SOT-223 High-Voltage Transistor Creates LCD Heater

Martin O'Hara

Telematica Systems Limited, University Way, Cranfield, Bedfordshire, MK43 0TR, England

CIRCLE 522

Occasionally, components cannot be obtained that function over the full temperature range of a product. For example, LCDs have a very limited operating-temperature range of typically 10°C to 50°C. One way to eliminate complications at the low-temperature end of this range is to provide a heat source for the component within the circuit design. A simple technique is presented in Fig. 1 that effectively requires only a single surface-mount transistor as a logic-controlled heating element.

This design takes advantage of the fact that FETs designed for high-voltage signal-switching applications often feature what might otherwise be described as high on-resistance values ($R_{DSON} > 10\ \Omega$). Yet, some of these FETs are designed to interface with low-voltage control systems. Hence, a 5-V TTL/CMOS signal can control these transistors, intended for over 200-V drain-source switching. Since these devices are expected to carry low currents, they are available in small surface-mount packages, such as SOT-223. Small package size allows easy integration without occupying a large amount of board space. Space is often a problem in designs where resistor heaters or TO220-packaged FETs are used.

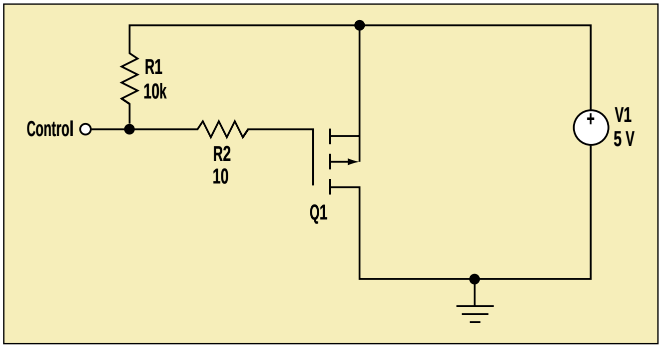
P-CHANNEL FET THERMAL CHARACTERISTICS WITH 5-V SUPPLY

FET	Max R_{DSON} (Ω)	Min R_{DSON} (Ω)	Min P_D (mW)	Max P_D (mW)	Min I_{DS} (mA)	Max I_{DS} (mA)	Min temp rise (°C)	Max temp rise (°C)
ZVP0545G	150	50	167	500	33	100	10	31
ZVP2120G	25	20	1000	1250	200	250	63	78

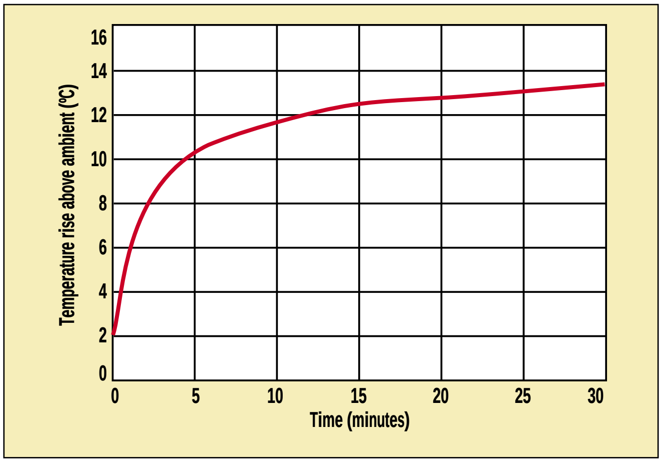
A p-channel FET simplifies the design, with control maintained via a 0-V (ground) signal applied to the gate. Otherwise, the heater is off and the gate is pulled high via a pull-up resistor (R1). R1 can be a low-power surface-mount resistor. The heat generated is transferred from the silicon through the metal tab of the 2-W SOT-223 package. Since the drain is also the tab connection on the SOT-223 package, the heater metalization also provides a ground shield even when the heater is off. Another benefit of this design is that the heater power can be easily increased by paralleling FETs. These FETs can have either a single control (i.e., on/off) or multiple digital controls, where different heating settings can be applied (e.g., rapid heat-up and maintenance heating).

Table 1 shows the calculated thermal performance at the tab of two Zetex FETs when operated at 5 V. The temperature rise is measured at the drain tab. Since some loss of heat will occur in the thermal transfer from the tab to the heating pad, the temperature at the drain tab is not the same as the temperature under the heated component.

The graph *(Fig. 2)* shows the temperature rise obtained using the ZVP0545G under a small LCD display. While the heat is not enough to cause significant overheating in either the FET or the LCD, it is sufficient to extend the low-end operating temperature of the product from 10°C to 0°C.



1. **This heater circuit utilizes the fact that FETs designed for high-voltage switching applications often feature high R_{DSON} values.**



2. **The temperature rise obtained is sufficient to extend the low-end operating temperature of the product from 10°C to 0°C.**