DOT MATRIX PRINTER CONTROLLER

DESCRIPTION

The μPD782 is an LSI Dot Matrix Printer Controller chip which contains all the circuitry and control functions for interfacing an 8-bit processor to the Epson Model 210, 220 and 240 Dot Matrix Printers. These printers are capable of printing up to 31 columns per row with 7 x 7 dot matrix. The μPD782 is ideally suited for low-cost Electronic Cash Registers (ECR) and Point of Sale (POS) systems because it frees the processor from direct control of the printer and simplifies I/O software.

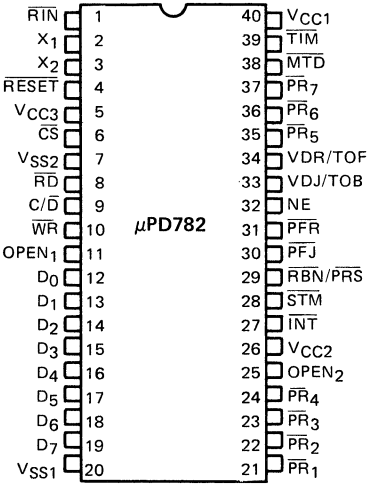
There are nine separate instructions, which the μPD782 will execute. Each of these instructions requires a single 8-bit byte from the processor to be executed. Upon receipt of the instruction, the μPD782 assumes the control of the printer, increments the position of the print head, activates the print solenoids, performs line feeds in either receipt or journal mode (or both), and performs all these operations for an entire print line.

The μPD782 contains its own on-board character generator of 96 symbols. It contains a 31 column printer buffer and is capable of supplying status information to the host processor on both the controller itself as well as the printer. After the character buffer is loaded from the host processor the entire row is printed out with a single print command.

FEATURES

- Compatible with most Microprocessors Including 8080A, 8085A, Z-80™ and others
- Capable of Interfacing to Epson Model 210, 210S, 220 and 240 Printers
- Print Technique – Serial Dot Matrix
- Print Font – 7 x 7 Dot Matrix
- Column Print Capacity
  - Model 210 – 31 Characters with 1 Dot Spacing; 26 Characters with 2 Dot Spacing
  - Model 210S – 28 Characters with 1 Dot Spacing; 23 Characters with 2 Dot Spacing
  - Model 220 – 14 + 14 Characters in Receipt/Journal Mode; 31 Characters in Normal Mode
  - Model 240 – 31 Characters
- 96 Character Set (Alphanumerics Plus Symbols)
- Print Speed – Approximately 3 Lines/Sec.
- Paper Feed Receipt and Journal; Fast Feed
- Paper Release and Ink Ribbon Change-Over Outputs
- Motor Error and Write Request Interrupt
- On-Board 6 MHz Oscillator (External Crystal Required)
- Operates from a Single +5V Power Supply (NMOS Technology)
- Available in 40 Pin Plastic Package

PIN CONFIGURATION



PIN NAMES

$\overline{RIN}$	Reset In
X_1 X_2	Crystal Inputs
$\overline{RESET}$	Reset
V_{CC1-3}	DC Power
V_{SS1-2}	Signal Ground
$\overline{CS}$	Chip Select
$\overline{RD}$	Read
C/$\overline{D}$	Command/Data
$\overline{WR}$	Write
$OPEN_{1-2}$	No Connection
D_0-D_7	Data Bus
$\overline{PR_1}$-$\overline{PR_7}$	Print Solenoids
$\overline{INT}$	Interrupt
$\overline{STM}$	Stamp
$\overline{RBN}/\overline{PRS}$	Ribbon/Paper Release
$\overline{PFJ}$	Paper Feed Journal
$\overline{PFR}$	Paper Feed Receipt
NE	Low Paper Detector
VDJ/BOF	Validation J/BOF Sensor
VDR/BOT	Validation R/BOT Sensor
$\overline{MTD}$	Motor Drive
$\overline{TIM}$	Timing Signal

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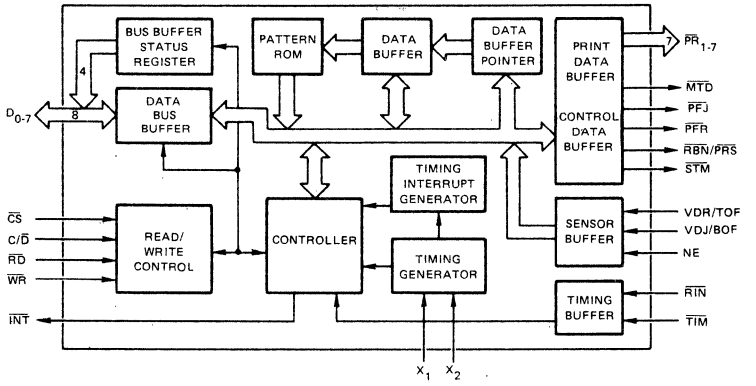
TM: Z-80 is a registered trademark of Zilog, Inc.

BLOCK DIAGRAM



PIN IDENTIFICATION

PIN NUMBER	PIN SYMBOL	PIN NAME	I/O	FUNCTION
1	$\overline{RIN}$	Reset In	I	This pin should be connected to the R Sensor from the printer so that it is active-low.
2,3	X_1, X_2	External Crystal Input	I	This is a connection to external crystal (Frequency: 6 MHz). X_1 could also be used as input for external oscillator.
4	$\overline{RESET}$	Reset	I	The Reset signal initializes the μPD782 When $\overline{RESET}$ = 0, the buffer and register contents are: Bus Buffer – (IOM-1, IOB=PSR=0). Column Buffer – All characters in this buffer become $20_{(16)}$ Column Buffer Pointer – It indicates the left side of the buffer.
5, 26 40	V_{CC1-3}	DC Power		These are connected to +5V power supply.
6	$\overline{CS}$	Chip Select	I	If the Chip Select is 0 when the data bus becomes active, it enables the transfer of data between the processor and the μPD782 via the data bus. If it is 1, the data bus goes into High-Impedance state (inactive). However, the operation of the printer is not affected when $\overline{CS}$=1.
7,20	V_{SS1-2}	Signal Ground		
8	$\overline{RD}$	Read	I	The Read Control Signal is used to read controller status or printer status to the host processor. When $\overline{RD}$ = 0, status information is presented.
9	C/$\overline{D}$	Command/ Data Select	I	The C/$\overline{D}$ Select is used to indicate what kind of data is being input/output on the data bus by the host processor. When C/$\overline{D}$=1 in Read Operation, it is a Controller Status and in Write Operation it gives commands. When C/$\overline{D}$=0 in Read Operation it is a Printer Status and in Write Operation it is print data.

PIN IDENTIFICATION (CONT.)

PIN			I/O	FUNCTION
NUMBER	SYMBOL	NAME		
10	$\overline{WR}$	Write	I	The Write Control Signal is used to write commands or print data to the μPD782. When $\overline{WR}$=0, data on the data bus is written into the μPD782.
12-19	D_{0-7}	Data Bus	I/O 3-State	It is an 8-bit bi-directional data bus and is used to transfer the data between the host processor and the μPD782.
11,25	$OPEN_{1-2}$	No Connection		These pins must be open. Do not connect them to +5V, GND or any other signals.
21-24, 35-37	$\overline{PR}_1$-$\overline{PR}_7$	Print Solenoid	O	These are drive signals for the print solenoids. When these signals are 0, the print solenoid should be activated. They are synchronized with the timing signal ($\overline{TIM}$), which is issued from the printer.
39	$\overline{TIM}$	Timing Signal	I	The timing signal is issued from the printer. It is used to generate and synchronize all the basic printer operations such as paper feed, paper cut, etc.
27	$\overline{INT}$	Interrupt	O	There are two reasons for this signal to go low. One is when the μPD782 is ready to receive data into the Data Buffer. It gets reset after the first byte of data is loaded. The other reason is the motor error during the printing or line feed. It will get set if the paper is jammed or if the print solenoid is kept on for more than 20 ms. It gets clear by the initialize command.
28	$\overline{STM}$	Stamp	O	Stamp output for Model M-220 printer. After the stamp command is given, this signal goes low for 200 ms.
29	$\overline{RBN}/\overline{PRS}$	Ribbon/ Paper Release	O	This is low active signal. For Model 210 and 210S it will select red ribbon. For Model 240 it will cause slip release. It is activated by print command.
30	$\overline{PFJ}$	Paper Feed Journal	O	This is the drive signal for the journal paper feed for Model 220 and for normal paper feed for other models. It is a low active signal.
31	$\overline{PFR}$	Paper Feed Receipt	O	This is the drive signal for the receipt paper feed for Model 220 and should be left open for other models.
32	NE	Low Paper Detector	I	This signal indicates a low paper condition in Model 220 and is active high.
33,34	VDR/TOF VDJ/TOB	Validation Sensors	I	These signals indicate the position of the print head in the printer. For Model 220 – right and left position. For Model 240 – top and bottom.
38	$\overline{MTD}$	Motor Drive	O	This signal activates the motor in the printer and is active low.

ABSOLUTE MAXIMUM RATINGS*

Operating Temperature . . . . . 0°C to +70°C
Storage Temperature . . . . . -65°C to +125°C
Voltage On Any Pin . . . . . -0.5 to +7 Volts①

Note: ① With Respect to Ground.

COMMENT: 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.

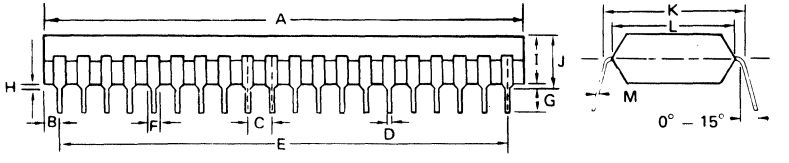
*T_a = 25°C

DC CHARACTERISTICS

T_a = 0°C to +70°C; V_{CC1-3} = +5V ± 5%; V_{SS1-2} = 0V

PARAMETER	SYMBOL	LIMITS			UNIT	TEST CONDITIONS
		MIN	TYP	MAX		
Input High Voltage (All except XTAL 1, XTAL 2, $\overline{RESET}$)	V_{IH1}	2.0		VCC	V	
Input High Voltage (XTAL 1, XTAL 2, RESET)	V_{IH2}	3.5		V_{CC}	V	
Input Low Voltage (All except XTAL 1, XTAL 2)	V_{IL}	-0.5		0.8	V	
Output High Voltage (D_{0-7})	V_{OH1}	2.4			V	I_{OH} = -400 μA
Output High Voltage (All Other Outputs)	V_{OH2}	2.4			V	I_{OH} = -50 μA
Output Low Voltage (D_{0-7})	V_{OL1}			0.45	V	I_{OL} = 2.0 mA
Output Low Voltage (All Other Outputs except D_{0-7})	V_{OL2}			0.45	V	I_{OL} = 1.6 mA
Low Input Source Current (VDR/BOF, VDL/TOF, NE, $\overline{TIM}$)	I_{LI1}			0.4	mA	V_{IL} = 0.8V
Low Input Source Current ($\overline{RESET}$)	I_{LI2}			*0.2	mA	V_{IL} = 0.8V
Input Leakage Current (RL, RR, $\overline{RD}$, $\overline{WR}$, $\overline{CS}$, C/$\overline{D}$)	I_{IL}			±10	μA	$V_{SS} \leq V_{IN} \leq V_{CC}$
Output Leakage Current (D_{0-7}, High Impedance State)	I_{OL}			±10	μA	V_{SS} + 0.45 ≤ $V_{IN} \leq V_{CC}$
Total Supply Current (I_{CC1} + I_{CC2} + I_{CC3})	I_{CC}		65	135	mA	T_a = 25°C

PACKAGE OUTLINE μPD782C



ITEM	MILLIMETERS	INCHES
A	51.5 MAX	2.028 MAX
B	1.62	0.064
C	2.54 ± 0.1	0.10 ± 0.004
D	0.5 ± 0.1	0.019 ± 0.004
E	48.26	1.9
F	1.2 MIN	0.047 MIN
G	2.54 MIN	0.10 MIN
H	0.5 MIN	0.019 MIN
I	5.22 MAX	0.206 MAX
J	5.72 MAX	0.225 MAX
K	15.24	0.600
L	13.2	0.520
M	$0.25^{+0.1}_{-0.05}$	$0.010^{+0.004}_{-0.002}$

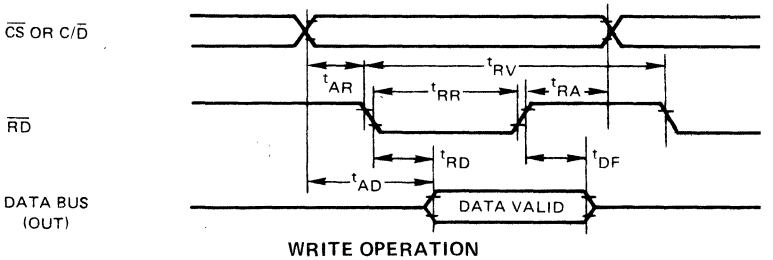
AC CHARACTERISTICS

T_a = 0°C to 70°C; V_{CC1-3} = +5V ± 5%; V_{SS1-2} = 0V

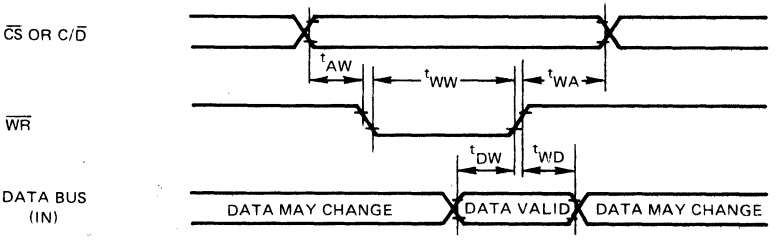
PARAMETER	SYMBOL	LIMITS MIN	LIMITS TYP	LIMITS MAX	UNIT	TEST CONDITIONS
READ OPERATION						
$\overline{CS}$, C/$\overline{D}$ Setup to $\overline{RD}$ ↓	t_{AR}	0			ns	D_{0-7} Input
CS, C/$\overline{D}$ Hold After $\overline{RD}$ ↑	t_{RA}	0			ns	
$\overline{RD}$ Pulse Width	t_{RR}	250		5000	ns	
$\overline{CS}$, C/$\overline{D}$ to Data Out Delay	t_{AD}			180	ns	
$\overline{RD}$ ↓ to Data Out Delay	t_{RD}			180	ns	
$\overline{RD}$ ↑ to Data Float Delay	t_{DF}	10		100	ns ns	
Recovery Time Between Reads And/Or Write	t_{RV}	1			μs	
WRITE OPERATION						
$\overline{CS}$, C/$\overline{D}$ Setup to $\overline{WR}$ ↓	t_{AW}	0			ns	D_{0-7} Output C_L = 100 pF
$\overline{CS}$, C/$\overline{D}$ Hold After $\overline{WR}$ ↑	t_{WA}	0			ns	
$\overline{WR}$ Pulse Width	t_{WW}	250		5000	ns	
Data Setup to $\overline{WR}$ ↑	t_{DW}	150			ns	
Data Hold After $\overline{WR}$ ↑	t_{WD}	0			ns	
PRINT OPERATION						
$\overline{RIN}$ ↓ to $\overline{T}_1$ Preset Time	t_{RT}			140	μs	6 MHz Crystal
$\overline{TIM}$ ↓ to $\overline{PR}_{1-7}$ ↕ Delay	t_{TP}	40		50	μs	
$\overline{RBN}$ ↓ to $\overline{MTD}$ ↓ Delay	t_{RM}		5		μs	
$\overline{RIN}$ ↓ to $\overline{RBN}$ ↑ Delay	t_{RRBN}	10		15	μs	
$\overline{TIM}$ ↓ to $\overline{PFJ}$, $\overline{PFR}$ ↕ Delay	t_{TF}	135		500	μs	
$\overline{TIM}$ ↓ to $\overline{SLR}$ ↕ Delay	t_{TR}	365		385	μs	
$\overline{RIN}$ ↓ to $\overline{STM}$ ↓ Delay	t_{RS}		12.5		μs	
$\overline{T}_{125}$ ↓ to $\overline{STM}$ ↑ Delay	t_{TS}		42.5		μs	
Stamp Time	t_{STM}	150.03		200.03	ms	
$\overline{TIM}$ ↓ to $\overline{MTD}$ ↑	t_{TM}			510	μs	

TIMING WAVEFORMS

READ OPERATION



WRITE OPERATION



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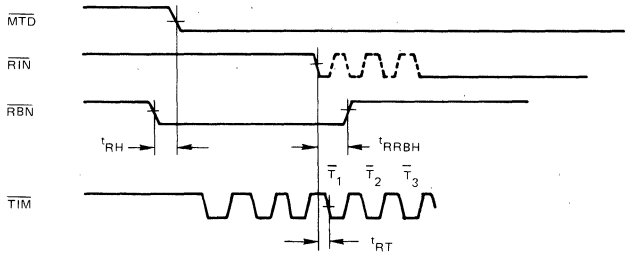
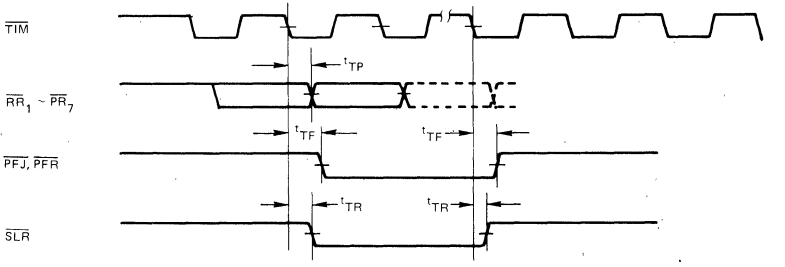
TIMING WAVEFORMS
(CONT.)

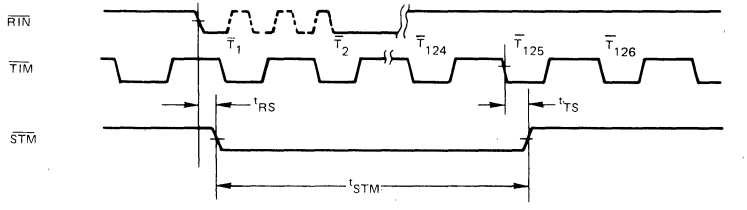
PRINT OPERATION



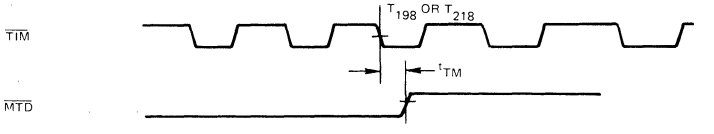
LINE FEED OPERATION



STAMP OPERATION



MOTOR ENABLE



COMMANDS

All transfer of information between the μPD782 and the host processor is via the data bus, and the four (4) control signals, CS, C/D, $\overline{WR}$ and $\overline{RD}$. The four control signals determine what type of data transfer will occur on the data bus.

$\overline{CS}$	C/$\overline{D}$	$\overline{RD}$	$\overline{WR}$	DATA BUS	OPERATION
0	0	0	0	–	Inhibited
0	0	1	0	Print Data	Write Data into Column Buffer
0	0	0	1	Printer Status	Read Printer Status
0	0	1	1	–	No Operation
0	1	0	0	–	Inhibited
0	1	1	0	Command	Write Command for Printer
0	1	0	1	Controller Status	Read Controller Status
0	1	1	1	–	No Operation
1	X	X	X	–	Disable μPD782

Before issuing any new command or loading new data into the column buffer, the host processor should check the controller status bits IOM, IOB and PSR. No new operation should be performed if IOB bit indicates that the μPD782 is busy.

CONTROLLER STATUS REGISTER

X	X	X	X	X	IOM	IOB	PSR

PRINTER STATUS REGISTER

S	T	V	X	X	X	X	M

COMMAND DESCRIPTION

COMMAND	DATA BUS							
	DB_7	DB_6	DB_5	DB_4	DB_3	DB_2	DB_1	DB_0
Initialize	0	0	0	1	0	0	0	0
Request Printer Status	0	0	0	0	X	X	X	X
Printer Format	0	1	a	b_4	b_3	b_2	b_1	b_0
Increment Column Printer	0	0	1	n_4	n_3	n_2	n_1	n_0
Print	1	0	LFJ	LFR	X	R	ST	SL
Fast Feed	1	1	k_1	k_0	m_3	m_2	m_1	m_0
Write Print Data	X	d_6	d_5	d_4	d_3	d_2	d_1	d_0

Note: X = Don't Care

CONTROLLER STATUS REGISTER

IOM – Input/Output Buffer Mode

The IOM flag indicates the direction of data on the data bus. If IOM=1 data is from processor to μPD782 (write into μPD782). If IOM=0 data is from μPD782 to processor (read from μPD782). Immediately after reading printer status, IOM goes from 0 to 1.

IOB – Input/Output Buffer Busy

The IOB flag indicates when the I/O buffer is busy and an operation is in process. If IOB=1 I/O buffer is busy and no new command should be performed. If IOB=0 μPD782 is ready to accept new command.

PSR – Printer Status Ready

The PSR flag indicates that the printer status may be read by the processor. If PSR=1 printer status is ready to be read by processor. If PSR=0 printer status is not ready.

PRINTER STATUS REGISTER

S	T	V	M	OPERATION
1	X	X	X	Status of the input pin 34
X	1	X	X	Status of the input pin 33
X	X	1	X	Status of the input pin 32
X	X	X	1	Motor Error – μPD782 will suspend output to $\overline{PR}_1$-$\overline{PR}_7$ solenoids and turn the motor off. Cleared by the initialize command.

INITIALIZE COMMAND

This command is the same as RESET signal. It clears the Data Buffer (set to blank 20H), set the Data Buffer Pointer to the left side. It also resets the motor error flag, and clears interrupt.

REQUEST PRINTER STATUS COMMAND

This command will latch the status of the input pins 32, 33 and 34 in the Printer Status Register. It must be followed by a Printer Status Read Operation. No other command will be accepted until the printer status is read.

PRINTER FORMAT COMMAND

This command sets the controller for the appropriate printer model and controls the format and timing of printing and line feed for different models of Epson printer. It should be issued after initialize command but before any other command.

a = 0 – 1 dot spacing between characters
a = 1 – 2 dot spacing between characters – only for Model 210 and 210S

b_4	b_3	b_2	b_1	b_0	MODEL PRINTER
1	1	1	1	0	M-210
1	1	1	0	1	M-210S
0	1	0	1	1	M-220 – Journal/Receipt mode (14 + 14 characters)
1	1	0	1	1	M-220 – One line print (31 characters)
1	0	1	1	1	M-240

COMMAND DESCRIPTION (CONT.)

INCREMENT DATA BUFFER POINTER COMMAND

The Data Buffer Pointer is incremented to the right by the binary value indicated by n_0 through n_4. In case of Model 220 in journal/receipt mode the pointer can only move within the receipt or journal side depending upon which side it is presently located.

PRINT COMMAND

The entire Data Buffer is printed and after the print operation is completed the contents of the buffer are reset to 20H (blank). During the execution of the print command no other commands are allowed.

Model 220

LFJ	LFR	OPERATION
0	0	After printing both receipt or journal line feed
0	1	After print performs line feed on receipt side only
1	0	After print performs line feed on journal side only
1	1	Print only
ST	1	No stamp
	0	The receipt side performs line feed 11 times after printing a line and the stamp solenoid is activated

Model 210, 210S

LFJ	R	OPERATION
0	X	After printing performs line feed
1	X	Print only
X	0	Print ribbon set to red
X	1	Print ribbon set to black

Model 240

LFJ	SL	OPERATION
0	X	After printing performs line feed
1	X	Print only
X	0	After print performs slip release (only 29 characters allowed in data buffer)
X	1	No slip release

FAST FEED COMMAND

The binary number indicated by m_3 through m_0 determines the number of continuous line feeds which is performed.

For Model 220

k_1	k_0	OPERATION
0	0	Receipt and Journal line feed
0	1	Receipt line feed only
1	0	Journal line feed only

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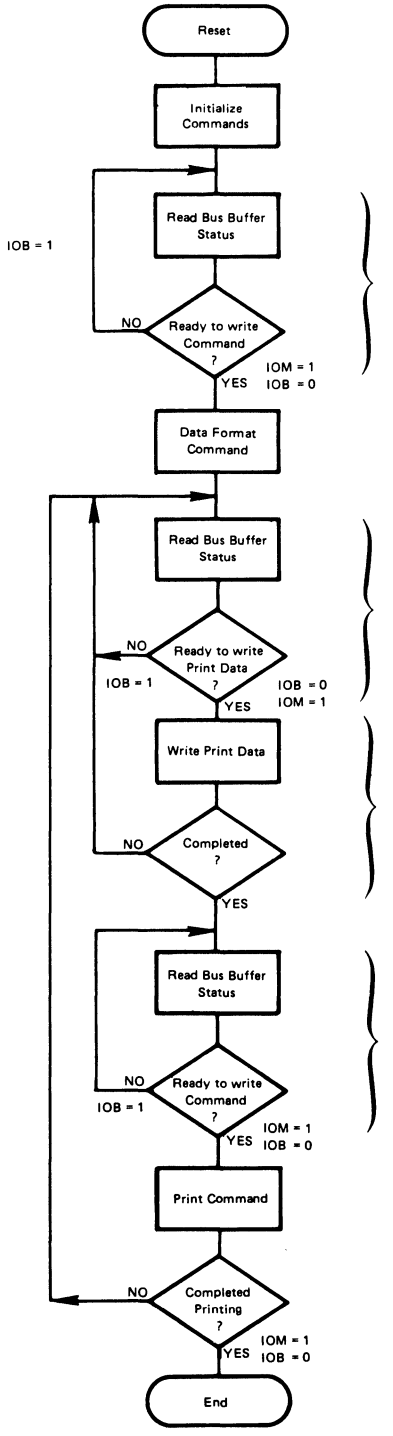
WRITE PRINT DATA COMMAND

After each character is written into the column buffer, the column printer is incremented by one. Do not exceed the column capacity defined in the printer format command. The following table defines the relationship between print data (d_0 through d_6) and the character set.

			(MSB) d_6	0	0	1	1	1	1
			d_5	1	1	0	0	1	1
			d_4	0	1	0	1	0	1
d_3	d_2	d_1	(LSB) d_0		2	3	4	5	6	7
0	0	0	0	0						
0	0	0	1	1						
0	0	1	0	2						
0	0	1	1	3						
0	1	0	0	4						
0	1	0	1	5						
0	1	1	0	6						
0	1	1	1	7						
1	0	0	0	8						
1	0	0	1	9						
1	0	1	0	A						
1	0	1	1	B						
1	1	0	0	C						
1	1	0	1	D						
1	1	1	0	E						
1	1	1	1	F						

OPERATING PROCEDURES



Power-on Reset

Initialize the μPD782. (Reset the Column Buffer and set the Print-Head at the left side.)

Check the Bus Buffer Status.

Indicate the format of the Column Buffer. Set the controller mode for the printer model.

Check the Bus Buffer Status.

Write up to maximum number of characters into the column buffer.

Check the Bus Buffer Status.

Print the entire contents of the column buffer. Indicate "Line Feed" or "Slip Release."

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