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Selecting an Electronic Load for Power Supply & DC to DC Converter Testing

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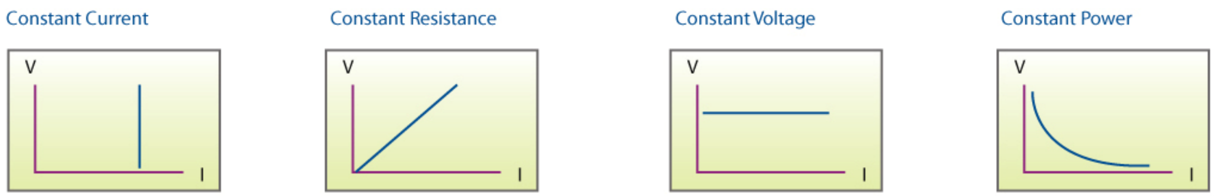
Having been around since the early 1960's, electronic loads evolved out of a necessity to emulate real world applications in power supply testing as well as batteries and now fuel cells. They began using Bi-Polar Transistors and have now settled in utilizing FET Technology to dissipate the power in the form of heat.

When selecting a load that best fits an application, the first and most important task is to define the UUT (unit under test) and how it needs to be tested. Specific questions may include:

- What are the lowest voltage / highest current operating points? (Cable drop should be considered)
- What specific measurements are needed? (RMS measurements; digitize V&I, etc.)
- One UUT or many? If many, true master/slave capability is critical.
- Are highly accurate loads at both low and high current settings needed? If so, three current ranges are necessary.
- Are minimizing cable drops and series inductance critical? Front panel connections are then needed for accurate loading.
- Is a system that can be reconfigured quickly for changing applications needed? Front panel modularity is critical to maintainability and configuration.

Answering these questions will ensure that when the product is placed in the field, its quality and reliability meets the required standards. Testing considerations include: Output Regulation, Noise Measurements, High Line and Low Line AC, Transient Measurement and Protection Circuit Operation.



CC Applications:

1. Load/Cross regulation test for CV power supply
2. Battery discharge time test and life cycle test
3. Fuel cell testing
4. Loading pattern simulation for automotive wiper

CR Applications:

1. Test current limit point and slew rate for power supply
2. Soft start test for telecom power
3. LED's drive source test
4. Loading simulation for automotive temperature controller

CV Applications:

1. Charger test for mobile phone
2. Current limit test for fold back power supply
3. Fuel cell test
4. Current source test

CP Applications:

1. CP power test
2. Battery capacity test and capacity life cycle test
3. Pout vs Eff% curve test

fig 1.

Once it is decided which tests are required, a load may be selected. The four main modes of operation for an electronic load are Constant Current, Constant Resistance, Constant Voltage and Constant Power (fig 1). Most manufacturers also include specialty modes for unique testing requirements. One important note to remember is that no matter what mode the electronic load is in, it is always controlling the current. Constant Current mode allows the test engineer to set a current level that the load will draw regardless of any change in voltage. Constant Resistance mode allows the test engineer to set a resistance value and the load will adjust the current draw inversely to compensate for any change in voltage in an attempt to keep the “resistance” value at a constant (R=V/I). Constant Voltage mode allows the test engineer to set a voltage that he wants to remain constant and the load will sink the necessary current in an attempt to keep the voltage at the set level. Constant Power mode allows the test engineer to set a wattage level that the test requires and will adjust the current draw proportionately to compensate for any change in voltage (P=IV). This will all hold true unless something occurs, triggering one of the protection modes.

Specialty features such as Dynamic Loading, Load Profiling, Constant Impedance, Short Circuit and Low Voltage Operation may be required for unique load emulation. Dynamic loading includes the ability to pulse load the power supply in an attempt emulate the actual load. In Dynamic Loading, the parameters of your load profile may be manipulated to get as close as possible to the actual load profile required by the device the power supply is powering (Fig 2). Adjustable parameters may include: Slew Rate, Frequency, Duty Cycle, Baseline Current, Amplitude and Triple Step Values.

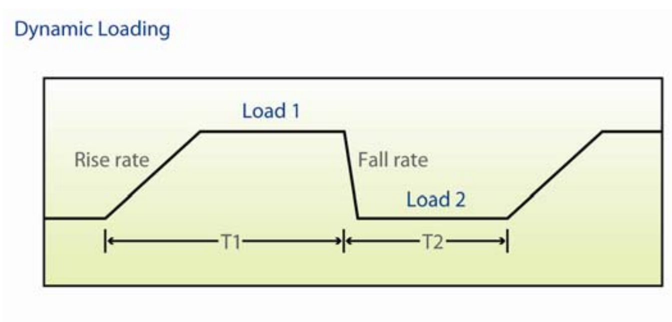


fig 2.

The limitation of most dynamic load profile schemes is the inability to generate anything other than a square wave. If the UUT requires a load profile that is more than an ON/OFF square wave type, then the load chosen will need to include a 0-10V analog input, which allows the test engineer to input an analog representation of his waveform at the external modulation input. The load will then track this input and adjust the current draw to the corresponding value. For example: The full scale of the load selected is 300A. The external modulation's input is rated for 0-10V. The 0-10V waveform put across this input will have a resolution of 30A per volt (fig 3). For both Dynamic Loading and Load Profiling, the load should have a bandwidth between 10KHz and 20KHz.

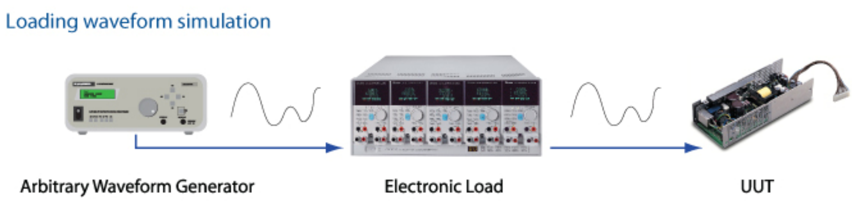


fig 3.

Constant Impedance has been developed by Chroma and made available recently in the 63600 series of modular loads. This mode provides the ability to simulate the impedance of the actual load during current changes and startup. Some power supplies react differently on initial turn on when impedance is present. This cannot be effectively emulated by any of the four current modes of operation. The Constant Impedance (CZ) mode allows the test engineers to set the capacitance, inductance and resistance values of the actual load in order to test real world transients (fig 4).

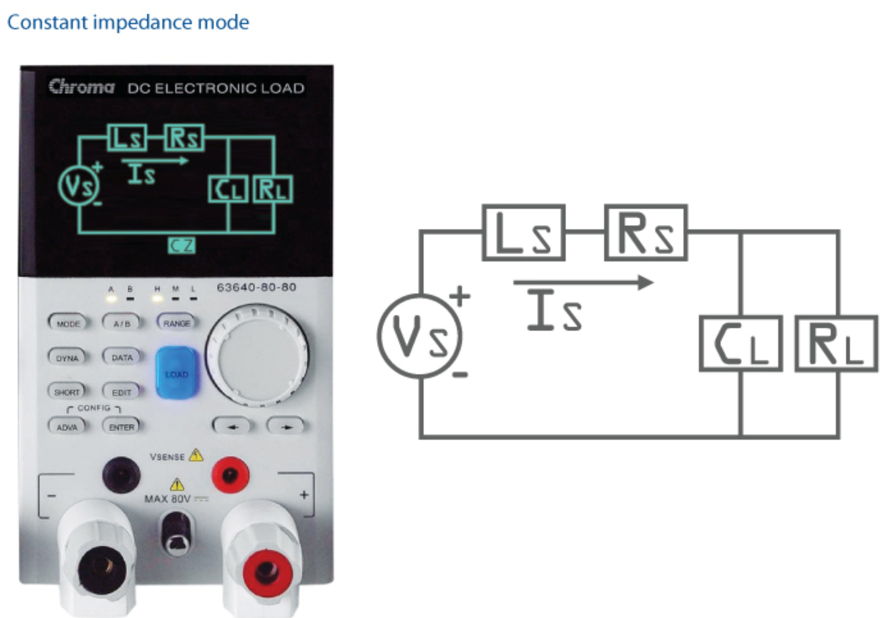


fig 4.

The Short Circuit function will test the UUT's current limit function by driving it to beyond its maximum current rating. Measurement can be made in both the current limit operation and the current trip level.

Most electronic loads cannot provide full scale current draw at very low voltages. Typically FET loads can provide maximum current draw at 10% of the rated voltage. For example: The loads full-scale voltage is 100V and the full scale current is 100A. Typically, this load can provide 100A of current draw at 1V (1% of FS). As the voltage potential across the load is reduced below 1V, the current draw will be reduced exponentially all the way down to 0V. Keep in mind that this is the voltage potential at the load, not the UUT. Ultra low voltage testing is more common in fuel cell and battery testing; however, may still be required for certain power supply or DC to DC converter applications.

The two cooling methods available are air and water. The air-cooled loads tend to be more robust and easier built; however, the air-cooled loads are more expensive than the water-cooled. One key issue regarding the cost of water-cooled loads that is frequently overlooked is the cost of the chiller or chilling system. Typically the cost differential is negligible until you reach about 30kW, unless of course your facility already has chilled water.

Air-cooled loads are portable and can be shared between departments if needed, while water-cooled loads are tied to a cooling system and cannot be moved without altering the plumbing. At many companies, installing water-cooling also involves the intervention of the facility manager.

Condensation is a design problem that has not been completely eliminated from water-cooled systems. Many water-cooled load failures are attributed to condensation forming on the components and shorting out the power section. This type of failure can be catastrophic leaving your load irreparable. Water control valves and water servo's attempt to prevent the chilled water from flowing when the load is not hot; however, these designs aren't fool proof.

Protection Features are essential to protect not only the electronic load, but also the power supply (UUT). Protection features may include: Over current (OC), Overvoltage (OV), Over power (OP), Under voltage (UV), Oscillation Control, Over temperature (OT) and Reverse Current Protection (RCP).

Many test engineers utilize complete systems such as Chroma's C8000 for their power supply testing requirements. These systems provide a comprehensive way to emulate the real world applications and collect essential data. These systems include a wide range of hardware such as Oscilloscopes, AC and DC Sources, Electronic Loads, Power Meters, Noise analyzers and DMM's. The hardware married with flexible software (PowerPro III) can provide for years of testing, which will grow with the end users products. These systems can be utilized in both engineering (design evaluation) and production environments (go/no go testing), which allows the R&D engineers and manufacturing floors to coordinate their efforts.

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