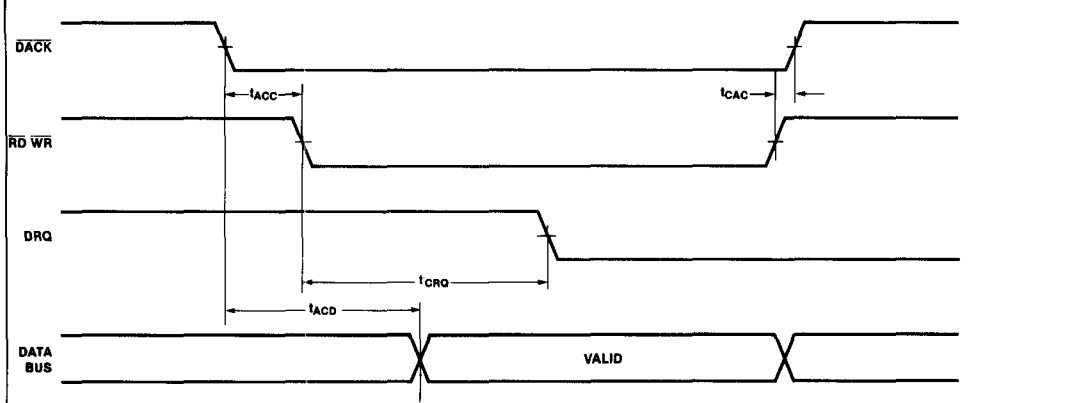
READ OPERATION—OUTPUT BUFFER REGISTER



WRITE OPERATION—INPUT BUFFER REGISTER



DMA AND INTERRUPT TIMING



A.C. CHARACTERISTICS (T_A = 0°C to 70°C, V_{CC} = V_{DD} = +5V ± 10%, V_{SS} = 0V)

DBB READ

Symbol	Parameter	Min.	Max.	Unit	Test Conditions
t_{AR}	$\overline{CS}$, A_0 Setup to $\overline{RD}$ ↓	0		ns	
t_{RA}	$\overline{CS}$, A_0 Hold After $\overline{RD}$ ↑	0		ns	
t_{RR}	$\overline{RD}$ Pulse Width	250		ns	
t_{AD}	$\overline{CS}$, A_0 to Data Out Delay		225	ns	C_L = 150 pF
t_{RD}	$\overline{RD}$ ↓ to Data Out Delay		225	ns	C_L = 150 pF
t_{DF}	$\overline{RD}$ ↑ to Data Float Delay		100	ns	
t_{CY}	Cycle Time	2.5	15	μs	

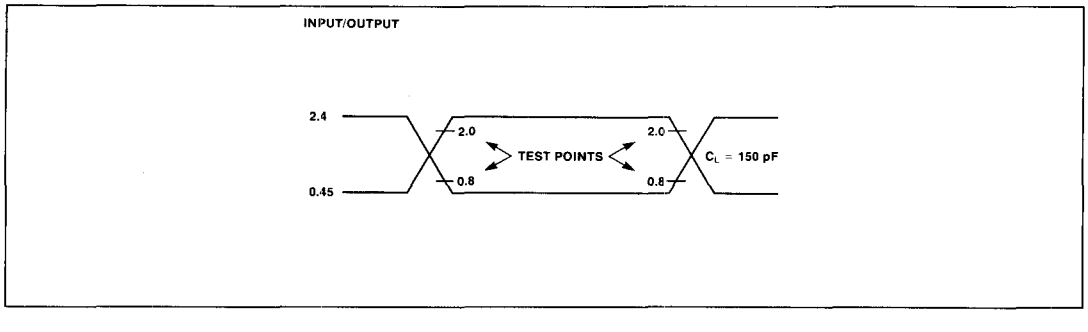
DBB WRITE

Symbol	Parameter	Min.	Max.	Unit	Test Conditions
t_{AW}	$\overline{CS}$, A_0 Setup to $\overline{WR}$ ↓	0		ns	
t_{WA}	$\overline{CS}$, A_0 Hold After $\overline{WR}$ ↑	0		ns	
t_{WW}	$\overline{WR}$ Pulse Width	250		ns	
t_{DW}	Data Setup to $\overline{WR}$ ↑	150		ns	
t_{WD}	Data Hold to $\overline{WR}$ ↑	0		ns	

DMA AND INTERRUPT TIMING

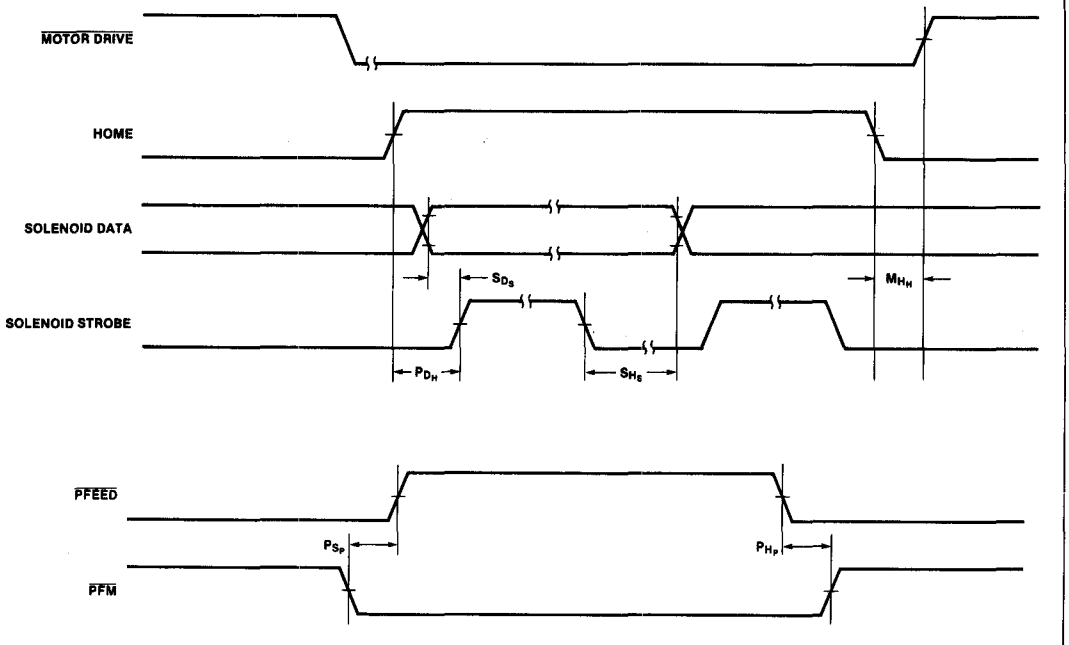
Symbol	Parameter	Min.	Max.	Unit	Test Conditions
t_{ACC}	$\overline{DACK}$ Setup to Control	0		ns	
t_{CAC}	$\overline{DACK}$ Hold After Control	0		ns	
t_{CRQ}	$\overline{WR}$ to DRQ Cleared		200	ns	
t_{ACD}	$\overline{DACK}$ to Data Valid		225	ns	C_L = 150 pF

A.C. TESTING INPUT, OUTPUT WAVEFORM



WAVEFORMS (Continued)

PRINTER INTERFACE TIMING



Symbol	Parameter	Typical
P_{DH}	Print delay from home inactive	1.8 ms
S_{DS}	Solenoid data setup time before strobe active	25 μs
S_{HS}	Solenoid data hold after strobe inactive	>1 ms
M_{HA}	Motor hold time after home active	3.2 ms
P_{SP}	PFEED setup time after PFM active	58 ms
P_{HP}	PFM hold time after PFEED active	9.75 ms