

# EE15140A DC Electronic Load 150 Watt



## Input Voltage

0 - 50 Volts DC (Absolute Max 58V)

**Input Current (adjustable)** 10k pot Int./ Ext.

0 - 40 Amps

(Quasi Power Mode / Constant Current are Standard)

Optional (On board Start-Up in CC Mode Stand Alone)

**Bias Power Requirements** ( requires only one )

1. Regulated 12 Vdc +/- .012V @ 150 ma

2. Unregulated 15-24Vdc @ 150ma

3. Optional Bias on board power requires 90-265 Vac  
some restrictions apply. (see power section of data)

**Switch Voltage (adjustable)** 50K pot Internal / External

0 - 50 Vdc. ( Switch from resistance mode to constant power mode.) (startup resistance is minimum of 1.0 meg ohms looking into power source.)

**Turn on time (Selectable)**

(slew rate) standard 0.5 seconds & 0 - 10 Sec.

(requires external capacitor, customer supplied)

See chart for time delay / slew rate.

**Power Dissipation / @ 25 & 50 Deg. C Air**

150 Watts (continuous) customer supplied heat sink

**Maximum base plate temperature 88 Deg. C.**

Do not exceed 88 C temperature or the unit will shut down.

Maximum air temperature is 60 C.

**Automatic Power Control Circuit**

Monitors input voltage for maximum current setting  
never allowing the unit to exceed its maximum current rating  
for that voltage.

**Dynamic Load Operation**

1.0 Khz @ Full Load, 3 db @ 8Khz, 6 db @ 20Khz

Maximum slew pulse 6 Amps/uS ( Source Imp. Dependent)

**Voltage Monitor**

Input voltage scaling 0-50 = 0-5VDC out +/- 2.5%

**Current Monitor**

Output 0-4 Volts DC +/- 2.5% Accurate

**Current Share / External Driver / D to A**

Input 0-4 Volts DC +/- 2.5% Accurate

**Thermal Shutdown Circuit**

Preset, 88 Deg. C. (turn on after cool down.)

Optional, fixed / adjustable range shutdown.

**Temperature Range (operating)**

0 Deg. C to + 60 Deg. C Air

**LCD meters 3 1/2 digit.**

Optional Voltage meter / Current meter

**LED Bias power monitor**

**Size:** High 1.75 x Length 4.91 x Width 3.0 inches

**Low Voltage Operation:**

The EE301xx & EE151xx are designed to operate to all most 0 volts. Typical operation starts at about 25 to 50 mV, standard mode of operation. Computer control or external control of load starts at 0.00 volts.

## Basic Operation:

Stand Alone DC Electronic Load that you can use just like a power resistor, only better! It has an optional internal power supply to run the electronics and draws only a few mills of current. Or, if you want, you can use an external +12 Vdc regulated power supply to run the load or a 15-24 Vic unregulated supply. The load starts up in resistance mode and then switches over to quasi constant power / constant current mode, with this point being adjustable & selectable. The load also has thermal and automatic over power protection. All you have to do is mount it on a heat sink & wire it to the power source UUT (Unit Under Test).

## Default Settings:

Your load comes from the factory adjusted for a 5.0 +/- 1.0 volts switch from OFF to ON in Quasi-Power mode. The current adjust is set for 1.5 amp +/- 0.5 amp of current. The slew rate is set for 0.5 seconds from NO LOAD to about 1 Amp.

## Input Voltage:

Recommended input voltage range is 0-50 Vdc. (58 Vdc absolute maximum). **Voltages above 58 volts could damage the unit.** The electronic load has transient over voltage protection in it but this does not guarantee that the unit will not be damaged. Accidental reversal of input could damage the unit. **(No Warranty Coverage on Miswired or Over Stressed units.)** Reversal can withstand 50 Amps.

## Input Current Adjust:

The load current can be adjusted internally with the supplied 10 turn potentiometer on the side of the module. 0 - 80 Amps. +/- 2.5% Or you can add your own external 10K 1/8 watt potentiometer to the connector on top of the module by removing three jumpers on the connector. See figure 3.

## Switch Mode Point: (Startup) / (Turn-off/on)

This is the point where your electronic load switches from a very high resistance to a quasi constant power mode. The point is adjustable from 0-50 Vdc. and can be changed by adjusting the 10 turn potentiometer on the side of the module. You may also use a 50K 1/8W external potentiometer by removing the three jumpers on the connector. See figure 3.

## Slew Rate:

This controls how fast the rate of change is applied to your power source. (i.e. when the electronic load changes from resistance mode to constant current). The load is set to half a second, this is considered adequate for most users. However, if you need to change it, you may remove jumper from the connector and add your own capacitor for the slew rate, you require. See figure 2 & 3 for correct capacitance and polarity connection.

## Automatic Power Control:

The power control circuit samples the amount of voltage and / or current that is applied to the electronic load and adjusts the maximum amount of voltage and / or current that the load can draw at that voltage level. So, if you have the unit adjusted for full load current, and that exceeds 150 watts, the circuit will reduce the current, or limit the current for no more than 150 watts of power dissipation +/- 25 watts but not less than 150watts.

## Thermal Protection:

Base plate temperature range is 0 to +88 degrees C. If for some reason the base plate gets too hot a thermal circuit will shut down the unit until the base plate cools off below 88 degrees C. There is an optional fixed or adjustable setting that can be done at the factory.

Last Update: 9/15/04

## Current Monitor / Current Share I/O

Full range output is from 0-4 volts with 4.0 volts being full scale. This represents a 0-40 amp output, the output voltage is +/- 2.5% accurate at any point in that range. Current monitor can be measured at the connector on top of the module and is referenced to the bias supply return. This output can also be used to drive another unit as a slave electronic load. The current monitor output can source 2 ma of current at the current monitor output pin with the on-board bias supply option or 10 ma with an external bias supply used with the electronic load.

1. If you are using the optional on board bias supply you can not use the current share operation with other electronic load.
2. If you need to use current share you will need to use an external bias supply for controlling all the electronic loads from the same bias supply.
3. Current share: One master electronic load can drive as many as 20 other slave electronic loads for use with current share. Note that start-up will also follow the master electronic load. And the master electronic load needs an external bias power supply, the same bias supply can be used with all the slave electronic loads.

## Scaled Output Voltage

The scaled output voltage is not an exact output just a relative output that is part of a divider circuit. Note: EE15140A, 0 to 50 volts = 0 to 5 volts, Maximum current 2 ma. If you are using an external bias power supply the maximum scaled output current is 10 ma.

## Mechanical Mounting:

When mounting the electronic load to a heat sink make sure that you have good heat conductivity and thermal flow. For your application try not to exceed the maximum temperature range of the unit. Use all mounting holes to get the best thermal bond / pressure that you can, to the heat sink. In most cases, adding thermal compound should help in heat transfer or use a metal heat transfer strip to help in the heat conduction.

**Note:** You should test each base plate to make sure that you are not exceeding +88 degree C. temperature range at your full power operation. Not all heat sinks and base plates conduct heat in the same manner or dissipate heat equally. You should test the electronic loads in middle on the base plate as that is where the maximum temperature will be.

## Hot Start:

The EE151xx series electronic loads can be hot started. This allows the customer to pre-apply a voltage to the current control pin in remote / local or constant current operation. The source under test can be switch on, or pre-started and then the current can be applied by a relay or switch to the load. This allows a current spike to be applied to the source under test. The electronic load can handle currents 2x there rated value for 0.010 seconds.

**Note:** ! We do not recommend hot starting electronic loads. Unless you know how your power source is going to respond. In doing a hot start your electronic load will start with its maximum current and then reduce to its set current. The settling time is a response of the loop time of the load and the source impedance + connecting cable resistance + cable inductance, etc.

## Accidental Reverse Current Hook Up:

If you hook up your source in the reverse current mode, the load has the ability to handle as much as 50 amps of current in this mode. If you exceed the 50 amp maximum it is possible to damage the electronic load, in these cases there is no warranty coverage. The load has reverse current protection diodes built into it.

## On-Resistance @ Full Current:

Typical ON resistance for this electronic load is 0.035 ohms at its full current. The ON resistance determines the maximum current at some voltage.  $I = \text{Volts} / \text{Resistance}$ . Example: 2.8 amps =  $0.1V / 0.035 \text{ ohms}$  this would be the maximum current you could draw at that voltage.

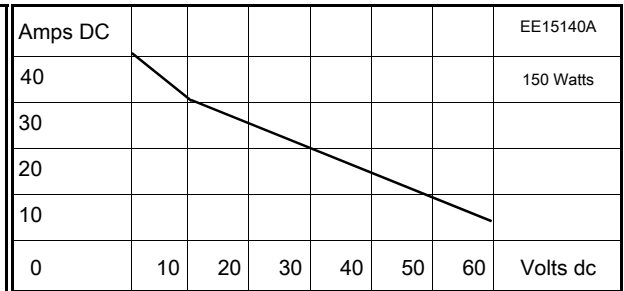


Figure 1.

Input Power Table: ( Volts ) x ( Amps ) = Watts

uF's	.002	.003	.070	.014	.028	.057	.113	.226	.450	.90	1.80
Time Seconds	.002	.035	.007	.014	.028	.057	0.11 3	0.22 6	0.45	0.9	1.8

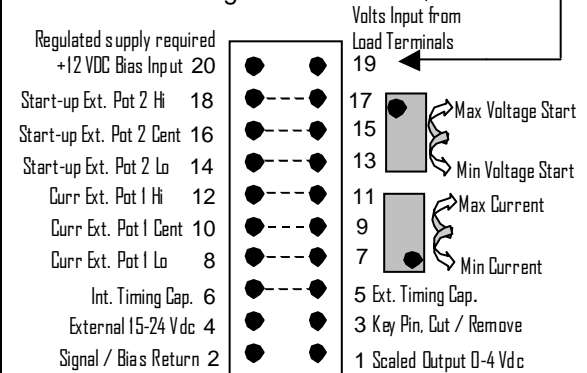
Figure 2. Slew Rate ( speed of turn on ) +/- 10%

(1Meg) x (Ext. Cap. in uF) = Up Time Apx.

(30k) x ( Ext. Cap. in uF ) = Down Time Apx.

## VIEW IS FROM TOP OF LOAD

Connector is on right side.



Dashed lines are default connections done through mating connector for use with load control pots/timing. -----

Pin 10, is external current share input and/or remote control for load. Maximum input is 0-4 VDC

Figure 3. Connector : Electrical Connections

## Special Connection & Operation

Parallel Operation:

(Yes) just parallel the inputs of two or more modules. Each load will need to be adjusted separately except if you are using current share.

External Pot1. = 10K for Current Control Adjust.

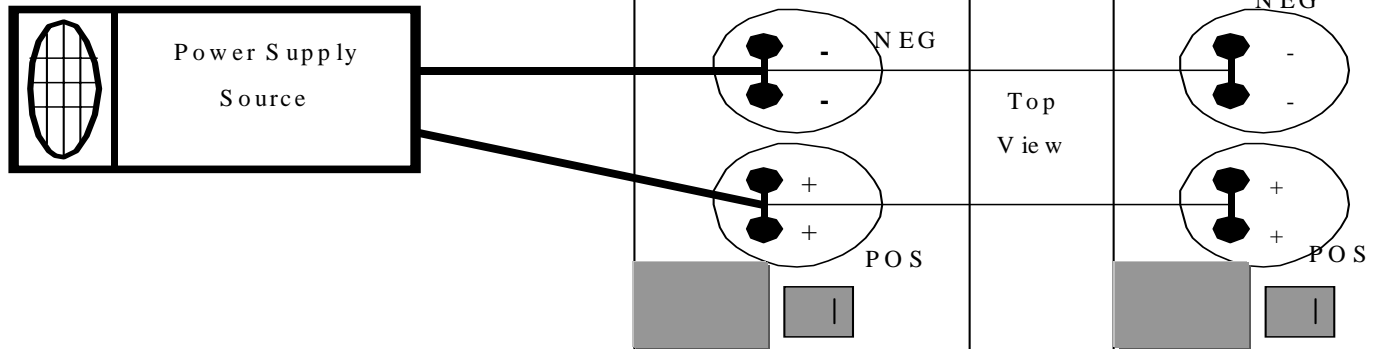
External Pot2. = 50K for Startup Voltage Adjust.

Pot power requirement is 1/8 watt.

Remove all jumper except start-up timing (5-6) when adding external pots.

## How to install your electronic load and typical hookup option information.

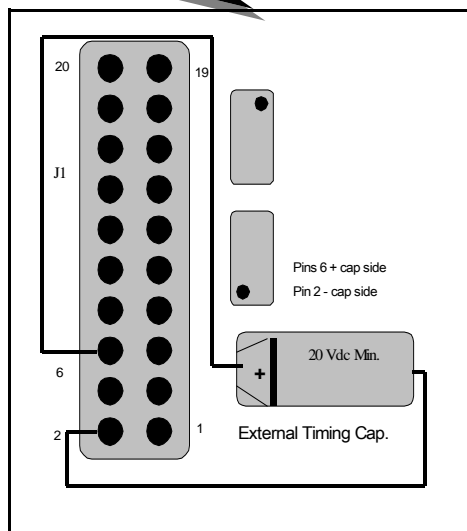
350 Watt supply



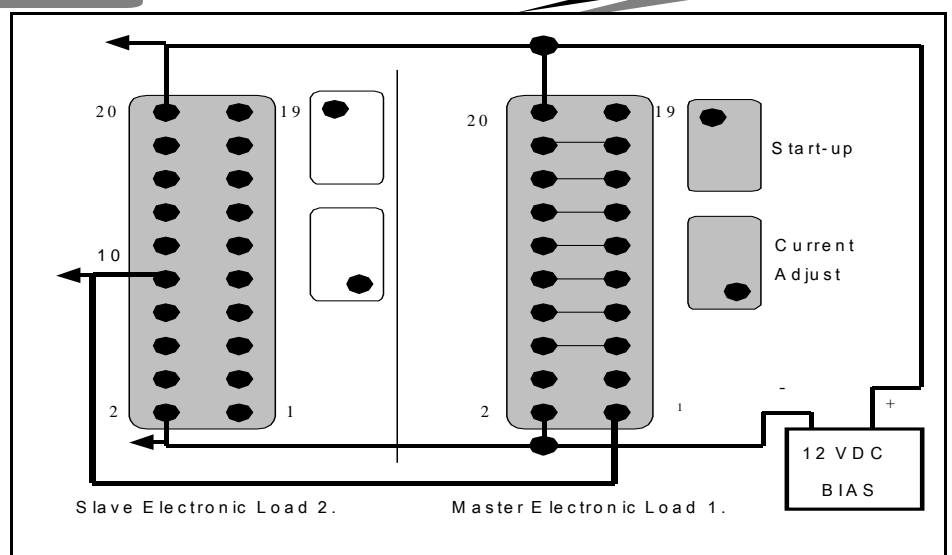
FOR EXAMPLE: 350 WATT POWER SUPPLY.  
FIRST WHAT IS YOUR VOLTAGE ? LET'S SAY 12V,  $350 \text{ W} / 12\text{V} = 29.17$  AMPS FOR FULL POWER. TAKE HALF OF THAT  $29.17 / 2 = 14.58$  AMPS THAT IS WHAT ONE LOAD IS GOING TO DISSIPATE. (175 WATTS) ONE HALF OF THE TOTAL POWER.

THEN CONNECT THIS LOAD IN PARALLEL WITH THE OTHER LOAD . THE FIRST LOAD IS NOW DISSIPATING 175 WATTS, THEN ADJUST THE SECOND LOAD FOR 175 WATTS. YOU NOW HAVE A 350 WATT LOAD.

How do I change the Startup Timing?  
Look at figure 2. for the time you want and wire the J1 connector as follows.



Can I use one pot to control the current in both units?  
YES ! And here is how you do it !



## FAQ ( Frequently Asked Questions )

### What is an electronic load ?

An electronic load dissipates power just like a power resistor.

### Why is an electronic load better than a power resistor?

With an electronic load you have better current control versus power dissipation at low resistance levels. For example, you have to have several different power resistors at 250 Watts for different voltages versus one electronic load.

### What is paralleling & what advantage do I have using it?

just like a resistor. And, in some cases, loads that have current share need only one adjustment. Just like with resistors, in most cases, you can parallel electronic loads of the same type... The load will share the power to control all the electronic loads at the same time.

### Do I have to use a HEAT SINK with the EE151xx series?

Yes..Yes..Yes...! First, you need to know how much heat you are going to dissipate. In some cases, for low heat dissipations, you may only need to mount the electronic load to the side of your test box. But, when you get up around that 15 watt level you will need a full fledged heat sink. The following factors should be considered - Is the unit going to be run in a continuous mode or intermittent mode? What is the ambient air temperature? If you are going to use the unit in a BURN-IN room that is at 50 C. you will need more heat dissipating ability. If you look in the Wakefield Heat Sink Book, the EE151xx series is designed to mount directly to 392 & 860 series heat sinks. Or, you can use the AAVID high power series heat sinks. The EE151xx was designed to be used on any heat sink with a 3.150 hole spacing, of which there are numerous ones that fit this specification. You can use heat sinks that are either forced air cooled or convection cooled. And, of course, forced air cooling works better than convection cooling. Also, forced air cooling will allow you to use a smaller heat sink.

### Do I have to use an insulator with the EE151xx series?

No..! You can mount the electronic load directly to the heat sink. The base plate of the electronic load is isolated electrically.

### Can I use current share with more than one unit?

Yes..! You can use up to 20 units in parallel. Beyond this the current sharing may become unequal.

### What does the Start-up set point do for me?

In some cases, the source that is hooked to the electronic load cannot start-up into a constant current or can only start-up after it has reached a certain voltage level. The EE151xx series allows you to set the point at which your electronic load will switch from its high resistance mode to its current mode.

### What advantages do I have with quasi-constant power?

Most measurement and burn-in is done in constant power or constant current. This allows the current from the power supply, or power source, to remain at the same power even though the voltage may be changing somewhat.

### What happens if the power supply shuts off and then restarts?

Every time the power supply shuts off, the electronic load will recycle just as it did at startup.

### Can I run two EE151xx in series to increase the voltage range?

In theory this may work. In practice it may not. A lot of factors must be taken into consideration. You should contact the factory before trying something like this. (**There are some modes that you cannot use...**). Using a load that is suited for that voltage range is the correct practice to do.

**Can I use a computer or signal generator to control a dc source, to control the electronic load?**

Yes you can! Note: If you use this to control the load, there is **NO Automatic Power Control, Over Temperature, or Startup Time Delay**, in the load. You are now controlling that. And you are running the electronic load in constant current mode only.

**Can I run the load in true constant current mode?**

Yes! but you will have No Automatic Power Control.

**Does the electronic load bias power supply shut off if I add a power On-Off switch? (EE151xx)**

Yes, The loads bias power supply will run whenever there is voltage supplied to it. However, by adding a power On-Off switch you will be able to switch the internal power control electronics on and off in the load. This will not damage the electronic load. Power may be applied to the load when the bias is turn off.

**What is the maximum size of the timing capacitor?**

The size is not the problem, the leakage is. The maximum leakage can be no more than about 50 uA and still work well. The leakage is a factor in the timing circuit, and when using very large capacitors may be more of a factor for timing.

**Should I use All of the Current Input Pin when connecting the load?**

In most cases yes. Each input pin is designed to handle about 45 Amps. By using more than one pin your total input load resistance will be lower. This can be very important to low voltage power supply sources. Otherwise you may not be able to get the maximum current that you desire.

**What is the maximum ON-Resistance of the electronic load?**

An example, if the on resistance is 0.03 ohms when you add all the circuits together. For current at 2 volts? Well that would be about 67 Amps but the automatic power control will limit you to the maximum current of the load if you exceed that.

**Can I use the electronic load below 2 volts?**

Yes. But remember you will need very large gage wire to get large currents to the load... in fact the gage of the wire may be more of a limiting factor to current than the electronic load is. And in most cases the load will go down to several mill-volts.

**Can I put a short circuit switch across the electronic load?**

**NO ! NO ! NO !** This is not recommended. Most of the time you will have voltage transients that exceed the input voltage rating of the electronic load. This is especially true with higher voltages. This may cause the electronic load to be damaged. Our suggestion is have a separate load control switch that switches the power source away from the electronic load and switches it to only the shorting switch in use at that time. Remember to switch both the positive and the negative lines, not just one line, to the shorting device.

**Do I need to FUSE the external bias supply power?**

**Yes ! Yes ! Yes !** Both the positive and the negative inputs to the bias power supply should to be fused on each electronic load. ... a 32 Vdc @ 1/4 Amp. Pico Fuse should be used on both bias power leads. Do Not use a larger Fuse as this may damage the circuits inside the Electronic Load.

**Remember if you can't find the answer here, Call us, Fax us, E-mail us, Write us.**

**We will get back to you just as soon a possible with your answer!**

## Test & Operation Setup

1. Read all of the information on these pages.
2. Determine what options your load has first.
3. Note: any series that starts with an EE151xxA will require an external power supply of 12 Vdc @ 0.150 Amps. Also, the power supply should be of an isolated type.
4. If you are using the EE151xxA-2 series, the unit has a built in bias power supply that will supply power to the internal circuits. This power supply works 90-265 Vac
5. If the unit is from the factory, it is set as follows: the unit is set to turn on at 5.0 Vdc input and will draw approximate 1.0 Amp at all voltages levels below 5 Vdc.
6. Should you be using a used unit the first step is to turn the current pot counter clockwise until you hear a click or 11 turns.
7. Then turn the startup pot counter clockwise until you hear it click or 11 turns.
8. At what voltage do you want to turn the load on? For the power supply or circuit you want to test with the electronic load usually a good choice is to have the startup pot adjusted to approximately 20% of the full voltage.
9. If necessary, next hook up the appropriate bias supply or AC power for the bias.
10. Apply the turn-on voltage you want to the main power input terminals and adjust the startup pot clockwise until you measure a voltage on pin 5 of J1 to pin 2 of J1 of approximately 10 - 12 Vdc. This tells you that the startup timing circuit is on. If you have 0-2 Vdc the circuit is in the Off mode and the unit will not allow any current to flow.
11. Adjust the current pot clockwise until you get current flow. You may use an amp meter, LCDs or current probe or measure the voltage from Pin 1 - J1 to Pin 2 - J1 to derive the current you are drawing from your power supply or circuit. ( 100 mV per Amp ) .

Note: To get an accurate reading of current at low power you may want to measure the off set voltage with no current from the current monitor circuit. Then, by subtracting the offset voltage, you can obtain a more accurate current reading. Remember that this is not a precision load and it has a total of a 5% tolerance.

12. Your Electronic Load should now be fully operational.

## Current Share Operation & Setup

13. For each load that is going to be current shared you should perform steps 1 - 10 first.  
You will need to pick one load that is going to be your master load. This load will control all the other loads. (Maximum slave loads recommended is 20 with external bias supply).
14. You will need to make a cable and wire the current monitor output from Pin 1 - J1 master load to Pin 10 - J1 of all the (Slave Loads) and remove the jumpers on pins (7-8),(9-10),(11-12),(13-14), (15-16), (17-18).

Note: You can not current share with one load running positive voltage and another load running a different voltage. The loads have a common ground using the internal or external bias power supply. You can only current share a single power source (UUT).

## Remote Control Setup & Operation (Computer & Function Generator)

15. Note: In using the remote control, the power foldback, startup time delays and thermal protection are disabled... ! ( Maximum power can be exceeded ) It is the customers responsibility to make sure that the power level is not in excess of the 300 watt level at any voltage or exceed a temperature of 88C on the unit's base plate.
16. Remove jumpers (7-8), (9-10), (11-12). Apply a dc voltage (+ 0 to 4.0Vdc) too Pin 10 - J1 positive and return ground to Pin 2 - J1, Your power supply voltage must be very stable and clean of noise (remember 0.1 volts is 2 Amp of power.) We suggest using a divider right at the connector of the electronic load to reduce the noise and add stability.

## **Temperature Shutdown**

17. The unit should go into thermal shutdown. It will turn on just as it did at start-up when the unit cools down. If you have the thermal option on your load, you can set the shutdown point from 0-88 deg C.

## **Constant Power / Automatic Power Control**

18. How can I tell if the power control circuit is working?  
Hook up an external power supply to the load input pins. Set the power supply to 10 Vdc. Measure Pin 12 - J1 for an approximate voltage of 3.0 Vdc. Then increase the power supply voltage output to 15 Vdc. The voltage at Pin 12 -J1 should have decreased to approximately 2.0 Vdc.

Note: The constant power circuits adjust the reference voltage as the voltage goes up or down to the electronic load thereby adjusting the power (current ) the electronic load is pulling from the external power source. It is possible to damage the electronic load at high voltages, as the fold back has limited range.

## **Constant Current Operation**

19. Can I operate the electronic load in true constant current mode?  
Yes! Remember by doing this you will disable automatic power control circuits .  
If you have ordered the constant current option remove the jumper from J2.  
The electronic load will now run in constant current. The over temperature circuit is still active and will still function in constant current. The start-up timing will also work.

## **Time Delay Adjustments**

20. The time delay can be changed by removing the jumper from Pins ( 5 - 6 ) and connecting a new time delay capacitor from Pin 2 - J1 (ground) to Pin 6 - J1 (positive). See the time delay chart for capacitor size for the time delay you need.  
Note: The charge and discharge times are different.

## **Disable optional Internal Bias Power Supply**

21. If you are using an EE151xxA series and want to disable the internal power supply first remove the AC from J3. The unit will not come apart from the electronic load bias supply sockets. See the Internal / External Bias Supply Operation section.

## **Adjusting and / or replacing optional LCD Meters**

22. You should never have to adjust a meter unless it is replaced. The meter is glued to main part of the electronic load, you will have to pry up on the meter, be careful not to damage the pin sockets that the meter goes into. The meter will have been calibrated at the factory prior to putting it into the load. Glue the meter in place. Make sure that the glue does not get into the pin sockets the meter fits into. If you need to calibrate the meter put a know current into the load about half current and adjust the meter as needed to meet that current or voltage reading. (The adjustment pot is on the back of the meter).

## **Applying AC Power to Bias Power Supply Input**

23. The AC power is applied to J3 a screw type input power connector. There is no right or wrong polarity when applying AC power and there is no need for a ground wire. The AC is fully isolated from the electronic load. The input voltage can be operated from 90-265 Vac.

## General Hookup

24. Effect of wire length & size and impedance: If you have a scope you should check to make sure that the electronic load is not oscillating (can't hear it sing, whistle or change pitch as the current is adjusted). Note: That all Power FET Electronic Loads have a tendency to oscillate under certain conditions. This is due to the inductance of the wire (length) resistance and the source impedance.

How Do I Fix the Oscillation?

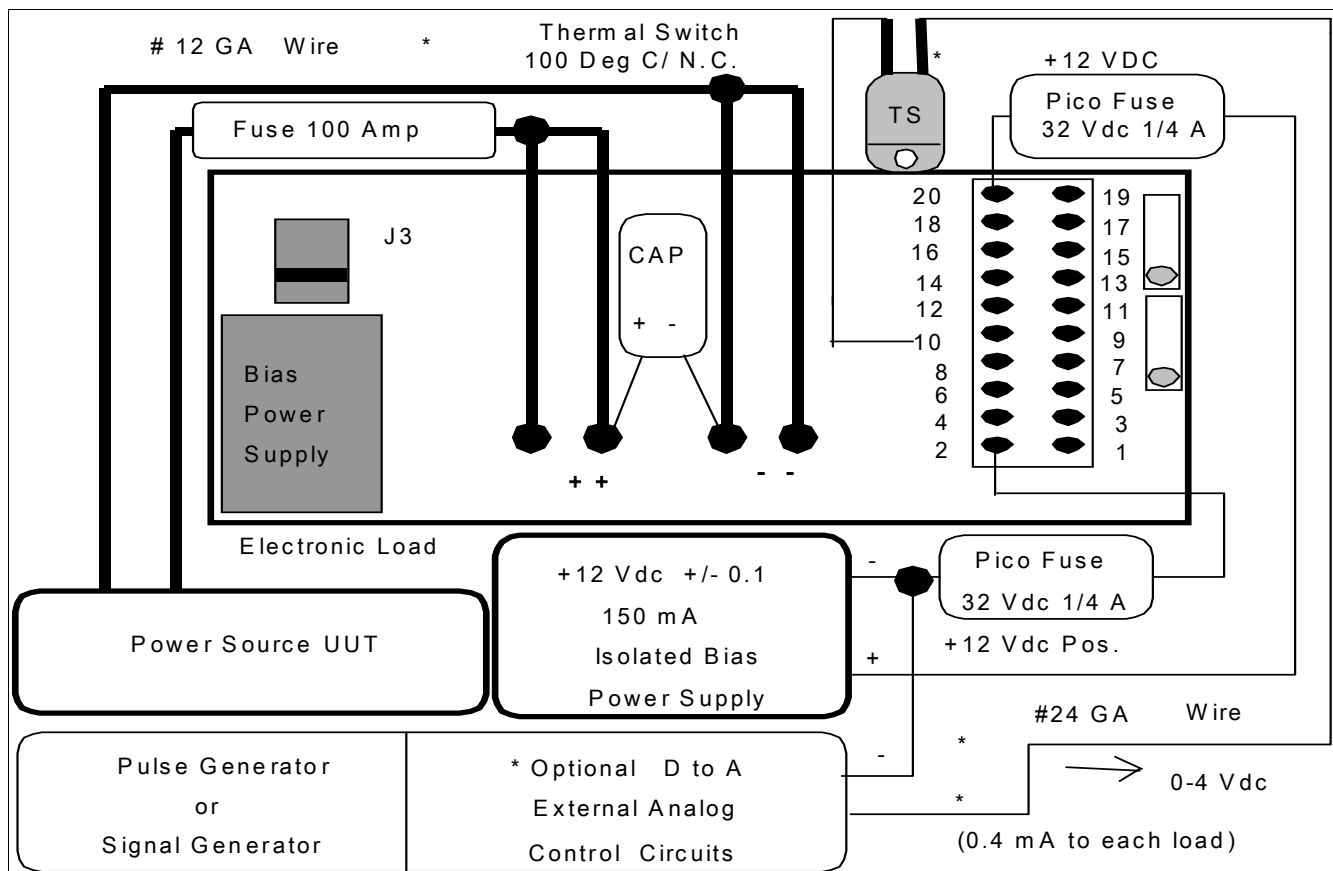
The easy fix is to add some capacitance to the input terminals at the Electronic Load end.

Typical values are between 500uF - 3000uF at what ever your maximum input voltage is.

If you don't want to add capacitance to the load you can use low impedance coax cable.

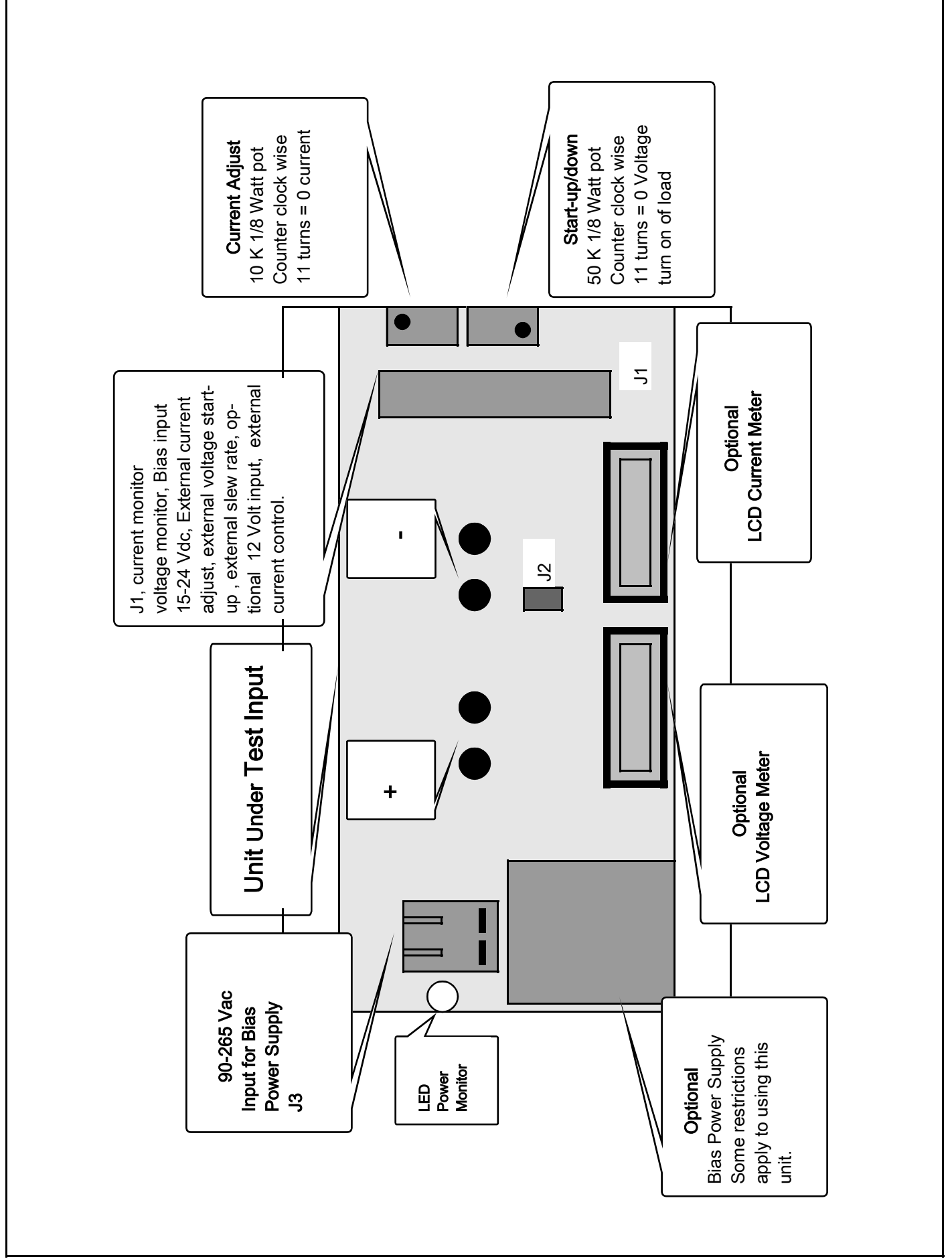
Or you can use twisted-pair wiring to the load input. Any of these options can be used to help in your application.

Note: You will not damage the Electronic Load if it starts to oscillate.



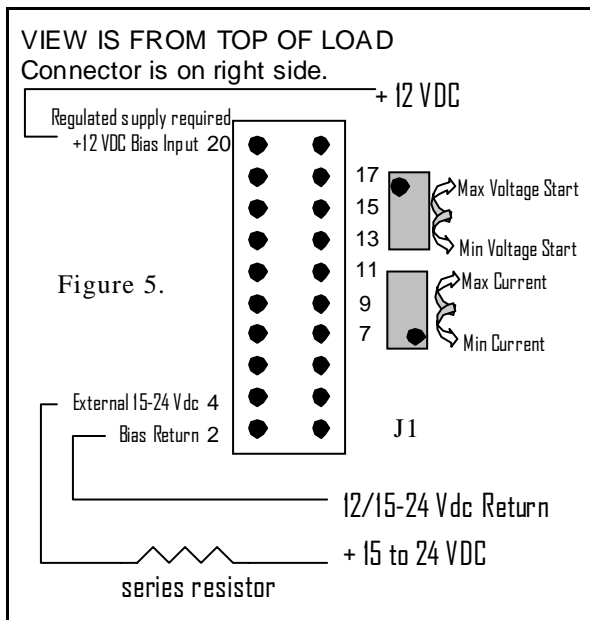
25. D to A or Signal Generator hookup (typical)
26. If you are using an Electronic Load in parallel, all the loads should have their own fuses. You can use a single Bias Supply for all the loads. The fuse is there to protect your power source UUT.
27. If you are going to add an external thermal switch it should be added to either the control input line as shown in the schematic above or added in the positive bias supply line. The switch should be in the normally closed (N.C.) mode and open at or before 88 Deg C.. You should mount the switch to the top side of the center screw on the same side as connector of the base plate of the load. The thermal switch should NOT have any air flow directed at or around it, as this will keep it from opening at the correct temperature. If you do have air flow around the thermal switch you can add some RTV over top of the thermal switch to block the air flow.
28. The maximum external control current is about 0.4 mA per electronic load (20K to ground at pin 10 on J1) .





### Internal / External Bias Supply Operation:

1. The electronic load has an optional internal bias power supply for running the control and operation circuitry of the unit. This option requires 90-265 Vac 50-60Hz and is only good to run in a stable power mode, the UUT source is none pulsed and /or wave mode. (Note, this is a floating bias supply and can be used in all isolations requirements). **Note:** Do not use the on board bias supply option with 2 or 3 below. The bias supply cannot be removed from the electronic load. If you are going to use 2,3,4 below use an external bias power supply.
2. The electronic load bias can be used from a 12Vdc regulated power supply with the following specifications, 12Vdc +/- 0.12 Vdc @ 150 ma. This is recommended if you are using a D to A or signal generator to drive the electronic load. (Note, in this mode the (-) side of the bias is also connected to the (-) side of the load power input [UUT]) isolation needs to be exercised. If more than 1 loads is connected to this bias supply, the power source under test and polarity need to be the same. External bias is applied to, (Pin 20) +12 VDC and (Pin 2) is Return.
3. If there **is no** optional AC bias power option 6 for the load. Then electronic load has an onboard precision voltage regulator that takes an unregulated 15-24 Volt DC input @ 100ma, this can be used in most applications of the electronic load. (note in this mode the (-) side of the bias is also connected to the (-) side of the load power input [UUT]) isolation needs to be exercised. If more than 1 loads is connected to this bias supply, the power source under test and polarity need to be the same. External bias is applied to, (Pin 4) +15 to 24 VDC and (Pin 2) is Return. Absolute maximum peak voltage input must not exceed 30 volts.
4. If **there is** the AC bias power option 6 for the load. Then electronic load has an onboard precision voltage regulator that takes an unregulated 15-24 Volt DC input @ 250ma, this requires a series resistor for correct operation of the voltage regulator, see the table below for correct selection of resistor value (table 3). This option can be used in most applications of the electronic load. (note in this mode the (-) side of the bias is also connected to the (-) side of the load power input [UUT]) isolation needs to be exercised. If more than 1 loads is connected to this bias supply, the power source under test and polarity need to be the same. External bias is applied to, (Pin 4) +15 to 24 VDC through the series resistor and (Pin 2) is Return. See figure 5.



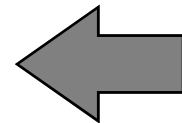
Voltage	Watts	Series Resistance
+15	1/4	33
+18	1/4	50
+20	1/2	83
+22	1	116
+24	1	150

Table 3

Note: The Electronic load needs only one bias power source, 12 Volts input or the 15-24 volt input. You should not run both at the same time.

#### Please Note:

The series resistor is **ONLY** NEEDED if AC option 6 is installed in the electronic load. In all other cases the series resistor is not needed.



**Note:** When connecting two or more loads to one power supply, the loads will share a common return path to each load's ground ( i.e. you need a separate +12 volt supply for each isolated electronic load). Or use option 6 with each load.

5. The loads can be operated from batteries, typical current will be about 40-60 ma. from a 12V battery, when using the operation mode there are no special requirements. The load will draw the same amount of current from the bias supply no matter what load current is. Batteries are just like a bias power supply, you should follow all the same rules. Batteries can also be used with the 15-24 volt input.

**Warranty:****What does your warranty covers:**

Any defect in material or workmanship.

**For how long after purchase:**

90 days for unit replacement. The warranty period for exchange unit begins with date sent.

**What will we do:**

Provide new or, at our option, replacement for repair of your unit.

**How do you get service:**

Get a return authorization number from the factory, or call the factory for a replacement unit and one will be charged to your account. When the returned unit arrives and is evaluated as a good unit it will be credited to your account.

**What does your warranty *not* cover:**

Customer instructions. The installation manual provides information regarding operation. Installation and set-up. Damage from misuse or neglect. Unit that has been modified or incorporated into other products. Exceeding manufacture specification limits of unit.

**How does state law relate to this warranty:**

This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

**Notes**