# The Ni-Wumpf
# System 80 / 80A / 80B CPU
# / Driver Manual

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Revision A

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## Overview

Once again, writing the manual comes last, and naturally the most painful part of any design: documentation. <sigh> moving on… at Ni-Wumpf, we've been trying to design a CPU board for all of the Gottlieb System 80 games (and there are 57) for about 27 years now. We designed the first one for hard-core pinball freaks to write their own game code with – maybe handle some of the games we could never hope to acquire, much less code, back in 1999. It was a full scale development environment with a four-MPU CPU, it's own IDE, language, and compilation backend to allow anyone on the Internet to code and write their own GTB games with this board and a network connection. A few people did. But in the end, we wound up coding about 16 of the games, and releasing the board as a product. It was clear that it was massive overkill for just a pinball CPU. So, we designed the next generation of the System 80 board with a single ARM CPU, ported the code over to *that* hardware and released a new board with far less expense to produce. The hardware supported all of the platforms; system 80, 80A, and 80B (of which only 1 game was written; Genesis), and worked just fine, but alas limited in game support. Each board required the coder (Ni-Wumpf) to have the actual game to write, test, and debug the game code on. That was not likely to happen for us.

So the dream languished, until recently, when ARM chips provided a very fast RISC MPU with embedded flash, memory and a lot of speed. By this time both our CPU products were using these chips, and we had even developed hardware emulators using them for standard components in most Gottlieb platforms, the 6502, 6532, and then finally the 6530 with embedded ROM. However, the chips just weren't fast enough to really handle all of the hardware emulation. Apart from that, when they ever did, we'd still have to license the firmware for these games from the license holders of the original Gottlieb. In 2025 we managed to cross those hurdles.

In 2026, the System 80 CPU board supports all 57 games, with a jumper on the board to differentiate the displays on the System 80B games from those on the earlier 80 and 80A platforms, and the CPU / Driver board leverages the design of that CPU directly onto the footprint of the driver board, incorporating the driver circuitry at the bottom of the board. Like all of our products, the game code is software selectable, as are the options that were once configured via 4 DIP switch banks on the original board. There is a micro-SD card hosting all of the GTB firmware for these games that is used to load the code into the system at boot up. The older NVRAM is hosted internally in the FLASH, without the need for a backup battery on the board. Because the board is hosting the original firmware, some of the circuitry will be familiar from the original CPU boards, while the rest is taken from our earlier designs. Unlike our previous boards, with the SD card, we are now able to update the entire software set via the removable SD card, making software updates truly a field upgradable option without constraints to memory patching. There is aldo a three-pin serial port provided on the board for rudimentary debugging output if necessary while the USB port is currently not supported.

## Service

The board is designed with as many surface mount components as possible to take advantage of the cost and availability of complex high-pin count components. These components form the core hardware functionality of the board – physically and electrically. These will be the first products released that reduces the amount of through-hole components at the edge interface to the actual pinball hardware, and while the highest likely damage vector arising through failed solenoid circuits are still

field serviceable through PTH components, the display circuitry has moved to SMT components as has the switch strobe chips. Backing up to the solenoid damage, to output FETs – it is no small feat replacing a SMT FET, however, we added thru-hole pads on the board to solder in vertical transistor in the field should the user be able to clip the leads off an SMT component, and then solder in a replacement FET standing thru-hole. It is hoped that with most of the modern games in the field now using only SMT, we'll all have enough SMT rework tools out there to address damage in these areas. I know, small justification for adopting the form factor that most suppliers are now providing.

# Design

## *Hardware*

The core of the System 80 CPU is an ARM core processor running at 160MHz. Inside it are the emulation stacks for the 6502, and the three 6532 I/O timer controllers. Because the output circuitry is so different between the 80 / 80A boards from the 80Bs, there is additional software to emulate BCD (binary coded decimal) chips on the original boards internally as well.

As the game powers down, the 3.3v capacitor stores enough charge to save off the NVRAM address space to FLASH when the power fail interrupt is generated at the +5v level. And as described above, the CPU supports a Micro SD file system compatible with a FAT file system hosting all the GTB firmware as well as any firmware updates. There is provision for a USB port that is not yet supported, and finally a three wire serial port for diagnostic output requiring a separate USB -> Serial dongle to plug into your host computer if needed.

Inputs to the board are through bullet-proof discrete components that, while being surface mount, have yet to be the culprit in a service call. The strobe lines to the switches are moved to simple inverter SMT chips.

Outputs to the displays are now hosted in 8-bit latch components (74HCT273) that replace the original latches and BCD decoders on the original board. While outputs to the lamp / driver circuits are pretty much the same as the original board.

## *Software*

The board is designed to handle ***all*** of the Gottlieb System 80 games with all code hosted separately on the SD file system. The board will not run without a GTB licensed Micro SD card – this is the same licensing model as some earlier GTB replacement CPUs where the boards were sold unpopulated with GTB specific PROM chips that would then be placed in the sockets by the buyer. Only the form-factor has changed, making it a lot easier to manage with less chance of damaging the legs on some of those chips. The Ni-Wumpf environment manages the emulators, boot, update, and initialization code, as well as all of the firmware to manage the hardware that the GTB firmware will be running in.

While the 6532 emulators run at warp speed, the 6502 emulator is clocked and gated to run at just shy of 1MHz – the same speed as the original boards. Keeping the execution timed with the original hardware speed is critical for game play compatibility.

Once the load environment is executed, and emulation has started, all system timers, and Ni-Wumpf environment coding is no longer accessible (except for the power interrupt code) to the user. This means that all initialization code to set up DIP

switches, set the game, or other hardware testing code is not available until a system reboot. Normal Gottlieb self-test routines are all provided at game emulation level, and are executed as usual through the front door self-test button.

### *Updating code on the CPU*

While the CPU is designed to support all of the System 80 games, it is also intended to support updates to the environment available online. If, for some reason, Ni-Wumpf releases an update to the Ni-Wumpf code, it will be available on the website with a firmware name describing the release date etc. That file would then be copied to the Micro SD into the root directory and named specifically: "Sys80U535update.bin". Capitals and spelling are enforced, or the board will not load this binary. Once loaded, you can tell that the firmware has been updated after removing and reviewing the card filesystem on your computer to find that the update binary has subsequently been deleted. And, as always, we welcome update requests by the community.

## Installation Caveats

The System 80 combination board was designed to be a plug-in replacement for the existing System 80 driver board, and is the same size, and mounting as this board. This brings up issues in several areas in mounting, cabling, and position. The installer will immediately notice that the connectors to the CPU (figure 1) are all shifted around on the board, and there is no longer any J4. While the driver harnesses are in the same basic positions they once were, the front door harness (J5) is now on the left side of the board, the playfield harness is moved from the bottom of the older board to the top of this one, and like J2 and J3 for the displays, they hug the upper right corner of the board.

Please note header H5 in the center right location: it selects how the CPU will output to the displays. With the jumper in the left position, the CPU will enter the initialization code assuming that it is connected to 6 or 7 digit displays in the System 80 / 80A line. With the jumper in the right position, it will output data for System 80B alphanumeric displays. If you are not seeing the boot menu on power-up, it is most likely this jumper is in the wrong position, and the CPU is trying to control displays that do not exist on your game!

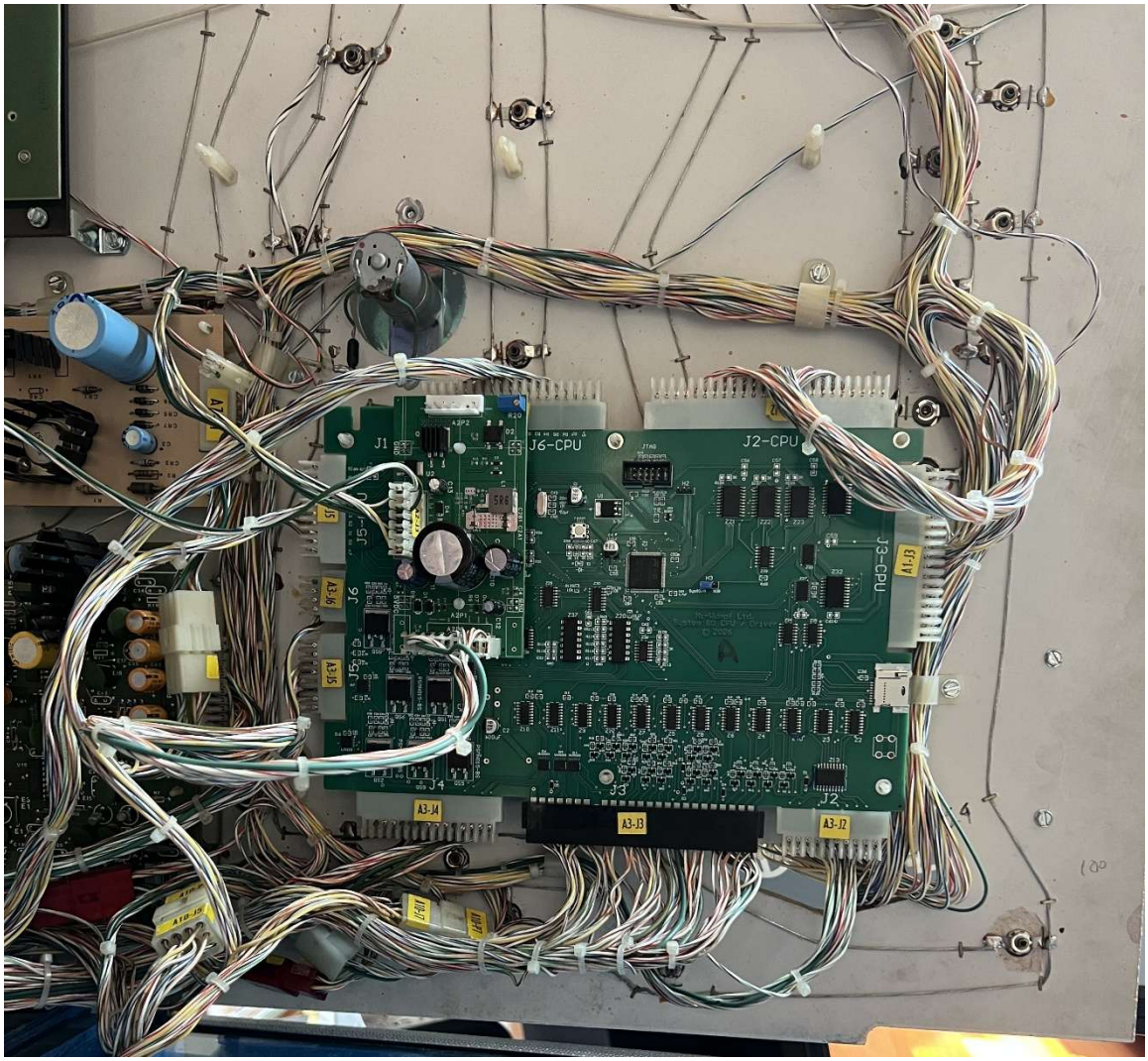



Figure 1 - Ni-Wumpf replacement CPU showing connector designation.

## *Mounting…*

Mounting the new board in place where the original Gottlieb CPU was, is a simple process made only somewhat more complex by the size of the board - the new board goes directly in the position that the driver board once mounted. The driver board connections are straight-forward, however the CPU harnesses will require repositioning. The display harnesses move down from where the CPU used to mount, and fold over to the upper right-hand side of the board. The two switch harnesses; A1-J5, and A1-J6 will drop down to find J5 connected to the upper left of the CPU while J6 folds over completely to mount on the top left corner of the board. All of these harnesses will have no problem reaching their new positions on the CPU, all, that is except A1-J1, the power supply cable which is now at the left-most top connector of the CPU far below where it was on the original CPU in the old position. If your existing J1 harness is too short to reach this connection point, there are two options to pursue; if your power supply is questionable - source the Ni-Wumpf power supply daughter board, and bring the two power connectors from the cabinet to this daughter board. The main CPU is powered directly by the daughter care w/out any additional harness. If not, Ni-Wumpf can supply a longer replacement J1 cable.

**-WARNING-**

**-WARNING-**

**-WARNING-**

***BEFORE*** the game is powered up with the new CPU there are several guidelines that must be followed to prevent the board from suffering damage.

**First**; a bad display will destroy the new CPU just as readily as it did the old CPU. Please be sure that all of the displays to be used are checked out before you power up the board. This can be a difficult procedure, especially when checking out an unknown display means possibly frying the test CPU if it is bad. Fortunately, there are not that many bad displays that fall into this category. To err on the side of safety is the best approach, and this means not to use a display whose functionality is questionable

**Second**, the connectors; J5 and J6 are almost as likely to be corroded as J4, and the pins, just as brittle. While these connectors cannot seriously damage the CPU because of their condition, it is imperative that they be checked and repaired to attain proper game operation.

**Third**, no connector should be removed from the CPU while it is powered up! This can damage the CPU, especially the display cables. Always power-down the CPU before removing any connectors.

## Boot Environment

When the game first boots up, the operator is given 3 seconds to enter into the setup environment on the board - unless it just arriving from the factory, in which case it will immediately enter into *Game Select* mode. If the operator depresses the self-test button within these 3 seconds, the game will enter the setup mode supporting 3 main menus; *Game Select*, *DIP Setting, and Hardwr Testing.* As with our older model boards, the two buttons; self-test, and game-start control how to navigate through these menus. Self-Test advances through the menu options, while the game start button executes the option displayed, advancing, toggling, or exiting the menu (through the "done" option).

If the game is already configured and there are no changes necessary, the board will simply start game emulation after this period.

### *GAME SELECT*

The first thing the operator must do is to select the game to load from the Micro SD card if it hasn't already been configured. Below are listed the games supported. Once in this menu the board will start by showing the game already selected, or lacking that; "Panthera" (or for System 80B – "Chicago Cubs"). The user will then have to advance the game shown by continuing to press the game start button until the game name is displayed for the board to use. Then, pressing the self-test button will exit the game select menu, and the game is set (you will have to press the self-test button again twice to advance to the "done" menu option and press the game start button again to set that game).

| System 80 | System 80A | System 80B |
|---|---|---|
| Panthera | Devils Dare | Chicago Cubs |
| Spiderman | Rocky | Bounty Hunter |
| Circus | Spirit | Rock |
| Counterforce | Punk | Tag Team |
| Star Race | Caveman | Raven |
| James Bond | Striker | Hollywood Heat |
| James Bond (timed) | Krull | Rock Encore |
| Time Line | QBerts Quest | Genesis |
| Force II | Super Orbit | Gold Wings |
| Pink Panther | Royal Flush | Spring Break |
| Mars God of War | Goin Nuts | Monte Carlo |
| Volcano | Amazon Hunt | Arena |
| Black Hole | Rack 'Em Up | Victory |
| Haunted House | Ready Aim Fire | Diamond Lady |
| Eclipse | Jacks to Open | TX Sector |
| | Touchdown | Robo-War |
| | Alien Star | Excalibur |
| | The Games | Bad Girls |
| | El Dorado | Big House |
| | Ice Fever | Hot Shots |
| | | Bone Busters |
| | | Night Moves |

Table 1 – Games supported

If the H5 jumper is in the left position, the game options will show the System 80 games shown below, then the System 80A games, before cycling back to "Panthera".

If the H5 jumper is in the right position, the menu selection will begin with "Chicago Cubs", and advance to "Night Moves" before cycling back around again.

Depressing the game start and the self-test button simultaneously will start the selection process to the beginning (Panthera, or Chicago Cubs).

## DIPS SETTNG

This is where it gets hairy - for a number of reasons. Among them is that the original game manuals are not always complete, sometimes contradictory, and may be necessary in order to set DIP specific settings. Ni-Wumpf has attempted to normalize and enumerate each option based on the original platform firmware, but the names shown below may be different than the manual.

| Field | Description | Possible Values |
|---|---|---|
| COINS LEFT | Left coin counter multiplier. | (see table 4 for matrix) |
| COINS RIGHT | Right coin counter multiplier. | (see table 4 for matrix) |
| COINS CENTER | Center coin counter multiplier. | (see table 4 for matrix) |

| | | |
|---|---|---|
| **EXTRA CREDIT**[1] | Add 9 credits for center coin chute | **0** - disabled; 1 - enabled |
| **CHUTE CONTRL** | chute control | **0** - allow separate coin chute control<br>1 - set coin chute 2 control to be that of chute 1 |
| **MAX CREDIT** | Maximum credits allowed. | 0 – 8 credits; 1 – 10 credits; **2** – 15 credits; 3 – 25 credits |
| **BALLS \| GAME** | Number of balls per game | 0 – 5 balls; **1** – 3 balls |
| **MATCH** | Match feature | 0 - disabled; **1 –** enabled |
| **MAXMUM REPLAY** | Maximum number of replay games allowed / game | 0 – no replay limit; **1** – limits each player to 1 replay /game |
| **NOVELY POINTS** | Novelty mode | **0** - disabled; 1 – Playfield SPECIAL and EXTRA Ball features award 50,000 points and 5 knocks. High Score, HGTD and Match disabled. |
| **THRESH EXBALL** | Making threshold awards extra ball[2] | **0** - disabled; 1 – enabled |
| **SPECIL EXBALL** | PF Special awards Extra Ball or Replay | **0** - disabled; 1 – enabled |
| **HGTD AWARD** | Award for beating HGTD score | 0 - no award to beat HGTD - not displayed; 1 – HGTD displayed, no award; 2 – displayed - two replays awarded; **3** – displayed, three replays |
| **SCORE SOUNDS**[3] | Play sounds when scoring | 0 - disabled; **1 –** enabled |
| **REPLAY SOUNDS**[1] | Play sounds upon replay | 0 - disabled; **1 –** enabled |
| **COIN TUNES**[1] | Play credit tune | 0 - disabled; **1** - enabled |
| **DISPLY CREDIT**[1] | Show credits | 0 - disabled; **1** – enabled |
| **TILT BALL**[1] | Penalty for tilting | **0** - ball; 1 - game |
| **ATTRCT ON**[4] | Attract mode enable | 0 - disabled; **1** – enabled |
| **DIP SW 8** | Game dependent – see manual | **0** - disabled; 1 **–** enabled |
| **DIP SW 31** | Game dependent – see manual | **0** - disabled; 1 **–** enabled |
| **DIP SW 32** | Game dependent – see manual | **0** - disabled; 1 **–** enabled |

Table 2 - Options settings and their descriptions

[1] For German games only, this setting adds 9 credits to the RIGHT coin chute setting.
[2] Enabling this setting disables HGTD and Match award settings.
[3] Not displayed for System 80A and 80B games.
[4] For System 80 games this controls playfield illumination; it is not used for System 80A games; and for System 80B games this controls the sound on/off in attract mode (or DIP switch 7 in the original game manual)

| Setting | System 80 | System 80A/B |
|---|---|---|
| 0 | one coin/credit | one coin/credit |
| 1 | one coin / 2 credits | one coin / 2 credits |
| 2 | one coin / 3 credits | one coin / 3 credits |
| 3 | one coin / 4 credits | one coin / 4 credits |
| 4 | one coin / 5 credits | one coin / 5 credits |
| 5 | one coin / 5 credits | one coin / 6 credits |
| 6 | one coin / 7 credits | one coin / 7 credits |
| 7 | one coin / 8 credits | one coin / 7 credits |
| 8 | one coin / 9 credits | one coin / 9 credits |
| 9 | two coins/credit[1] | one coin / 10 credits |
| 10 | two coins / 2 credits[3] | two coins / 1 credit |
| 11 | two coins / 3 credits[3] | two coins / 2 credits |
| 12 | two coins / 4 credits[3] | two coins / 3 credits |
| 13 | two coins / 5 credits[3] | two coins / 4 credits |
| 14 | two coins / 3 credits[2] | two coins / 5 credits |
| 15 | three coins/credit[3] | two coins / 6 credits |
| 16 | | two coins / 7 credits |
| 17 | | two coins / 8 credits |
| 18 | | two coins / 9 credits |
| 19 | | two coins / 10 credits |
| 20 | | three coins / 1 credit |
| 21 | | three coins / 1 credits |
| 22 | | four coins / 1 credit |
| 23 | | four coins / 3 credits |
| 24 | | five coins / 1 credit |

Table 3 - Coin counter multiplier table

## HARDWR TESTING

This is the Ni-Wumpf specific hardware testing routine for the game, *and requires a separate RS-232 cable attached to H2*. Please refer to Appendix A for more information on the hardware needed for this. It consists simply of a Mini USB cable connected to an RS-232 serial adapter (eg: Amazon HiLetgo CP2102) with jumper wires to connect from the adapter to the board. Upon entering the hardware testing mode on the board, it awaits serial input from your computer through the USB. Commands then include:

| Command | Description | Possible Values |
|---|---|---|
| 'f'n | Fire one of the 9 standard coils | 'n' can be any value between 1 – 9 |
| 'fl'n | Fire lamp controlled coil | 'n' should correspond to the lamp # |
| 'l'nn | Light one of the playfield lamps | 'nn' can be 1 – 48[3]. |
| 'lt' | Toggle the lamp test between lit and flashing | |

[1] No credit is given until the last coin is deposited.
[2] One credit is given for the first coin with the balance given after the last coin is deposited
[3] **DO NOT exercise lamp-controlled coils with the lamp test – you may fry that coil**

| | | |
|---|---|---|
| 'r' | Reset the game to factory settings | |
| 't'nn | Play Sound | 'nn' can be 0 – 31 depending on the sound board |

Table 4 – Hardware testing commands

**DONE**

Unlike previous Ni-Wumpf CPUs, the options selected for the game, and DIP switch settings *will be saved* if the game is rebooted before exiting the setup menus cleanly. However, it will be necessary to depress the game start button at this last menu entry ("DONE") in order to validate the DIP switch settings match the game selected, and to resume booting the game code selected.

## *Troubleshooting*

Isolating what may not be working as expected is going to rely on the LED, and the serial output port. The table below is far from complete, but is intended to help the operator isolate the correct procedure to help diagnose the board performance. Should some symptom exist that does not fall into any of these categories, you should reference the website (www.ni-wumpf.com) for further assistance and contact information.

The CPU should normally blink *once* during power-up to indicate that it is operational. Following this single flash, the game should immediately enter into the boot select environment for 3 seconds to allow the operator to adjust settings. Following this, the system 80 games will idle for around 7 seconds before entering into idle mode – the System 80A and 80B games will immediately launch.

| Symptom | Possible Cause |
|---|---|
| Displays show the 'e' and 'h' segments brightly lit upon boot | The Micro SD card is missing or not inserted properly. |
| LED blinks continuously on power-up. | The Micro SD card is missing or not inserted properly. |
| LED blinks once at power-up. | Normal operation |

| | |
|---|---|
| LED blinks a second time at power-up | The CPU board is updating the code with the file on the SD card. |
| Lamps do not operate that correspond to one or more strobe columns (1 to 12) | Z17 or Z18 may need to be replaced – these surface mount chip buffers outputs to lamp columns. Z17 handles lamps 25 – 48, while Z18 covers lamps 1 to 24. These chips are not normally damaged. |
| 25% of lamps don't operate correctly | Z16 may be damages controlling the lamp data outputs. |
| Solenoid 1, 2, 5, 6, 8, or 9 continually energized or will not energize. | Z15 may need to be replaced – this 7406 buffers solenoid outputs to solenoids 1, 2, 5, 7, 8, and 9 on the driver board. |
| Solenoid 3, 4, or 7 continually energized or will not energize. | Z14 may need to be replaced – this 7406 buffers solenoid outputs to 3, 4, and 7. |
| The same segment(s) on all digits in Display Bank A (player 1 and player 2) are stuck on or off. | Z21 may need to be replaced – this 74HCT273 buffers segment outputs to display bank A |
| The same segment(s) on all digits in Display Bank B (player 3 and player 4) are stuck on or off. | Z22 may need to be replaced – this 74HCT273 buffers segment outputs to display bank B |
| The same segment(s) on all digits in Display Bank C (timer/bonus and credit displays) are stuck on or off. | Z23 may need to be replaced – this 74HCT273 buffers segment outputs to display bank C |
| A digit in the same position on all display banks (for player 1, player 3, and the bonus/timing display if present) shows brightly or does not light at all. | Z12 may need to be replaced – this 74LS240 buffers outputs for digits 1 through 8 |
| A digit in the same position on all display banks (for player 2, player 4, and the bonus/timing display if present) is showing brightly or not lit at all. | Z13 may need to be replaced – this 74LS240 buffers outputs for digits 9 through 16 |
| One or more switches are not recognized – corresponding to switches on a specific <u>return</u> line. | The return buffers are SMT components, and this may indicate a factory repair |
| One or more switches are not recognized corresponding to switches on a <u>strobe</u> lines 1 – 4. | Z4 may need to be replaced |

| | |
|---|---|
| One or more switches are not recognized corresponding to switches on a strobe lines 5 - 8. | Z5 may need to be replaced |
| CPU crashes/sporadically resets during game play | Generally, this is not a CPU problem, but rather an associated problem with the +5 voltage level. The problem can normally be reproduced by causing the CPU to energize a solenoid, while simultaneously energizing a non-CPU controlled solenoid (such as a bumper). This will stress the power supply enough to drop-out the voltage regulator or surge the ground. Check that all solenoids are the correct part number and that the snubbing diodes across them are working. Check for good ground connections at the power supply header pins. Check that the solenoid drive transistors are not "leaking". Check the connector between the CPU and driver board for good connection. Check the power supply voltage regulator for a solid +5 volts. |

Table 4 – Troubleshooting Chart

# Warranty

The ***Ni-Wumpf*** replacement System 80 CPU is warranted against manufacturing defects and premature component failure, known as infant mortality, for up to 90 days after the date of it's purchase. For this reason, it may be prudent to keep a copy of the receipt for the board handy, in case the need should arrive to lend some credibility to your claims as to when it was actually purchased. In the unlikely event that a part should fail on the board within this time frame, simply package up the board, with a copy of your receipt, and return it to the factory address mentioned on our website, with some note of explanation as to why we are receiving this unexpected gift. Your CPU will be repaired or replaced and returned to you as quickly as possible.

Failure of the system within the warranty period due to abuse, incorrect installation, or faulty game components, is not covered by this warranty. The purpose of this warranty should be quite clear: we are willing to accept responsibility for manufacturing defects of the boards we are building, and feel that 90 days is a sufficient period to determine if such a defect may exist. We are not willing to accept the responsibility of others who may install this board into a game that may be broken enough to cause damage to the CPU.

## *Returning Your Board for Repair*

To determine the steps required to repair your CPU, it is best to gather the information necessary to get the board serviced, whether by yourself or the factory. First of all, be certain that the CPU is actually broken before calling it in for service, and the best way to ascertain this is to consult this manual in detail under the configuration and troubleshooting sections. Next, armed with the confidence that a smoking chip is indeed reason for repair, contact your distributor or refer to the website below to determine what steps to take next. If you intend to do the repair yourself, he will be the person with the parts necessary to replace the chips you deem necessary. He will also be the person with the knowledge of what repair costs the factory will be charging if you wind up sending it in for repair (and in the case that the company address should change, he will know what the current address for ***Ni-Wumpf*** will be).

Repair of the ***Ni-Wumpf*** CPU is performed at the factory for all SMT failures. However, because the board design is targeted toward isolation of SMT component by "edge" buffer components, it should also be reasonable to undertake repair of the these components yourself should you feel capable of doing so. Most of these edge buffers are freely available at electronics supply stores, also these parts may be purchased directly from the factory or your distributor if they are determined to be at fault. In the case of board repair being sent to the factory, return the board to our address mentioned on our website with a note describing the problem. Repair costs may be required in advance and may be determined by contacting the factory beforehand.

Ni-Wumpf LTD.
www.ni-wumpf.com

# Schematic supplement for the
# Ni-Wumpf System 80
# Replacement CPU / Driver board

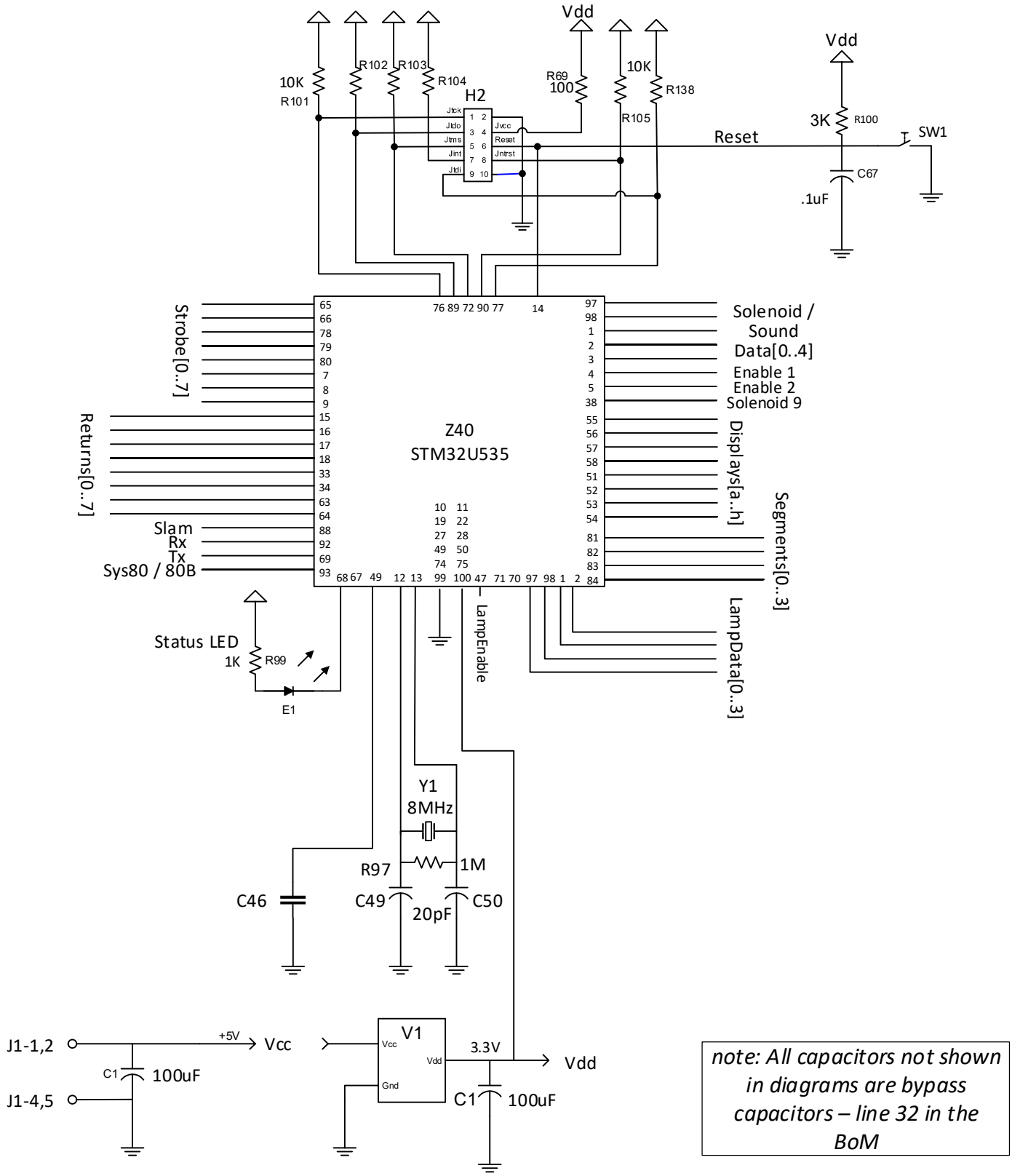



Figure 2 - System 80 CPU Circuit

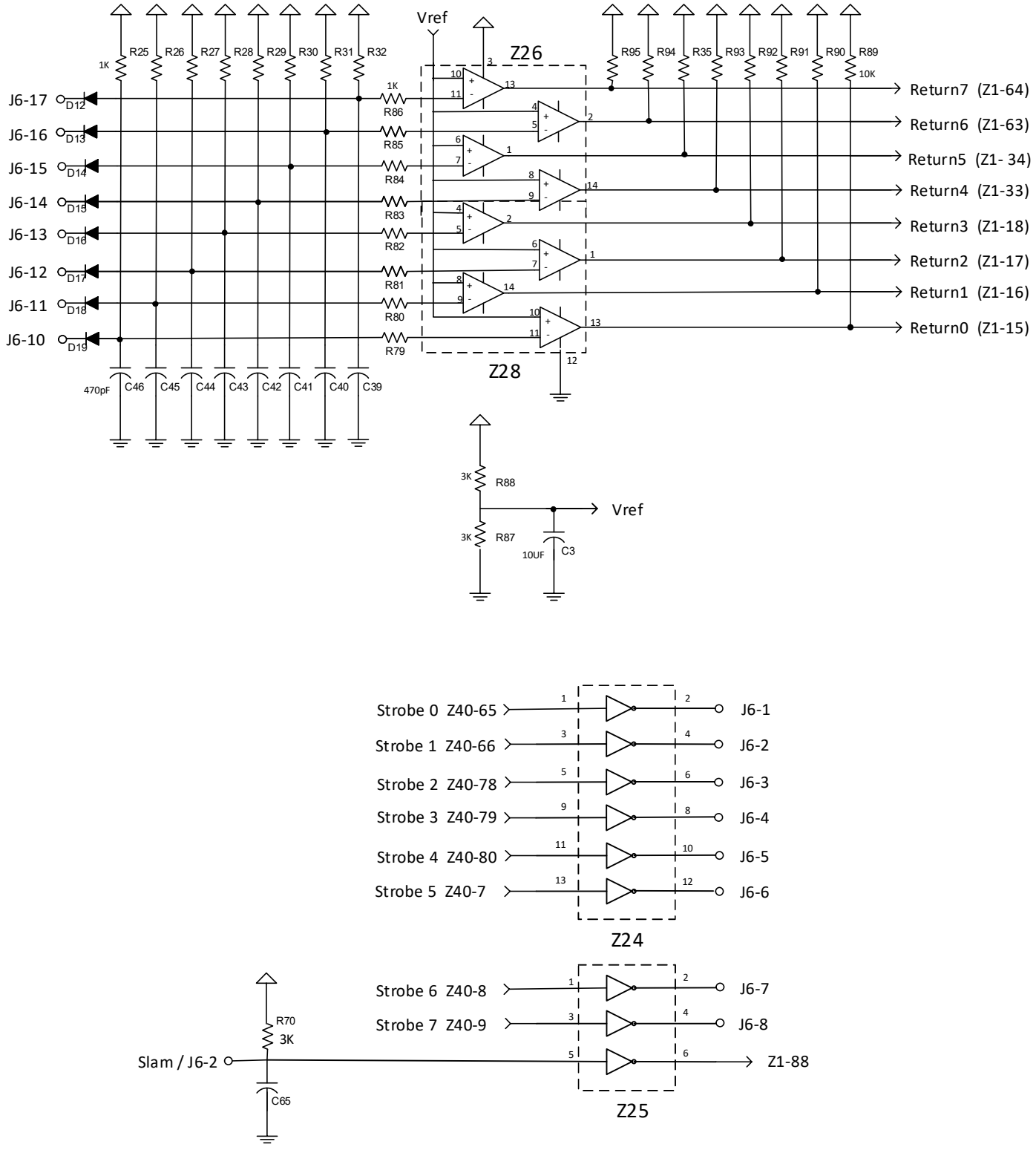



Figure 3 - System 80 Switch strobes and returns

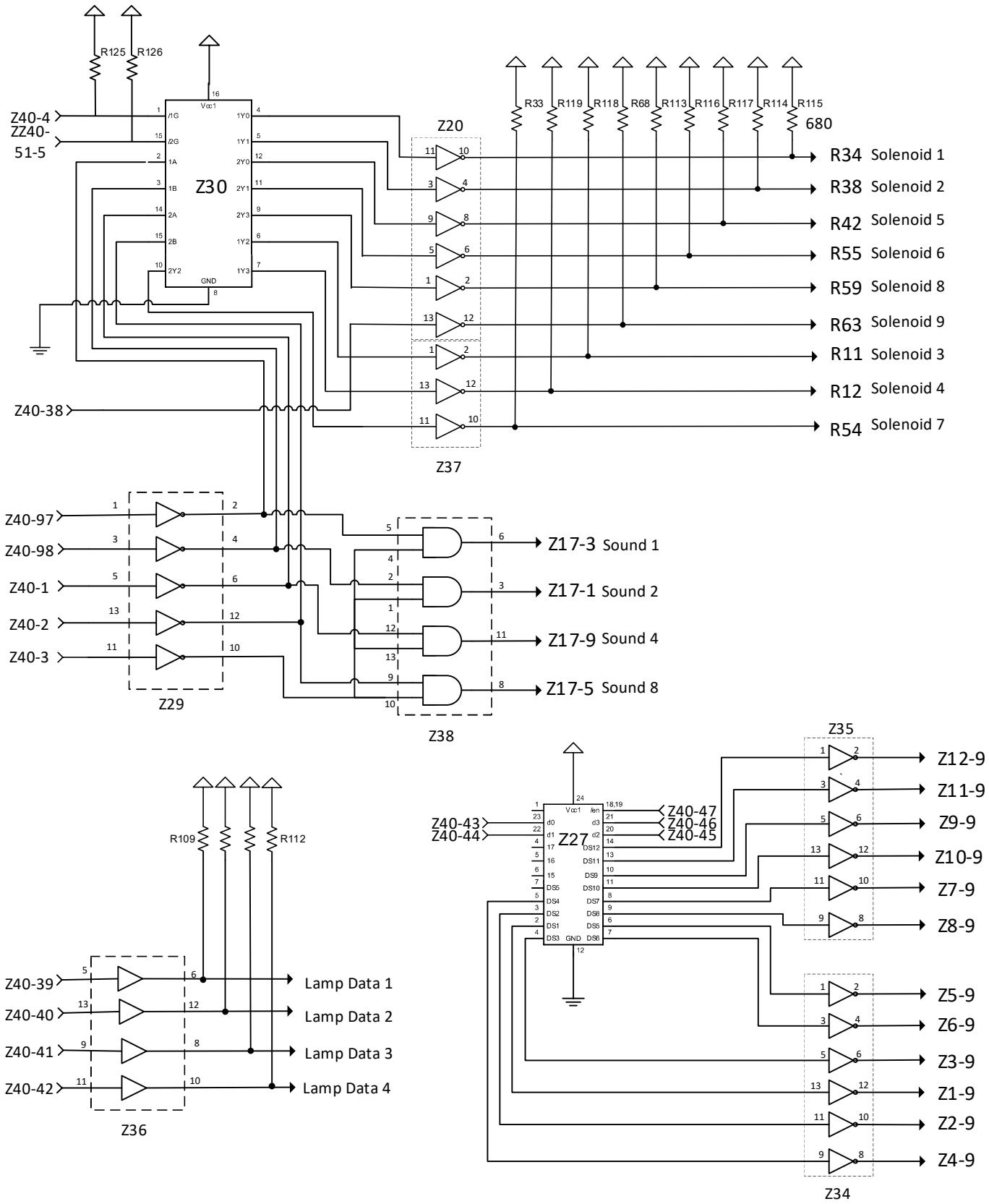



Figure 4 - System 80 Lamps, Sounds, and Solenoids

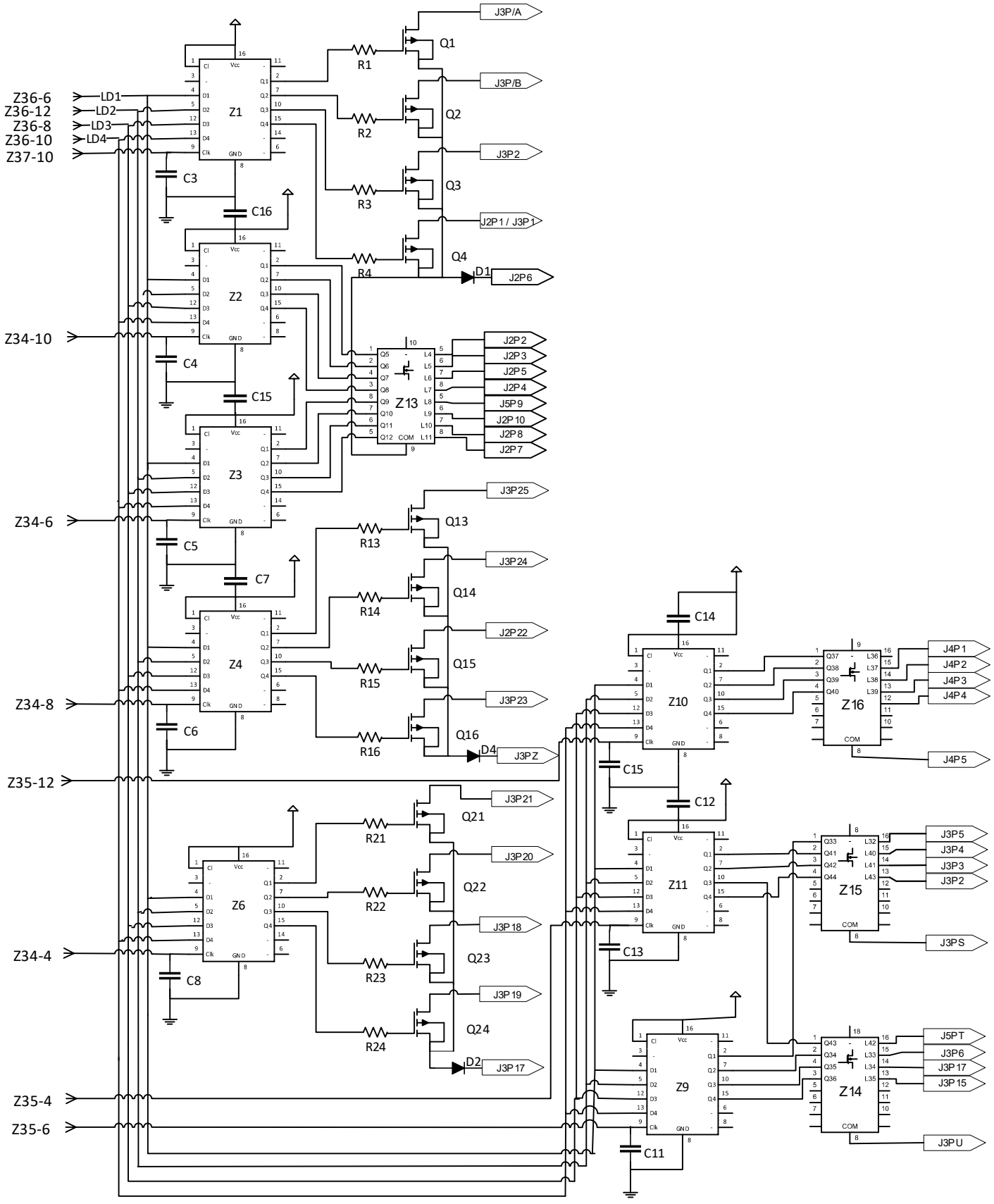



Figure 5 – System 80 - Lamps

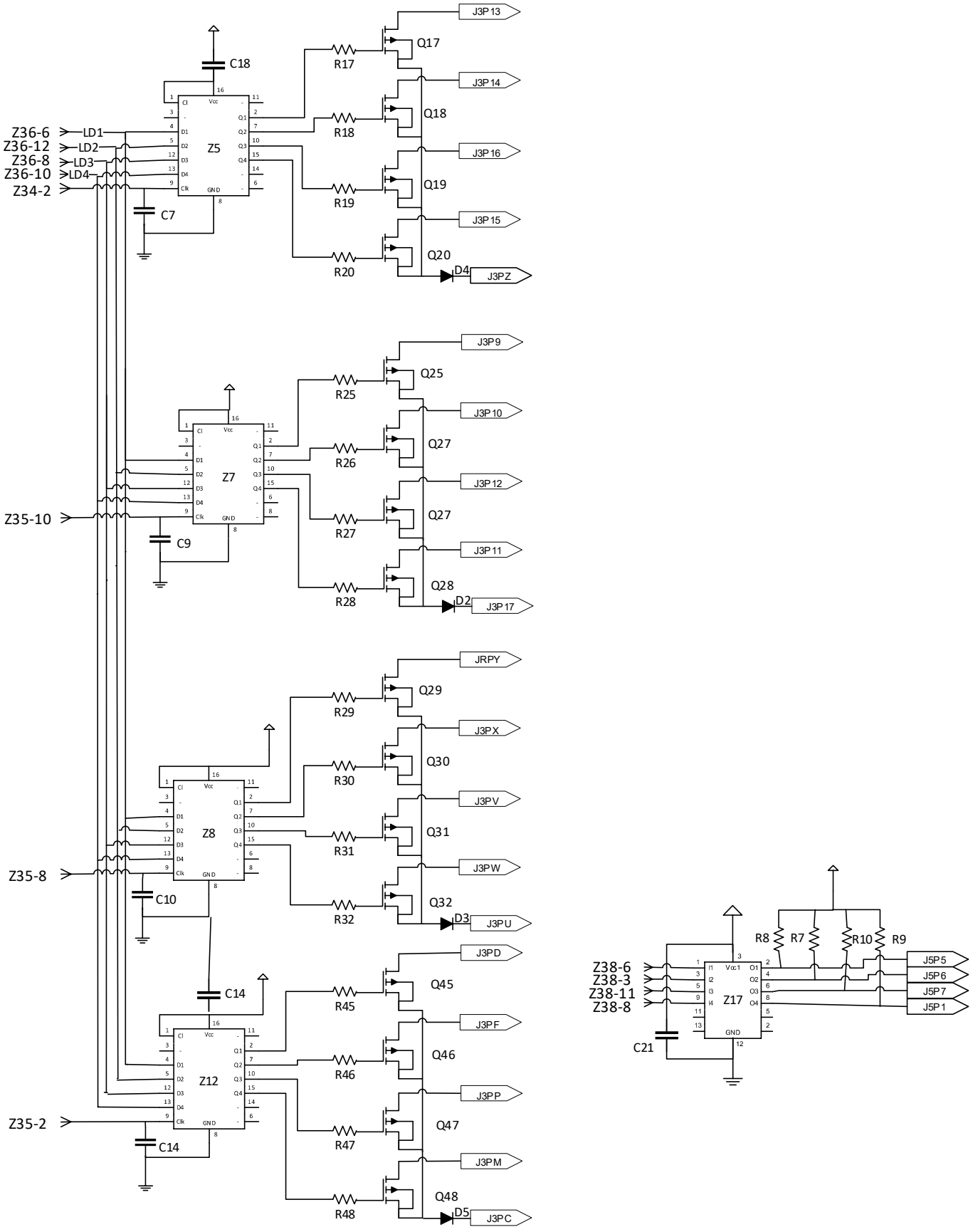



Figure 6 – System 80 Lamps and Sound

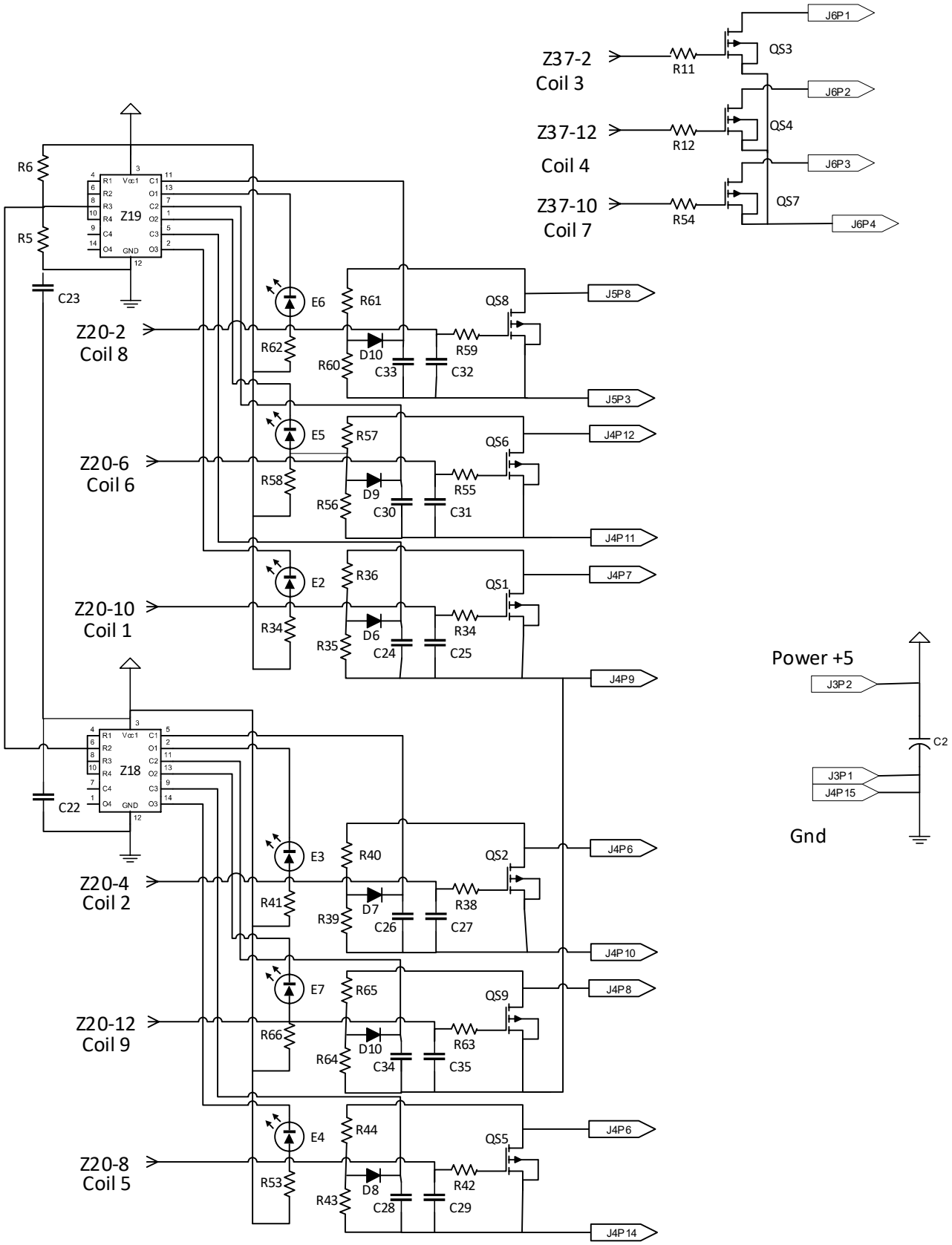



Figure 7 – System 80 Solenoids

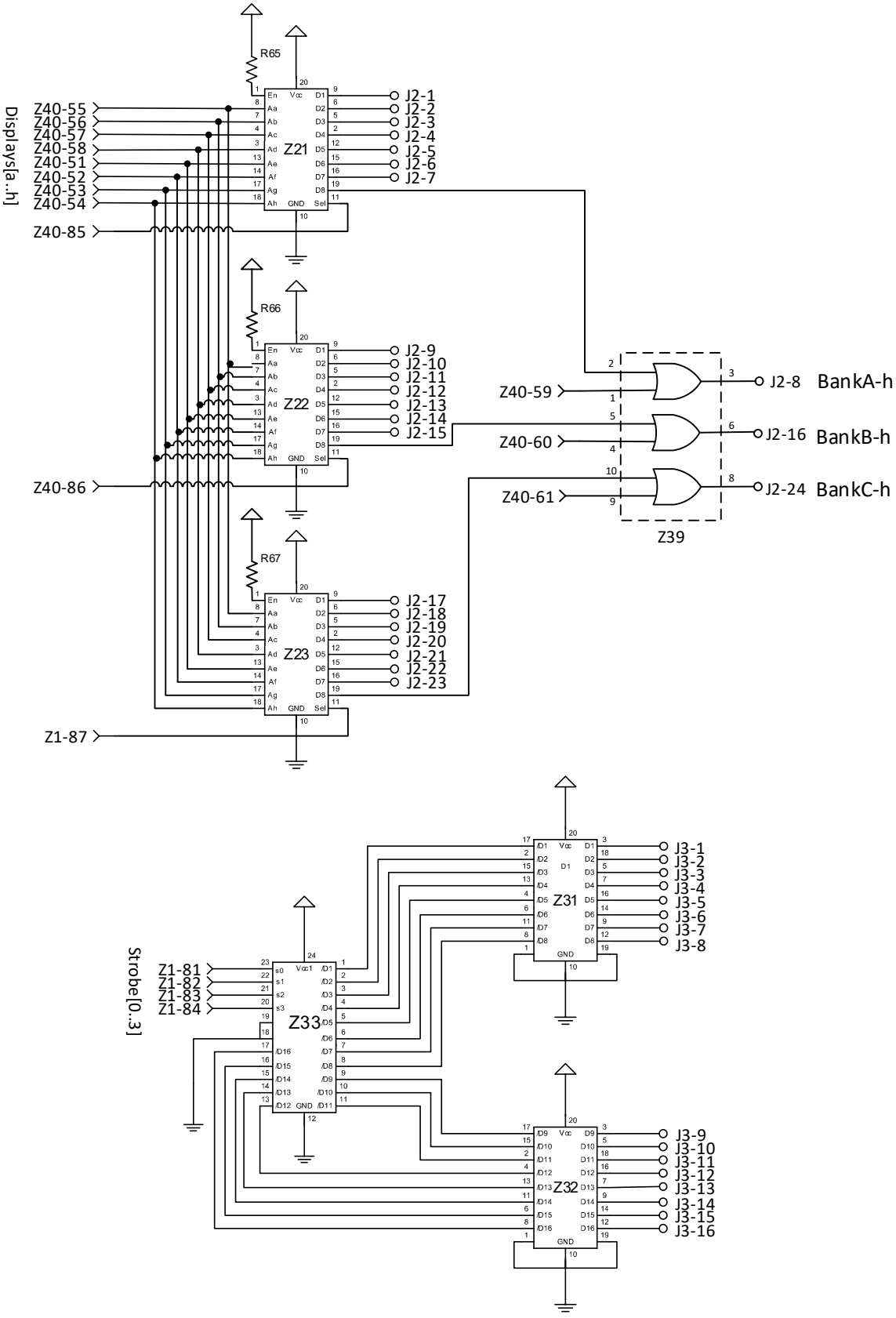



Figure 8 - System 80 Display Outputs

| Designator | Qty | Description |
|---|---|---|
| C1,C2,C4 | 3 | 100uF,16V, 2000Hrs@85℃ |
| C15,C16,C17,C18,C19,C20, C21,C22,C23,C24,C25,C26, C27,C28,C29,C30,C31, C32,C33,C34,C35,C36,C51, C52,C53,C54,C55,C68,C47, C48,C56,C57,C58,C59,C60, C61,C62,C63,C65,C66,C67, C69,C70 | 43 | 10nF,50V,10%,X7R,0603 |
| C3 | 1 | 10uF,16V, 1000Hrs@85℃ |
| C39,C40,C41,C42,C43, C44,C45,C46 | 8 | 470pF,100V,5%,C0G,0603 |
| C49,C50 | 2 | 20pF,50V,5%,C0G,0603 |
| C5,C6,C7,C8,C9,C10, C11,C12,C13,C14,C37,C38 | 12 | 22nF,50V,10%,X7R,0603 |
| C64 | 1 | 4.7K,5%,1/8W,0603 |
| D1,D2,D3,D4,D5 | 5 | 1N4007W diode,1kV,5uA |
| D12,D13,D14,D15,D16,D17, D18,D19 | 8 | BAS16W,115 diode,100V,4A |
| D6,D7,D8,D9,D10,D11 | 6 | 1SS04 Schottky diode,20V,300mA |
| E1,E2,E3,E4,E5,E6, E7 | 7 | LED red,2V,54mcd,0603 |
| H1 | 1 | JTAG 10-pin IDC |
| H2,H3 | 2 | PZ2.54-1*3 3-pin SIP |
| H4,H5,H6,H7 | 4 | 2x2P 4P IDC header |
| M1 | 1 | MEM2075-00-140-01-A |
| Q1,Q2,Q3,Q4,Q13,Q14, Q15,Q16,Q17,Q18,Q19,Q20, Q21,Q22,Q23,Q24,Q25,Q26, Q27,Q28,Q29,Q30,Q31, Q32,Q45,Q46,Q47,Q48,Q49, Q50,Q51,Q52,QS3,QS4,QS7 | 35 | DMN6075S,60V 700mW SOT-23 MOSFET |
| Q53 | 1 | BC847,45V NPN BJT |
| QS1,QS2,QS5,QS6,QS8,QS9 | 6 | PSMN015-BS MOSFET,60V,50A |
| R1,R2,R3,R4,R11,R12, R13,R14,R15,R16,R17, R18,R19,R20,R21,R22,R23, R24,R25,R26,R27,R28,R29, R30,R31,R32,R45,R4,R71, R72,R73,R74,R75,R76,R77, R78,R79,R80,R81,R82,R83, R84,R85,R86,R996,R47,R48, R49,R50,R51,R52,R54 | 52 | 1K,1%,1/8W,0603 |
| R89,R90,R91,R92,R93,R94, R95,R96,R138,R101,R102,R103, R104,R105,R125,R126,R127,R128 | 18 | 10K,5%,1/8W,0603 |
| R120,R121,R122,R123,R124 | 5 | 47K,5%,1/8W,0603 |
| R129 | 1 | 4.7K,5%,1/8W,0603 |

| | | |
|---|---|---|
| R130 | 1 | 68K,5%,1/8W,0603 |
| R131 | 1 | 12K,5%,1/8W,0603 |
| R132,R133,R134,R135,R136,R137 | 6 | 3M,5%,1/8W,0603 |
| R33,R68,R113,R114,R115,R116, R117,R118,R119 | 9 | 680,5%,1/8W,0603 |
| R35,R39,R43,R56,R60,R64, R97 | 7 | 1M,5%,1/8W,0603 |
| R36,R40,R44,R57,R61,R65 | 6 | 4.7M,5%,1/8W,0603 |
| R37,R41,R42,R53,R58,R62, R66,R34,R38,R55,R59,R63 | 12 | 2.2K,5%,1/8W,0603 |
| R5,R6 | 2 | 3.3K,5%,1/8W,0603 |
| R69 | 1 | 100,5%,1/8W,0603 |
| R7,R8,R9,R10 | 4 | 2.7K,5%,1/8W,0603 |
| R70,R87,R88,R98,R100,R106, R107,R108,R109,R110,R111,R112 | 12 | 3K,5%,1/8W,0603 |
| SW1 | 1 | SPST-NO,24V,50mA |
| V1 | 1 | LF33CDT-TR,D-Pak |
| Y1 | 1 | 8MHz,20pF,HC-49/US |
| Z1,Z2,Z3,Z4,Z5,Z6, Z7,Z8,Z9,Z10,Z11,Z12 | 12 | SN74LS175DR,SOIC-16 |
| Z13 | 1 | ULN2803 Darlington Transistor Array,50V 500mA,SOP-18 |
| Z14,Z15,Z16 | 3 | ULN2003 Darlington Transistor Array,30V 500mA,TSSOP-16 |
| Z17 | 1 | SN74LV06, TSSOP-14 |
| Z18,Z19 | 2 | LM339MX,SOP-14 |
| Z20,Z37 | 2 | SN74LS06, SOIC-14 |
| Z21,Z22,Z23 | 3 | SN74HCT273DWR, SOIC-20 |
| Z24,Z25,Z29,Z34,Z35 | 5 | SN74LS04, SOIC-14 |
| Z26,Z28 | 2 | LM339MX,TSSOP-14 |
| Z27,Z33 | 2 | 74HCT154M, TSSOP-24 |
| Z30 | 1 | SN74LS139DR, SOP-16 |
| Z31,Z32 | 2 | 74LS240DWR, SOP-20 |
| Z36 | 1 | SN74LS07, SOIC-14 |
| Z38 | 1 | SN74LS08, SOIC-14 |
| Z39 | 1 | SN74HCT32, SOIC-14 |
| Z40 | 1 | STM32U535VET6 |

Table 5 – Bill of Materials for the Ni-Wumpf CPU / Driver Board

# Appendix A – The Serial Output Port

As mentioned previously, there is a serial output port on the board to assist in *some* feedback from the board as to what it is doing. Hooking the device up to your computer, and then configuring the Serial device in the USB device menu will allow you to review diagnostic messages as the board executes up to the point that it runs the emulator.

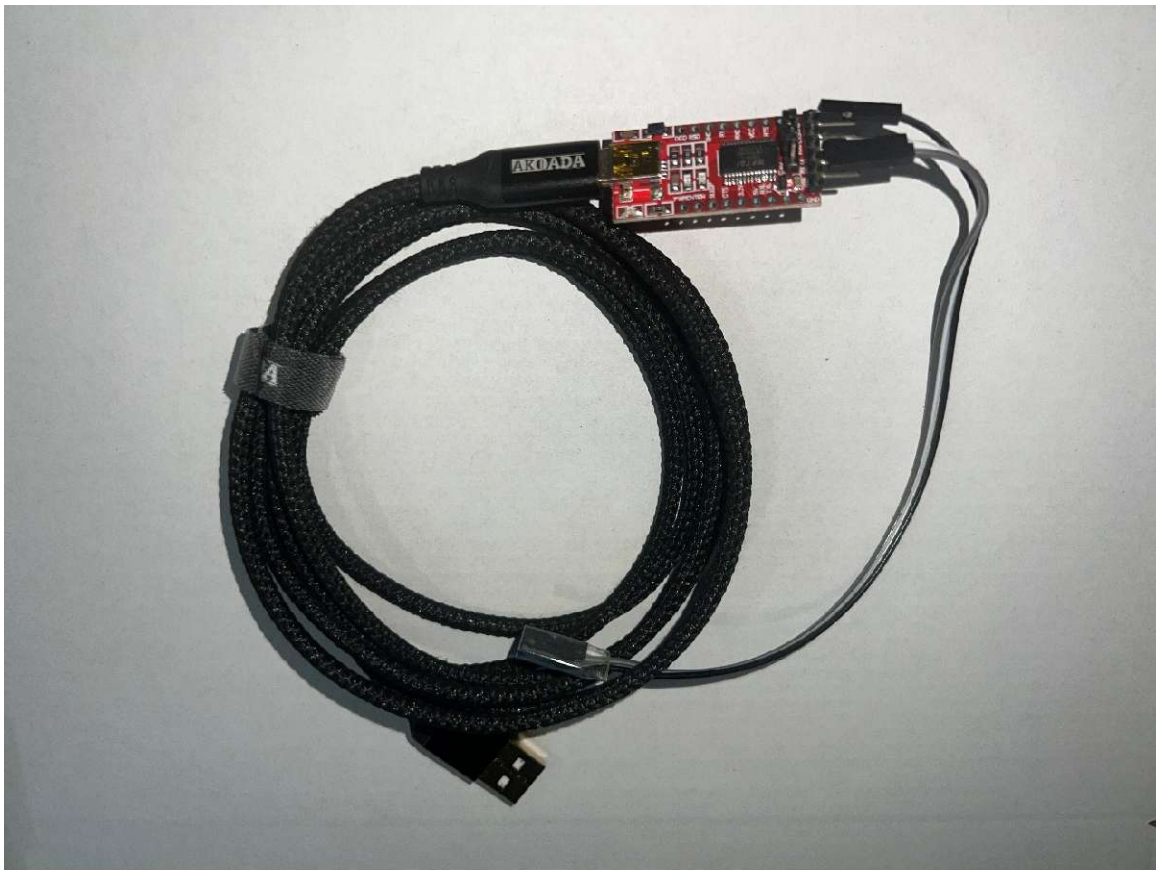



Figure 6 – USB to Serial Adapter with Cabling

Once this adapter is connected to your computer you will find an additional device entry in your "Device Manager" (for Windows) table, as illustrated below:

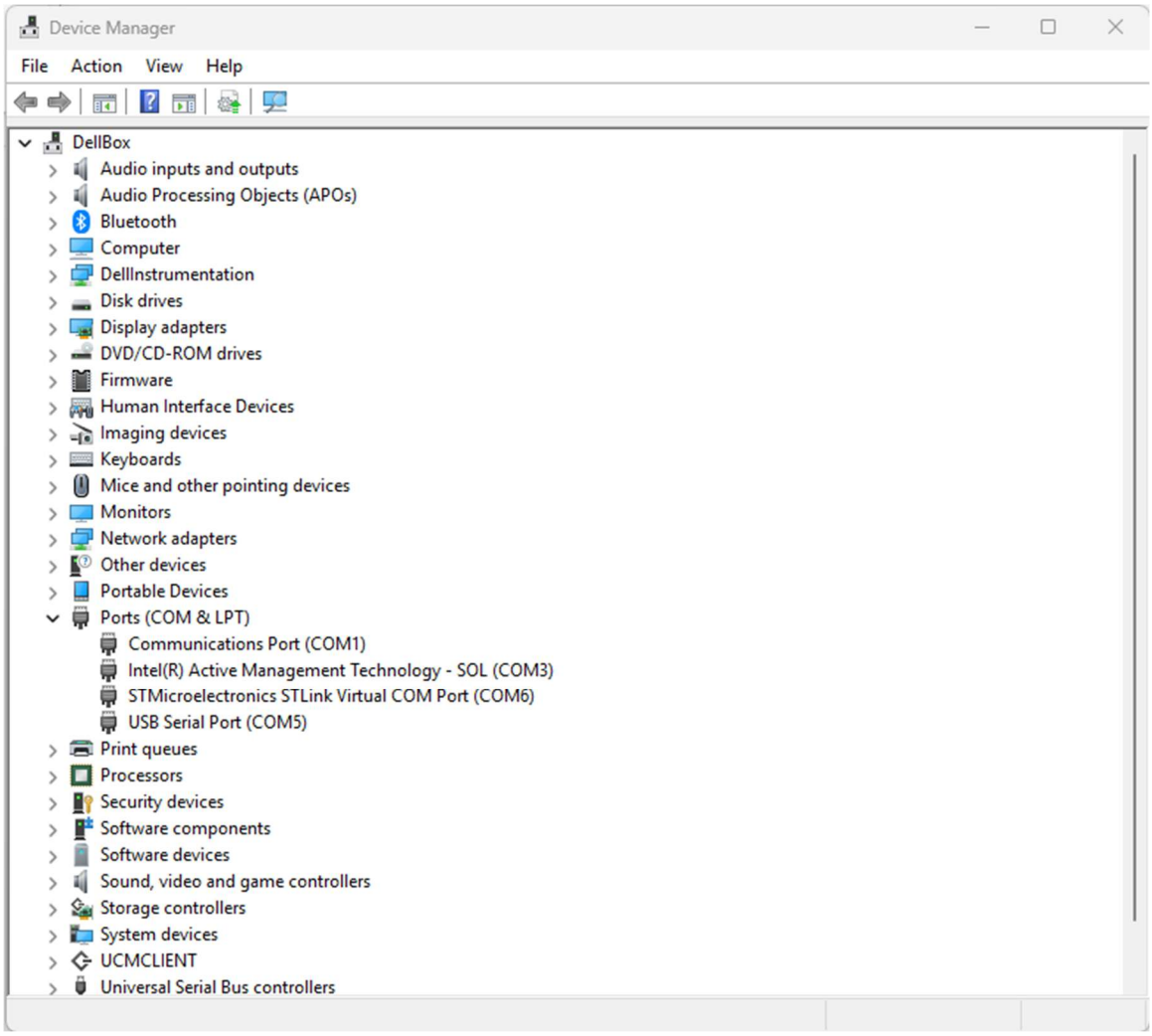



Figure 7 – Window Device Manager

Above, the device is identified on the system here as: "USB Serial Port (COM5)" under the "Ports" entry. The port identifier, "COM5", is the salient entry to make note of. Using a Serial terminal program installed on your Windows device, and I use the example of using "PuTTY" below, you will need to create a new Session entry for the serial connection to your Ni-Wumpf CPU. The options for the session will include the name for the port (from above; COM5), and the speed by which the serial connection will communicate; 115200 baud as shown below. The flow control parameters are the default 8-N-1, with no parity or flow control bits.

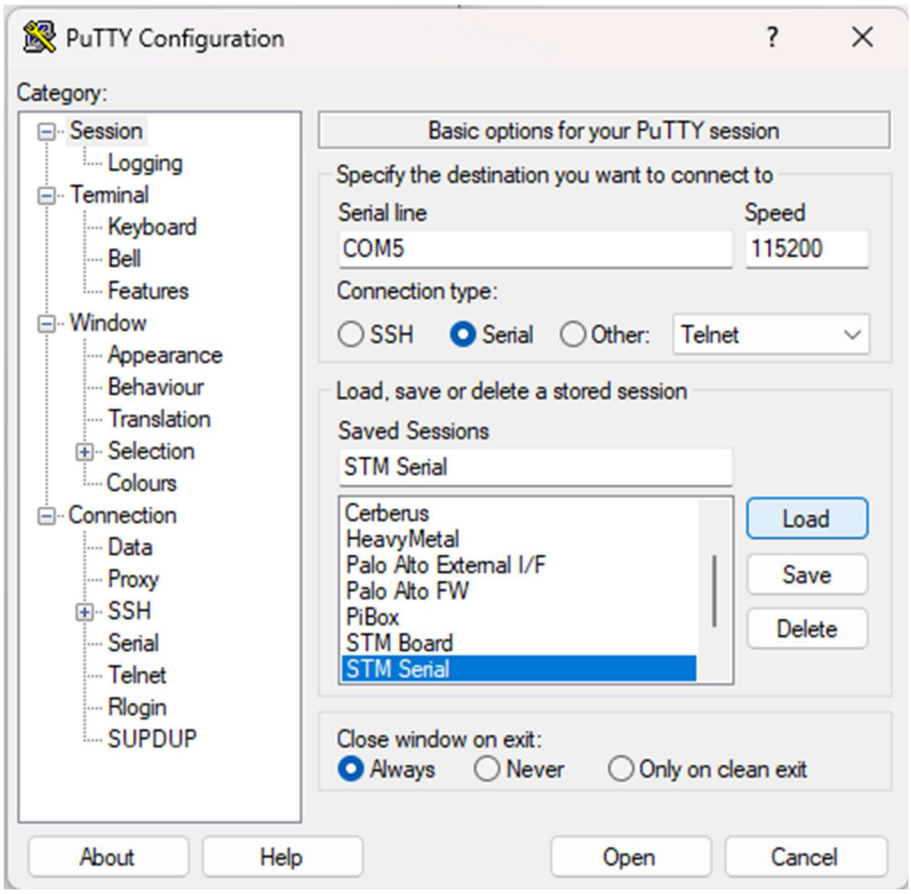


Figure 8 – PuTTY Session Configuration Menu

The connection to the CPU is via three wires; Rx (Receive), Tx (Transmit), and GND. On the CPU, you will find these same pin descriptions. Always remember that Rx from one device connects to Tx on the other, and vice versa. Once connected, and the terminal program running, if you find that you are not receiving any data from the CPU, try reversing the Rx / Tx on your dongle to see if that helps. The Serial port does ***not*** accept operator entry through this port to the CPU.