1. Summary

HP403B AC meter. S.N. 523-05634

Existing condition poor. Battery removed, and some corrosion on inner metal. Meter dial with cracked and peeling face. Some e-caps replaced. No AC mains fuse.

Battery replacement

Battery provides mid-point 0V and -6.5V rail from 26V generated by CC output P/S. 4x 6.5V 225mAh Ni-Cad battery modules. 6.5V = 5x 1.3V cells. Charge current is typ 6.2mA, with 4.8mA to circuitry. R39 can be used to increase charging current up to 11mA. A discharging Ni-Cad cell would have down to 1vpc, with a 1.2V stable region.

Each 6.5V battery replaced by a TL431 set for 6.0V nominal at 15mA (0.1W), to emulate 1.2vpc. TL431 Vak is capacitor bypassed, and needed to be at least 22uF 16V for sufficient phase margin stability with 10mA zener current, and use a similar capacitor across the dropper resistor (https://www.tnt-audio.com/clinica/regulators_noise3_e.html).

Divider from 6.0V to 2.495V, with 2.495V across R2, so R1=1.4xR2. 4k7/3k3 = -1.7% (with 6/8k=0.75mA). So 4k7/3k3 = 6.048V minus 0.002mA*4k7 = 0.01V.

Use pins 2,3,6,7=anode, 1=cathode, 8=ref. 4k7 & 10uF between pins 1 and 8. 3k3 between pins 2,3,6,7 and 8. 47uF between pins 2,3,6,7 and 1. External connections to pins 1(+) and 6(-).

LM431 sample. 6.15V reg for >1mA feed. 20mA feed: 6.00V + 6.11V + 6.08V + 6.16V (pos end).

PSU provides 12mA into regulator string with 100R dropper (1.2V). That is nominal current for battery and circuitry. Picotest reads 0mVac on 100mVFS range on supply rails.

For operation without mains connection (ie. low noise), a battery supply is used based on 2x 12V + 1x 6V series SLA connection, along with a series 12mA CC reg (LM317 with 1.2V/12mA=100R series resistor, with 1.2+1.5=2.7V minimum drop from input to output).

AC mains safety

Added bel MJS 350mA 250V in-line fuse to active line (Wh/Blk), with heatshrink cover.
Confirmed all primary side wiring was separated.

Operational repair

Level switch contacts cleaned.

Circuit voltages not accurate enough. Initially suspected e-cap leakage.
C20 at 10.02V via 15k 9.63V (25uA) C12 < 20uA C9 ~.7/15k=46uA
C11 .56/15k=37uA- replaced C14 replaced C19 replaced - it has a zener across it??
Replaced all e-caps.

Resistors: R9 and R35 were >10% so replaced. R7 is 43k, not 34k (as marked in schem).

Input impedance. 10.0mV on HP403B (not within cal) and 200k in series measures 9.05mV with R6=5M6, so ok.

Partly restored meter - curling dial paint was limiting needle – sliced off curls. Inspected movement - no apparent debris, but some slop in bearing which may be causing some of the stiction.

0.1V scale adjusted for 300kHz by comparing 400Hz/300kHz/1MHz when no DMMs are loading signal and 50R term, and then 1MHz adjusted using C16.

Alternative metering
DCV across C19 (meter) is 270mVdc=0.978 FS on 0-1 scale, and 262mV=3.00 on 0-3 scale, and Aneng 8009 (10Meg input) doesn't load the reading. Meter is 100uA FS, so voltage across 220R is 22mV, and voltage across meter is 270-22=248mV, so meter resistance is nominal 248mV/0.1mA = 2.5kohm.

3x 4mm banana sockets fitted to added rear bracket, with cutouts in top slide cover. Divider across C19 added: 68k+3k3 ; 150k+10k ; 390k, to give 0-1 scale as 100mVdc FS, and 0-3 scale as 30mVdc FS.

Shorted input measurements
Shorted input (mains power) generates 22mVdc on 1mV range, 18mVdc on 3mV range, 16mVdc on 30mV range, back to 21mV on 10V scale down to 16mV on 300V range. So shorted input tests show noise is generated in first active stage, and is just being attenuated from 22mVdc to 16mVdc due to inter-stage attenuation resistor divider R18-R23.

Shorting the input to 2nd active stage generates 2.2mVdc to meter. Shorting the output of 1st active stage generates 1.3mVdc to meter. So 2nd active stage is fairly noiseless.

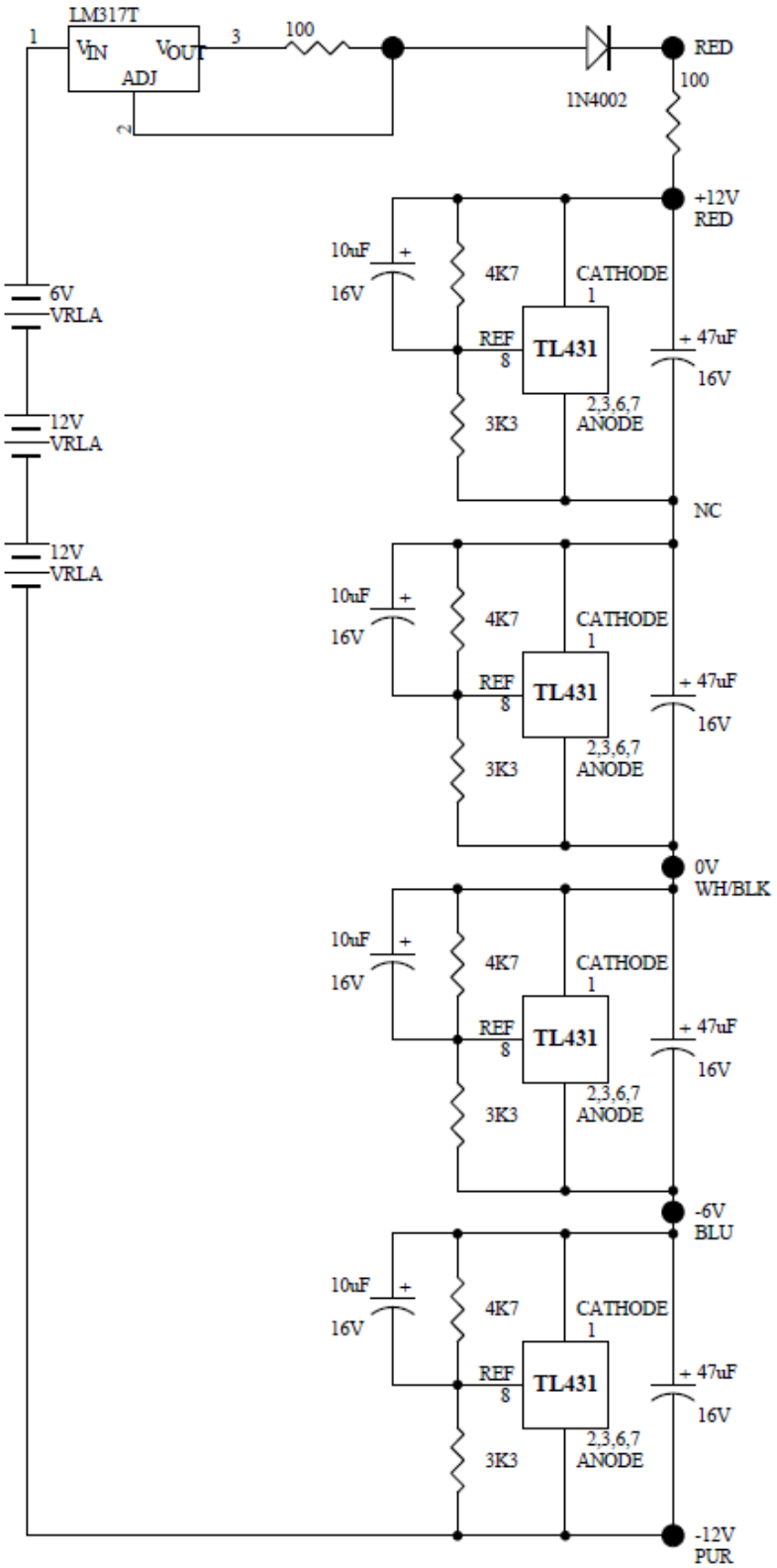
Shorted input (battery power) generates 3.8mVdc on 1mV range, 1.6mVdc on 3mV range, 1.2mVdc on 30mV range, back to 2.8mV on 10V scale down to 1.3mV on 300V range. Top was open, so need screened location.

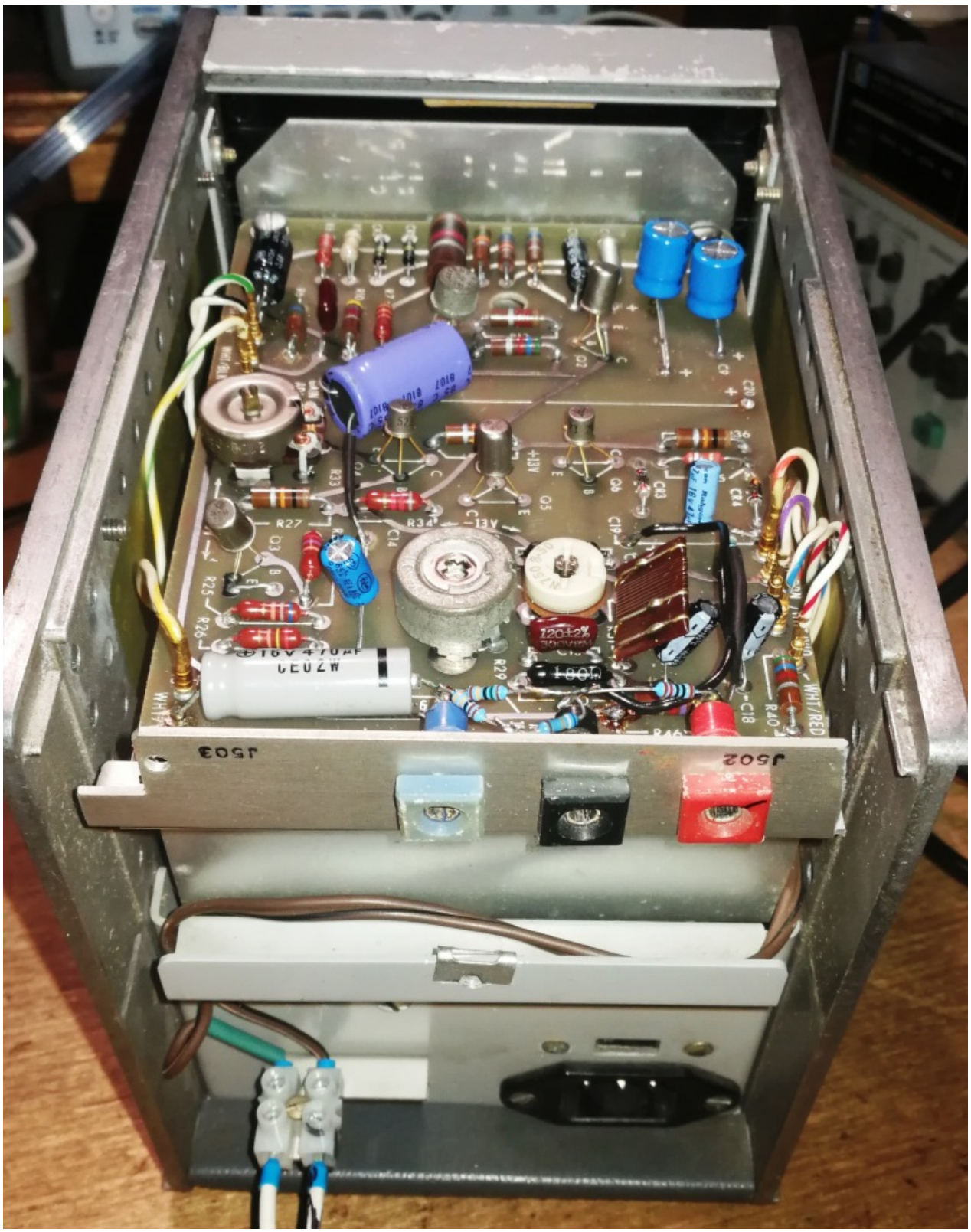
Meter adjustment/calibration
HP3325A with 50Ω termination used to adjust/calibrate HP403B rear terminal meter outputs to Aneng 8009 for 1mV, 100mV, 3V ranges at 400Hz and 300kHz and to confirm at 1MHz and intermediate ranges, with Keithley 197 and Picotest M3510A to confirm test voltage.

300V 400Hz signal source – TMC oscillator using 40Ω output with 8Ω internal DCR and external 15Ω in series – driving Ferguson OP25 output transformer 2.1Ω secondary winding to generate >300Vrms at PP terminals at 400Hz from TMC oscillator with 40Ω output. Unloaded OPT HV frequency response peaks at circa 400Hz, and falls to 30V by 20kHz, and 168V by 30Hz.

The rear terminal meter output was calibrated for +/- 1% FS at 400Hz and 300kHz, with the dial typically showing about -3% FS level. Accuracy at 1MHz confirmed. Response at 2MHz was about +3% FS.

Battery replacement HP403B





Rear view showing external DMM connections, and external battery connection