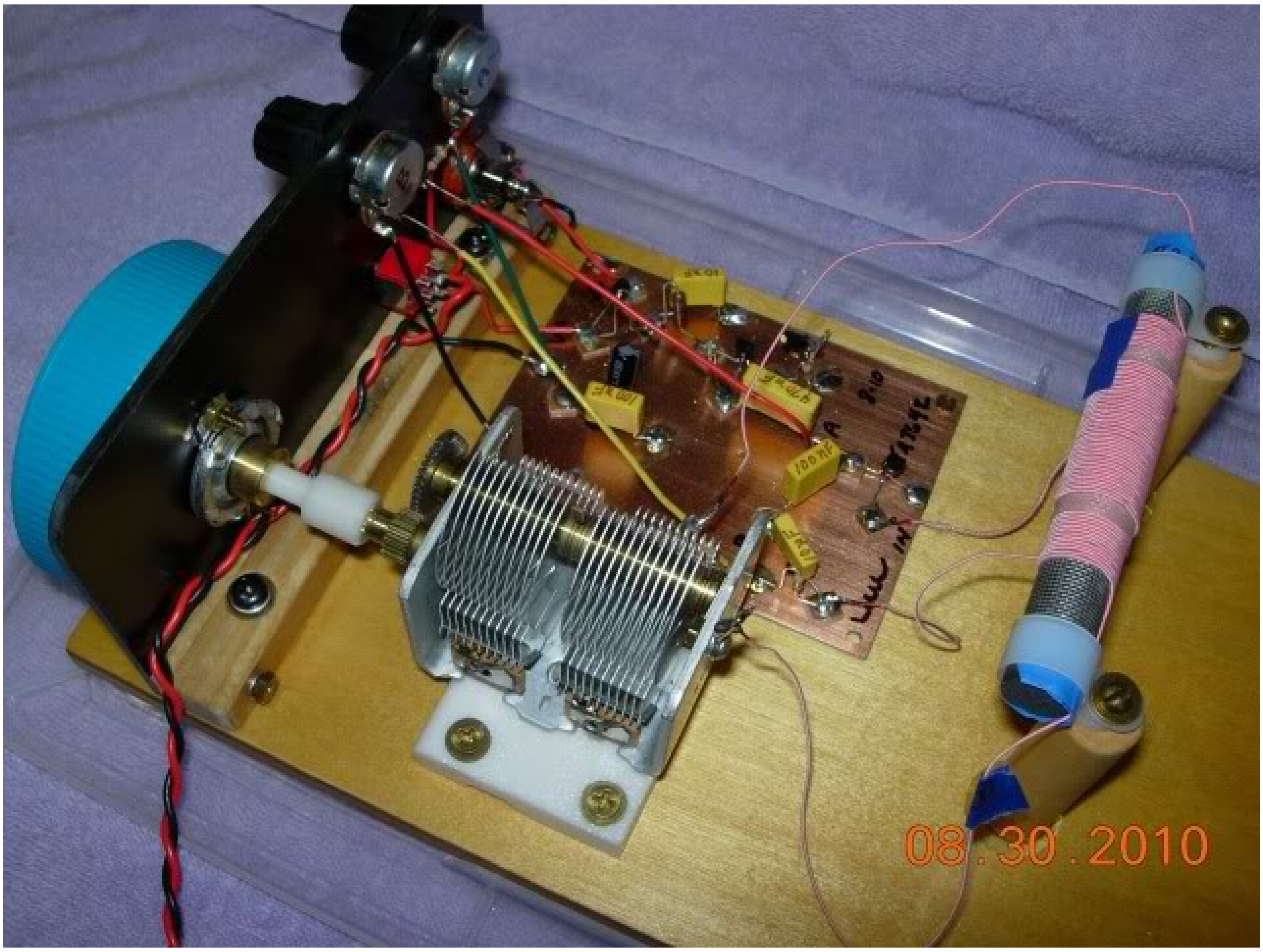
MK484 Design Notes

By, Dan McGillis, WB3KBW

The complete thread can be found here:
http://theradioboard.com/rb/viewtopic.php?t=2791 (http://theradioboard.com/rb/viewtopic.php?t=2791)



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Hi all. I've been wanting to play around with the "simple" radios based on the MK484 chip for awhile. Bruce Kizerian (ElmerDude) had kindly sent me some a few years ago and it's about time to dust them off. Sorry if all this is "old hat".

Reading-up on the MK484, its predecessor the ZN414, and successor the TA7642, I found that folks either love them or hate them. By far the biggest complaint is "they don't behave well when faced with strong signals". Those that love them seem to live in the country.

The data sheet for the currently available TA7642's is no help with the "strong signal problem" -- not much there: http://www.rapidonline.com/netalogue/specs/82-1027.pdf (http://www.rapidonline.com/netalogue/specs/82-1027.pdf)

The data sheet for the older MK484 doesn't have much either: http://kitsrus.com/projects/mk484.pdf (http://kitsrus.com/projects/mk484.pdf)

BUT, the data sheet for the original design by Ferranti - the ZN414Z - is a gold mine: http://www.jaycar.com.au/images_uploaded/ZN414484.PDF (http://www.jaycar.com.au/images_uploaded/ZN414484.PDF) There's a hint in the operating notes on page 6 as to how to handle strong signals.

> It says: " — the gain of the ZN414Z is voltage sensitive so that, in strong signal areas, LESS (my emphasis) supply voltage will be needed to obtain correct AGC action. Incorrect adjustment of the AGC causes a

strong station to occupy a much wider bandwidth — cause the RF stages to saturate — swamping – reduced AF output.“

ie. – not well behaved.

Most of the MK484/ TA7642 circuits I've found use the recommended circuit shown on page 9 of the ZN414Z data sheet. This circuit places the same voltage on the power pin (the output pin) and the AGC line - which is the line through the 100k resistor and the tank coil to the input pin. So you have to reduce the chip supply voltage in order to reduce the AGC voltage -- they're hooked to the same voltage.

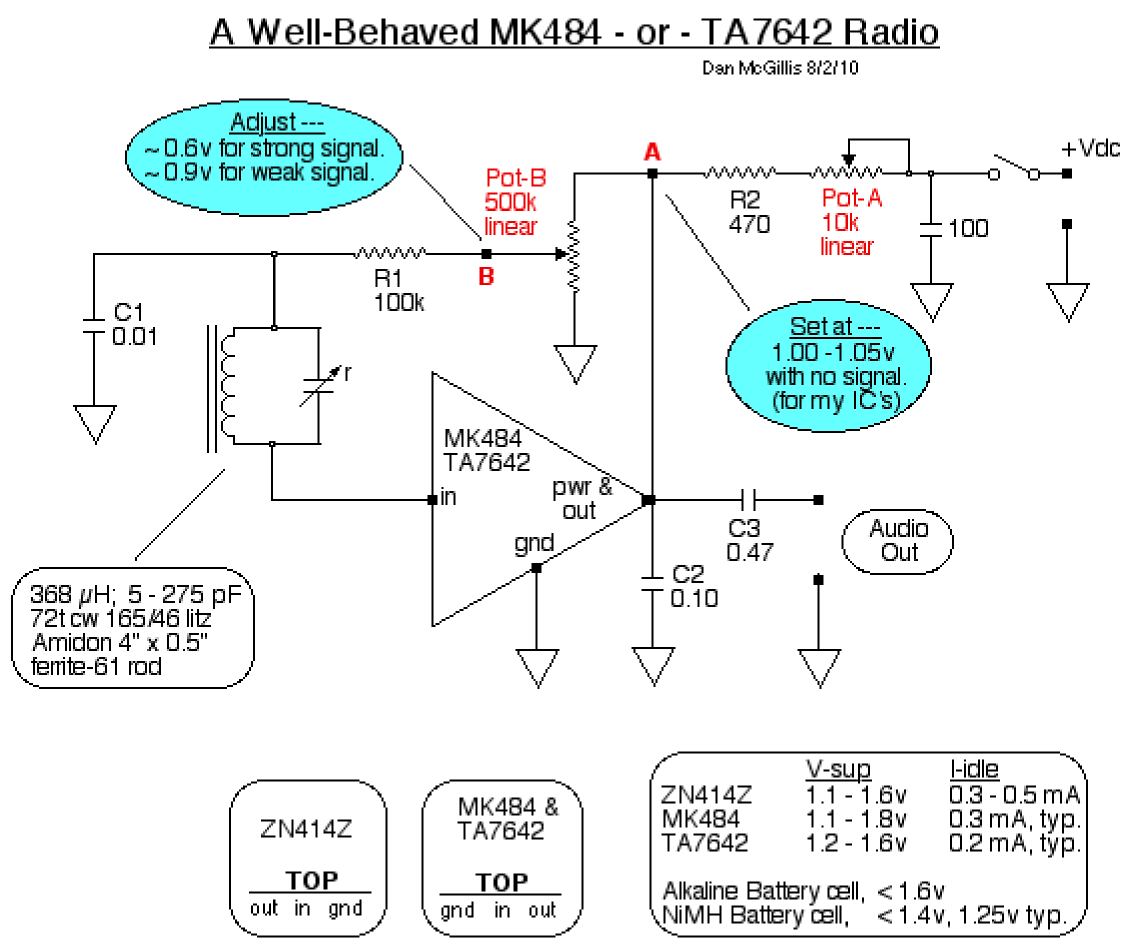
And that's another problem because the MK484/ TA7642 chips work well only over a fairly narrow range of voltage on the output pin. A voltage of ~ 0.9v seems typical. See for example the excellent article at: http://www.mikroe.com/old/books/rrbook/chapter3/chapter3g.htm (http://www.mikroe.com/old/books/rrbook/chapter3/chapter3g.htm)

I built several radios following, or slightly modifying, the data sheet circuit - and tried to put ~ 0.9v on the output pin by proper choice of supply resistor. But they all suffered from the "strong signal problem" - and frankly all of them were a pain-in-the-butt or so-so performers.

BUT– there's a solution to the "strong signal problem" in an ingenious circuit referenced in: http://cool386.tripod.com/zn414/zn414.html (http://cool386.tripod.com/zn414/zn414.html) It's called a "Performance Breakthrough" for the MK484 chip. And it is!

Evidently, in ~ 1986, the engineer(s) at a company called Technicraft developed a circuit that made the ZN414Z handle strong signals well. "They" (sure wish I knew who "they" were, to give them proper credit) broke the connection between the supply voltage and the AGC voltage. Each voltage can then be separately and EASILY optimized. Once you do that, the chip is VERY WELL BEHAVED for both weak AND strong signals.

Shown below is my version of "their" circuit – and it works like a champ, at least for the 2 different MK484 chips, and the 2 different TA7642 chips I tried.



The separated voltages Va and Vb, and the 2 pot adjustments make a HUGE difference.

The trick to setting up the chip supply voltage, Va at point “A”, is to quickly evaluate how a particular chip (and circuit) behaves. Here’s what I did.

1.) Set the AGC voltage at point “B” to 0v using Pot-B. That’s like having “no signal”.

2.) Adjust the supply voltage at point “A” to a PRECISE value - like 1.05v - using Pot “A”.

3.) Now increase the AGC voltage to about 0.8 - 0.9v or so by adjusting Pot “B” - and start tuning around the band from 530 kHz to 1700 kHz.

NOTE that once you tune-in a signal, you can increase or decrease the volume by adjusting Pot “B”. NEAT!

4.) Take note of the apparent bandwidth and sensitivity as you tune across the band. They change as you go from 530 kHz to 1700 kHz.

5.) Now, reset the voltage at point “B” to 0 again, and adjust the supply voltage at point “A” to a new value using Pot-A. And repeat the above procedure - noting the apparent selectivity and sensitivity. It doesn’t take long.

Here’s an example of the kind of quick characterization I did for each chip:

MK484 #1.

Va = 0.90v; Too sensitive, tends toward instability, Pot-”B” adjustment “touchy”.
Va = 0.95v; Excellent sensitivity & selectivity across whole band. Pot-B not “touchy”
Va = 1.00v; Excellent sensitivity & selectivity across whole band.
Va = 1.05v; Selectivity somewhat degraded at high end of band.
Va = 1.10v; Poor selectivity, lower sensitivity at high end, OK at mid to low end.

“Conclusions:

— The “good” operating range for Va is pretty small!

— The target Va for this chip (and circuit) is Va = 1.00v +/ - 0.025v. Use Pot-A to dial-in this optimum supply voltage. Re-adjust Pot-A as the battery ages. No problem.”

All 4 chips I played with behaved pretty much the same - except:

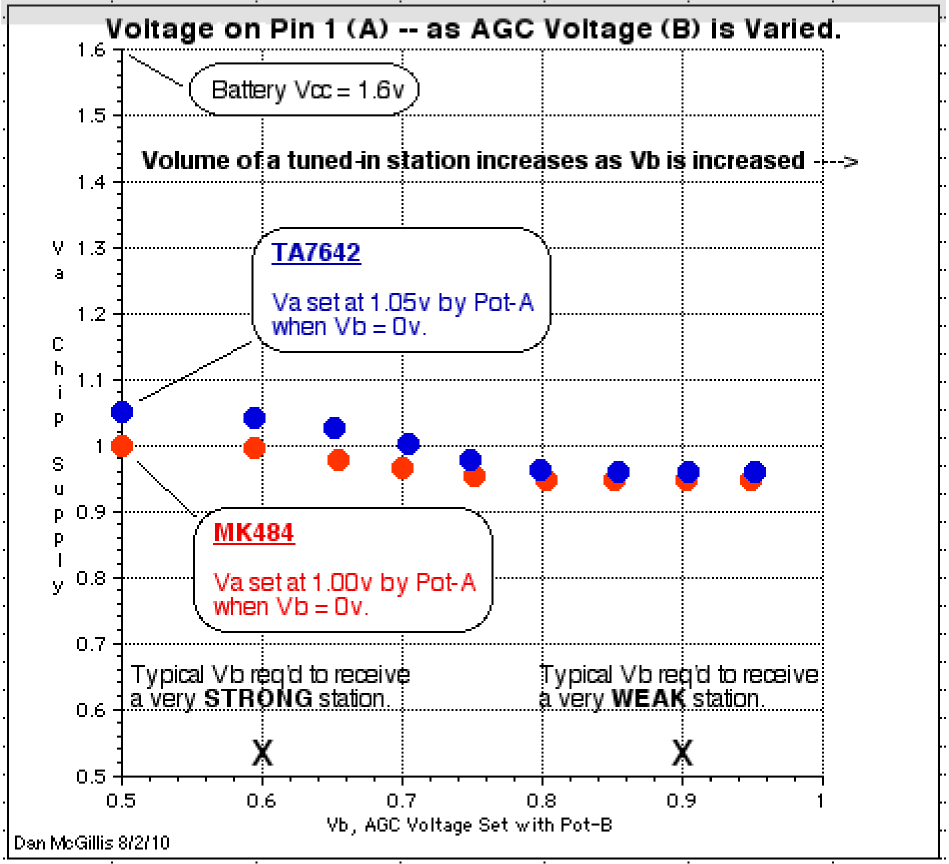
— the MK484 chips had noticeably better selectivity, but less sensitivity than the TA7642’s;

— the MK484 chips seemed closer to oscillation than the TA7642’s. I could hear the “sea shell” affect in the audio. Reducing the 100k AGC line resistor lessened the tendency, but I left it at 100k.

— the TA7642 chips had a slightly wider “good” supply voltage operating range (Va) than the MK484 chips.

You adjust Pot-B, if necessary, to change the AGC voltage to suit the station you’re tuned to - weak or strong. When Pot-B is changed, the supply voltage Va on the output pin is also slightly changed from it’s “set” value. Hopefully, it does not get out of the preferred range as determined during the chip characterization exercise described above.

In the graph shown below, I’ve plotted the way the chip supply voltage on the output pin (Va) changes as the AGC voltage at point “B” is changed - by varying Pot-B.



There are a couple of things to note about the graph:

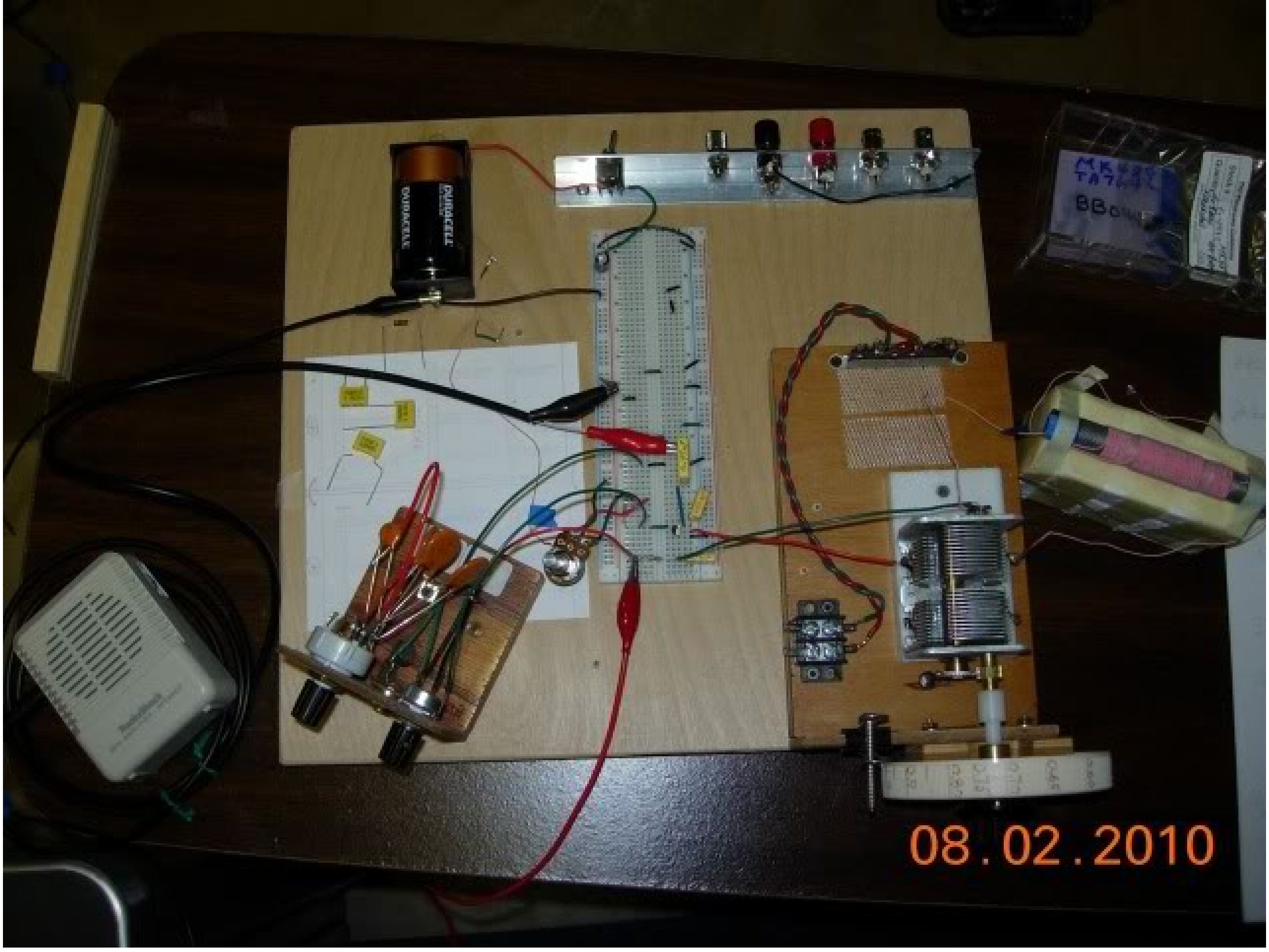
1.) The voltage Va changes as Vb is varied - but seems to stay in the “good” range.

2.) You need an AGC voltage at point “B” near ~ 0.6v to tame very strong stations.

3.) Very weak stations - even right next to strong stations - can be heard by increasing the AGC voltage at point “B” to near ~ 0.9v.

Ordinarily, in the “standard” MK484 circuit, if you had set Va = 0.9v --- then Vb would also be 0.9v, and the radio would respond well to a weak signal, but have trouble with a strong signal.

I’ve included a picture of my setup, --- it’s a mess. But it works very well. I suppose it demonstrates that the MK484 & TA7642 are more tolerant than we think.



Without an antenna - just the 4” ferrite rod – and in the basement, the “mess” can easily pick up my moderate – to – strong daytime stations, and a few weak ones too.. And at night, it hears - and separates - lots of DX.

With an antenna/ ground to a Tuggle tuner — lightly coupled to the MK484/ TA7642 tank, the “mess” becomes a hot DX radio. And it’s a well behaved hot DX radio.

Thanks for putting up with another long-winded post. I get excited about these “simple” radios ‘cause it’s all new to me. And great fun.

Hi all. **Here’s an update.**

1.) Reduced the Vcc supply to an AA rechargeable battery (1.33v). I’ll let this run continuously for a few hundred hours to see how the set handles a drop in voltage and increased battery resistance.

— Eventually, if all goes well, I’d like to put a solar cell on the radio to trickle charge the battery. 2.) Added just a touch of + feedback to narrow the selectivity a bit. It also reduces the audio bandwidth a little which helps my bad ears. I don’t know if this is really worthwhile or not -- have to play with it some more. It’s fun to fiddle with.

3.) Added a headphone amplifier as described in the LM501T data sheet. (Thanks WA4QAL, Dave.) I had tried a few others, but this worked about the best – at least for this setup. Plenty of volume even for night time DX.

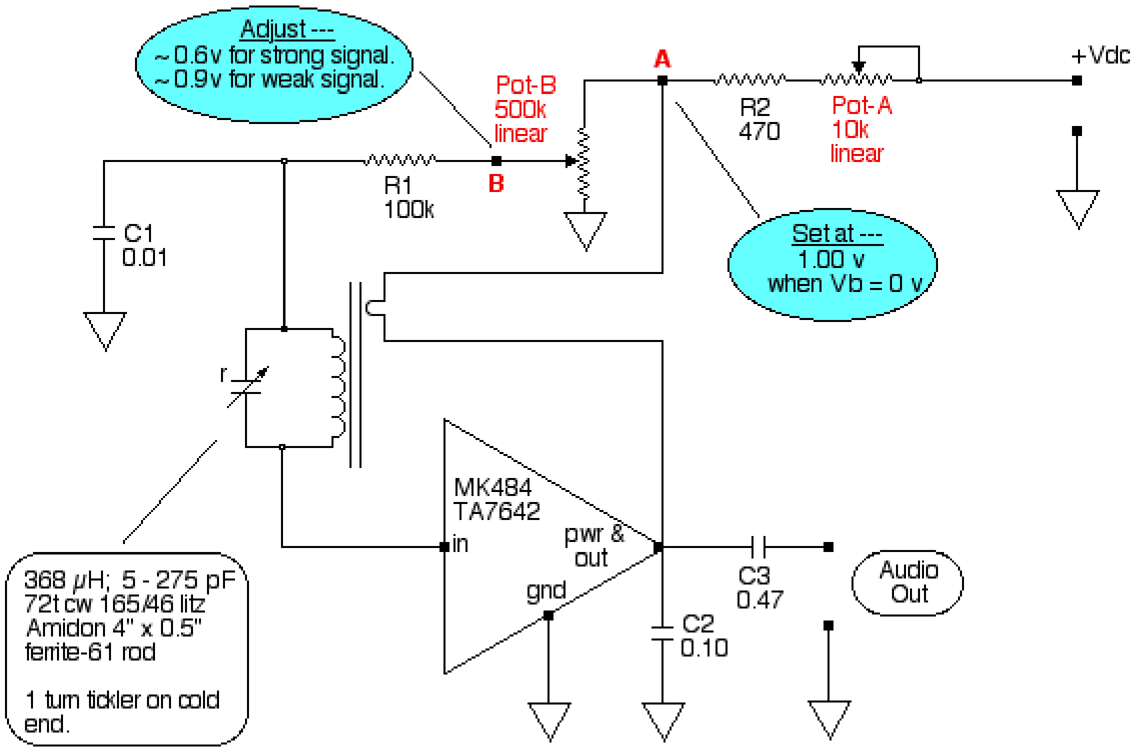
— A “Walkman” type headset is used with the amp. Very comfortable. All I have is a flea-market unit that measures ~ 36 ohm per element. I’m only using one element -- eventually I’ll wire both elements in series to give ~ 70 ohms and maybe pick up even more volume.

4.) Put the whole thing on a “Lazy Susan”. The radio can be easily rotated since there is no external antenna or ground hook-up.

— This REALLY helps null-out a particularly loud daytime station 3 miles away. At night - when they reduce power - it’s not needed. It’s kind of fun to rotate the thing and play “direction finder” games.

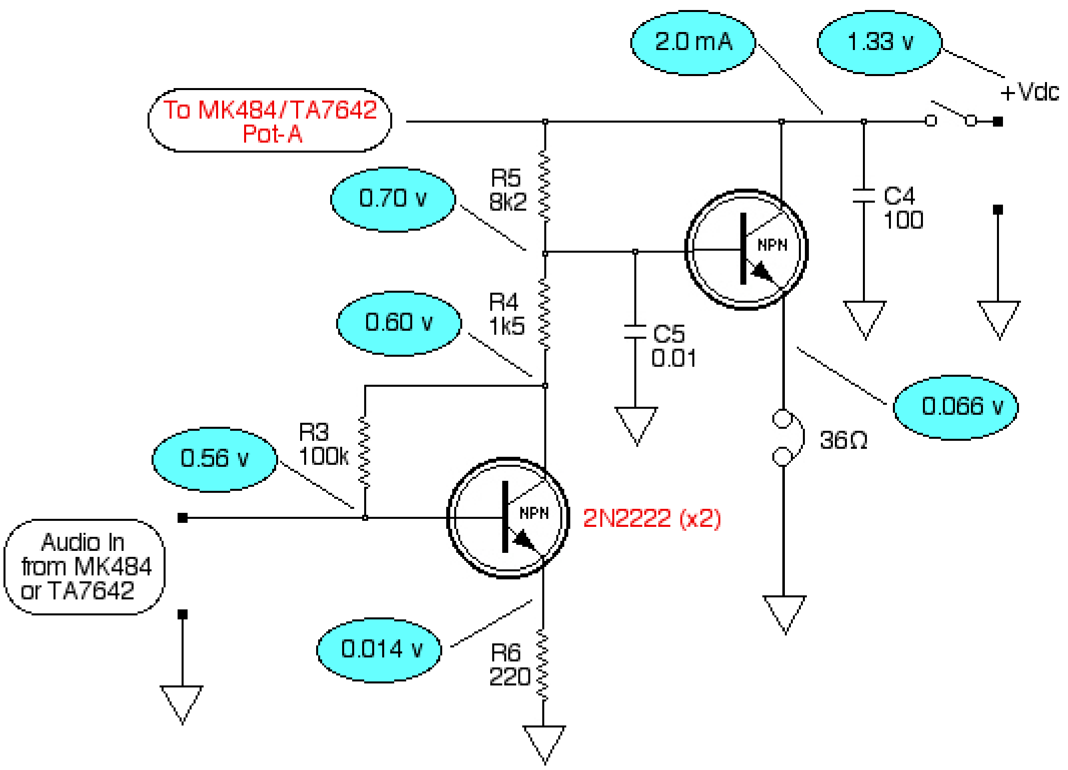
A Well-Behaved MK484 - or - TA7642 Radio

Dan McGillis 8/6/10



Headphone Amplifier from LMF501T Datasheet

Dan McGillis 8/5/10



Hi all. This bypass & decoupling info is probably well known - but I'll pass it along anyway because I had a good time learning about it the hard way.

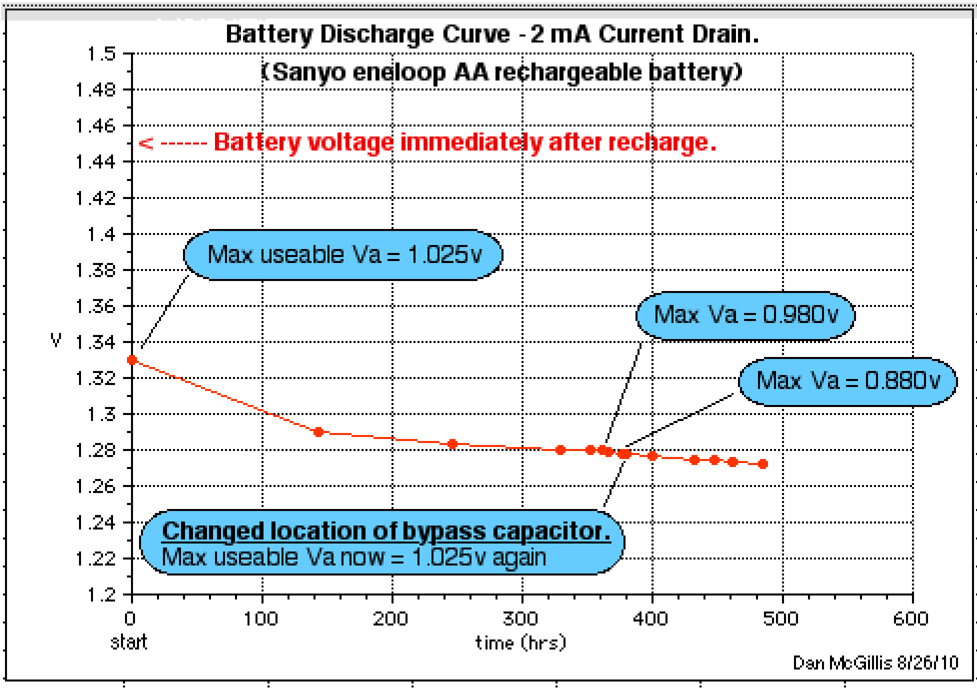
After fiddling with and listening to this little radio for awhile, I ran into my first glitch.

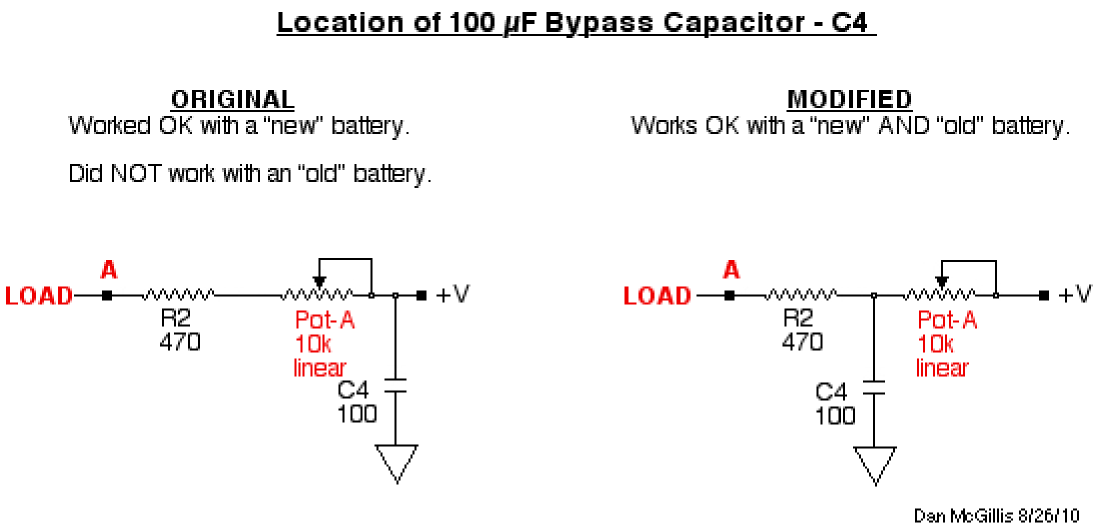
The radio has been running continuously off of a used rechargeable AA battery. I wanted to see what happened as the battery aged and it's internal resistance increased.

Sure enough, after about 360 hours of run time, the radio started to "act up" in the form of bad audio distortion. At first, I cured the problem by adjusting Pot-A to lower the supply voltage "Va" to the TA7642's output pin. This also reduced the radio's sensitivity -- not good.

But within 24 hours I had to reduce Va again as distortion crept back in again. Va was now so low that the radio's sensitivity was seriously compromised.

Shown below is a plot of the battery's output voltage over time - AND the points at which I had to reduce Va to get rid of audio distortion that kept creeping back in.





The idea behind the location change is discussed by Ken Kundert in his article "Power Supply Noise Reduction": http://www.designers-guide.org/Design/bypassing.pdf (http://www.designers-guide.org/Design/bypassing.pdf)

See especially Figure 6 and his discussion of decoupling.

I think the "cure" explanation is (trying to paraphrase Ken):

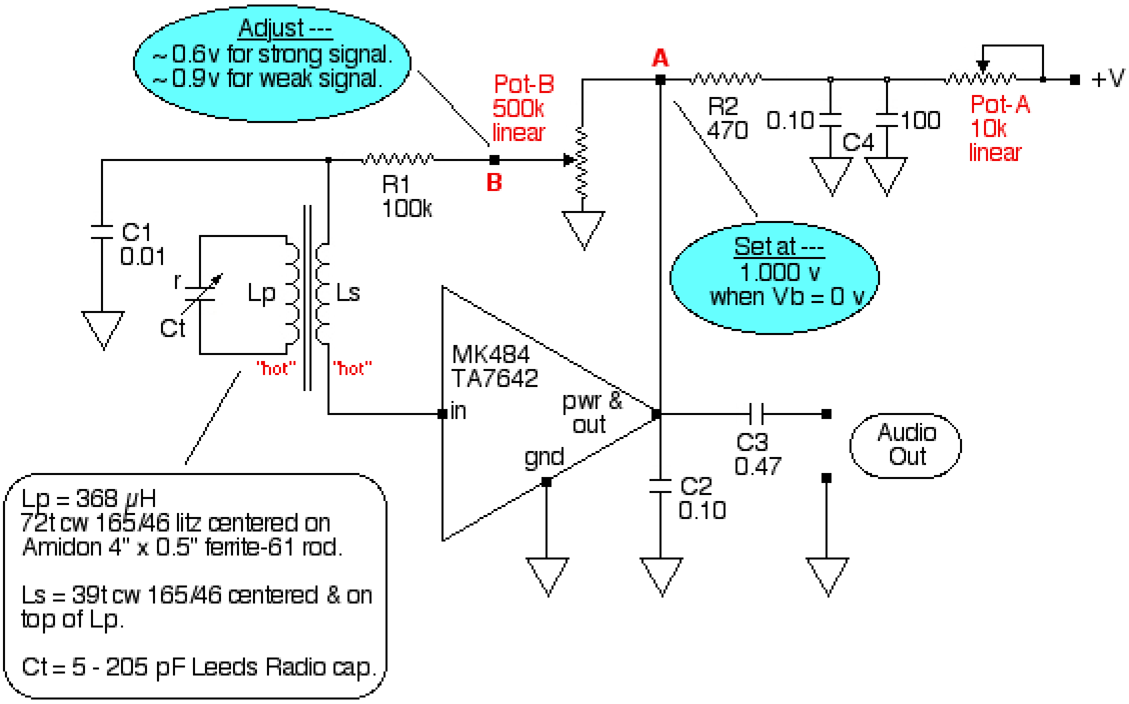
— Shifting the location of the bypass capacitor (C4) places the "high" resistance Pot-A in the supply line BETWEEN the battery and the bypass capacitor. This FORCES high frequency noise current from the TA7642 circuitry load to flow through the low impedance bypass capacitor rather than the battery.

IF the high frequency noise currents reach the battery, and IF the battery is "old", - ie. has a high internal resistance - sufficient high frequency noise voltage is generated on the supply line to affect the circuits connected to the battery. ---

Here's the TA7642 (MK484, ZN414) final:

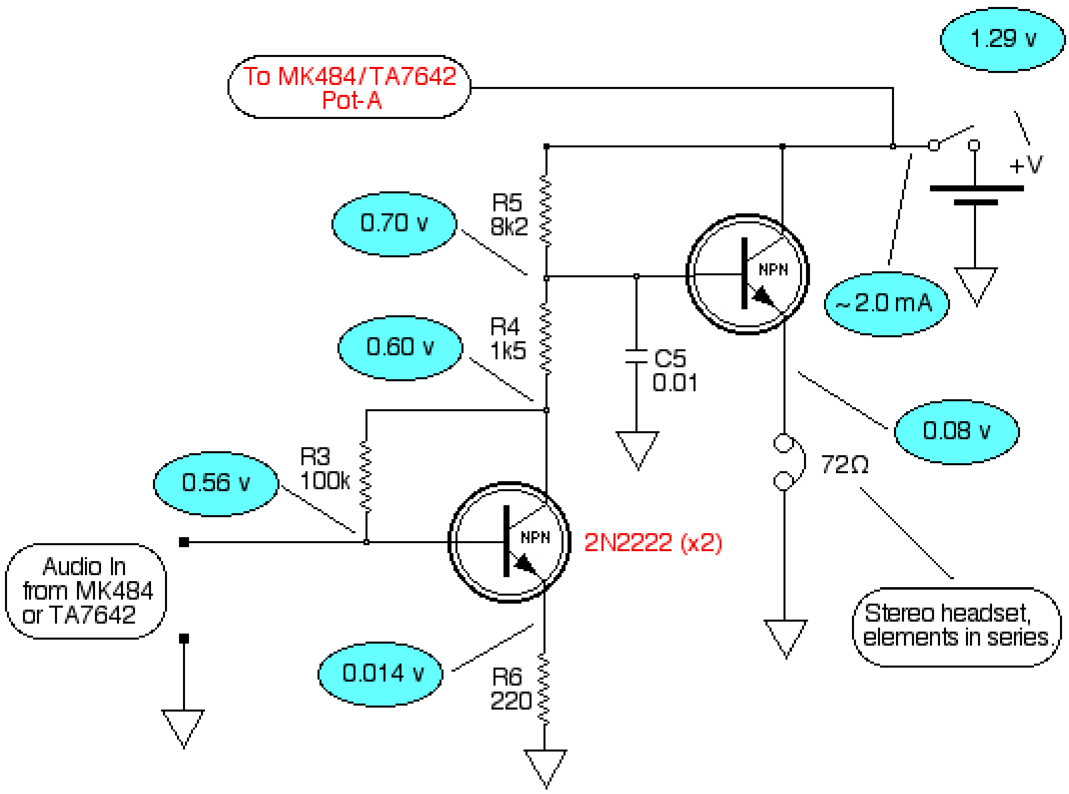
A Well-Behaved MK484 - or - TA7642 Radio

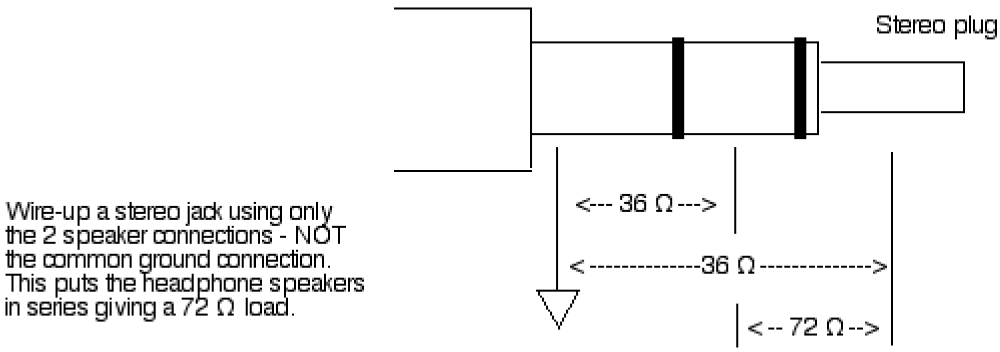
Dan McGillis 8/21/10

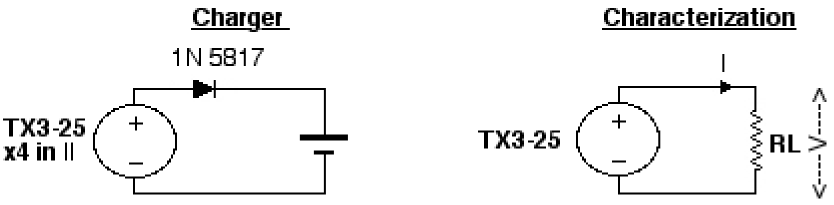


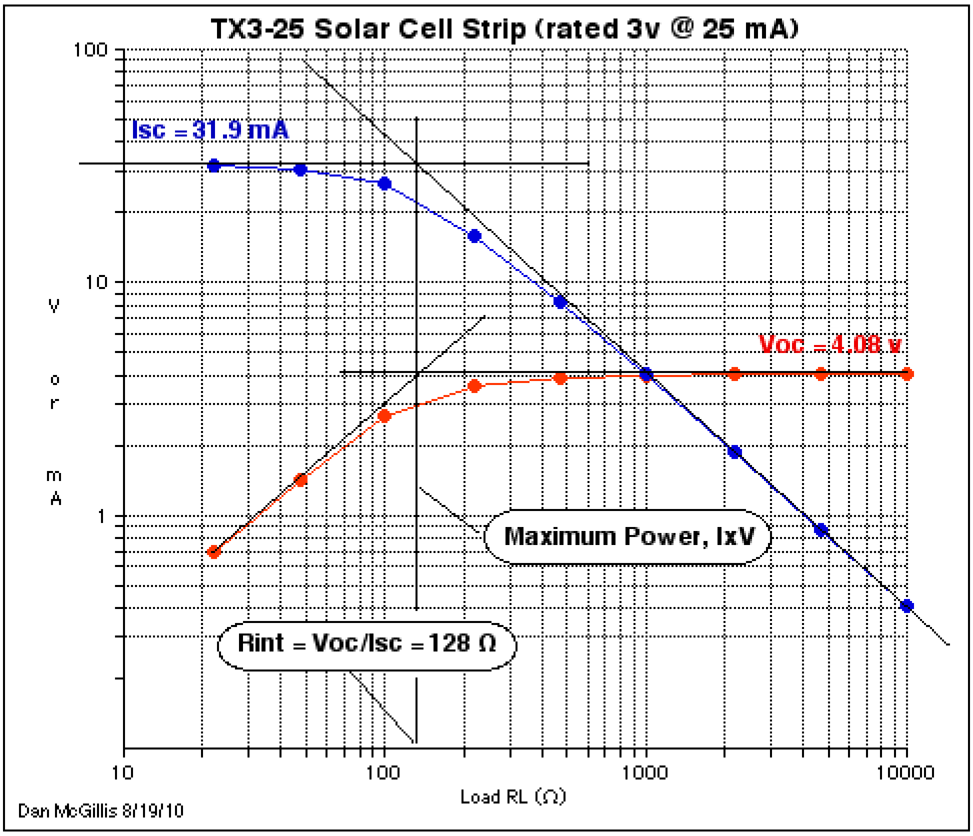
Headphone Amplifier from LMF501T Datasheet

Dan McGillis 8/21/10









The data was NOT taken at maximum illumination (local noon, but not tilted) so the Isc is a tad low.

The data shows how the load RL on the cell affects the output current and voltage. The graph also shows how:

— Isc, the short-circuit current,
— Voc, the open-circuit voltage,
— Rint, the cell's "internal resistance" (assuming the simple emf model), and,
— the maximum IxV power conditions,

are all related. You can see from these curves how the cell gets it's "3-25", ie 3v-25mA, rating.

Fun stuff.

73, Dan

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