EM Electronics A10, A22, A23 and A29 notes

Table for the amplifiers, data taken from the Website

	Eq noise resistance ohms	1 sec filter	Offset V Temp Co	Bias Current Temp Co	Internal Gain setting resistor	Output current	Output V	Op Current
A10	20	1nVpp	1nV/C	5pa/C	1 ohm, 5ppm /C	+-2 ma	+-3V	2 ma
A22	150	3nVpp	1nV/C	2pa/C	10 ohms, 15ppm/C	+-2 ma	+-3V	1.5 ma
A23	25	1.3nV pp	1nV/C	2pa/C	1 ohm, 15ppm/C	+-2 ma	+-3V	1.5 ma
A29	700	7nVpp	5nV/C	2pa/C	10 ohms, 25ppm/C	+-2ma	+-6V	3 ma

This support board allows –

1. Selectable gain and filtering
2. Input low thermal Latching reversing relay
3. Offset voltage and current adjustment
4. Power polarity protection and preregulation
5. Calibration of the amplifier gain

Selectable gain and filtering

The control can be via the DIP switch on the PCB, a Remote DIP SW, or an X1801 interface board installed in a K2001 or K2002. Talk to TiN about the X1801 interface PCB. An original Keithley 1801 interface PCB should work also but I have not tested it. This may require a custom interface cable.

Input low thermal latching reversing relay

The support PCB also offers onboard reversing of the input leads to check thermal EMF issues. The relay has less than 15nV of thermal EMF so the thermal EMF of the external wiring can be reduced to this level.

Offset voltage and current adjustment

With an A2X preamps, it has pots to adjust bias current and offset voltage of the amplifiers. The A10 has internal adjustment pots. There are holes in the pcb to allow adjustment with the A10.

A22 Module R7= 500Meg

A23 Module R7= 50Meg

A29 Module R7= 100Meg

Power polarity protection and pre-regulation

For battery power, I use 2ea, 12v 10AH Motorcycle batteries. With 5 ma current draw they last for over 2000 hours (several months). I have also used a normal HP6235A Triple output power supply with no problems. For applications with unlimited operating time I use TiN's X1801 interface board.

Calibration of the amplifier gain

How do you verify the gain of the amplifier? How do you generate a 1uV calibration signal with better than 0.1% accuracy? You can purchase tight tolerance gain feedback resistors but the CMOS switch and the internal feedback resistor have tolerance and they change value with temperature. You may not care about the absolute accuracy of the amplifier gain if you are only using the amplifier for null detection.

The PCB has provisions for a 100,000:1 precision divider. It consists of a precision 10k resistor and a 1%, 50ppm/C, 0.1 ohm 4 wire resistor (Ohmite Series 13). Calibrating the divider will require the builder to measure the resistors after installation. I leave some 1 inch wire stubs at each resistor to PCB connection so I can do a 4 wire measurement of each resistor to calibrate the divider.

NOTE: there is a table silkscreened onto the PCB that relates DIP switch position with system gain. This table is valid for the A10 or the A23 preamp because they have 1 ohm feedback resistors. The system gain will not match the table with different gain resistors (R6, R7, or R8) or with the A22 or A29 amplifier.

Operational notes

With the 5ppm / deg C spec of the internal gain setting 1 ohm resistor, this is a 4 ½ or 5 ½ digit accurate amplifier. You can connect the preamp to whatever meter is convenient but remember you are not getting 8.5 digits **accuracy** when using this amplifier.

For one test I put the amplifier inside a heated metal box (2 deg C above ambient). For this special test I was looking for offset voltage and wiring thermal EMF stability. The heated enclosure helped null stability when data was collected over several hours. I believe I achieved better than 0.02nV stability with 10 minute averaging with this setup.

Chopping frequency

The A10 operates at around 488Hz chopping frequency. I don't know about the other amplifiers. I have never seen an issue with chopper input current spikes or noise on the output. But keep it in mind.

Soft clipping

Here is a problem I ran into when setup with a gain of 1000. For this low gain you need a 1000 ohm feedback resistor. The output voltage swing is specified at +-3V but the output current is limited to +-2ma. So with a 1000 ohm feedback resistor the output voltage swing is effectively limited to +-2v. It does not do a hard clip if you go beyond 2ma it's more like gain compression. So the errors are not obvious. At higher gains you can use the full +-3v output voltage swing because the current stays in spec.

Board assemble notes

With the A23, use small spacers to maintain a slight gap between the module and the pcb while soldering. You don't want the metal edge of the amplifier pressing on the solder mask.

With the A10 be sure to double the check the clearance between the bottom of the PCB and the top of the amplifier screws. It would not hurt anything to put a layer of tape over the Case screws on the right side of the A10 amplifier before installing the pcb.

The "–" input pin of the amplifier is also power ground so your power ground needs to float.

To begin with the amplifier should be electrically floating inside it's enclosure. Ground the case to some point in your circuit.

The support board is designed to be flexible. It can work with any DVM or analog meter. It can be powered several different ways. The Gain and filtering can also be controlled several different ways.

Not all of the parts are used with every assembly.