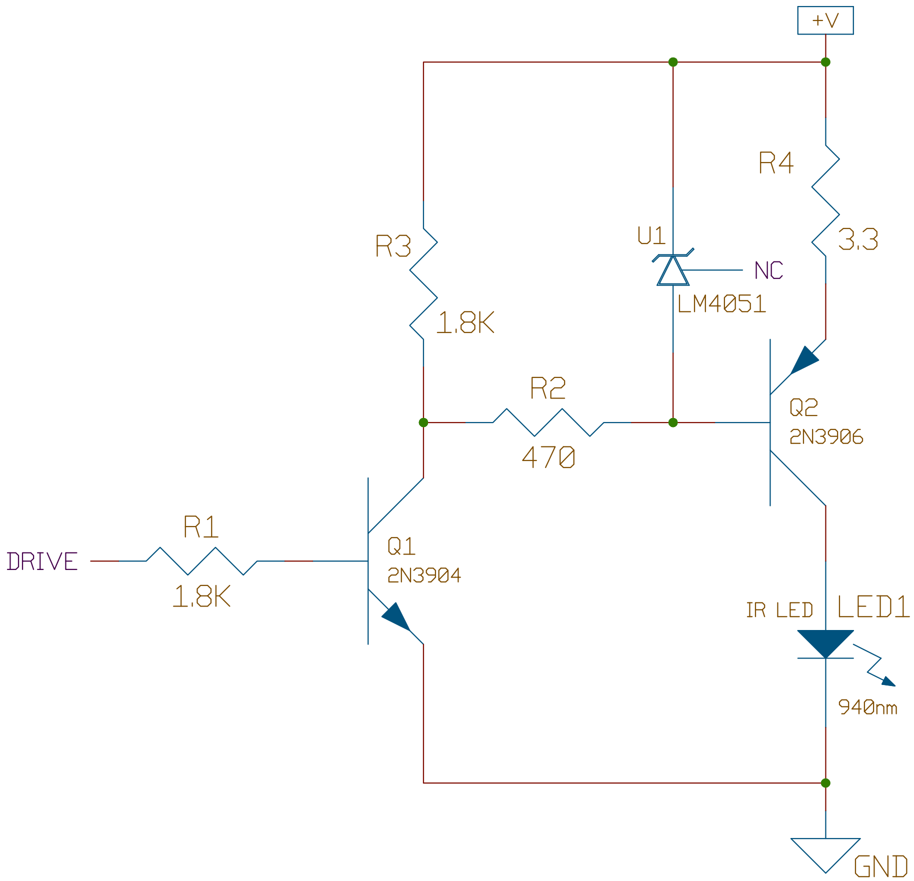


Fig. 1

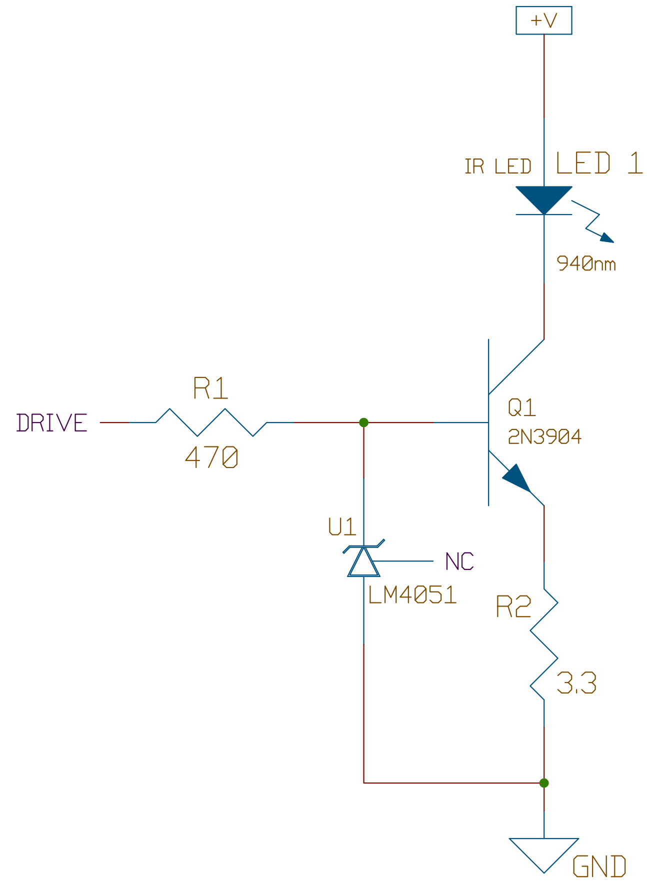
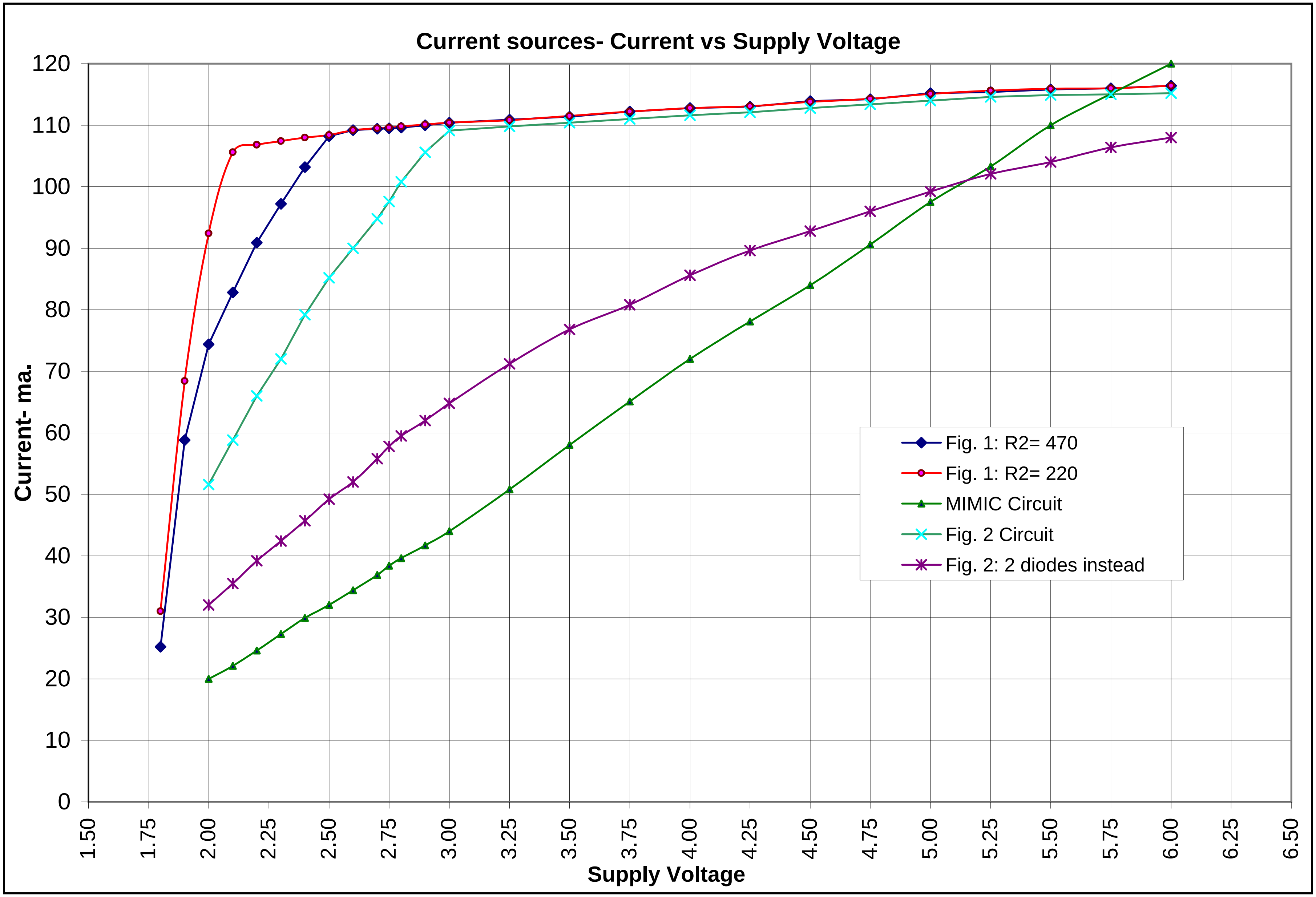


Fig. 2

IR MIMIC alternative driver schemes-
designs stabilize IR LED currrent over
a wide range of battery supply voltages.
SEE TEXT.



Current sources- Current vs Supply Voltage
Current- ma.
Supply Voltage
0
10
20
30
40
50
60
70
80
90
100
110
120
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
4.00
4.25
4.50
4.75
5.00
5.25
5.50
5.75
6.00
6.25
6.50
Fig. 1: R2= 470
Fig. 1: R2= 220
MIMIC Circuit
Fig. 2 Circuit
Fig. 2: 2 diodes instead

IR MIMIC alternate LED drive schemes

The IR MIMIC devices are an excellent way to "home build" IR remote control devices, however, like any circuit, there is *always* ways to improve performance. Analog current sources have been a long-time specialty of mine, and after purchasing some of these products, I felt in important to get more consistent output from the IR LEDs. Running the IR LEDs at maximum is probably the best way to get consistent range and functionality, but a resistor type current limiting approach is quite poor if batteries are used as a supply, varying easily 250% from 3 to 5.5v. By implementing a current source type of circuit, an IR LED can be set to run at maximum over a great voltage range with only a few % variation in current. See the graph and circuit.

After some thought, I boiled the circuits down to these two candidates. Important factors were circuit simplicity, current regulation at the lower end of input voltage, compatibility with the present ICs, and readily available parts. It was possible to tweak the performance with various added components, but these were omitted in order to keep it simple.

Fig. 2 is the core design, as it uses a transistors' Vbe to maintain current regulation. The circuit is simple, predictable, and regulates nicely without much fuss. The Tempco influence of Vbe is relative small unless you want to use this in extreme climates- where your Television and other electronics won't work anyway.

The circuit works by clamping the "on" level base drive voltage to a specific level (1.225V), balanced against the current-related voltage drop in the Emitter ballast resistor, which rises until there is current balance, essentially a constant value. Use 400mV as the calculated drop across the Emitter ballast resistor, as there is significant drop in the Emitter resistance of the transistor, the Vbe being in the order of 825mV at 110ma current.

This minimum parts count circuit uses an inexpensive voltage reference "diode" to clamp the high level voltage to a consistent value, with minimal variation versus current. This circuit gives good regulation down to 3.0 Volts, where base drive starvation starts. A stiffer source drive would allow a smaller resistor for R1, but the MIMIC output is essentially tapped out, and cannot provide this extra current. The Fig . 1 circuit addresses the drive issue.

For fun, a pair of Silicon diodes (1N4148) were tested in place of the Reference diode to put to rest the commonly used idea of a cheap Si diode serving as a decent "clamp". As you can see, the typical 2-diode current source approach performs poorly due to its dynamic impedance, although it does tend to temperature compensate the transistor current. In fact, the 2-diode circuit fares only slightly better than the non-regulated circuit! (160% vs. 250%, 3.0 to 5.5V).

Its important to remember in testing, that the drive characteristics are derived from the I/O Pin on the MIMIC IC, which gets its power from the rails, so its enhancement (gate drive) drops along with supply voltage. The lowered supply voltage also reduces drive, yielding the steep current / voltage slope.

Another goal is to minimize "burden" voltage so the circuit can regulate well at very low voltages, and gets the most out of batteries. The circuit must draw "zero" current when the input drive is in the low state, as is in the original design. Having regulation of current allows a higher average set current while limiting peak current with fresh batteries. This circuit makes dependency on specific battery types less of an issue, for example NiCad batteries can be used easily, and the only attention is to keeping the MIMIC IC and IR detector from damaging voltages.

Fig. 1 addresses the previously mentioned loss of drive at low supply voltages. Bipolars are superior here due to the predictable and low base voltage thresholds, where many FETs have 2:1 or greater "spec" gate threshold variations, many cases at 2 volts or higher. Fig. 1 flips the circuit around to maintain the "low is off" polarity, by using a PNP current source instead of NPN. The input transistor is easily driven hard at low voltages, as it needs only a few hundred ua, and provides very stiff drive at the current source input down to minimal voltages. This eliminates the output limitations of the MIMIC PIC device, and lightens its load, to 2.7ma maximum at 5.5v supply with the 1.8K Ω resistor. A much larger value will work, up to tens of KΩ, with minimal effect.

R2 limits the current to the reference chip, and pushes its maximum specified current beyond spec. at 5.5v and 220 Ω, to 19.5ma., so care needs to be made in selecting these components at your chosen supply voltage. Lowering R2 increases drive so it performs better at lower voltages, but adds power and reduces reliability, so it may be good for a 3-cell NiCad battery power supply. The drive current is flat to 2.5v with 470 Ω, and 2.1v with 220Ω as the graph shows.

The reference diode is expected to clamp fairly cleanly, during the rise and fall of the (up to) 56KHz. modulation. I have only tested the LM4051 type reference, but it performs fairly well. A ~1.2v reference is needed here, as the 2+ volt ones raise the minimum supply voltage significantly, and waste considerable power in the ballast circuit. The LM4051, like most active circuits tend to take several microseconds to settle, usually overshooting around 30% or so. In this case, the overshoot is fairly well filtered by the optical system, and is not a problem. Adding a bypass cap helps a bit, but slows the edges considerably. Other devices' data sheets show up to 200us turn on transient settling times, unacceptable at best. Good candidates are probably (from the data sheets): LM4041, LM 4051, LM4121.

One could get fancy and design a dynamic pre-bias circuit that biases up the reference a bit, to minimize overshoot, and stops bias after switching stops, in order to reduce quiescent power, but it seems unnecessary.

Some improvements in transistor Vbe might be achieved by going to Zetex devices, but this seems to work well enough to not require much fiddling. SMT devices would be a good fit for this circuit, as it would be quite compact. Parallel (3) 10 Ω resistors for the ballast if 110ma is your choice of drive. The very low drop of a IR LED opens the possibility of using 2 in series, with higher supply voltages, doubling the signal power. The Fig. 1 circuit allows the drive IC to be fairly well isolated, so the IC could run on a voltage tap from 3 of 4 Alkaline batteries (~4.5v) and the LED drive would tap the 4^{th} battery (~6.0v) to increase the voltage for double LED strings. An extra LED pair and drive circuit could also be run in parallel, to give a total of 4 LEDs at 110ma, so they could be narrow beam ones, aimed in different directions. This would make the remote rather insensitive to "aim". You might be able to cook small insects as they fly by. (Just kidding).

With the Fig. 1 circuit, and 470 Ω for R2, you could expect regulation with 2 LEDs down to about ~4.1v, and ~3.75v with 220 Ω. These are pretty much at or below depleted battery voltages for (4) Alkaline cells. When the Alkalines hit the *end of life* charge amount, they will be quite obvious as they die. A White, Green, or Blue LED with a 100Ω series resistor across the pair of IR LEDs would probably give a good visual voltage-sensitive drive level indicator, drawing only a milliamp or so.

Raising the Ballast resistor value will allow scaling the LED current accordingly, where 10Ω will give approximately 40ma LED drive current.