Documentation for z80 Mainframe

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Legal Information

Disclaimer of Warranty

Limitation of Liability

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

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 supply 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 excessive noise.

For the rear panel power connections, any connectors may be used as long as they have sufficient current capacity for the load expected.

For the data connections, it is recommended 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 clocked 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 the pinout is preserved. It is recommended 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.

Pin Number	Function	Wire Color
1	Data-	White/Orange
2	Data+	Orange
3	NC	White/Green
4	NC	Blue
5	NC	White/Blue
6	NC	Green
7	Clock-	White/Brown
8	Clock+	Brown

Table 1.1: Interface Pin Functions

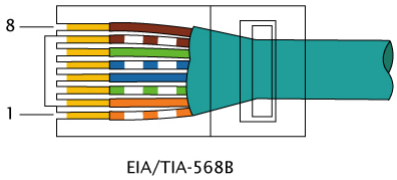


Figure 1.1: Example wiring using EIA-568B
Example wiring using EIA-568B[1]

Using a parallel connection would allow for a higher throughput however this comes at a higher cost 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 transceivers specified in Appendix A cannot be acquired, lower speed components may be used however, the clock speed of the z80 must be lowered accordingly.

The z80 mainframe was designed to be modular and expandable. It accomplishes 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 the 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 so the OS can determine settings without the ROM needing to be modified to be installation dependent.

Chapter 2

Front Panel

Chapter 3

VGA Terminal

Chapter 4

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).

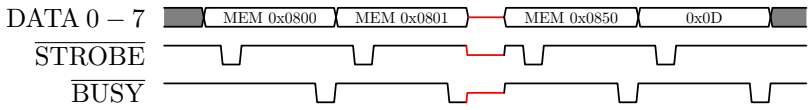


Figure 4.1: Driver Board to Printer Timing

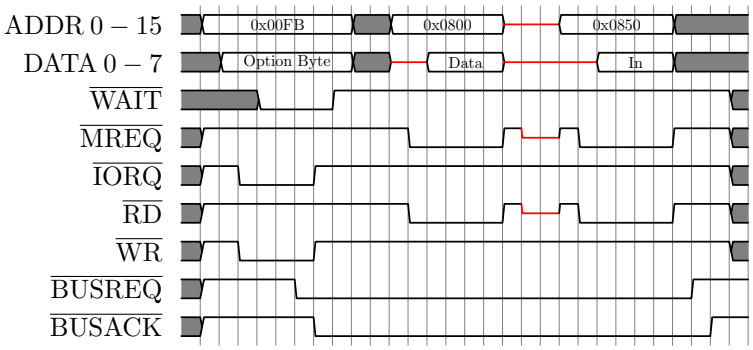


Figure 4.2: Main Bus to Printer Driver Timing

Chapter 5

Card Punch & Reader

Chapter 6

Paper Tape Punch & Reader

Appendix A

Code Listings

A.1 ROM Listing

A.2 Main Board Interface Listing

A.3 VGA Terminal Listing

A.4 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  }
```

A.5 Card Punch Driver Listing

A.6 Card Reader Driver Listing

A.7 Paper Tape Punch Driver Listing

A.8 Paper Tape Reader Driver Listing

Appendix B

Part List

B.1 Main Board

B.2 Front Panel

B.3 VGA Terminal

B.4 Line Printer Driver Board

Ref	Value	Desc	PN	Quantity	Price	Notes
R1	4k7	1/4 watt	CF14JT4K70CT-ND	1	$0.10	
R2	10k	1/4 watt	CF14JT10K0CT-ND	1	$0.10	
R3,R4	27R	1/4 watt	CF14JT27R0CT-ND	2	$0.10	
R5,R6	270R	1/4 watt	CF14JT270RCT-ND	2	$0.10	
R7,R8	2k	1/4 watt	CF14JT2K00CT-ND	2	$0.10	
R9,R11,R12,R14	600R	1/4 watt		4		
R10,R13	120R	1/4 watt	CF14JT120RCT-ND	2	$0.10	
C1,C2	47p	Ceramic	BC1009CT-ND	2	$0.27	
C3	100n	Ceramic	BC5229CT-ND	1	$0.23	
C4	470u	Polarized electrolytic	P5141-ND	1	$0.10	
C5,C6,C7,C8	10n	Ceramic	BC5136-ND	4	$0.21	
D1,D2		5mm red led		2		
U1	FT230XS	FTDI USB to Basic UART	768-1135-1-ND	1	$2.04	
U2	PIC16F1503-IP		PIC16F1503-I/P-ND	1	$0.93	
U3	74HC595	8-bit Serial-in Parallel-out Shift Register	296-1600-5-ND	1	$0.53	
U4	PCA9615	Differential I2C Bus buffer	568-11484-1-ND	1	$2.95	
J1		USB type B Female		1		
J2		1x6 .1” male header		1		
J3		1x3 Power connector		1		
J4		8p8c female		1		
J5		Dsub-25 female w/ mounting holes		1		

B.5 Card Punch & Reader Driver Board

B.6 Paper Tape Punch & Reader Driver Board

B.7 Miscellaneous Parts

Desc	PN	Quantity	Price	Notes
Male XLR Receptacle	SC2465-ND	5	$5.26	
Female XLR Receptacle	SC1992-ND	5	$5.80	
Male XLR Plug	889-2138-ND	5	$4.43	
Female XLR Plug	SC2465-ND	5	$4.75	

Appendix C

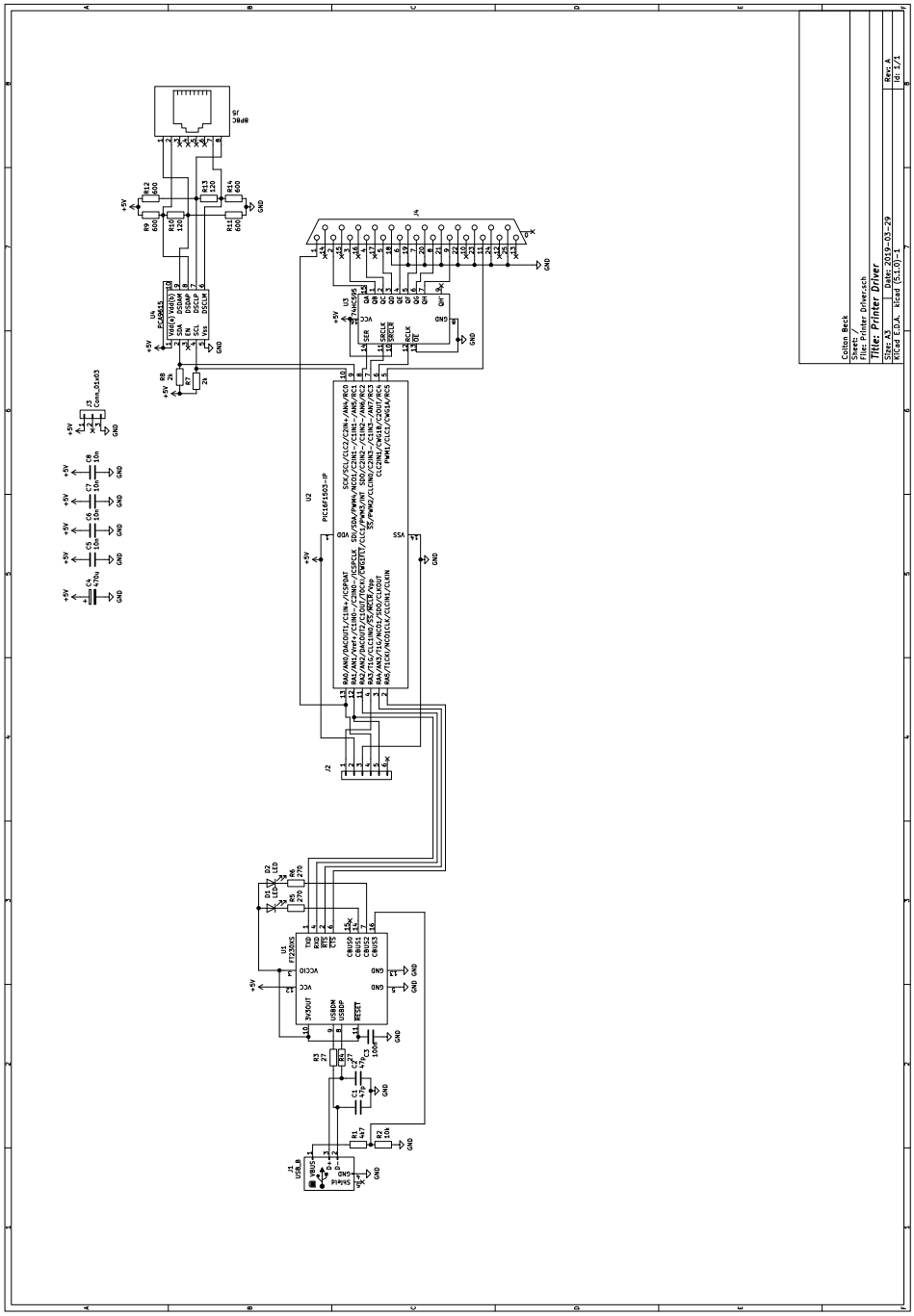
Circuit Diagrams

C.1 Main Board

C.2 Front Panel

C.3 VGA Terminal

C.4 Line Printer Driver Board



C.5 Card Punch & Reader Driver Board

C.6 Paper Tape Punch & Reader Driver Board

Appendix D

PCB Masks

D.1 Main Board

D.2 Front Panel

D.3 VGA Terminal

D.4 Line Printer Driver Board

D.5 Card Punch & Reader Driver Board

D.6 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.