AB4795

Thermal Management of the VP16256

Application Brief

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PACKAGE CONSTRUCTION

The VP16256 is supplied in a 208-lead PowerQuad 2 package. This package has been specifically designed to assist in the removal of heat from the die surface, by replacing much of the plastic molding compound in the lower half of the package with a high thermal conductivity, metal 'heat-slug'. As the device is attached directly onto this heat-slug with an electrically conductive paste, the exposed metal will be at the same potential as the back surface of the internal device. In the case of the VP16256, this is V_{DD} and care must be taken, when employing external thermal management techniques, not to inadvertently introduce a short circuit.

Fig. 1 shows cross-sections through a standard PQFP package and PowerQuad 2 package. The arrows show the primary heat paths from the device to the outside world.

The simplest route is directly out through the top of the package into the surrounding air. As the thermal resistance of air is far higher than that of plastic, the body size can make a major difference to the amount of heat which can be dissipated. This route will also be affected by changes in die and slug size (since the thermal conductivity of silicon and copper is, in turn, at least 100 times better than that of the plastic) and also affected by changes in the surrounding ambient, such as an increase in the air flow by use of a fan or the addition of metal heatsinks to the top of the package. This, however is not the only route.

Even on a single-layer board, a substantial amount of heat will flow along the leads and into the board itself. The apparent thermal resistance of the part is, therefore, heavily dependent on the size and construction of the circuit board. The presence of the metal slug in the PowerQuad 2 package serves to reduce the thermal resistance between the die and surrounding leads, thereby enhancing this path.

There is also a path through the underside of the package into the circuit board. The effectiveness of this path is usually limited due to the air gap between the base of the package and board (stand-off). However, bridging this gap using thermally conductive pastes or solder can result in a major improvement in thermal performance, particularly in the case of the PowerQuad 2 package. (NB If solder is used then the pads on the circuit board must be either electrically isolated or at the appropriate voltage level, depending on silicon back face potential). In this construction, the thermal performance will be totally dominated by the thermal resistance of the board, rather than the package, since the thermal resistance between the device and base of the heat-slug will be less than 2°C/W.

CALCULATION OF MAX. OPERATING TEMPERATURE.

The maximum junction temperature, based on 2 years continuous operation, for a plastic package, is normally considered to be 125°C. This is determined by the life expectancy of the interface between the aluminium bond pads on the silicon device and the gold wires used to connect them to the package. Reducing the junction temperature to 100°C will considerably extend the projected life of the part (over 6 times, based on the Arrhenius equation and an activation energy of 1·05eV).

Table 1 shows supplier's data for the 208-lead PowerQuad 2 and 208-lead PQFP packages, containing a test die of similar size to the VP16256, against the maximum allowable still air ambient temperature, based on 125°C maximum junction temperature and VP16256 anticipated power dissipation figures.

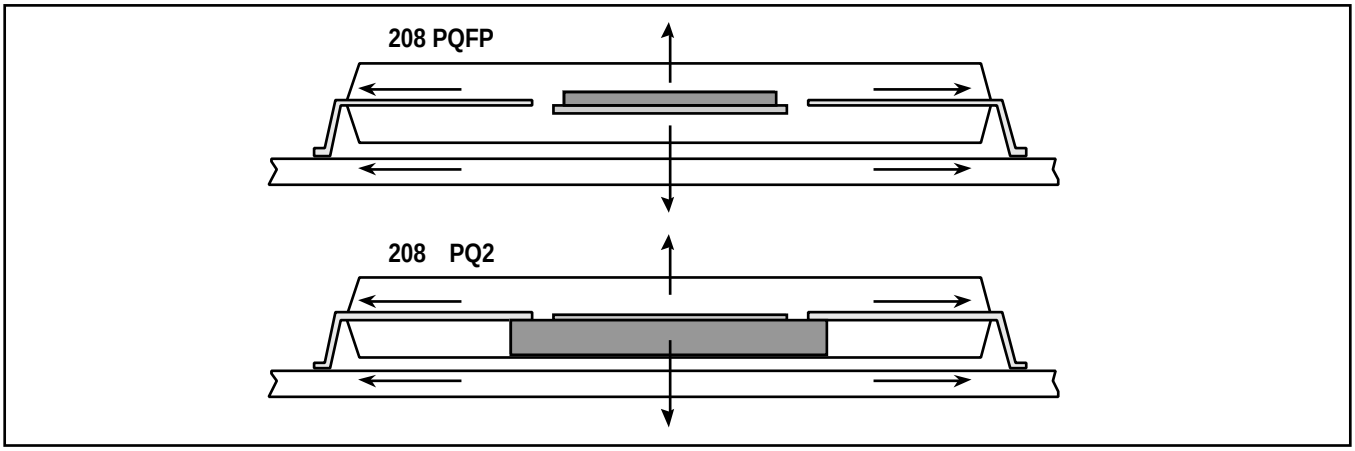

Fig. 1 Package cross-sections

Package	Board	Description	θ_{j-a} (°C/W)	Maximum still air ambient temperature (°C)	
				1·8W (27MHz clock)	2·5W (40MHz clock)
208 PQ2	Semi Std.	13cm×13cm, < 25% Cu on one side only	17	94	82
208 PQ2	4-layer	13cm×13cm, < 25% Cu/side, plus V_{DD} and ground plane	13	101	92
208 PQFP	Semi Std.	13cm×13cm, < 25% Cu on one side only	36	60	35
208 PQFP	4-layer	13cm×13cm, < 25% Cu/side, plus V_{DD} and ground plane	26	78	60

Table 1

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