Power Monitor/Distribution Panel

Build this early warning system.

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Very few station power supplies or transceivers are equipped with meters to monitor voltage and current, yet knowing the level of both is important and often provides the first warning that something is wrong. Of course, omitting these meters reduces the cost and size of power supplies, many of which will be tucked out of sight under the operating desk or on a high shelf and seldom glanced at after being turned on. Also, as we all know, the front panel of the usual commercial transceiver teems with so many knobs, switches, and push-buttons that there's no room for these useful voltage and current meters. Omitting them also reduces manufacturing costs.

Every ham should know whether the regulated voltage from the power supply is steady and at the correct level. An unusual variation is a warning and should be investigated immediately.

Murphy's Law being what it is, occasionally the power supply regulator can quit, allowing the output voltage to soar to dangerous levels. Although some commercial power supplies contain protective circuits to prevent this, some do not. Also, many home-brewed regulated power supplies may not be protected from the results of regulator failure at all. Therefore, to protect your transceiver as well as your bank account from major damage, this panel includes a means of monitoring the DC voltage and automatically disconnecting it from the transceiver should the voltage exceed a safe pre-set level. A fuse alone would not open the circuit rapidly enough to prevent damage, although a fuse should be included in the positive DC lead.

Because many ham and/or satellite stations have more than one transceiver as well as many other pieces of equipment, separate parallel branches should be available to distribute DC voltage to all present and planned equipment to be powered from the main station power supply. Additional "goodies" can easily be incorporated, such as regulated low voltages to power accessory equipment.

The panel described here provides all the amenities described above. It can often be constructed entirely from a well stocked junk box, but for those few who lack a well filled one, I'll tell you where to purchase the most expensive components, the meters, for little more than pocket change. Except for the panel itself, which can be a flat panel, an aluminum chassis, or a home-brewed enclosure, the total parts cost should not exceed ten dollars. This is very inexpensive insurance for expensive equipment which also provides maximum flexibility in monitoring and routing DC operating voltage to your equipment.

The circuit

Fig. 1 illustrates the schematic diagram of this panel. Aside from its primary functions of monitoring, distributing, and automatically disconnecting power from the load(s), should the voltage soar out of bounds, it includes optional but very handy outputs at the three most useful regulated voltages often needed for accessories but not directly available from the station power supply.

Regulated DC voltage from the station power supply is applied to the positive and negative input terminals of J1. A barrier strip is shown, but separate DC input and output connectors can be used to replace the barrier strip and eliminate the exposed voltage terminals. This input voltage is bypassed where it enters the panel by capacitors C1, C2, and C3, which eliminate incidental noise or spikes generated externally or internally. Positive voltage from J1 passes through fuse F1 and the normally-closed contacts of relay K1, then through current shunt R2 which is in parallel with ammeter M1, to the power output terminals on J1. Negative (ground) terminals on J1 and all grounds in the panel are connected to the station ground. Output terminals for three distribution lines are shown. You may install however many you wish. Meter M1 will display the total current drawn by loads connected to the output terminals when they are turned on. Positive voltage at the output of the shunt R2 is also applied to the suppressed-zero, expanded-scale voltmeter M2. This meter indicates a narrow range of voltages around the nominal power supply voltage as chosen by the builder. This will be explained later.

The input DC voltage is also tapped off between fuse F1 and the moving contact of relay K1 and applied to the automatic voltage monitoring circuit consisting of R1, D3, Q1, and K2. When R1 has been properly adjusted and the DC voltage exceeds the level chosen by the builder, D2 avalanches and applies a positive voltage to the base of Q1, driving it into saturation. The coil of K2 is the collector load for Q1, whose collector current energizes K2 and closes its normally open contacts. This applies operating voltage to relay K1. K1 then switches and opens its normally-closed contacts, removing the DC input voltage from all output terminals as well as the panel monitoring circuits, and both meter needles will fall to the left end of the scale. The input voltage, now somewhat excessive, maintains both relays in their operated positions, without damaging the monitoring and control circuit, until the power supply is turned off. Because the normal elapsed time between a power supply malfunction and its being turned off by the operator will probably be only a few seconds at most, the monitoring circuit will not be adversely affected.

Three optional three-terminal regulators, U1, U2, and U3, derive their input voltages from the input side of shunt R2 and ammeter M1, so the current drawn from these regulators will not be monitored on M1. Voltages of 5, 6, and 9 are suggested as being the most useful if this option is included. Each low regulated voltage should be available at two or three parallel-connected output connectors, such as coaxial power jacks, to provide flexibility in powering small accessories.

Although not indicated in **Fig. 1**, a low-cost AC line voltage monitor which indicates AC line voltage from 90 to 130 VAC is recommended if you have space (see "Line Voltage Monitor," *73*, January 1996, page 86). Unfortunately, the schematic diagram was inadvertently omitted and is reproduced in **Fig. 2**. This will add about three or four dollars to the overall cost of the panel, and will provide a warning if the line voltage falls too low or rises too far.

Even if you have a large budget and have your heart set on nice, neat, high tech digital meters to use for M1 and M2, I very strongly recommend using analog meters instead. A digital meter, while extremely accurate, must be inspected closely to see just what its indication is. An analog meter merely needs a quick glance at the position of the needle to assure you that all is well.

Because new analog d'Arsonval meters are extremely expensive, I suggest you order a "grab bag" of five very high quality surplus meters from: Fair Radio Sales, Inc., PO Box 1105, Lima OH 45802. Phones: (419) 223-2196 and (419) 227-6573. 24-hour FAX: (419) 227-1313. Ask for Catalog No. WS97.

The meters you will receive will be of their choice, not yours, but all will be high quality, name brand meters, with basic movements ranging from 100 µA or less to 1 mA; at a couple dollars each for top quality meters, you can hardly go far wrong.

Fuse F1 should be commensurate with the maximum current your power supply is rated to deliver. Most 100 Watt transceivers draw about 20 Amperes on peaks, so a standard 20A fuse is sufficient. However, if you use modes requiring constant full power output, a slow-blow fuse or a standard fuse rated a bit higher might be the best choice.

Relay K1 can be single or double throw as long as there are closed contacts when the relay is not energized. The contacts must be rated to switch the maximum current expected to be drawn by the load. A DPDT relay with 10 Amp contacts can have the contacts connected in parallel to form a 20 Amp relay. Its coil is rated for 12 VDC.

Relay K2 has very little work to do and its contacts handle only the coil current of K1. A small DIP relay is ideal, and half-Amp contacts are sturdier than needed.

Construction

Just how this panel is constructed depends entirely upon the size of the panel or enclosure and on the size of the meters. The only cautions which should be observed are when connecting C1, C2, and C3 directly across the point where the DC voltage input is applied to the panel, and when routing the heavy wire lead between R2 and the K1 contacts and from R2 to the output terminals on J1. These two leads must connect to the ends of the shunt R2.

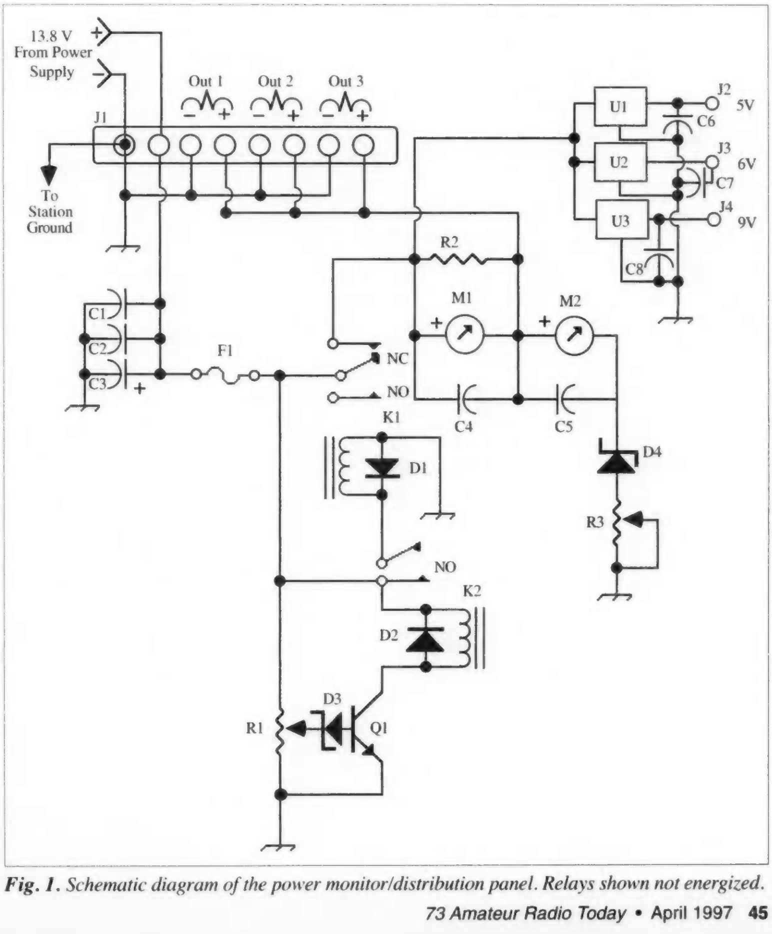

Fig. 1. Schematic diagram of the power monitor/distribution panel. Relays shown not energized.

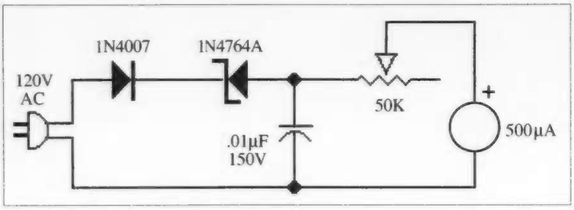

Fig. 2. AC line voltage monitor (optional).

Because there's little chance that the scales on the two meters you use will be exactly what you need, they cannot be mounted until the scales have been modified to fit your requirements and any internal rectifiers, shunts or multiplier resistors have been removed. To accomplish this you will need far more information than can be included here, but do not despair! (See "Use Those Surplus Meters," 73, January 1992, page 42.) If you do not have a copy or cannot locate one locally, back issues and photocopies of articles can be purchased from the publisher. That article has all the information you'll need to modify many different styles of meters.

When you have made the shunt R2 for M1 and changed the meter scale, both can be remounted and wired into the circuit. When M2 and its associated zener diode D4 and voltage adjust trimpot R3 have been determined and the meter scale modified to meet your requirements, these components can be mounted and wired into the circuit.

Before moving into the next section, check all your wiring and all soldered connections. Adjust R1 and R3 to place their wipers at the ground end of rotation.

Adjustment

Temporarily apply the DC output of your power supply to the input terminals of J1, maintaining correct polarity. Place the panel in the same relative position it will occupy when permanently installed, measure the DC voltage between the positive terminal of M2 and ground with a DMM (preferably) or accurate analog multimeter, and note the exact voltage. Adjust R3 so the voltage indicated on M2 is the same as that just measured. Remove the voltage from J1.

Determine the maximum DC voltage your transceiver or other load can withstand and still operate correctly. This will be found in the list of specifications in the operating manual.

Apply a source of variable, filtered DC voltage capable of being varied from below to slightly above the maximum safe level, and set that voltage from the variable source with your DMM or multimeter. Slowly adjust R1 and listen for the click when K1 energizes. Back off R1 until K1 clicks again as it opens, then readjust RI until K1 just energizes. Do this carefully and do not overshoot.

Now, slowly vary the input voltage a bit lower, adjusting very slowly so you can hear K1 click as it operates. Measure the input voltage again with your meter. It should be extremely close to the trip voltage set by R1. Very minor adjustments, made extremely slowly, of R1 may be required until you are sure the DC voltage will be interrupted should it exceed the tripping level you have established. This completes all adjustments. Operation will now be automatic.

Operation

Install the panel permanently where it can easily be seen from your operating position. Connect the DC input and output cables from the station power supply and other equipment to the panel connectors. When all cables have been connected and you are certain no errors have been made, turn the power supply on. The output voltage will be displayed on meter M2.

Then turn a transceiver on. The current drawn in the "Receive" mode will move the needle of M1 slightly up the scale. This will probably not indicate the exact value printed in the specifications. The latter is not exact and transceivers vary among themselves. Also, analog meters usually have a rated accuracy of ±2% of full scale.

Connect a dummy load to the transceiver, and plug in a key. The current indicated by M1 will be close to that cited in the specifications with the key closed. If you do not have a straight key, either a paddle or mike will serve to kick the needle on M1 around to let you see that all is working properly.

Now, turn everything off, get a cold "807" from the refrigerator, lean back in your chair and admire your handiwork. You can be secure in the knowledge that a glance at the meters will be reassuring, and that your expensive rig(s) will be protected automatically should Murphy interfere with your power supply regulator.

Parts List	
C1	0.001 μF ceramic disc
C2, C4, C5, C6, C7, C8	0.1 μF ceramic disc
C3	22 μF 25VDC electrolytic
D1, D2	1N4148
D3	5.6V 400 mW zener diode
D4	10V or 11V 400 mW zener diode
F1	Fuse
J1	Barrier strip or builder's choice
J2, J3, J4	RCA jack or builder's choice
K1	SPDT or DPDT 12V relay, NC contacts
K2	SPST relay, NO contacts, 12V coil, DIP or similar small relay
M1	Ammeter
M2	Voltmeter
Q1	2N3904 or similar NPN small signal transistor
R1	10kΩ trimpot
R2	Shunt
R3	Trimpot voltage adjust
U1	7805 regulator
U2	7806 regulator
U3	7809 regulator

One thing you should remember—if you notice the needle on M2 wiggling up and down on voice peaks or while keying—no regulator is perfect, and because M2 is an expanded scale meter these excursions are much smaller than they appear at first glance. 73