Assorted ASCII Schematics

Contents:

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1. Headlight Reminder Circuit

From: ps10@jet.uk (Paul Simmonds)

A [...] solution is to go from the +12 Switched sidelight feed, via a buzzer to the drivers door light switch, you then need to put a diode in the door circuit to stop the other doors operating the buzzer.

```
    +12v  (sidelights)
     |
   +-+--+
   |    | Buzzer (12v)
   +-+--+
     |
     +-------|<|-------- To existing drivers interior light switch
     |       Diode
     |
```

```
  O
----|  Drivers door switch
  O
  |
Car Chassis
```

Thus when you leave your lights on **AND** open the drivers door, the buzzer sounds. If you mean to leave your lights on, just shut the door and the buzzer stops!

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2. Parallel Port DAC

(From Tomi Engdahl)

Connectors: D25 male
Resistors: 640k,320k,160k,80k,40k,20k,10k,5k,390 (+-1%)
(You can use different values of resistors, but the ratio of the values of the resistors must be same. 0.5, 1, 2, 4, 8, 16, 32, 64 etc.) 1, 2, 4, 8, 16, 32, 64, 128
Capacitor: Electrolytic or solid Tantalum 10 uF 10V

SCHEMATIC

(Parallel Port FAQ Reference)

```
+---+
| 2 | ---<640k>---+
| 3 | ---<320k>---+
| 4 | ---<160k>---+
| 5 | ---<80k>----+
| 6 | ---<40k>----+
| 7 | ---<20k>----+-----+---- 10 uF -------> Out
| 8 | ---<10k>----+     |
| 9 | ---<5k>-----+   <390>
|   |                   |
| 25| ------------------+------------------+
+---+                                      |
                                          ===
                                         Ground
```

How to build

Solder all D25 male connector pins to corresponding D25 female connector pins (pin 1 to pin 1 etc) Connect the resistors according the chematic. It is maybe not possible to obtain exact resistor values. If you can't obtain them, try nearest values. <1% deviation is acceptable.

How to use

Connect this circuit to the centronics printer port of your IBM PC or compatible. Connect the printer cable to the D25 female connector of the circuit. Your printer should work correctly with this circuit and you can keed this circuit connected all the time. Connect the sound output to your stereo system. Line in and mic lines are suitable because the output level of this circuit is adjustable (about 0-2V PP). The sound quality is very good.

---

3. Quiz-Show Indicator

From: dthomas@bbx.basis.com (Dave Thomas)

```
"Name something you eat with eggs."
        -<bzzzzt!>-"Fiberglass."
```

Here's a simple, cheap circuit that will let you conduct your very own quiz shows. It has a lamp and a button for each player. When a button is pressed, it lights that player's lamp and locks out the other button until the circuit is reset.

```
      SW3
+6V -o_|_o----+----------+----------->>--------+----------+----->>
              |          |                     |          |
            LAMP1        |                     |         LAMP2
              |          | SW1                 | SW2      |
              +--A>     |o              <A--   o|         |
              |       ==|    --B>         |    |==   <B--+
            -----       |o   |            |   o|       -----
      SCR1  \   /        |   |            |   |        \   /  SCR2
             \ /        R3   ^            ^   R4        \ /
            -----        |  CR1          CR2  |        -----
              |  \       |   |            |   |       /  |
              |   +--R2--+---+            +---+--R5--+   |
              |   |                                  |   |
              |   R1                                R6   |
              |   |                                  |   |
GND ----------+---+----------------->>----------------+---+--->>

SW1,SW2         normally open momentary pushbuttons
SW3             normally closed momentary pushbutton
LAMP1, LAMP2    6V incandescent lamps
R1, R6          470 ohm
R2,R3,R4,R5     1 K
SCR1, SCR2      Small SCRs, not power type
CR1, CR2        1N914 diodes
+               connection
^               cathode of a diode
--A> <A--       are connected (jump)
--B> <B--       same deal
```

Circuit Description

When the circuit is first powered up (or after a reset -- same thing), both SCR gates are held at ground potential by R1 and R6. Therefore, neither SCR will latch up, and both lamps will be off.

When one of SW1 or SW2 is pressed, the corresponding SCR's gate is pulled high, so the SCR latches on. Even if the switch is released, the SCR remains latched, keeping the lamp illuminated.

Diodes CR1 and CR2 ensure that only one lamp may be on at a time. Once an SCR turns on, it forces the other SCR's gate to remain at a low voltage, even if its switch is pressed.

It is probably possible to change the bulbs and the power supply to 12V with no other circuit changes, but I have only built a 6V system. The circuit does not draw current when the lamps are off, so it may be battery powered with no additional cutoff switch. I built the whole thing in a plastic shoebox.

Serving Suggestion: These are great fun in elementary school classes, and as the whole thing can be built for about $5, it's well worth letting the kids have fun while they destroy it!

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4. Frequency and Capacitance meter

From: kenny@m.cs.uiuc.edu

An [...] idea is to use the 555 as a monostable, and trigger it with a fixed frequency clock. Duty cycle will be proportional to capacitance.

Circuit will look something like:

```
+5 ---+---------------+---+
      |               |   |
      R            +----------+
      |(see below) |  8   4   |
  +---+------+-----|7        3|------/\/\/\---+------- Vout
  :          |     |  LMC555  |               |
  C to test  +-----|6         |             -----
  :                |          |             -----
ground       +-----|2        5|----+          |
             |     |    1     |    |        ground
             |     +----------+  0.1 uF
             |          |          |
   Clock ----+        ground     ground
     ^
(see | next section - CMOS Oscillator)
```

The ON time for the monostable is about 1.1RC, so component values that should work would be a 50 Hz clock, say a 1 Hz low-pass filter on the output, and R = 9.09K, 1%. That combination will give an output of one volt per microfarad. Switch R in decades for smaller capacitors. Trim R for calibration.

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5. CMOS Oscillator

From: mjohnson@netcom.Netcom.COM (Mark Johnson)

```
> What I am looking for is a low power oscillator (>.5 mA @ 5V)
> running at a frequency of roughly 1 MHz. However, the frequency-
> determining component should be an inductor with a value of
> approx. 75 uH
```

The circuit below uses a single CMOS lowspeed 74C14 inverting Schmitt trigger chip, your 75uH inductor, and two 10K resistors. It draws about 400uA and oscillates at about 4MHz.

The oscillator period will be approximately linearly related to the inductor value, Period ~=~ K1 + (K2 * L) [Note also that K1 will not be zero]

```
                                             +-----------> Output
                                             |
                                             |
     |\            |\            |\          |     |\
     |  \          |  \          |  \        |     |  \
     |    \        |    \        |    \      |     |    \
  +--|     >O------|     >O------|     >O----+-----|     >O-----|
  |  |    /        |    /        |    /            |    /       |
  |  |  /          |  /          |  /              |  /         |
  |  |/            |/            |/                |/           |
  |                                                             |
  |                              +5.0V                          |
  |                                |                            |
  |                                \                            |
  |                                /  R1                        |
  |                      /|        \ 10K                        |
  |                    /  |        /                 L1         |
  |                  /    |        |                75 uH       |
  +----------------O<     |--------+---+----------)()()()(------+
                     \    |            |
                       \  |            /
                         \|            \  R2
                                       / 10K
                                       \
                                       |
                                      GND
```

6. Adjustable flashing LED

From: dwg@hpqmola.sqf.hp.com (David Grieve)

Use a 555 timer IC as the (resistor controlled) frequency source, choose component values to run at 2 x desired flash rate - get the data sheet for this part, it's pretty comprehensive. Use the output to clock a flip flop (e.g. 74HC74). Feed flip-flop Q and /Q outputs to simple transistor stages, viz...

```
                         ___+5V
                          |
                         _|_
                        _\_/_  LED
         ____             |
TTL ____|6k8 |__________|/
        |____|    |     |\e
```

```
 _|_     _|_
|4k7|   |270|
|_ _|   |_ _|
  |       |
 _|_______|_GND
```

Drive transistor 1 from Q, drive transistor 2 from Q or /Q via a switch. Run the whole thing from +5V. If you want to run it from +9V, no problem, us a 4000 series CMOS flip-flop and change the emitter resistor to 560. If you don't want the hassle of transistors then the ULN2003 darlington driver array could replace the transistor stages.

From: NURDEN1@elaine.ee.und.ac.za (Dale Nurden)

Yes, you do get variable capacitors, but they are usually very low values so they probably won't be much good to you. The easiest way to do this IMO is just a pair of transistors plus 4 resistors and 2 capacitors. I threw one together the other day and it works perfectly. To change the flash rates, you just change two resistor values (one for each LED). To make both LEDs flash together, you would your switch to switch them in parallel.

The circuit is called a **monostable multivibrator** (should find one in a good elementary electronics book), and goes something like this (drawn from memory, so don't count on it being 100% error free):

```
   -----+--------+--------+--------+--> +9v (whatever)
        |        |        |        |
       R1       R2       R3       R4
        |        |        |        |
 +------+        |        |        +------+
 |      +---C1---+        +---C2---+      |
 D1    c|        |        |        |      D2
 |       \       |        |        |c     |
 |    Q1  |------|--------+     b /       |
 |       / b     +---------------|   Q2   |
 |     e|                         \       |
 |      |                          |e     |
-+------+--------------------------+------+--->GND

Q1, Q2  ... anything NPN : BC108, 2N2222, etc
R1, R4  ... 1k0
R2, R3  ... 10k0
C1, C2  ... 10uF
D1, D2  ... Your LEDs
```

I think it is R2 and R3 that you vary to change the frequency, but you can just fiddle a bit to figure it out. Also, the capacitor values will also affect the frequency. If this doesn't work this way round, then try swapping the values of R1 and R2, and R3 and R4. I can never remember which way round they go - I always do it by trial and error.

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7. LED Display controller

From: byron@cc.gatech.edu (Byron A Jeff)

> " I would like to make a big LED scrolling display (like the ones you find in a bank), about 10 "characters" long. Do I have to make a huge array of led's myself or is there a supplier of premade displays? I suppose I can wire up the logic to drive the display, but again, is there a chip or board that will display and scroll characters? "

No need to wire up individual LEDs. Look in magazines such as Circuit Cellar Ink or Radio Electronics for 5x7 multiplexed LED display modules. They are designed where common cathodes are wired along the columns and common anodes are wired along the rows. One advertiser (in CCI I believe) sold these at a price of 8 for $15.

Driving these displays takes a little work. Since they are multiplexed only one row/column can be active at a time. I found that lighting up a column at a time is best (less flicker due to only 5 columns per pass as opposed to 7 rows per pass). To get even brightness each column must be left on the same amount of time and each common anode needs a current limited connection to +5. I accomplished this by connecting the output of a 7407 open collector TTL buffer to the anode along with the current limited +5. When the buffer was on it would sink the current and the LED would not light. If the buffer was off then the current flowed through the LED and it would light up. See diagram below:

```
                     +5VDC
                       |
                       \
                       /  270 ohms
                       \
                       /
Control|\ 7407         |
-------| >-----------+
       |/              |
Control = 1 LED on     |
Control = 0 LED off    |
                       |
                     LED
                    anode
```

Note: 7407 can sink up to 30 mA of current. Current limiting resistors down to 166 ohms can safely be used. Also remember not to exceed the breakdown current of the LED. LED's can be pulsed at greater than average current for more brightness.

Now for the cathodes. Remember due to multiplexing only one cathode can be on at a time. Otherwise all columns with multiple cathodes on will show the same LEDS on (due to common anodes). So I chose to use a demultiplexer to select a single cathode line at a time. I chose a 7445 BCD demultiplexer because it can sink 80 mA of current. However this was just an experiment and I wasn't looking to send messages to my neighbors down the street. Since the 7445 has 10 outputs it can drive two of these displays. For brighter displays the cathodes need more sinking current. Sprague makes a BiMOS driver IC that is serially driven and can sink more current. I've also seen LED driver chips in various mags. Or you could simply wire a transistor for each cathode that is driven by a TTL output.

I don't know of any board to control this. I controlled mine from my PC parallel printer port (Just an experiment). But if I was doing this for real I'd probably use one of the nifty microcontrollers on the market. An Intel 8031 can be wired up in 4 or 5 chips plus the LED driver circuitry. Since it has a built in serial port is could have messages downloaded to it through from a PC through an RS-232 link.

+

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8. Info on CO2 lasers wanted (ho hum)

(From Wouter Slegers)

I'd like to get some info CO2-lasers... I read the following on a BBS.. If anyone has a sequel on this, please email it to me:

```
            Supreme 7 (S7) Productions proudly present....
                 Palm Beach BB Uk - (0303) 265979

               LASER WEAPONRY / PART 1 / LASER SIGHTS

                     by The Deceptor and Flip
```

WELCOME!.....To part 1 of LASER WEAPONRY - to be included in each issue of ELEKTRIX. This first tutorial deals with building your own laser sights as seen in films such as 'THE TERMINATOR' and actually used by US military and UK M.O.D. for such weapons as ANTI-TANK GUNS, APRLs and other high- power military weapons. The type of sights mentioned here can be strapped onto the barrel/tube and provide perfect targetting - also phreaks people out if you walk down the street pointing the beam at people.

NOTES:

- The laser used is a helium-neon one which emits a bright red beam.
- Pointing it in someone's eyes will probably blind them so be careful with where you point it - unless ofcourse you intend to do damage (?!)
- It can't burn skin or paper or anything - it's only really useful in this case as laser sights - although in future issues I others will explain how you can use it for Data Snooping.
- Total project cost is about 40 quid.

WHAT YOU NEED:

- A Helium-Neon laser tube.
- A portable power supply (easily transformed into a backpack)

A fairly decent tube can be obtained from BULL ELECTRICAL for about 25 quid

J&N BULL ELECTRICAL
250 PORTLAND ROAD
HOVE, BRIGHTON
SUSSEX BN3 5QT

The specs. of the JN BULL tube are as follows:

Maker: Philips (holland) - could buy cheaper direct I guess.
makers ref.no: LHN-VLP/04
type: Helium-Neon
Size: approx 260mm x 40mm
Striking voltage: 6-8KV
Running voltage: 1.2-1.5KV
Output: 1.6mW (not bad at ALL! - usual MAX is around 2mW!!!)
Running current: 5mA
Polarity: white lead = negative, black lead = positive
Estimated life: 5000 hours
Warm-up time: 1 second
Wave length .63+0.01um (62.8nm roughly - red part of spectrum)

Although the light emitted is actually red you'll only see the actual beam if the air is misty or dusty...though the spot at the end of the beam is perfect - the invisible beam is an advantage though if you don't want to be detected.

I've included that info in case you pickup the beam as surplus stock some- where without the info. The tube isn't too fragile either - I dropped mine from two foot once - nothing.

As you're going to need a power supply that's portable then you'll be hard pressed to find a company that does one....so here's the docs.

```
Part 1:
~~~~~~~                              C4-C10 - DISK CERAMICS
                    1M-1Watt
                       R3    100p       100p      100p      100p
                  ----====----||---------||--------||--------||-------
    D3-D11:      |            C4    /\   C6   /\   C8   /\  C10    /  |
       high-     |  Diodes follow  /  \      /  \      /  \       /   |
       voltage   |  direction to  D5   D6   D7   D8   D9   D10   D11  |
       3kV diodes|  D11 from D5  /      \  /      \  /      \   /    | |R4
  A              |              /   C5   \/   C7   \/   C9   \ /     | |47K
  <--------------|------D3>|--------||--------||--------||-----       |
              _  |             |   100p      100p      100p          | |R5
     Diode   /|\ D4            |                                     | |33K
     going    |  |          C2===0.1/1.6KV                            |
     up.....> |  |             |                                  ____|
  B              |             |                           +VE -_|_
  /______________/|\_____________|                               |   |
  \              |             |                               |   | LASER
                 |             |                               |   | TUBE
  <--To part 2   |          C3===0.1/1.6KV                     |___|
                 |             |                           GND - |
                 |             |                                 |
                 |             |                                 |
                 |______________|_________________________________|


                   ________________________________
                  |                               /\||
  Part2:          |                               \/||
  ~~~~~~          |              R1               /\||
                  |       ______----______________\/|| ----- <- From Part 1
                  |      |      ----      ____|____ ||/\                  (A)
```

```
                |      |      110 2W   /    |   /\||\/
                |      |        ______/    | |  \/||/\  <--Ferrite core
                |      |       /         R2|_|1K/\||\/     transformer
                |      |_____|/            /  __\/||/\
DU 1n4002 100v  |      DU    |\X   C1 |------|__  ||\/
Going: UPWARDS  |    __|_______|___)|_|    \    /\|| ----- <- From Part 1
                |   |  DD      |   )|       |   \/||                   (B)
DN 1n4002 100v  |__/___|_____|/X  10uf      |   /\||
Going: DOWNWARDS   \         |\______________\__\/||
                    |                        /
                    |                       |
                    |                       |
                    |                        \ - Switch
X - Collector       |                       |
                    |                       |
Transistors are:    |                     =====
    D4005 NPNs      |                      ---   12V of AA NICADS in series
                    |                     =====       (BATTERY)
                    |                      ---    (11x1.2V is sometimes a
                    |                       |      little more reliable)
                    |                       |
                    -------------------------
```

I hope people understand those schematics - TXT files make life so hard!...

If you can't understand something then contacts us at Palm Beach and we'll send u a photocopy of our own docs if you like (fax optional).

Use:

Strap the tube (maybe put it in a protective casing too) to the barrel/tube and then FIRE AWAY!!!!

If you point it at someones eyes or your own then you/they can say goodbye to them for good.

Phun with your tube:

As well as being GR8 for sights you can use it for other things:

- Shine it at a neighbours window while they're sleeping and the room will fill with a eerie red light!! haha - gr8....and this can be done from a few hundred feet with excellant results.....
- Another good use is to point it just in front of someones feet while they are walking....The red dot on the ground will make them REAL paranoid!
- Picking up conversations in buildings by bouncing the beam off a window and via modulation of the beam and conversion at the opposite end you can hear very high quality conversations without being seen or heard - this is a bit more tricky though....details in the next ELEKTRIX issue.
- PLAIN TERROR! YERRRRR! PHUCK this is the bit I love.....walk down the road real casual or through a town centre....carrying your nice laser....aiming the beam at people as they go by....This really phreaks them out...best if you and a m8 piss about and make out he's gone blind. People will run fer their lives - you need to add a nice buzz noise to

it - that really makes it seem quite an awesome device!

That's it for this LASER WEAPONRY issue.....a great addition for any launcher ,tube, rifle, or just about any direct beam weapon......It could also be a fantastic sight for a carbon dioxide laser (needed since CO2 lasers are not at all visible - phun).....YUP! CO2 laser is in Part 2 of LASER WEAPONRY... fully portable and with over 200W output we are talking *** SERIOUS POWER ***

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9. Crystal 32.768KHz CMOS Oscillator

From: cs911225@ariel.yorku.ca (KEN E WILLMOTT)

Try a Pierce oscillator, with the following specific component values:

```
             1/6 4049 or equivalent<>

               |\          |\
            *--| >0---*----| >0--->
            |  |/     |    |/
            |         |
            |--\/\/\--|
            |   15M   |
            |         \
            |         / 330K
            |         \
            |         /
            |32.768KHz|
            ----|[]|---
           _|_       _|_
   10pf    ___       ___  39pf (variable)
           _|_       _|_
           \ /       \ /
            V         V
```

---

10. Crystal Oscillator

(From Goran Olsson)
(Updated April 16, 1994)

The world is full of xtal oscillators twiddled by digital designers lacking in the analog design knowledge necessary. Just look at all the PC real time clocks that lags or leads by several minutes per day. And they eat backup batteries too! IC's with pins that say "Xtal here" can't be trusted either!

The design below, for 1 MHz, is a good starting point for a discussion:

```
CMOS or HCMOS inverter
```

```
            |\
         +--| >0---+----> OUT
         |  |/     |
         |         |
         +--\/\/\--+
         | 1 Mohm  |
         |         |
         |         \
         |         / 2.7 kohms
         |         \
         |         /
         |         |
         |   1MHz  |   parallel resonant
         +---|[]|--+
        _|_       _|_
55pf    ___       ___  60pf
        _|_       _|_
        \ /       \ /
```

First of all, all crystals have two modes of resonance, the series and parallel resonances. These are closely spaced, and the circuit design must ensure that the resonance mode specified for the crystal is in operation, or you will end up with a frequency different from what is stamped on the crystal.

In the series mode, the crystal shows a low impedance at the resonant frequency. This impedance is on the order of 100 ohms to a few kohms. In the parallel mode, the crystal together with a specified capacitance in parallel, normally 30 pF, shows a high impedance at the resonant frequency. The 30 pF value is used regardless of the frequency.

All crystals have resonances at the odd harmonics, 3, 5, .. times the fundamental (overtones). At frequencies above 25 MHz, crystals are often made to operate at one of the harmonics. In all cases the external circuit must be made to suppress operation at the wrong harmonics or fundamental.

Normally the crystals are specified for the parallel resonance mode. The circuit above is designed for such a crystal. The crystal and the 30 pF parallel capacitor are here transformed into a pi filter network by dividing the 30 pF cap into two 60 pF caps and grounding the middle node. When one end is driven from a low impedance, this network has a 90 deg phase shift at the frequency of maximum gain. With a suitable driving impedance, the phase shift is brought close to 180 degrees. Thus the 2.7 kohm resistor. Other good reasons for it are that harmonics are damped by the resulting RC filter, and that the inverter output is removed from the strange load of the crystal network. A rule of thumb for determining the value of the output to crystal resistor is that it should have the same impedance as the capacitor at the operating frequency:

```
R:= 1/(2*pi*f*C)
```

For a 32 kHz oscillator this resistor becomes 160 kohm.

The gain and 180 degrees phase shift of an inverter is now all that is needed to make this circuit oscillate at the right frequency with no twiddling necessary. The resistor between input and output is essential to put the gate in the range of linear operation so the necessary gain to start oscillation will be there. Since a CMOS inverter has very high input impedance, the value can be large. It is not critical, but a low value will increase power dissipation. Use 1000 times the series resistor if you have no other preferences. Note that the inverter *must*not* be a Schmitt trigger. Also note that one of the capacitors is adjusted to correct for the input capacitance of the inverter. In an actual circuit, corrections should also be made for other stray capacitances. The frequency is fine tuned by trimming the capacitors.

At higher frequencies account must be taken to the phase shift of the inverter. The phase shift for a gate when operated as a linear amplifier is certainly not to be found in any data sheet. Just note that 8 ns delay corresponds to 45 degrees phase lag at 16 MHz. Use this type of info as a starting point for adjustment by reducing the R & C:s.

An 4000 series CMOS inverter is usable up to around 5 MHz. Use HC to 25 MHz, AC to 40 MHz. Above that you are into F, ALS or AS families. The same principles apply, but the DC feedback must be arranged by a voltage divider, and the impedance is much lower, on the order of kohms.

To use a 3:rd or 5:th harmonic crystal, you need to insert a bandpass filter into the feedback to avoid oscillating at the fundamental or other harmonic. A series resonant LC filter is something that easily could be inserted between the output and the resistor in the above circuit. Zero degrees phase shift at the center frequency means that the other design criteria still hold. The Q of the filter should be low, around 1-3. Example for 30 MHz: (Just the filter.)

```
                          .47 uH    56 pF        180 ohms
from inverter output-----(((((------| |---------\/\/\/-+- to xtal
                                                       |
                                                      _|_
                                                      ___ 56 pF
                                                       |
                                                      _|_
                                                      \ /
```

A C-L-C pi filter and series resonant crystal is another solution:

```
                          180 ohms    .47uH
from inverter output----\/\/\/--+---(((((----- xtal --+-- to input
                                |             series  |
                               _|_                   _|_
                               ___ 120pF             ___ 100pF
                                |                     |
                               _|_                   _|_
                               \ /                   \ /
```

Component values should not be taken literally. (No indication of inverter type given!)

Some additional hints:

Don't distribute the inverter output node over a large PC board. Instead use free inverters of the same chip for buffering.

If you use the other inverters of the same chip for other signals, be aware that there is crosstalk that causes phase jitter in the oscillator output that might be disturbing in critical applications. For a clean noise-free output, a local voltage regulator to supply the inverter is also a good idea.

Also apply care in the PC board layout of the oscillator. Ground plane, good power decoupling, no signal wires routed under the crystal circuit.

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11. FM Oscillator

(FM Transmission FAQ Reference)

From: dthomas@bbx.basis.com (Dave Thomas)

Here's a dandy circuit for a VCO and buffer that operates across the entire FM broadcast band (88-108 MHz). I stole the main idea from the local oscillator in a radio shack scanner (pro2004). I like this design because it doesn't require a tapped coil, it tunes very broadly, it's stable, and it has a nice, hot output.

FM BROADCAST VCO AND BUFFER

```
        VR1
<G>-+-/\/\/\--+--+-----------+--------+--R6--+----+-----+-----<+12VDC>
    |   ^     ^  |           |        |      |    |     |
    C2  |    CR2 C8          R4      | c      R8 | c    C11
    +---+     |  |           |      |/       |  |/      |
        |  <G>+--+    +--C5--+---+--|        +--|      <G>
audio   R1            |      |   |  |\       |  |\
in      |             |      |   C6 | e      |  | e
O--C1---+--R2--+--C4--+      R3  |    |      |    |
        |      ^      |      |   +----+--C9--+    +--C10--O  RF out
        C3    CR1     L1     |   C7   R5     R7   R9
        |      |      |      |   |    |      |    |
<G>-----+------+------+------+---+----+------+----+-----------<G>

                                    Q1          Q2

+               connection<G>             ground connection
^               cathode of a diode

C1, C2, C8, C11 .1 uF
C3, C4          .001 uF
C5, C6, C7      39 pF NPO or silver mica
C9              10 pF NPO or silver mica
C10             22 pF
CR1             ECG616 varactor (tuning) diode
CR2             9v Zener
L1              5T #20 wire, 1/8 inch I.D., adjust spacing for tuning range
Q1              2N3663
Q2              2N3904
R1, R2          47 K
R3              22 K
R4              15 K
R5              1 K
R6              390 ohm
R7, R8          4.7 K
R9              100 ohm
```

```
VR1             100 K, linear taper
```

As with all VHF circuits, pay particular attention to construction technique. I recommend cutting little square islands on one side of a two-sided copper-clad board. Use the remainder of that side as the ground plane, and leave the bottom side to serve as a shield. If you keep all lead lengths short, the circuit is quite stable.

With the parts listed here, effective frequency range extends well beyond the FM broadcast band in both directions. If a 6V zener is substituted for CR2, the circuit will run from a 9V battery, with a slightly smaller tuning range. The output is hot enough that the signal can easily travel a city block using just a clip lead for an antenna.

---

12. Video amplifier

From: iisakkil@gamma.hut.fi (Mika Iisakkila)

> " Got some questions about video amps. I've seen an NE592 used as a video buffer amp at the end of a 75 ohm line. Used so that the 75 ohm line could drive all kinds of neat processing stuff without affecting the signal (that's what a buffer is after all, right?) Now National Semiconductor makes an LM592 that's also a video amp. Do these two chips cross reference to eachother? "

They are the same chip. Sources for NE/SE/LM/uA592 include TI, Harris, Philips (Signetics) and Motorola. Be aware that there are 8 and 14 pin versions of it, the difference being that the larger package has two additional gain control pins. It's not really an op-amp, so you can't use feedback to control the gain. Additionally, they're _fast_ circuits, so use a ground plane and ceramic bypassing caps as close as possible to the supply pins.

> " Also, is there a relatively simple video buffer amp I could make with discrete components? I really don't want capacitive coupling, since video has DC components. "

The DC components in video are normally a non-issue. Most video equipment are AC coupled (at least the input), which is the reason why you can't get away without black level clamping if you plan to process the video signal. Nothing is said about the actual voltage levels of the video signal, they are just referenced to the black level which may float anywhere (well if I remember right, you're guaranteed to have less than 1W power dissipation in the terminating resistor with standard video...). A typical video input has a 75 ohm terminating resistor to ground and then the signal is fed to the input buffer via a ~50uF electrolytic cap.

Anyway, here's a simple discrete video output stage. Can't get much simpler than this. Note that there's a serial matching resistor on the output, so you'll have to feed 2Vp-p video into the buffer to get the usual 1Vp-p into the equipment you're driving. This is the way it's usually done. Sorry for the crude transistors, but I hate doing ASCII graphics.

```
             o +5v
             |
         +---+
         |   |
      1k R   |
         |   |c  BC108B
         +-b
2Vpp     |   |e      75ohm
video    |e  +--------R-------> video out
in >---b     |                 1Vpp @ 75 ohm
         |c  R 1k          +-->
   BC178B|   |             |
         +---+            ---
             |
             o -5v (yes, two-sided power supply, not ground)
```

And while I'm at it, here's the input stage to go with it. It provides the 2x voltage gain you need to feed the output buffer above.

```
                               o +5v
                               |
              +----+-----------+
              |    |           |
          3k8 R    R 680R      R 56R
              |    |           |
              |    |           |e BC178B
Video in      |    +----------b
1Vpp/75R   +  |    |c          |c    100n plastic
>---+----||---+--b    BC108B   +-----||--------> to black level clamping
    |  47u    |    |e          |                  2Vp-
    |         |    |           R 220R
   R 75R      R    +-----------+
    |         |1k8             R 150R
   ---       ---               |
                              --- (single power supply this time)
```

The simplest black level clamp consists of a signal diode (1N4148) reverse-biased to ground from the output line of the input buffer above and a 4k7 resistor in parallel with it. That forces the sync tips to be at (gnd - threshold voltage of the diode), which shifts the black level of a 2x amplified video reasonably close to ground. Add that and you can connect the two circuits above together and see how they work. They should be very good as far as the signal quality goes (maybe not broadcast quality, but no visible signal degradation). Don't forget good power supply bypassing, use at least 220u of electrolytics and 100n ceramic caps near the transistors on both circuits (the output stage needs them on _both_ supplies).

---

13. 'Nixie' display tubes

From: mkuhn@news.weeg.uiowa.edu (Martin W Kuhn)

Nixies are lots of fun. I just recently built a digital clock out of Nixies, so I think I can help you here. (BTW, if anyone is interested in details of the clock, let me know)

There is no heater connection; these are not like vaccuum tubes. There may be some unused pins, however, or perhaps they are for a decimal point or other symbol the old equipment didn't use.

Nixies have a cathode for each symbol, and one anode which is used for all the symbols (usually a grid-shaped element in the middle of or in front of the symbol elements.)

Here's a super-simple power supply to try experimenting with them:

```
        D            R
 <------>|-------/\/\/\/---
                     ^
                     |---------------> To anode terminal
 To                    |
 120 VAC               |    C
                       ----|(----
                                |
    <--------------------------|----> To selected cathode

D :  any rectifier diode of >= 250 PIV
R :  100 K or so variable resistor
C :  20 uf (or more) at at least 250 WVDC (observe polarity!)
```

CAUTION: Take care when using the above circuit! If you have an isolation transformer around, use it! Output of this supply can be **over 150 VDC!** Also, make sure you discharge C when you are done using it--- It is a good idea to wire a resistor across C when you use this circuit as a shunt. (something like 100K to 1M or so is fine) Make sure you connect it to the tube **BEFORE** plugging it into an outlet, in order to avoid a nasty shock by accidently touching the output leads! A .5 amp or so fuse might be a good idea too, to protect against short circuits.

NOTE: This might not be the best possile circuit, and others might want to suggest changes to it, but it works, and is simple enough.

After you wire it up, connect it to the anode and one of the cathodes. Make sure R is at its **MAXIMUM** resistance. After you plug it in, slowly adjust R until the selceted digit just manages to glow completely. If the wire lead connecting the number to the pin on the base of the tube also glows, then R is too low; turn it back! The exact voltage necessary to light the tube will depend on the particular tube you are using. Also, you may want to wire an ammeter in series with the tube when you first try this out. The tube should only draw a few mA. If it draws much more than 5mA or so, something is probably wrong!

BTW, the Nixies should glow a "pure" even amber-orange color. If they are sort of a lighter color with blueish fringes, then they are somewhat gassy, but still usable. If you see blue "clouds" in the tube and/or the symbols are fuzzy and indistinct, then the neon has gotten too contaminated, and the tube should not be used.

If you are planning to use Nixies in something like a logic circuit, you can easily drive them with any NPN transistor with a CEO of at least 200V and an Ic of at least 10mA or so. (actually, low-power high-voltage transistors of this type are not so easy to get these days)

If you have any specific problems/questions let me know; I am not sure what sort of info you are looking for. Hope this helps, anyway.

14. Condenser microphone hookup

From: Andrew Mitz

```
                            capacitor (0.5 uf or so)

                                | |
 +---------------------+--------| |--------------> to amplifier
 |                     |        | |
 | (positive lead)     |                 _   _
 |                     +----------/ \_/ \_/----------+
MIC                          (resistor 1-2K or so)   |
 |                                                   | +
 | (ground lead) (-)                              -------
 |                              (battery 9v or so)  ---
 |                                                   |
 |                                                   |
 +---------------------------------------------------+----> ground
                                                             to amp
```

15. Bringing NiCd's from the dead

(Battery FAQ References)

(From no-idea)

The failures the article talks about occur in mutli-cell Ni-Cd battery packs, and are due to the voltage differences between cells. Say you have four 1.25 V cells in a pack connected to a 200 ohm load. The load "sees" 5 volts and draws 25 mA. Since each cell must pass the entire 25 mA and each cell's potential is 1.25 volts, Ohm's Law tells us that each cell sees the equivalent load of 50 ohms.

But in practice, no four cells in a battery ever exhibit exactly the same output voltage. Assume that one cell is delivering only 1.2 V, and the others are at 1.25 volts. Now, the 200 ohm load sees 4.95 volts and draws 24.75 mA. Since all four cells must pass the entire 24.75 mA, each of the strong cells at 1.25 volts sees an equivalent load of 50.5 ohms; the weak cell sees only 48.5 ohms. The weak cell works into the heaviest load and as a result will discharge more rapidly than the other cells. If the pack is charged for only a short period of time, the weak cell, which has been working the hardest, is also the one that receives the least charging power.

This usually doesn't matter if you trickle charge after each day of flying. The inequality is small for any given charge or discharge cycle, due to the relatively flat output voltage NiCd cells exhibit over most of their range. But a combination of incomplete charges and deep discharges will exaggerate the energy difference between a weak cell and the other cells. Operated continually in this manner, the weak cell invariably reaches its "knee," the point at which its voltage decreases sharply, long before the other cells reach the same point.

Now comes the problem! Suddenly, the weakest cell sees an increasingly heavy load, which causes its voltage to drop even faster. This avalanche continues until the cell is completely discharged, even as the other cells continue to force current to flow. The inevitable result is that the weak cell begins to charge in reverse, which eventually causes an internal short. Once an internal short develops, recharging the cell at the normal rate is futile. The short simply bypasses current around the cells active materials. (Even though the cell is apparently dead, most of its plate material is still intact.) If the small amount of material that forms the short could be removed, the cell would be restored to virtually its original capacity once again.

```
            300 ohm              Charge
               5W             /  Switch
20-40 + O---/\/\/\----o------o  o------------o----------------o
VDC                   |                      |                |
                      |      Zap             |                |
                      |      Switch          |               +|
                      |      ___|___         |           -----------
                      o------o     o---------o              -----
                      |                      | +    Shorted   |
      6000 micro-     | +                 -------    Cell     |
      Farad, 40V  _________               |     |             |
      Capacitor   ---------               |_____| Volt        |
                      |                      |    meter       |
                      |                      |                |
      - O-------------o----------------------o----------------o
```

Using the circuit shown, the internal short can be burned away in a few seconds. In operation, energy stored in the capacitor is rapidly discharged through the dead cell to produce the high current necessary to clear the short. Current is then limited by the resistor to a safe charge rate for a small A cell.

Several applications of discharge current are usually necessary to clear a cell. During the "zapping" process, it is a good idea to connect a voltmeter across the cell to monitor results. Momentarily close the normally open pushbutton switch several times to successively zap the cell, allowing sufficient time for the capacitor to charge up between zaps, until the voltage begins to rise. Then, with the toggle switch closed, watch as the potential across the cell climbs to 1.25 volts. If the potential stops before full voltage is reached, some residual short remains and another series of zaps is in order. If you observe no effect whatsoever after several zaps and shorting out the cell and taking an ohmmeter measurement indicates a dead short, the cell is beyond redemption and should be replaced.

Once full cell potential is achieved, remove the charging current and monitor battery voltage. If the cell retains its charge, it can be returned to charge and eventually returned to service. But if the cell slowly discharges with no appreciable load, the residual slight short should be cleared. To do this, short circuit the cell for a few minutes to discharge it, zap again, and recharge it to full capacity.

---

16. Phase shifter circuit

(From Richard Karlquist)

Here is a well known op-amp phase shifter. I am surprised no one has posted it yet, so I guess I will have to. The circuit will have 90 degrees phase shift at:

```
          FREQ = 1/(2*PI*R3*C)
```

At low frequencies it has 0 degrees of phase shift and at high frequencies it has 180 degrees of phase shift. By making R3 a pot, you can vary the phase at a given frequency from nearly 0 to nearly 180 degrees. Since you want to work at 1 MHz., you will need to use a high frequency op amp, like the Burr-Brown OPA620.

```
      R1=R2                   |---\/\/\/\/\\/\--|
                              |       R2        |
                              |                 |
                 R1           |     |\          |
                              | INV | \         |
INPUT --------\/\/\/\/\/\/----------|  \        |
          |                         |   \       |
          |                         |    \-------- OUTPUT
          |       R3                |    /
          |                 NON-INV |   /
          |---\/\/\/\/\/\/----------|  /
                              |     | /
                              |     |/
                              |
                              |
                           -------  C
                           -------
                              |
                              |
                              |
                              |
                           GROUND
```

(From David Medin)

How about the simple single-transistor phase splitter?

```
                         V+
                          |
                          R
              V+          |
               |          +---------+
              10K        /          |
     0.1 uF    |       |/              0.1 uF
IN>----||------+-------|  2N2222    O<--||---> High impedance output
               |       |\E          T            (should be buffered)
              10K        \          |
               |          +---------+
              GND         |
                          R
                          |
                         GND
```

The circuit uses the inverting properties of an emitter follower with a collector load. You have to experiment for a value of R and the pot that will keep the transistor's power dissipation within limits given the V+. The output stage should be buffered by another emitter follower stage, or an op amp, etc. Note that this circuit induces some loss in the p-p value of the signal, too. It is not completely distortionless, but reasonable if you do it right.

The same topology can be employed with op amps: One inverting and one non-inverting with the pot between their outputs, buffered by a third op amp.

---

17. Ultrasonic transducer oscillator circuit

(From Chris Abbott)

Allows the transducer to oscillate at its self-resonating point, with no tedious setup.

As far as I can tell, the circuit will run on 5V-9V.

```
+V --o----------o--------------------o-------------o-------o
     |          |                    |             |       |
     |          |     R3            /              |       |
     |          |   +----+       /-C               |       |
     |          o---+ 15K+---o---B | TR1           |       |
     |          |   +----+   |   \-E              /        |
     |          |            |      \          /-C         | 47nF
    +++        +++           |       ----o-----B | TR2   =====
    | | 2M2    | | 10K       |        C1 |     \-E         | C2
    | | R1     | | R2        |  D1     =====      \        |
    +++        +++           |   | /|    | 10nF    |       |
     |          |        /---o---|< |----o---------o-------o
     |          |     /-C        | \|                      |
     |      /--o-----B | TR4     1N4148                   |  Earthy
     |    /-C         \-E                                -----  Side
     o----B | TR3        \                                XXX
     |    \-E             |                              -----
     |       \            |                                |  Transducer
     |        |           |                                |
     o--------|-----------|--------------------------------o
     |        |           |
     |  | /|  |           |
     o--|< |--o-----------o-------  0V       All transistors 2N3707
        | \|                                 NPN, Emitter at bottom.
       D2  1N4148
```

---

18. RR LED flasher (alternating)

(From Darren Leigh)

You can get a 50% duty cycle if you use a CMOS version (a 7555 for example). CMOS has a rail-to-rail output swing which lets you get away with this:

```
            +--------+
            |        |
            |  7555  |
            |        |
       +----|2       |
       |    |       3|--+---> output
       +----|6       |  |
       |    +--------+  |
       |                |
       +-----/\/\/------+
       |       R
     -----
     ----- C
       |
       |
      gnd
```

To make little railroad lights alternately flash, hook the output to a pair of LEDs -- one via a 3904 (small NPN) and the other via a 3906 (small PNP).

```
             ^ Vcc
             |
             \
             / R
             \
             /
             |
             |
            ---
            \ / LED   (glows when 555 ouput is high)
             V
            ---
             |
             |
             /
           |/
in -\/\/\--|  3904
      R    |\
             V
             |
             |
            gnd
```

and:

```
             ^ Vcc
             |
             /
           |<
in -\/\/\--|  3906
      R    |\
             |
             |
             |
             \
             / R
             \
             /
             |
             |
            ---
```

```
            \ / LED   (glows when 555 output is low)
            ---
             |
             |
            gnd
```

(From rschramp@et.tudelft.nl)

I think the easiest way is to build a relaxation oscilator with an opamp (e.g. 741), some resistors and an capacitor. Use two LEDs as lights.

```
0V--cap-+--resist--+
        |          |                 +5V
        | |\       |                 _|_
 +5     +-|-\      |                 \ / LED
  |       |  \     |     +----resist--+
 resist   |   >----+-----+
  |       |  /     |     +----resist--+
  +-------|+/      |                 _|_
  |       |/       |                 \ / LED
  |                |                  |
  +----resist------+                  0V
  |
  |
resist
  |
  0V
```

This is a smitt-trigger (a circuit with hysterysis) which alternating charges and discharges a capacitor through a resistor. If the output voltage is low the upper led is lighted the current throug the led is limmited by the series resistor. If the output is high the lower led is lighted.

---

19. HV supply: 12VDC in, 12KV out

(Switching Power Supply [repair] FAQ Reference)

(From Sam Goldwasser)

Simple High Voltage Generator - 12 V in, 12,000 V out inverter. Modify appropriately for 24 V in, 30,000+ out, lower power.

```
   *VCC     Q1   +-----------------C ||
     o           |                 C ||
     |       B |/ C                C ||
     |  +------|    2N3055         C ||
     |  |      |\ E            5T  C || C-------|>|----------o  +HV
     |  |        |                 C || C     HV Diode, usually
     |  |       -_-                C || C        built in
     |  |                          C || C
     +--|--------------------------C || C
     |  |   Q2  _-_                C || C
     |  |        |                 C || C Secondary (HV) winding,
```

```
 |  |    B |/ E           5T  C || C intact.
 |  |  ----|    2N3055        C || C
 |  |  |   |\ C               C || C
 |  |  |     |                C || C
 |  |  |     +----------------C || C
 |  |  |                        || C
 |  |  ------------------------C || C-------------------o  -HV
 |  |                     2T  C ||
 |  |              +----------C ||
 |  |              |      2T  C || T1 - Flyback transformer from BW
 |  +--------------------------C ||      or color TV or computer monitor.
 |                 |
 |            R1   |     R2
 +----------/\/\/\--+--/\/\/\---+
            110        27    _|_
            2W         5W     -
```

Read in Entirety!

1. Obtain flyback transformer with known good HV secondary winding. primary may be left intact if it is known to be in good condition - non shorted. A flyback removed due to failure may be used if it was the primary that failed and the primary turns can be removed without damaging the HV secondary or losing the secondary return connection! Flybacks fail in both ways (primary and secondary).

2. Wind 10 turn center tapped drive winding and 4 turn centertapped feedback winding using #16-20 guage insulated wire. Make sure both halves of each coil are wound in same direction.

3. VCC should typically be in the range 12-24 volts at a couple of amps. Circuit should start oscillating at around 5 volts VCC or so. If you do not get any HV out, interchange the connections to the transistor bases. Heat sinks are advised for the transistors. Be aware of the capability of your flyback (BW monitors up to 15KV, color up to 30 KV). You risk destroying the secondary windings and/or HV rectifier if you get carried away. Running this on 24 volts will probably cause an internal arc-over in a small flyback, at which point you start over with more caution and a new flyback.

4. Actual output will depend on turns ratio of the flyback you have. For typical monochrome computer monitors or video display terminals, you should be able to get around 12,000 volts with 12 volts input. I made one from a dead MacPlus flyback from which I removed the (dead) primary windings.

5. Frequency of operation will be in the KHz to 10s of KHz range depending on VCC, load, and specific flyback characteristics.

6. You can experiment with # turns, resistor values, etc. to optimize operation and power output for you needs.

7. **CAUTION**: contact with output will be painful, though probably not particularly dangerous due to low (a few mA) current availability. **HOWEVER**, if you add a high voltage capacitor to store the charge, don't even think about going near the HV!

Parts list:

Q1, Q2
: 2N3055 or similar NPN power transistors (reverse polarity of VCC if using PNP transistors.) Maximum stress on transistors are about 2-3 times VCC. Heat sinks will be needed for continuous operation.

R1
: 110 ohms, 2W resistor. This provides base current to get circuit started.

R2
: 27 ohms, 5W resistor. This provides return path for base feedback during operation.

T1
: Flyback transformer from/for BW TV, color TV, or computer monitor modified according to text above. Most modern flybacks include built-in HV rectifier diode(s) so output without additional components will be high voltage positive pulses. Note: this kind of flyback transformer drives the CRT directly and uses its glass envelope as the high voltage filter capacitor. (A foot square piece of 1/8" Plexiglas with Aluminum foil plates makes an adequate filter capacitor.)

Wire
: A couple of feet of #16-#20 hookup wire, magnet wire, or any other insulated wire for home made primaries. Use electrical tape to fix windings to core. Wind feedback winding on top of drive winding.

---

20. Generating -5VDC from +5VDC

(From Richard Friesen)

If you happen to have the March 1984 issue of Radio-Electronics, turn to page 78. This issue has the very first instalment of Robert Grossblatt's "Designer's Notebook" column. In it, he shows a simple circuit which will supply a negative voltage, given a positive voltage. It's basically a 555-based oscillator, and a voltage-doubling rectifier. He claims the negative-voltage output should be good for about 60ma. No-load voltage should be pretty close to the input voltage (but negative), although the voltage will drop a bit, depending on the load. If you put +5V into the circuit, it'll give you around -5V out. load. If you put +5V into the circuit, it'll give you around -5V out. If the load makes the voltage drop too low (-3V or -4V), you could always just feed the circuit with a higher voltage (like maybe 9V or 12V) and then just regulate the output down to -5V using a 7905 regulator. I've used this circuit a couple of times for powering op-amp's, and it works great!

I'm not that great at ASCII-art, but I'll give it a shot. If the following schematic doesn't make sense, let me know, and I'll try it again...

```
                 +V
```

```
           ^
           |
   +-------+---+
   |       |   |                  -V Output
  R1       |8  |4        +----+--->
   |    7 -------        |    |            Parts List:
   +-----|       |      D2    |            IC1 = 555
   |  +--|       |  +    |    |             R1 = 1.5K
  R2  | 6|  IC1  |---C1--+    |             R2 = 10K
   |  |  |       |3      |    |             C1 = 10uF,16V
   +--+--|       |      D1   C2             C2 = 22uF,16V
   |    2|       |       |    |+            C3 = 1500pF
   |      -------        |    |          D1,D2 = 1N4001 diodes
  C3         |1          |    |
   |         |           |    |
   +---------+-----------+----+
             |
            ===
           (GND)
```

Note: In the above "diagram", both diodes point down (the anodes are at the top). Also, watch the polarity of C1 & C3.

The circuit is set up to oscillate at about 45kHz, with a duty cycle pretty close to 50%. None of the values of any of the parts are terribly critical, so if the capacitors or resistors are "in the ballpark", it should still work okay.

---

21. Ground loops

(From Thomas Maier)

When you have two circuits that are tied together electrically, but one of them is high current then you should direct the ground and power paths to "feed" them separately. You want the current of the driver to stay on the driver side and the current of the logic to stay on it's own side. The thin trace inbetween is still needed because this is not galvantic isolation.

```
                                                  e->
         <-e                                   |------------|
       |----------                             |            |
       |         |  <<<<  physical            CURRENT     POWER FOR
  --REGULATOR   LOGIC    separation >>>>      DRIVER       DRIVERS
       |         |                              |           |
       |   e->   |      ground                  |   <-e     |
  -----|---------------------------------------------------------------
         ^ thick          ^ thin                 ^
           traces           traces              very thick
           from reg to                          traces from
           logic load                           drivers to supply
```

The common mistake is to "daisy chain" the ground by having the ground of the high current item seek it's current path through the ground of the logic. This causes ground spikes on the logic and thus logic errors due to bad voltage levels at the logic chips.

Physical separation is to prevent electromagnetic coupling, of course. Even getting the grounds proper won't help if you couple the magnetic field back into the logic traces.

Always image traces to be resistors. Thick ones are small resistance and thin ones are large. The objective in laying out the board is to encourage the large currents to take the path back to their own source without getting onto the other grounds.

Separating them in this way can make a micro run right along side of a vicious current driver and not have logic problems in most cases. The cases in which it usually doesn't work is when the signal being sent to the driver is analog instead of digital. You're going to get some amount of ground differiental with the separate ground paths and so the analog signal will reflect this differance in the signal voltage relative to ground.

Current loop coupling of the signal to the driver could solve a really bad problem of ground differientals, but I have never used that technique. If your going to go to that extreme then you may as well isolate them altogether.

If your signal is digital you can clean it up abit by having a schmidt trigger on the driver side of the loop with it's ground relative to the high current load. This can provide a volt or more of tolerance in the ground differance.

If you get the currents going right you will see less problems with the logic side, but you might see more problems with the driver because it's signal from the logic is corrupted by lifting of the ground potential because of the high currents. When you have reduced this effect by minimizing the high current ground ohmage to the point where you cann't minimize it any more AND you have included schimdt buffering, then it's time to admit defeat and galvanically isolate the two circuits.

By using these guidelines I have been able to run six amp chopper drive circuits on the same board with micros and no galvanic isolation. The layout of the current loops is critical.

---

22. Peltier coolers/heaters

(From Chris Webster)

A typical peltier device consists of a number of series-connected N- and P-type semiconductors sandwiched between two ceramic plates, such that the flow of majority carriers (electrons or holes) in each semiconductor occurs in a single direction, as shown below:

```
                            (hot side)
                    ==============================  <-- ceramic
 /|\                   __________    __________
  | majority          |   |  |   |  |   |  |   |
  | carrier           | N |  |  |  | N |  |  |
  | flow    (-)  _____|___|  |___|__|___|  |___|_____  (+)
```

```
                    ==============================  <-- ceramic
                            (cold side)
```

The device works by depleting the cold side of thermally-generated carriers and moving them to the hot side; in essence, the device is a heat pump. When a fixed potential is placed across the device's terminals, a fixed temperature difference will be maintained between the hot and cold sides. If the hot side has a sufficiently "beefy" heat sink, this temperature difference can be several tens of degrees C.

The process is reversible -- placing a temperature difference across the device will cause a voltage to develop across its terminals.
