LIGHTING CONTROL COMPANY

DIMMER EFFICIENCY

The efficiency of a dimmer module can be determined by loading it to full capacity and then measuring the voltage drop across the dimmer module.* The components of a dimmer module have resistance and the energy used to overcome that resistance produces heat. This needs to be taken into consideration when calculating the amount of Heating Ventilating and Air Conditioning (HVAC) required in a dimmer room.

Dimmers manufactured by Electronic Theatre Controls (ETC) test at efficiencies of 89.2% to 96.9% depending on capacity and rise time.**

This means that a D20AF module with a 2400 Watt load will dissipate 117.6 Watts as heat. Ohm's law tells us that Power (Watts) = Voltage (Volts) x Current (Amps). If the voltage supplied to the dimmer is 120V the current in the circuit is 2400W /120V = 20A. 117.6W / 20A = 5.88V. In other words we may drop almost 6 Volts across the dimmer module by putting it in series with a 2400 Watt load.

What is responsible for the voltage drop? The SCR's (Silicon Control Rectifiers) that provide current control in the power device, part of the dimmer module, drop about .75 Volt across each junction (there are two). The choke is responsible for the remainder of the voltage drop. The amount of voltage drop across the choke varies proportionally to the connected load (at full conduction, dimmer at full).

At this point we have only connected the 2400 Watt load to the dimmer through zero feet of wire. All wire has resistance. #12AWG wire has a resistance of 1.62 Ohms per 1000 feet***. If we connect the 2400 Watt load to the dimmer through 100' of 12/3 cable we will have a resistance of .32 Ohms in series with the dimmer and the lamp. Remember that there are two 100 foot long wires, one for the hot and one for the neutral, used to complete the circuit. If the current in the circuit is 20A then Ohm's law tells us that the wire is responsible for 6.4 Volts of voltage drop. This value will vary in direct proportion to the connected load.

To sum up: There will always be a dimmer insertion loss of at least 1.5 volts + the voltage drop across the choke. Chokes in High Rise Time dimmers will have a larger drop than chokes in lower rise time dimmers. There will always be a voltage drop across the load wiring to the lamp. These voltage drops sum and mean that a dimmer hooked up to a 120V supply will output 118V, at best, under no load. Connect a 1000W load through 100' of #12AWG cable and there will only be about 113V at the lamp. If we add another 1000W fixture, the current in the circuit increases and the voltage drop will increase as well. 2000W/ 120V = 16.6A.

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16.6A x .32Ohm = 5.2V drop in 100' of wire. Add the voltage drop in the wire to the voltage drop across the dimmer to calculate total voltage drop.

This 7 to 10 Volt drop is what causes TV engineers to complain because lamp color temperature changes as a function of lamp voltage.

The above statements are true for all SCR / Choke based dimming regardless of manufacturer.

There are two solutions: Increase the size of load wires to minimize the effects of voltage drop in the distribution system. Increase the Voltage supplied to the dimming system.

ETC allows for increased voltage feeds to our dimmer racks and provides an adjustment on the CEM to change each dimmers output voltage. BE SURE THE CUSTOMER / ENGINEER / CONTRACTOR IS FULLY COGNIZANT OF ALL THE RAMIFICATIONS INVOLVED IN PROVIDING HIGHER THAN NORMAL VOLTAGES TO DIMMER RACKS. 1 - All circuits connected to dimmers in switched mode will receive unregulated line voltage minus line loss.**** 2 - The "Boost" value will need to be adjusted for every new variable introduced in the circuit. Adding a lamp or changing the length of cable will have an effect on voltage. Failure to compensate will result in lower color temperature or decreased lamp life.

* Connect a True RMS voltmeter between the Line and neutral supplying the dimmer and record the Voltage. Connect the meter to the output lug of the dimmer module and neutral and record the Voltage. subtract the second measurement from the first and divide the difference by 100. Subtract the quotient from 1 to get the efficiency as a percentage.

** These specifications are published in an Engineering Note dated April 27, 1994 by Bill Florac (ETC).

*** Resistance values per 1000' for copper and aluminum wire are published in the National Electric Code, Table 8, Conductor Properties.

**** See Technical Bulletin - "SCR Dimmer Theory" for a discussion of dimmer regulation.

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