Multi Volt Photocontrols

Several decades ago photocontrol manufacturers gave in to market demands for a control that would work in either a 120 or 240 volt application. The range was later expanded to meet ANSI standards from 105 to 285 volts. Now, in the 1996 version of ANSI C136.10, the range is 105-305 to work on 120, 208, 240 or 277 volt systems.
The attraction of multi-volt controls to the distributor and end-user was obvious. One control could be used anywhere. Instead of stocking three or four types, a distributor could stock just one higher priced unit. The electrician or utility lineman couldn't make a mistake. There was no need to know the voltage of the lighting circuit in order to replace the photocontrol.

All non-electronic (or conventional) voltage photocontrols are compromises. Compromises may be a necessary part of everyday life. But they don't make for the best engineering. To understand the compromises that led to the dual volt photocontrol, it is necessary to recall Ohm's law:
Most photocontrols consume power to hold a relay or a bimetal switch in the OPEN or OFF position. Some do it backwards and consume power to the contacts CLOSED or ON. However, they all consume power (P). From the above equation, it can be seen that, if the voltage (E) is doubled, say from 120 to 240, the power consumed would go up four times. That's the E squared effect. Going from 105 to 285 volts would increase the power consumed by 7.4 times.

From the user's standpoint, you might say "so what" to this extra power consumption. From the manufacturer's standpoint, it means severe compromises. If a conventional multi-volt photocontrol works well at 120, it burns up at 277. If it works at 277, then it operates poorly 120 volts. This shows up in early turn-ON and late turn-OFF. It wastes energy and costs money.

To overcome the electrical and mechanical engineering problems described above, manufacturers have tried several solutions. Only four have survived the test of time, only one is very good:

1. The most common solution is to use a varistor and a resistor in a shunt regulator circuit. The output from this regulator drives a sensitive relay -- a relay made sensitive by reducing contact gap and contact force. This, of course, reduces real load carrying ability but that fact is ignored when the product is marketed. These compromises also make the control very sensitive to impact damage. An accidental drop from a few feet may not break the housing but it can misalign the contacts enough to cause premature failure. Properly made, the shunt regulator circuit approach works. However, these controls consume power twenty-four hours per day when used on 208 volts and above. Four watts x 365 days x $.10/KWH = $3.50 per fixture per year in power wasted by the control alone. Another problem is that the turn-ON and turn-OFF levels change with voltage. This means that multi-voltage controls will meet a utility's spec only at one of its operating voltages, not the full range of voltage.
2. The next most common method for providing dual volt capability is with an internal fuse. Commonly used by manufacturers of bimetal (thermal) controls, this method uses a small fuse or fusible link that opens when the control is first used above 200 volts. It permanently changes the control from a 120 volt to a 208-277 unit. It also changes your turn-ON from 2 - 5 ftc (foot candles) to 0.5 - 1.5 ftc. The problems are obvious: you can't test the unit at 240 and then use it at 120; surges may open the fuse; and, most utilities will not accept very wide tolerance turn-ON values. The biggest use for this type of dual voltage control is in the distributor and contractor markets.
3. Another approach is to ignore voltage regulation. In other words, assume that line voltage will never be below 110 (but still rate the control 105 - 285) and accept turn-OFF levels of 20 ftc at 120 and turn-ON values of 0.3 - 0.8 at 277, and sell it for a very low price. Controls built with this approach are actually in use in the field. It has been somewhat successful because its price is low and because purchasing agents don't usually see the energy bills or replace failed controls. Despite manufacturer claims, these controls will not meet most utility specs or ANSI standards.
4. The best way to make a good multi-volt control is with electronics. The power supply circuit of the controls use solid state regulators and other components that are stable over the full 105-305 voltage range, do not waste many watts of power, and generate very little heat. Turn-ON and OFF levels of the controls can be made to not change with input voltage. Initial cost of these controls is slightly higher but life is much longer. Electronic multi-volt controls can be made to meet ANSI, IES and all utility standards.

Now, let's go back to the historic premise that "Multi-Voltage" controls must operate from 105-285 VAC and cover the nominal 120, 208, 240 and 277 voltages. 105 was derived by taking the old 110 standard and subtracting 5%. In reality if the line voltage ever got to 105, there would be a lot of air conditioners, refrigerators and machinery that would be in big trouble. Most conventional multi-volt controls don't work at 105. It's when they are used at 115 VAC and don't go OFF until midmorning that people start to notice.

At the other end of the voltage spectrum is the 277 line. The standard of "285 VAC" as the design maximum for controls intended for use on 277 VAC was not established based on actual power line data. It was based on what was technically feasible in conventional, low cost controls.

277 VAC is very common for power and lighting in industrial, commercial or institutional settings. This can become a real problem for controls rated for only up to 285 volts. At night, when indoor lighting and industrial loads are off, 277 lines often run high. The author has measured 300-305 for hours on end. If a photocontrol is marginal at 285, then at 300 it will suffer quick death due to over-heating, usually on the first hot day of summer. Therefore, we recommend that conventional multi-volt controls never be used in situations where the supply voltage is known to be 277 VAC. An electronic multi-volt control made to the 1996 ANSI rating of 105-305 volts is a better choice.

One final word of caution. Don't confuse multi-volt fixtures that have transformer (ballast) taps for 120, 208, 240 and 277 with applications requiring dual volt controls. If you have a 120 VAC line, buy 120 VAC photocontrols. Ditto for 208, 240 and 277.

The following is a typical generic specification for an electronic multi-volt control:

1) Photoelectric control must meet all requirements of ANSI C136.10-1996.
2) Line voltage operating range: 105-305 VAC @ 60 Hz.
3) Turn-ON: 1.5 " 0.3 ftc @ 120 VAC. Turn-OFF: 1.5 times the turn-ON. This shall not change with changes in line voltage.
4) Photosensitive device shall be sealed CdS or silicon sensor.
5) Instant turn-ON. Time delay of 2-5 seconds for turn-OFF.
6) Control must be capable of withstanding a drop of 3 feet to a concrete floor without changing electrical operation.
7) MOV (metal oxide varistor) surge protection shall be rated at least 160 joules and 6500 amps
8) Control shall be Fail ON as defined in ANSI C136.10-1996.
9) Contact chatter on opening of contacts (turn-OFF of photoelectric control) shall not exceed 5 milliseconds.
10) Warranty: 4 years.

Examples would be DTL's models D124-1.5-STM or DP124-1.5-®