

APPLICATION NOTE

Capacitance Control in Load Mode

AZX SERIES



1 Abstract

This application note describes the over voltage conditions that can occur at the input of the AZX when in Electronic Load mode when connected to an EUT that changes to a high impedance. These conditions can result in over voltage faults being tripped. Ways to mitigate such conditions by adjusting output capacitance of the programmable electronic load are explored.

2 Current Control Mode and EUT Impedance

When the AZX-L is used as an electronic load, it controls the AC or DC current to maintain the desired current, power or resistance setpoint. The same is true when the AZX is used as programmable current source. To do so, the impedance of the EUT should be low enough to not exceed the maximum Vac or Vdc rating of the electronic load. For the AZX, the highest Vac limit is 440Vac rms L-N and for DC it is +/- 650Vdc.

When the EUT changes to a high impedance state – or when the EUT is suddenly disconnected – the Load suddenly 'sees' a high impedance and it can no longer regulate the current due to this open circuit and thus very high impedance condition. The internal capacitors in the output filter of the AZX power stages get charged up quickly causing the voltage to rise rapidly. Once this voltage reaches the over-voltage protection level (OVP) setpoint, the OVP protection circuits trip a fault. The OVP fault turns the AZX load input off.

Note that the high impedance or open circuit conditions may be caused on purpose by the user or happen unintentionally. Examples of such purposeful conditions could be the manual opening of a circuit with a switch/relay or turning off the EUT. Or an unintentionally high impedance event could be due to the EUT's self-protection circuitry causing it to turn-off if equipped with such a circuit.



APPLICATION NOTE



The instance these events happen while AC current is flowing, the voltage can go positive or negative depending on the current polarity at the time of the open circuit condition. Even if the current was transitioning through zero, a small deviation can cause it to charge the power inverter capacitance and reach the fault voltage trip point. In general, the higher the current and/or the smaller the capacitance of the AZX, the faster it rises to the voltage fault level.

CAUTION: This type of OVP fault takes some microseconds to shut down the AZX unit and that could cause the voltage to go even higher than the OVP level setpoint. It is recommended to take this into account and allow for some margin when setting the OVP trip level.





3 High Impedance Condition Cautions

Special care must be taken when operating in high impedance conditions because the voltage at the input to the AZX Electronic Load could reach up to +/- 700V (high voltage range) and +/- 450V (low voltage range).

For example, assume a voltage source like the 3150AFX which has a 333Vac output voltage range is connected to the AZX load inputs and the AZX is operated in the high voltage range (0 – 440Vac LN). If the OVP setting of the AZX is not below 450Vac minus some safety margin, the 3150AFX power source could be damaged when such an over voltage event occurs.

This same condition applies to any device under test unless some physical disconnection is performed using a contactor or a certain amount of delay is inserted.



Figure 3-1: AC Load testing an AC Voltage Source



4 Capacitance as a function of Power Source Configuration

The AZX output capacitance will have different values depending on the mode of operation selected as well as the phase mode and the number of AZX units in parallel if any. The following conditions apply:

- The AZX series configured for low voltage range and in three phase (FORM3) or split phase mode (FORM2) has two power stages per phase connected in parallel resulting in an output capacitance of either 4.4uF or 22uF.
- The AZX series configured for high voltage range and in three phase (FORM3) or split phase mode (FORM2) has two power stages per phase connected in series resulting in an output capacitance of either 1.1uF or 5.5uF.
- In single phase mode (FORM1), all three phases are connected in parallel, so the capacitance is multiplied by three.
- With AZX units connected in parallel for higher power requirements, the capacitance is multiplied also by the number of units in parallel.
- **Note:** For high impedance operation, if a fast rise/fall time is **not** required, it is recommended to use more capacitance in Electronic Load or Current Source mode to reduce the rise rate of the voltage and mitigate over voltage events.

5 Capacitance Control SCPI Commands for ATE Applications

For automated test systems where the AZX Series is used as an electronic AC load, the output capacitance can be controlled using this SCPI command over the LAN, USB or GPIB interface bus:

As mentioned earlier, in voltage mode, the AZX has 11uF of capacitance per power module. In current source and electronic load mode, it switches to 2.2uF per power module by default to improve current rise and fall time performance. However, it can be configured under program control using the following remote control SCPI commands:

OUTPut:CAPacitors[:CONTrol]# <0|1>

0 = 2.2uF per module, 1 = 11uF per module, single AZX unit in 3 or 2 phase mode.

OUTPut:CAPacitors[:CONTrol]#?

Returns the programmed capacitance setting state as either 0 or 1.

This level of capacitance control is unique to the AZX Series and provides the user with greater flexibility in handling a wide variety of products that can be tested or evaluated using the AZX as a regenerative electronic load or true current source.

6 Summary

The impact of output impedance of an electronic load in either AC, DC or AC+D mode of operation can have a significant impact on its operation when interacting with a unit under test. Protection mechanisms such as over voltage trip faults may be triggered under certain circumstances that are designed to avoid permanent damage to either the end user's unit under test – often a scarce and expensive early prototype of a new product – or prevent damage to the test equipment itself which could delay the product development schedule.



APPLICATION NOTE

Either is undesirable or can often be very costly. Advanced features like programmable capacitance of the power stage impedance as described in this application are unique capabilities found only in the AZX Series product line from Pacific Power.

7 Customer Support

For application support, contact Pacific Power Source's Customers Service - Toll Free US: +1 (800) 854-2433 / <u>support@pacificpower.com</u> or your local authorized Pacific Power Source distributor.



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