

# **Introduction to Commodore 8-Bit Maintenance**

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Bil Herd

# Introduction

- Commodore Business Machines
  - Life in the 80's
  - Days of the thru-hole and 1/2watt resistor
  - Made for the masses
  - MOS IC's

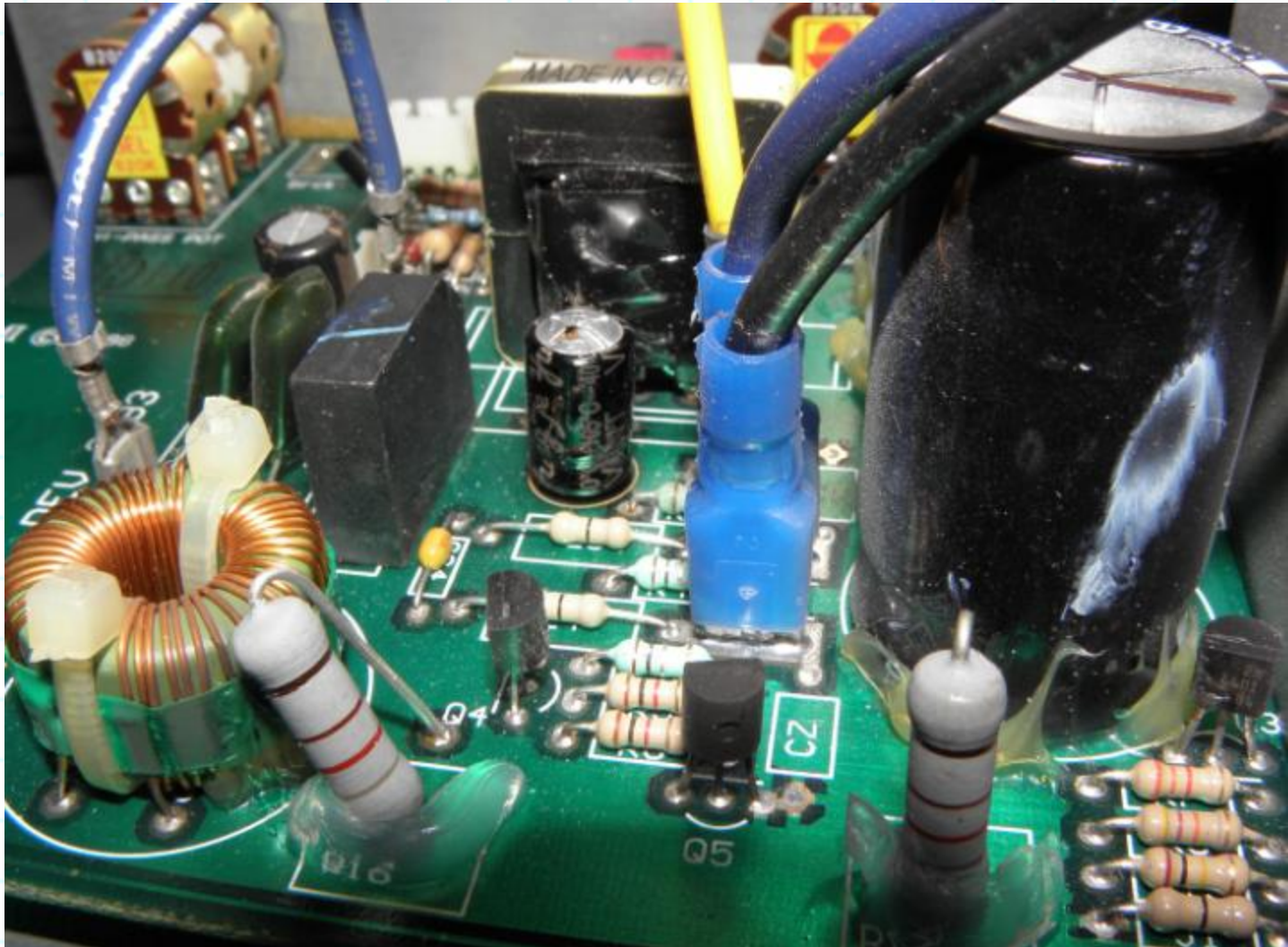
# Goals

- Determine the desired level of test and repair
- Assess the target system
  - Quick appearance vs. Fully operational
- Troubleshoot
  - Parts Swap vs. Full in depth
- Repair
  - Parts availability, swap, hack

# Inspection

- Look, look, look, look some more, seriously.
- Initial Turn On
  - Watch, listen, smell, heat
  - The “rap”
  - Moving parts, oxidation, discoloration
- Blown Fuse
  - About Fuses

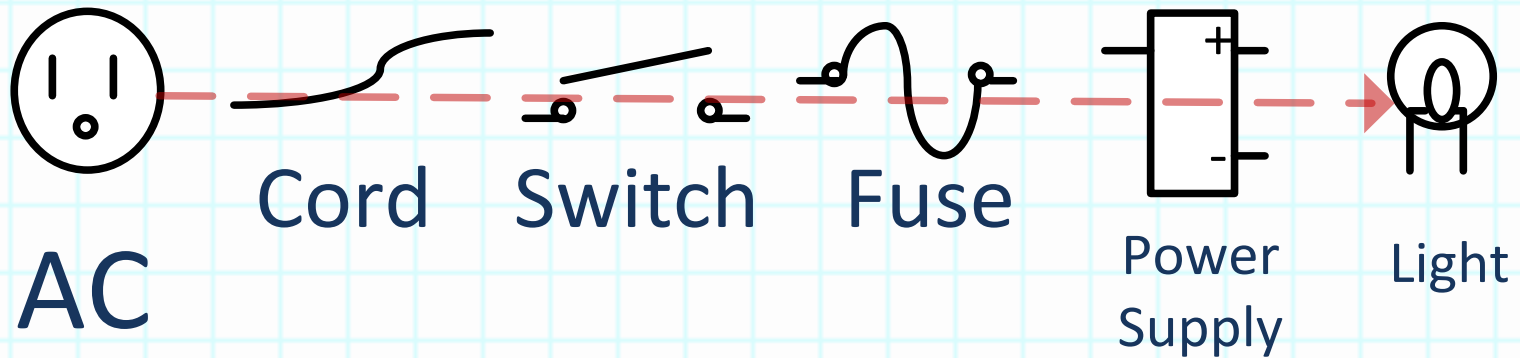
# Anything Look Unusual



# Troubleshooting

- “Localization”

Simple Example – What it takes to light the indicator



# Step One

- Establish the Power Supplies are good
  - Logic Supply +5V
  - Analog Supply +12V, -12V
  - Adjunctive Supply 9VAC
  - Hi-Voltage CRT 18+ kV
    - Safety
    - Listen

# What Next

- Supplies are good, now...

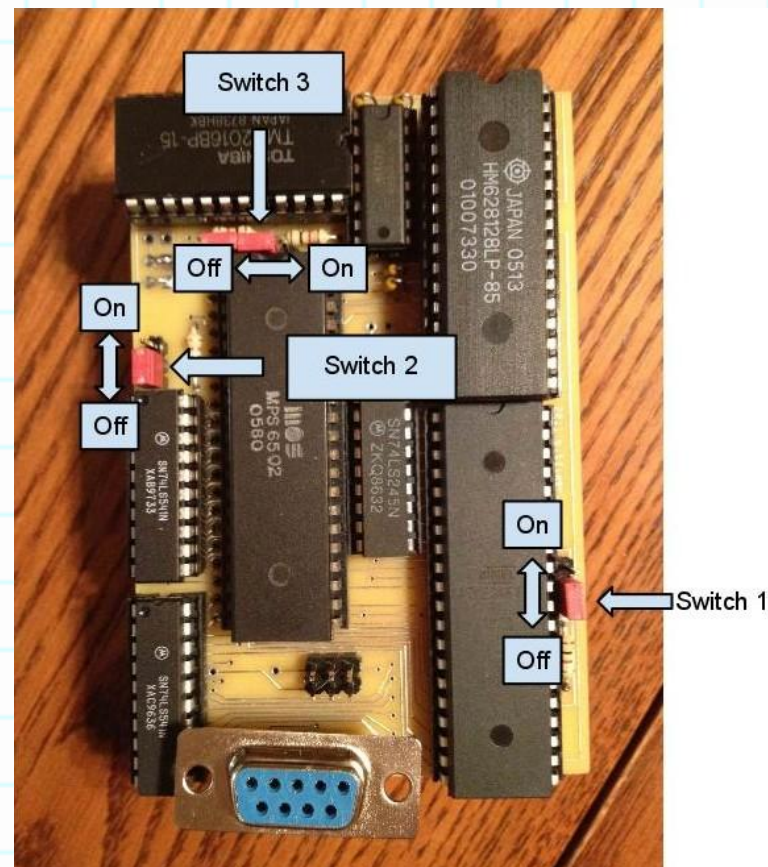


# Diagnostic Hardware

- PET
  - Built in diagnostics on 2001
  - The PETvet
- VIC-20
  - Commodore Diagnostic
- C64 / C128
  - Dead Test Cartridge (Really Useful)
  - Other Diagnostic Cartridge
- Plus/4, C16, C232
  - Diag264

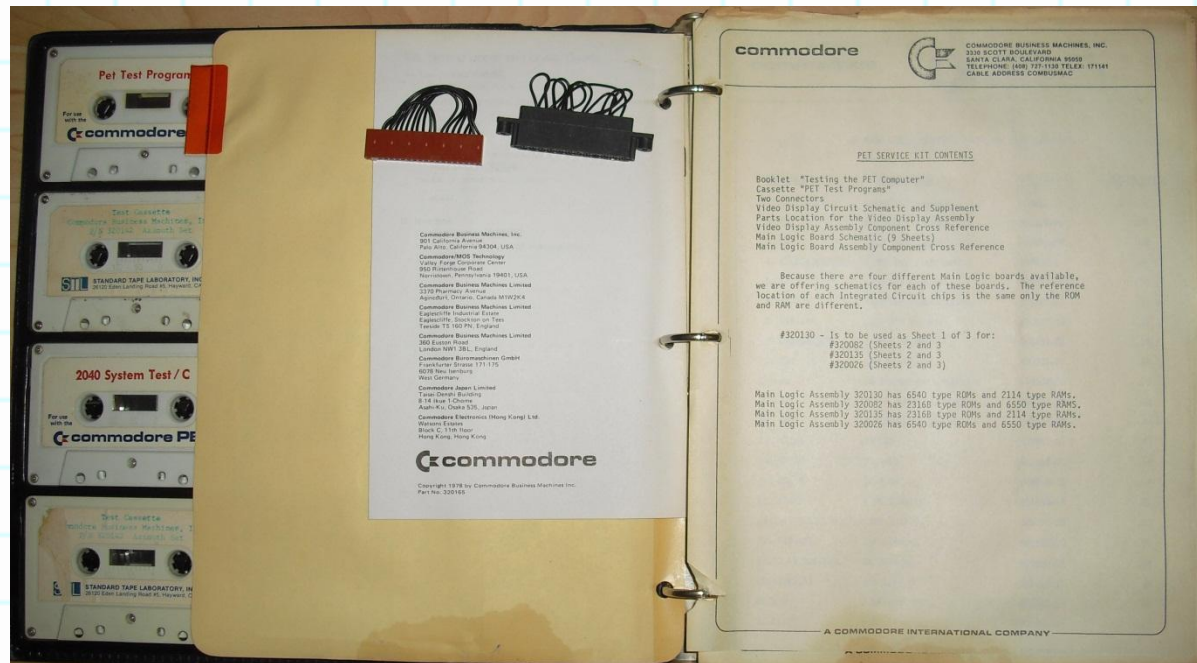
# PETvet

- Developed By Mike Hill
- Programmable ROM/RAM replacement
- Customisable Memory Maps
- Reprogrammable by Serial port
- Tools to halt CPU and view memory



# Other PET Tools

- Built in diagnostics on Rev-1 ROM's
- LED on board 2001 series
- Build a NOP generator
- The 2001 Service Kit!



# DiagPET / PETvet

- Replaces the top 1k ROM (FC00-FFFF)
- Installs ROM at A000 (normally unused)
- Checks all RAM/ROM, including ZP/Stack

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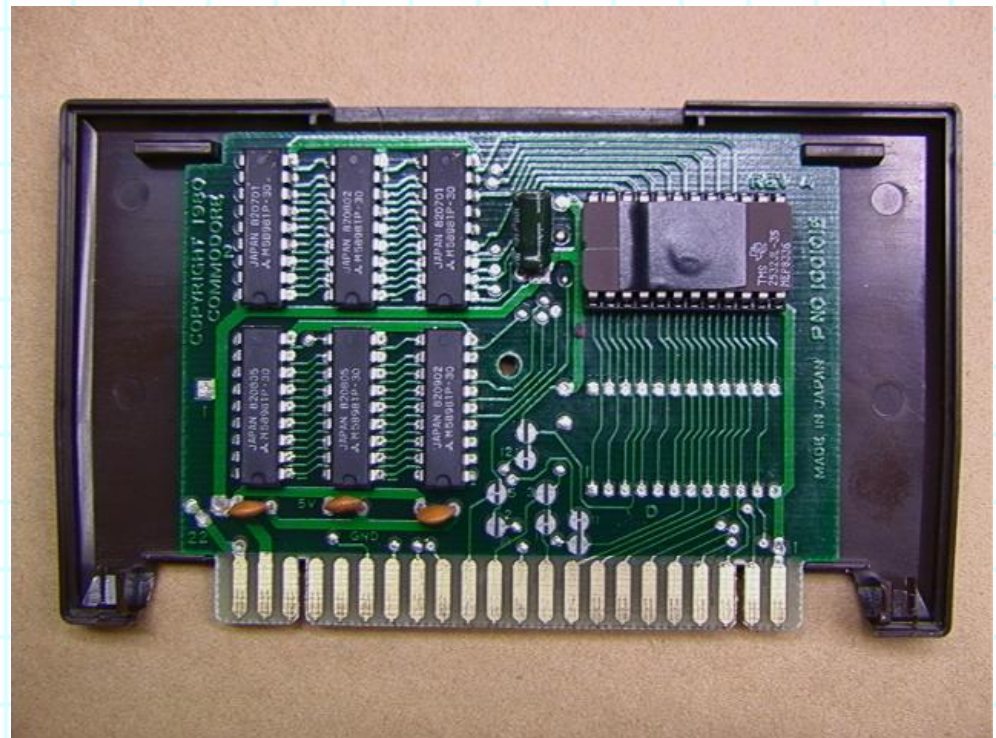
LOW  RAM
VIDEO
HIGH RAM  00 8400 00
          02 1C00 3B

BASIC    C0 03E7CB 756C BASIC1 R2 C0
BASIC    C8 03E4FE 9FFE BASIC1 C8
BASIC    D0 0431FC 1251 BASIC1 D0
BASIC    D8 0445CB 96BA
EDIT     E0 03CA92 4EFE EDIT1 N
KERNAL   F0 042263 BE33 KERNAL2 F0
KERNAL   F8 01FAEC 264A KERNAL1 F8
    
```



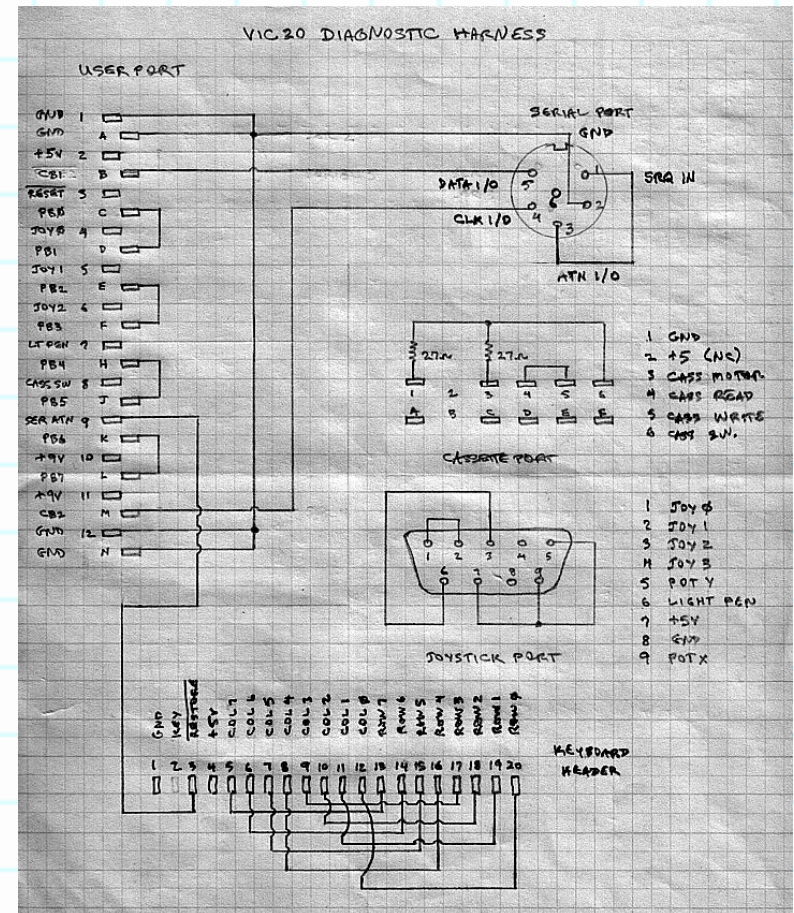
# VIC-20 Diagnostic

- Commodores own tool
- External ROM with own RAM



# VIC-20 Diagnostic

- RAM / ROM Checksums
- Primarily for I/O
- Loop Backs most ports

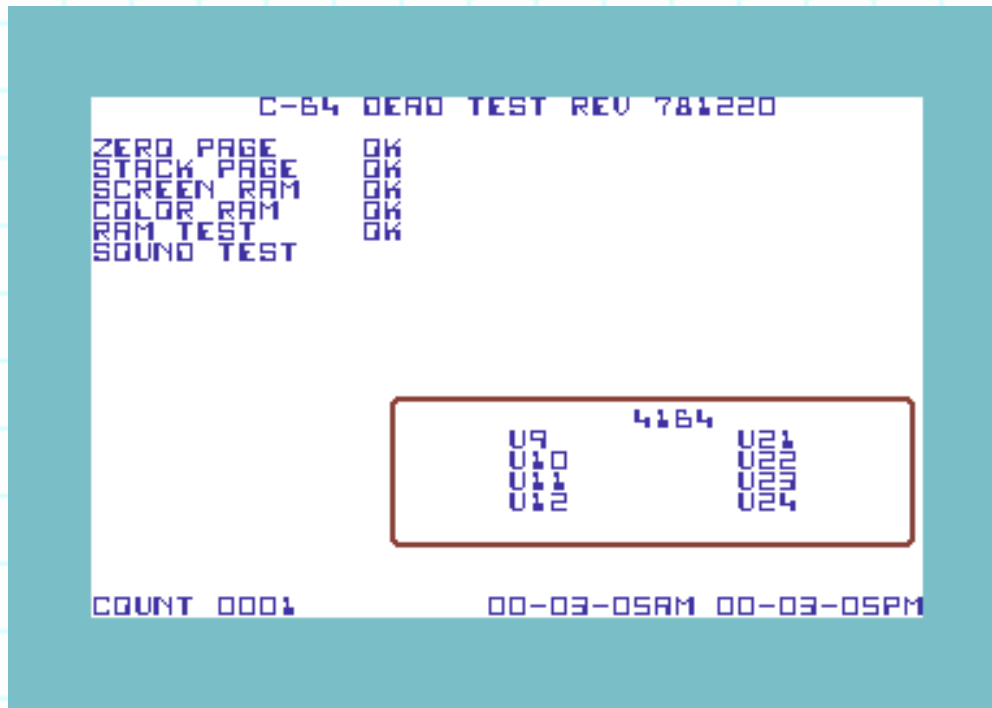


Picture Courtesy Ray Carlsen



# C64 / C128 – Dead Test Cart

- Ultimax mode to bypass Kernal
- Works with no RAM/ROM/SID or CIA's
- Uses border to indicate bad RAM



# C64 / C128 – Diagnostic Cartridge

- Needs a bootable machine
- Like VIC cart, loops back I/O ports

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C-64 DIAGNOSTIC REV 586220

ZERO PAGE      OK      CASSETTE      OK
STACK PAGE     OK      KEYBOARD      OK
SCREEN RAM     OK      CONTROL PORT  OK
RAM TEST1      OK      SERIAL PORT  OK
RAM TEST2      OK      USER PORT   OK
PLA TEST       OK      TIMER1 A      OK
COLOR RAM      OK      TIMER1 B      OK
KERNAL ROM     OK      TIMER2 A      OK
BASIC ROM      OK      TIMER2 B      OK
CHARAC ROM     OK      INTERRUPT     OK
                        SOUND TEST     OK

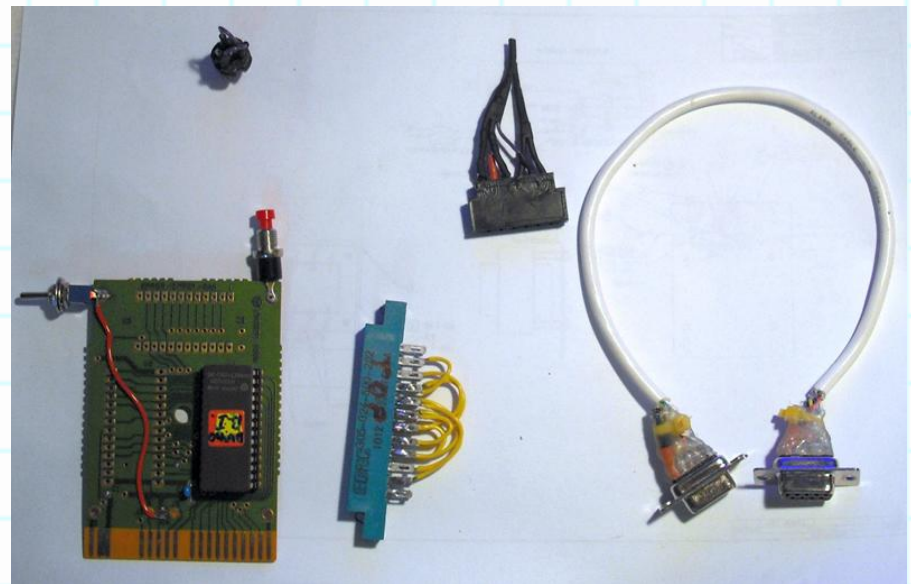
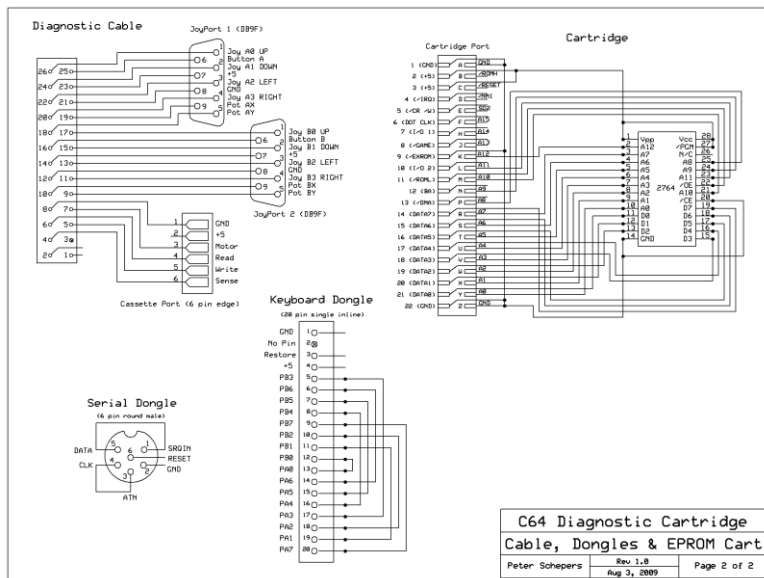
6510 U7          4164
6526 U1          U9          U21
6526 U2          U10         U22
6567 U19        U11         U23
6581 U18        U12         U24
82S1 U17

COUNT 0000      00:00:41AM 00:00:41PM
  
```



# C64 / C128 – Diagnostic Cartridge

- Easy to build your own
- Schematics freely available, but over complicated!
- C128 Version similar but untested by me.



# Plus/4, C16, C232 – Diag264

- Built to fix a Commodore 232
- Kernal or Cartridge based
- Comprehensive testing of RAM/ROM & Ports

```

DIAG264 - V8.1B

LOW RAM          OK      00
HIGH RAM         OK      00
BASIC ROM        OK      00
KERNAL ROM        OK      00
FUNC-LO ROM      OK      00
FUNC-HI ROM      OK      00
KEYBOARD         OK      00
JOYSTICKS        OK      00
CASSETTE         OK      00
SERIAL PORT      OK      00
USER PORT        OK      00
RS232 PORT       OK      00
INTERRUPT        OK      00
2X CLOCK         OK      00
TED REGISTERS    OK      00

64K
1C3133          318006-01
1C089C          318004-05
1B1E78          318053-01
1C09A1          318054-01
F1 S T V 9 P . 2
1-UDLRF 2-UDLRF
$FD10-D2

56 0B 0A 29
27 05 04 12

0001                                CROCK 2012

```

# Common Culprits - PET

- Mostly ROM & RAM
  - 6540 / 2316 adapters from Jim Brain
  - 2114's and 4116's still plentiful (later 2001's)
  - 6550's are tricky!
- Decoding Logic (use a NOP generator)
  - Standard 74 series TTL
- Occasionally CPU or VIA's / PIA's, but rarely
  - WDC Still makes 6502's

# Common Culprits – VIC 20

- Reliable, mine all work today with no fixes!
- ROM's easily replaceable
- RAM's easily sourceable (2114's, TMM2016)

# Common Culprits – C64

- 64's are cheap, so by implication...
- Most commonly PLA (black screen)
- ...& SID (works but defective sound)
- CIA's are fragile but replaceable
- For everything else, Ray Carlsen...

# SuperPLA Multi

- Created by Jens Schoenfeld
- Extracted C64 PLA eprom image in 1994
- Equations derived as part of C-One project
- Implemented on a MACH210 modern PLA
- Includes PLA's from CBM-II's, Plus/4, and 1551
- Also includes modes not implemented on C128



# Resources

- PET  
<http://www.bitfixer.com/bf/petvet>  
<http://www.6502.org/users/andre/petindex/index.html>  
<http://www.zimmers.net/anonftp/pub/cbm/pet/index.html>  
<http://www.vintage-computer.com/vcforum/forumdisplay.php?21-Commodore>
- VIC-20  
<http://sleepingelephant.com/ipw-web/bulletin/bb/index.php>
- C64, C128  
<http://www.retro-donald.de/pages/superpla-multi.php>  
<http://www.swinkels.tvtom.pl/swinsid/>  
<http://www.lemon64.com/>  
<http://personalpages.tds.net/~rcarlsen/>
- Plus/4, C16, C232  
<http://inchocks.co.uk/commodore/Diag264/HTMLManual/Diag264.htm>  
<http://plus4world.powweb.com/home>  
<http://www.commodore16.com/index.php/forum.html>
- Spares  
<http://www.arcadecomponents.com/index.html>  
<http://store.go4retro.com/>  
<http://retro-donald.de/sinchai-shop/>
- General Info  
<http://www.softwolves.pp.se/misc/arkiv/>  
<http://personalpages.tds.net/~rcarlsen/>  
<http://www.zimmers.net/anonftp/pub/cbm/>



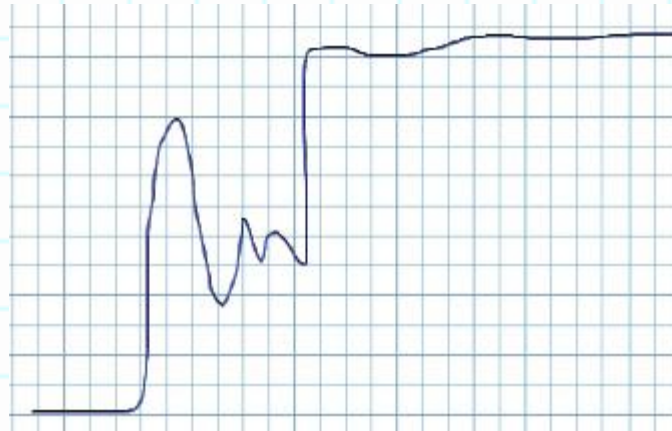
# After Swapping the Chips

- Check the environment carefully
  - Requires an Oscilloscope (or it'd already be fixed)
- Power Supply - most Common Denominator
  - Ripple and noise
  - Non-monotonic
  - Absolute values



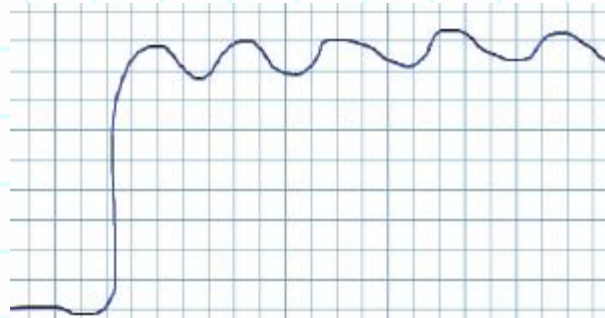
# Power Supply

- Non-monotonic power up

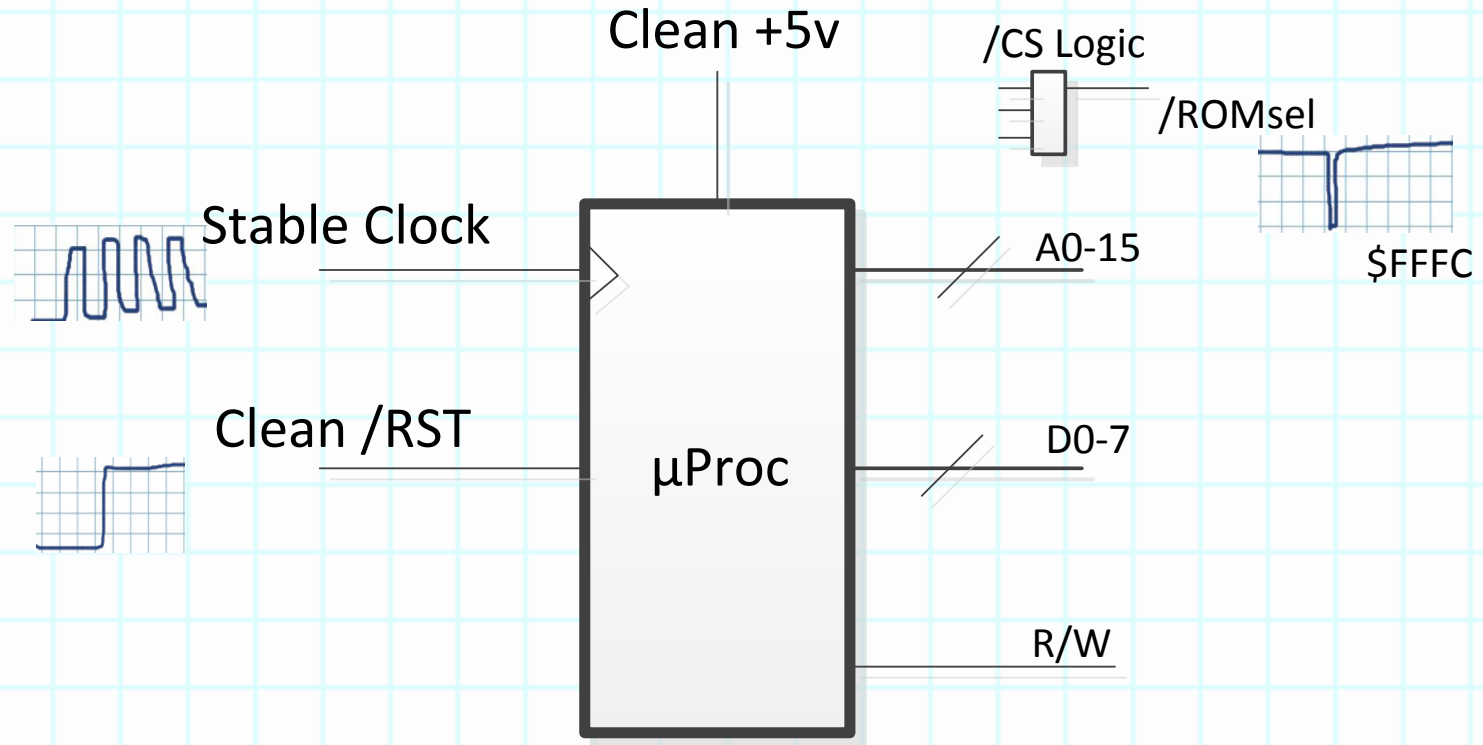


# Power Supply

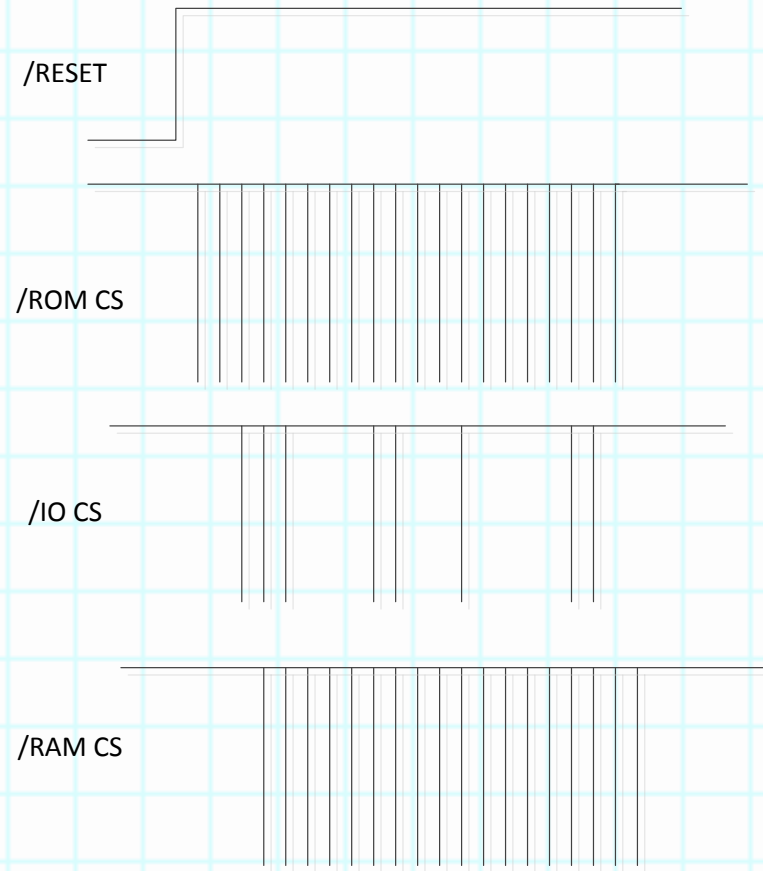
- Excessive ripple or other noise



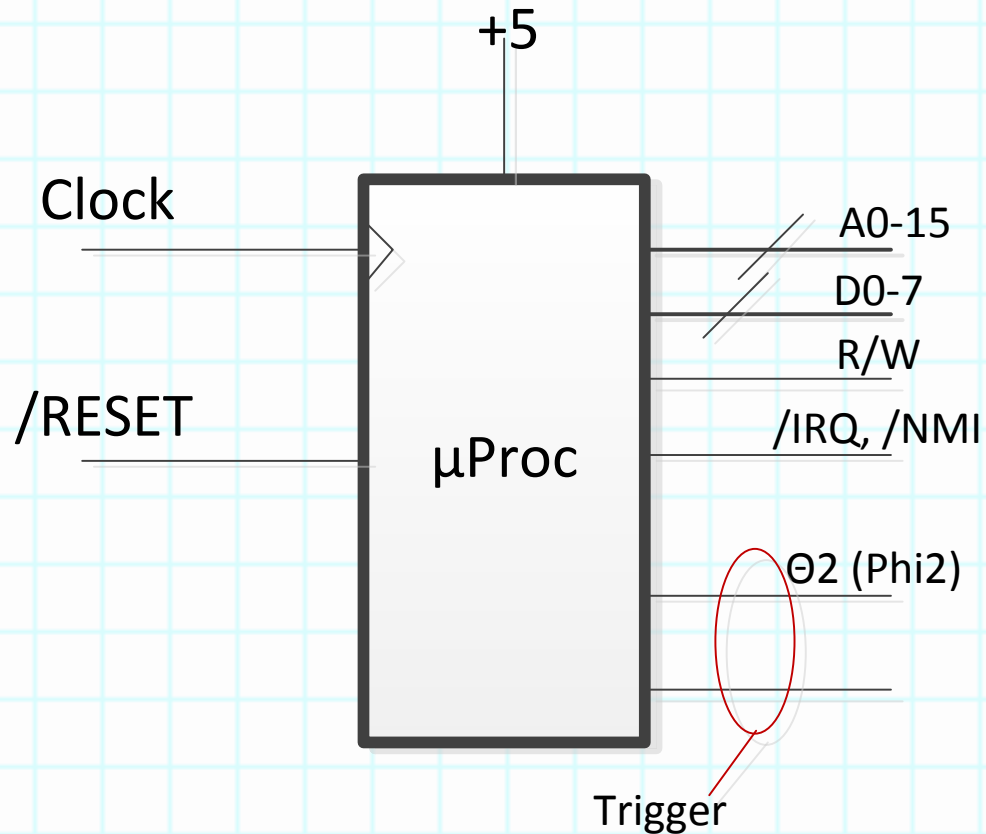
# Care and Feeding of $\mu$ Proc



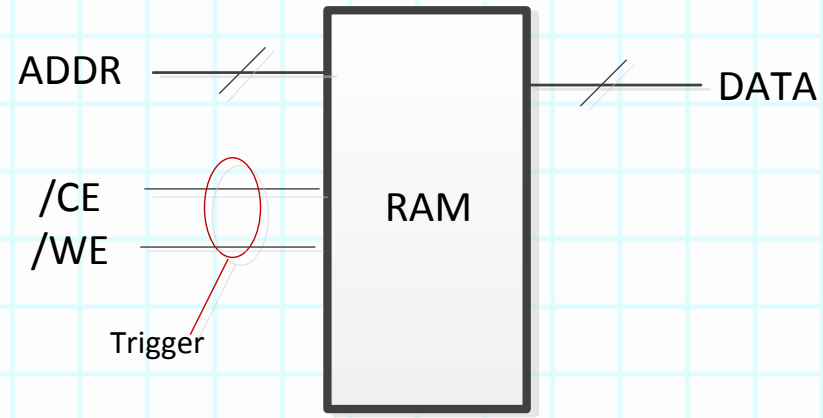
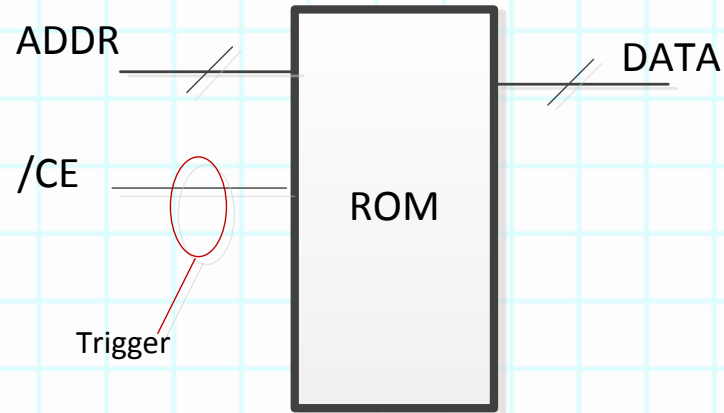
# The Order of Things



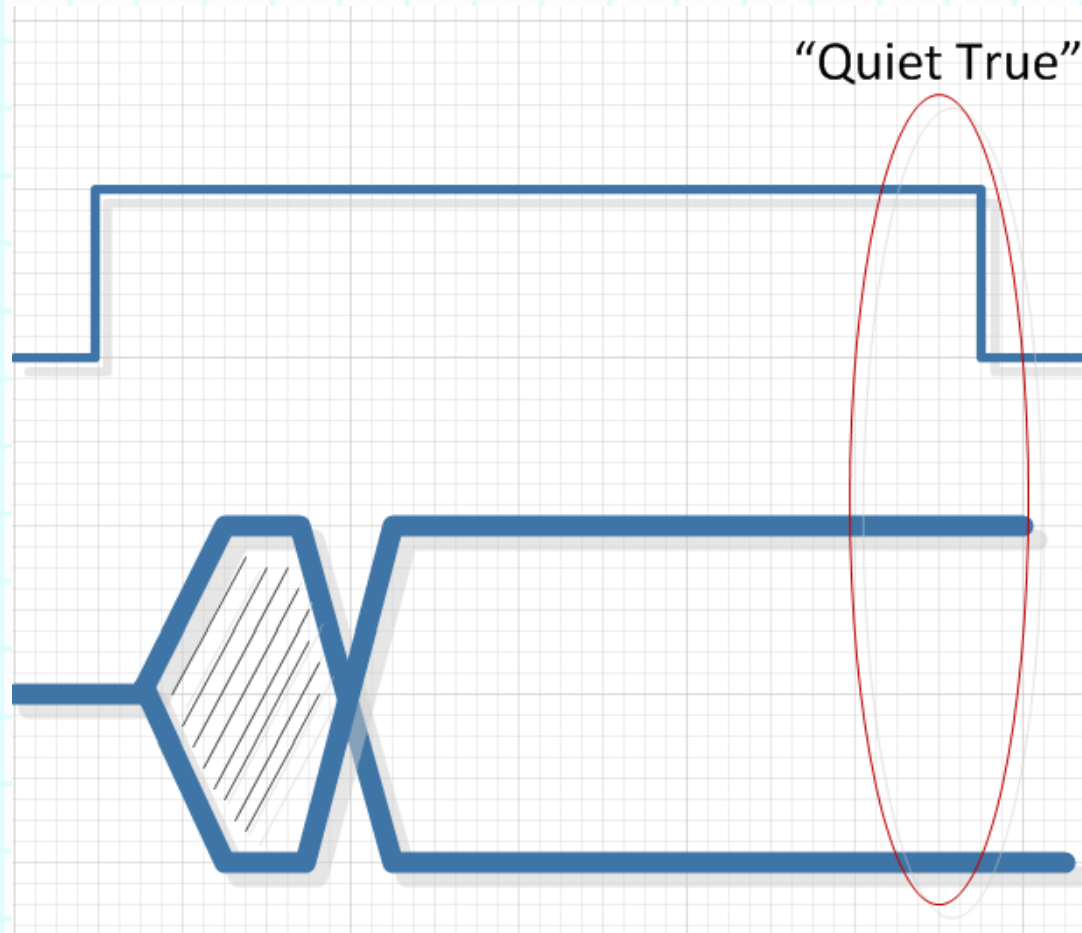
# Get to know the Neighbors



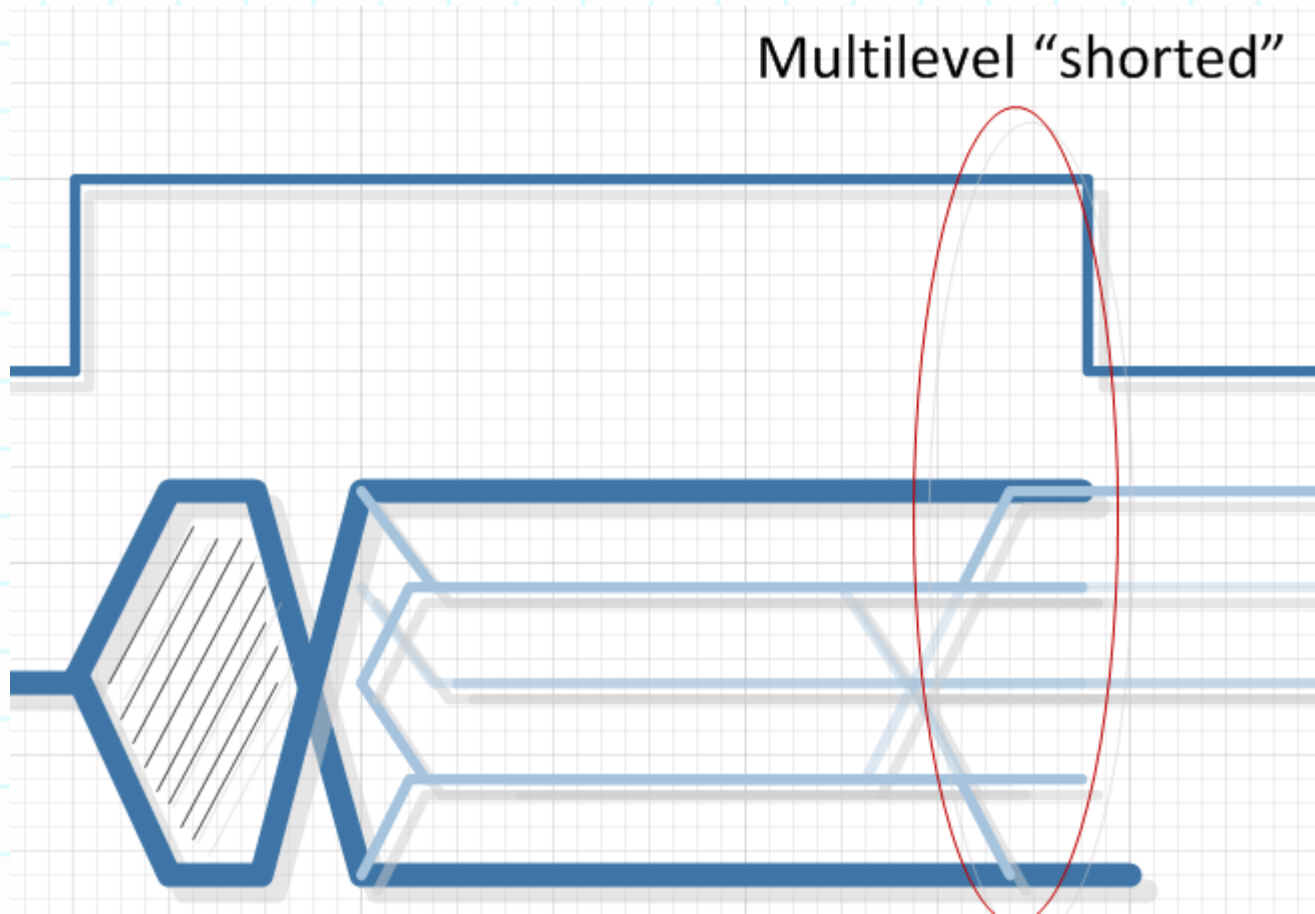
# RAM/ ROM



# Making Sense of Chaos

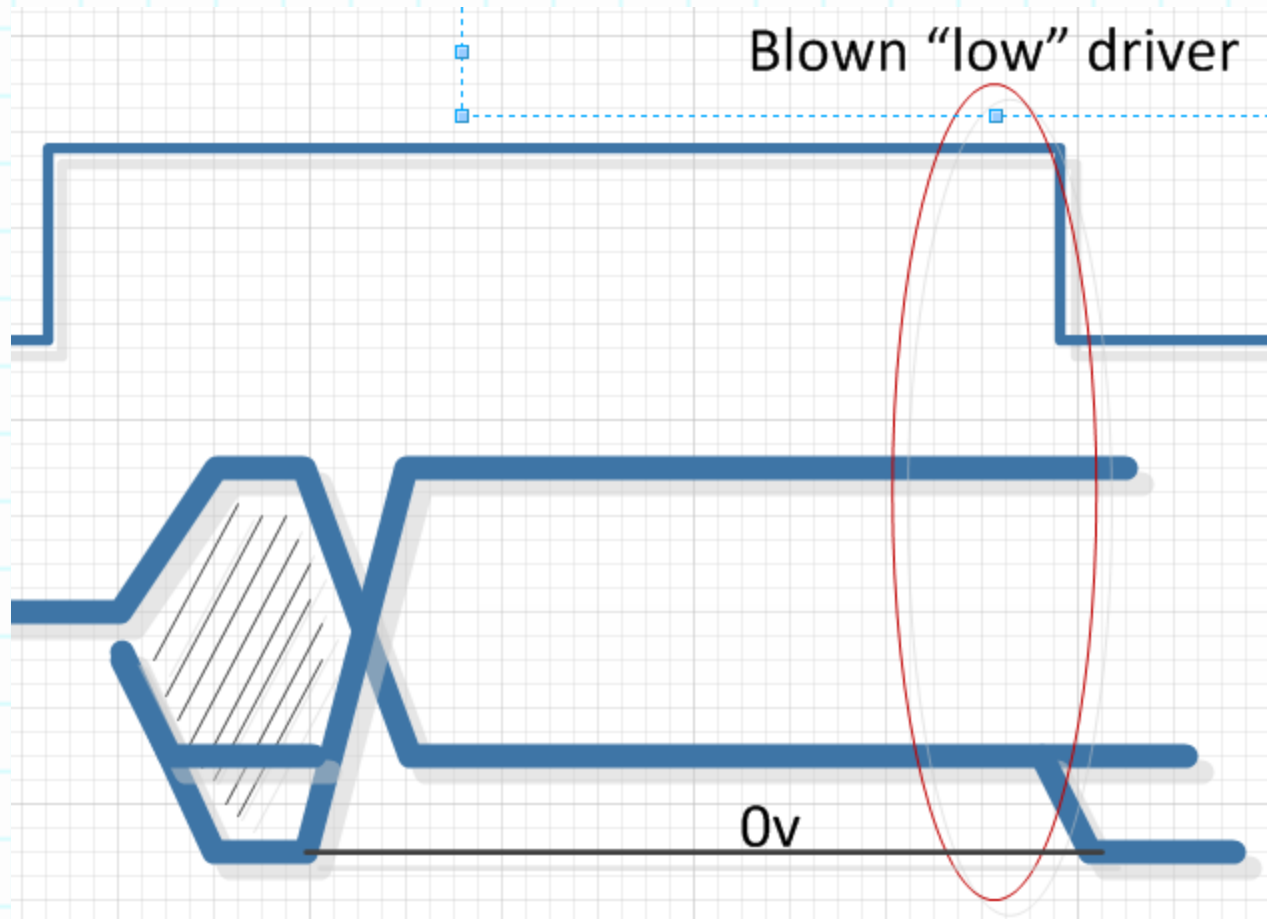


# When Logic is Invalid





# Zero or One



# Good Diagnostics

- Problem with most microprocessor systems is it's an all or nothing affair.
- A good diagnostic runs with minimal requirements. First establishes RAM works before using it for more advanced diagnostics.