Documentation for z80 Mainframe

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Dedication

Dedicated to caffeine for giving me the energy to write this and sleep deprivation for making me think this was a good idea.

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Chapter 1

Main Board

The system is designed to use one higher wattage power supply to provide the low voltage for the peripherals and main board. For the system as shown here, the supply should be rated at least seven amperes at five volts and fifteen amperes at twelve volts for a combined two hundred fifteen watts of total power. If additional peripherals are expected to be added, then the power suppy should be of a higher wattage so that the whole system can be powered from a unified supply to avoid the risk of ground loops that could induce exxecive noise.

For the rear panel power connections, any connectors may be used but it is advised to use incompatable connectors for the low voltage and high voltage connections to avoid accidental interconnection. For this reason, the parts list specifies NEMA L5-15 plugs and recepticals for the high voltage and NEMA L5-20 plugs and recepticals for the low voltage(See Table A on pg 9)

For the data connections, it is recomended to use

The inter-peripheral communication is done via a differential serial link over 4 pair u/utp cabling in a full duplex configuration. This link is cloked at 40MHz limited by the maximum bandwidth of the shift register and differential driver. This link is designed to be wired as illustrated in figure 1.1 and in table 1.1. Either of EIA-568A or B or some other wiring scheme may be used as long as

Pin Number	Function	Wire Color
1	Tx-	White/Orange
2	Tx+	Orange
3	TxClk-	White/Green
4	RxClk+	Blue
5	RxClk-	White/Blue
6	TxClk+	Green
7	Rx-	White/Brown
8	Rx+	Brown

Table 1.1: Interface Pin Functions

the pinout is preserved. It is reccomended to keep the differential signal pairs on twisted pairs to minimize crosstalk and interference since the link has a high data rate and interference could be detrimental to the operation of the system.

Using a parallel connection would allow for a higher throughput however this comes at a highercost due to the cost of connectors and cabling. Hardware limitations in the serial to parallel converter limit the maximum clock speed of the z80 since all 31 lines needed for peripheral communication need to be sent every clock cycle due to the z80 having an inconsistent number of clock cycles per instruction. This limits the z80 to a clock speed of 1.25MHz since there are 31 bits plus a start/stop bit being sent at 40Mbit/s. If the shift registers and differential tranceivers specified in Appendix A cannot be acquired, lower speed components may be used however, the colck speed of the z80 must be lowered accordingly.

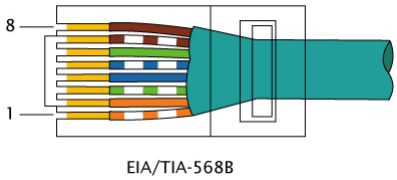

Figure 1.1: Example wiring using EIA-568B[1]

The z80 mainframe was designed to be modular and expandable. It acomplishes this by having a simple interface that brings out the lines from the main bus necessary for IO control and direct memory access. The system is limited to 232 connected peripherals because of the limitations of the z80's IO addressing technique. The z80 only uses the lower 8 bits of the address bus for IO addressing while the contents of the accumulator are placed on the upper 8 bits in teh case of the IN A,(n) instruction[2, p. 295]

The peripherals are designed to look for a specific address after which the device pulls the BUSREQ line low and reads from 0x0800 to 0x084F or writes to 0x850 to 0x089F. The peripherals listed here are designed to be configurable as to what address they respond to and the OS is configurable for where it is trying to address these devices at. Both are configured in hardware rather than in software to simplify configuration co the OS can determine settings without the ROM needing to be modified to be instalation dependant.

Chapter 2

Dot Matrix Printer

The main output for the z80 mainframe is the printer. This particular setup is designed to use an Epson LX-810 printer interfacing over a parallel port as shown in figure (null pointer).

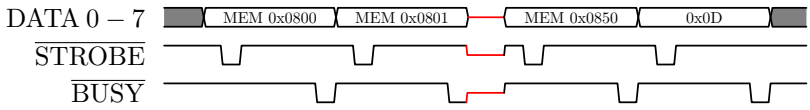

Figure 2.1: Driver Board to Printer Timing

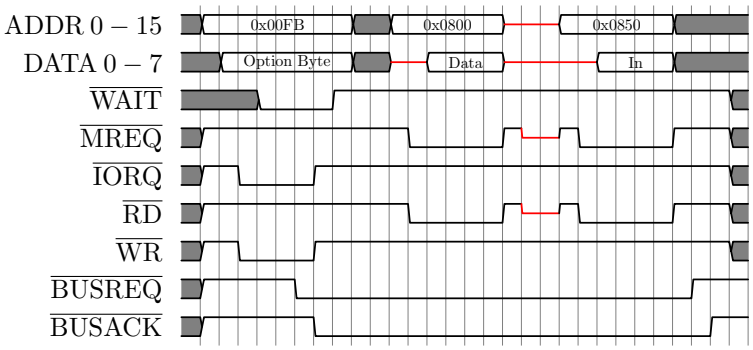

Figure 2.2: Main Bus to Printer Driver Timing

Chapter 3

Card Punch & Reader

Chapter 4

Paper Tape Punch & Reader

Appendix A

Part List

Source	Part Number	Description	Quantity	Price/each	Line Total
McMaster	7162K29	L5-15P Cable Mount	1	$9.15	$9.15
McMaster	7162K32	L5-15R Cable Mount	2	$16.29	$32.58
McMaster	7162K8	L5-15P Panel Mount	2	$12.06	$24.12
McMaster	7162K77	L5-15R Panel Mount	1	$16.00	$9.15
McMaster	7162K36	L5-20P Cable Mount	5	$11.59	$57.95
McMaster	7162K38	L5-20R Cable Mount	5	$18.00	$90.00
McMaster	7162K9	L5-20P Panel Mount	3	$14.65	$43.95
McMaster	7162K94	L5-20R Panel Mount	5	$20.59	$102.95
McMaster	7422K22	16/3 SJOOW Cable	70	$0.72/ft	$50.40
Mouser	ATMEGA328	8-bit Microcontroler	5	$1.96	$9.80
Mouser	Z84C0010PEG	CMOS Z80 CPU	1	$5.36	$5.36
Mouser	AT28C64B-15PU	8Kx8 EEPROM	1	$3.13	$3.13
Mouser	71256SA12TPG	32Kx8 SRAM	2	$3.13	$6.26
MFN	PN	Desc	0	$0.00	$0.00

Appendix B

Code Listings

B.1 ROM Listing

B.2 Line Printer Driver Listing

```
1  char header[]={0x00,0x1B,0x40,0x1B,0x52,0x00,0x1B,
2                 0x74,0x01,0x1B,0x36,0x12,0x1B,0x50};
3  void setup() {
4    // put your setup code here, to run once:
5    Serial.begin(2400);
6    pinMode(2,OUTPUT);
7    pinMode(3,OUTPUT);
8    pinMode(4,OUTPUT);
9    pinMode(5,OUTPUT);
10   pinMode(6,OUTPUT);
11   pinMode(7,OUTPUT);
12   pinMode(8,OUTPUT);
13   pinMode(9,OUTPUT);
14   pinMode(10,OUTPUT);
15   pinMode(11,INPUT);
16   digitalWrite(10,HIGH);
17   for(int i=0; i<sizeof(header);i++)
18   {
19     for(int j=0;j<8;j++)
20     {
21       if(((header[i]>>j)&1)==1)
22       {
23         digitalWrite(j+2,HIGH);
24       }
25       else
26       {
27         digitalWrite(j+2,LOW);
28       }
29     }
30     delayMicroseconds(10);
31     digitalWrite(10,LOW);
32     delayMicroseconds(10);
33     digitalWrite(10,HIGH);
34     while(digitalRead(11)==HIGH){};
35   }
36   Serial.println("Ready...");
37 }
38 int feed = 0;
39 void serialEvent()
40 {
41   char data=Serial.read();
42   for(int j=0;j<8;j++)
43     {
```

```
44        if(((data>>j)&1)==1)
45        {
46          digitalWrite(j+2,HIGH);
47        }
48        else
49        {
50          digitalWrite(j+2,LOW);
51        }
52      }
53      delayMicroseconds(10);
54      digitalWrite(10,LOW);
55      delayMicroseconds(10);
56      digitalWrite(10,HIGH);
57      Serial.print(data);
58      if(data == 0x0d){feed++;Serial.println();};
59      if(data != 0x0d){feed=0;};
60      if(feed >= 3){
61        feed=0;
62        data = 0x0c;
63        for(int j=0;j<8;j++)
64        {
65          if(((data>>j)&1)==1)
66          {
67            digitalWrite(j+2,HIGH);
68          }
69          else
70          {
71            digitalWrite(j+2,LOW);
72          }
73        }
74        delayMicroseconds(10);
75        digitalWrite(10,LOW);
76        delayMicroseconds(10);
77        digitalWrite(10,HIGH);
78      }
79      while(digitalRead(11)==HIGH){};
80  }
81
82  void loop() {
83    // put your main code here, to run repeatedly:
84
85  }
```

B.3 Card Punch Driver Listing

B.4 Card Reader Driver Listing

B.5 Paper Tape Punch Driver Listing

B.6 Paper Tape Reader Driver Listing

Appendix C

Circuit Diagrams

C.1 Main Board

C.2 Line Printer Driver Board

C.3 Card Punch & Reader Driver Board

C.4 Paper Tape Punch & Reader Driver Board

Appendix D

PCB Masks

D.1 Main Board

D.2 Line Printer Driver Board

D.3 Card Punch & Reader Driver Board

D.4 Paper Tape Punch & Reader Driver Board

Appendix E

Part Drawings

Bibliography

[1] Wikimedia Commons. File:rj-45 tia-568b left.png — wikimedia commons, the free media repository, 2015. [Online; accessed 3-March-2019].

[2] Zilog, Inc. *z80 CPU*, 8 2016. Rev. 11.

Fonts

This was typeset in Computer Modern using pdfLaTeX and bibTeX. The timing diagrams were made with the tikz-timing package. The code listings were made with the listings package