Cabinet Trim Heat Control using TPWM601

Overview

Trim heating is normally required in all chilled and frozen food cabinets. This is for a variety of reasons including preventing; door glass mist, door seals sticking due to ice, condensation on exterior panels, ice formation on cabinet front hand rails. Trim heaters are electrical devices and the power they consume varies according cabinet size and design. Typical cabinets each use between 500W and 1500W and heaters are **always on**.

Trim heating tapes are available in standard sizes and power ratings. A cabinet manufacturer must install one or more heat tapes to meet or exceed the trim heat demand in their design criteria. It is most likely the total heat tape rating will exceed this demand as tapes cannot simply be cut down to size.

Duty Cycle and Power Switching

To reduce the **average** heater power used, the heaters can be turned off and on. When this switching follows a regular pattern it is known as duty cycle control and is normally expressed as a percentage. The duty is the percentage of a fixed period of time over which the heaters are turned on. The duration of the fixed period is important for good trim heat regulation and heater protection.[1]

In installations where trim heaters do not operate on a duty cycle, their supplies are normally controlled by the cabinet controller through a suitably rated contactor. This method works well for **infrequent** switching because electro-mechanical parts are prone to wear. Contact material erosion increases rapidly with the load current. These devices are therefore not suited to the very frequent high current switching required for duty cycle control of a trim heater.

To avoid stressing electro-mechanical parts, a TRIAC type switch may be used instead. This is a solid-state (no moving parts) electronic device capable of switching high AC currents many times a second for an indefinite length of time. A TRIAC combined with suitable electronic circuitry makes a very effective interface between the trim heater relay on a cabinet controller, and the trim heaters. The TPWM601 is such an interface module.

JTL Trim Heater Control

As standard JTL cabinet controllers are equipped with trim heater control logic to enable the reduction of trim heater power consumption. A fixed duty percentage is set in the cabinet controller which adjusts for any mismatch between the cabinet design and any over-capacity of the installed heater tapes. Further reductions in power consumption are possible on a dynamic basis over the JTL network, according to the time of the day or in response to ambient temperature and humidity changes for example.

Direct connection of the cabinet controller to the trim heaters is **not** possible. Controller output relays are not suitable for frequent switching of high current loads, as previously mentioned, and the fixed time period is too long for good trim heater regulation. The TPWM601 module addresses these issues by direct switching of the heaters, and by translating the duty cycle fixed time period from 5 minutes in the controller to 2 seconds at its output.[2] Additionally it minimises any electrical noise (EMC) by ensuring on/off switching occurs at the zero-cross point in the mains waveform.

---

[1] Empirical evidence shows that protracted duty cycle periods cause damage to the trim heaters. The exact mechanism is uncertain, but it is likely that long on and long off periods result in greater thermal expansion and contraction in the elements, ultimately leading to fatigue and failure.

[2] It can take up to 5 minutes for the TPWM601 to determine the duty percentage from the cabinet controller. Until this has been determined the default duty is 50% - 1 second on, 1 second off.

The TPWM601 will switch resistive heating loads of up to 1500 W directly. Two or more modules can be controlled by a cabinet controller for heater loads exceeding 1500 W.[3]

The TPWM601 must be adequately ventilated owing to the heat generated during operation. The heat generated can be as much as 10 W at full load, reducing with lower duty and lower heater power.

Example

A cabinet manufacturer builds a cabinet that demands 960 W of trim heating according to its design. The manufacturer has to install 1200 W of trim heater tape as this is the nearest combination of standard sizes exceeding the demand. The cabinet is to be installed in a store that trades from 7am until 10pm daily.

Without trim heater control, this cabinet will continually consume an extra 240 W of electrical energy. Adjusting the duty to 80% would reduce the average power used to 960 W and bring it into line with the cabinet design. The 240 W is immediately saved.

Furthermore, allowing a network adjustment of, say, 50% during non-trading hours, would reduce the duty to 40% (50% of 80%) and reduce the average power consumption to 480 W during these hours. For the cabinet in the preceding example the energy consumption without and with trim heater control would be:

Always on trim heating

Daily consumption = 28.80 kWh / day (1200 W x 24 hrs)

Annual consumption = 10.51 MWh / year (28.80 kWh x 365 days)

Annual cost (@10p/kWh) = £1,051.00 / year (10,510 kWh x £0.10/kWh)

Controlled trim heating with non-trading hours set-back

Daily consumption = 18.72 kWh / day (960 W x 15 hrs + 480 W x 9 hrs)

Annual consumption = 6.83 MWh / year (18.72 kWh x 365 days)

Annual cost (@10p/kWh) = £683.00 / year (6,830 kWh x £0.10/kWh)

A direct saving of £368 per cabinet per year is shown. Additionally, as trim heating forms part of the refrigeration load, further savings in refrigeration energy will be made but are beyond the scope of this example

[3] Where more than one TPWM601 is used with a single controller, the control inputs may be connected in parallel, but the outputs may not. To switch more than 1500 W, the heater load must be split into discrete groups each totalling less than 1500 W.

JTL Systems Limited

Head Office	Newbury	tel: 44 (0)1635 263646
Technical Support Centre	Newbury	tel: 44 (0)871 3157535
Monitoring Centre	Newbury	tel: 44 (0)871 3157531