TRANSISTOR RATINGS

Voltage ratings

COLLECTOR TO BASE

V_{CBmax} The maximum permissible instantaneous voltage between collector and base terminals. The collector voltage is negative with respect to base in PNP transistors and positive with respect to base in NPN types.

V_{CBmax} ($I_E = 0$) The maximum permissible instantaneous voltage between collector and base terminals when the emitter terminal is open-circuit.

EMITTER TO BASE

V_{EBmax} The maximum permissible instantaneous voltage between emitter and base terminals. The emitter voltage is negative with respect to base in PNP transistors and positive with respect to base in NPN types.

V_{EBmax} ($I_C = 0$) The maximum permissible instantaneous voltage between emitter and base terminals when the collector terminal is open-circuit.

COLLECTOR TO EMITTER

V_{CEmax} The maximum permissible instantaneous voltage between collector and emitter terminals. The collector voltage is negative with respect to emitter in PNP transistors and positive with respect to emitter in NPN types. This rating is very dependent on circuit conditions and collector current, and it is necessary to refer to the curve of V_{CE} versus I_C for the appropriate circuit condition in order to obtain the correct rating.

V_{CEmax} (Cut-off) The maximum permissible instantaneous voltage between collector and emitter terminals when the emitter current is reduced to zero by means of a reverse emitter base voltage, i.e. the base voltage is normally positive with respect to emitter for PNP transistors and negative with respect to emitter for NPN types. The term '(Cut-off)' is sometimes replaced by $V_{BE} > x$ V, or $R_B/R_E \leq y$, which are equivalent conditions under which the transistor may be cut off.

V_{CEmax} ($I_C = x$ mA) The maximum permissible instantaneous voltage between collector and emitter terminals when the collector current is at a high value, often the maximum rated value.

V_{CEmax} ($I_B = 0$) The maximum permissible instantaneous voltage between collector and emitter terminals when the base terminal is open-circuit or when a very high resistance is in series with the base terminal. Special care must be taken to ensure that thermal runaway due to excessive collector leakage current does not occur in this condition.

Due to the current dependency of V_{CE} it is usual to present this information as a voltage rating chart, a curve of collector current as a function of collector-to-emitter voltage (see Fig.1). The permissible area of operation under all conditions of base drive (provided the dissipation rating is not exceeded) is shown as area 1 and operation under certain specified conditions is shown as area 2.

To assist in determining the rating in area 2, further curves can relate the voltage rating to external circuit conditions, for example: R_B/R_E, R_B, Z_{Bg},V_{BE}, I_B or V_{BB}/R_B. An example of this type of curve is given in Fig.2 with V_{CE} as a function of R_B/R_E for two values of collector current.

It should be noted that when R_E is shunted by a capacitor, during switching, the collector voltage V_{CE} must be restricted to a value that does not rely on the effect of R_E.

In the case of an inductive load, when an energy rating is given, it may be safe to operate outside the rated area provided the specified energy rating is not exceeded.

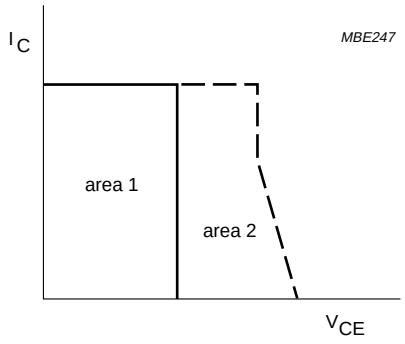

Fig.1 Graph of permissible operating areas.

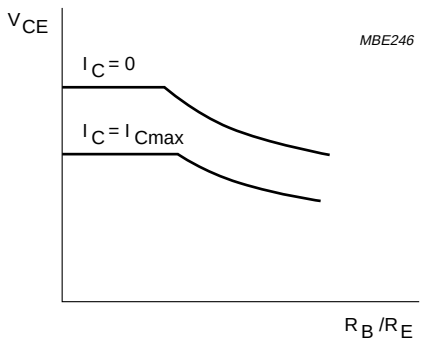

Fig.2 Graph showing effect of collector current on permissible operating areas.

Current ratings

COLLECTOR

I_{Cmax} The maximum permissible collector current. Without further qualification, the DC value is implied.

$I_{C(AV)max}$ The maximum permissible average value of the total collector current.

I_{CM} The maximum permissible instantaneous value of the total collector current.

Emitter

I_{Emax} The maximum permissible emitter current. Without further qualification, the DC value is implied.

$I_{E(AV)max}$ The maximum permissible average value of the total emitter current.

$I_{ER(AV)max}$ The maximum permissible average value of the total emitter current when operating in the reverse emitter-base breakdown region.

I_{EM} The maximum permissible instantaneous value of the total emitter current.

I_{ERM} The maximum permissible instantaneous value of the total emitter current when operating in the reverse breakdown region.

BASE

I_{Bmax} The maximum permissible base current. Without further qualification, the DC value is implied.

$I_{B(AV)max}$ The maximum permissible average value of the total base current.

$I_{BR(AV)max}$ The maximum permissible average value of the total base current when operating in the reverse breakdown region.

I_{BM} The maximum permissible instantaneous value of the total base current. The rating also includes the switch-off current.

I_{BRM} The maximum permissible instantaneous value of the total reverse current allowable in the reverse breakdown region.

Power ratings

The total maximum permissible continuous power dissipation in the transistor, $P_{tot\ max}$, includes collector-base dissipation and emitter-base dissipation. Under steady state conditions, the total power is given as:

$P_{tot} = V_{CE} \times I_C + V_{BE} \times I_B$.

In order to distinguish between ‘steady state’ and ‘pulse’ conditions, the terms ‘steady state power (P_S)’ and ‘pulse power (P_P)’ can be used. The permissible total power dissipation is dependent on temperature; this relationship is shown in Fig.3.

The temperature may be the ambient, the case or the mounting base temperature. Where a cooling clip or heatsink is attached to the device, the allowable power dissipation is also dependent on the efficiency of the heatsink.

The efficiency of this clip or heatsink is measured in terms of its thermal resistance ($R_{th\ h}$) normally expressed in degrees Kelvin per Watt (K/W). For mounting-base rated devices, the added effect of the contact resistance ($R_{th\ i}$) must be taken into account.

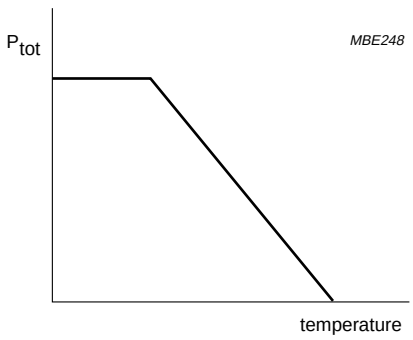

Fig.3 Permissible total power dissipation.

The effect of heatsinks of various thermal and contact resistance is often included in the graph of permissible total power dissipation.

The relationship between maximum power dissipation, ambient temperature and thermal heatsink resistance is given by:

$$P_{tot} = \frac{T_j - T_{amb}}{R_{th\ j-a}}$$

where $R_{th\ j\text{-}a}$ is the thermal resistance from the transistor junction to the ambient. For case rated or mounting-base rated devices, the thermal resistance $R_{th\ j}$ is made up of the thermal resistance junction to case or mounting-base ($R_{th\ j\text{-}mb}$), the contact thermal resistance ($R_{th\ i}$) and the heatsink thermal resistance ($R_{th\ h}$).

For the calculation of pulse power operation, the maximum pulse power is obtained using a graph as shown in Fig.4

The general expression from which the maximum pulse power dissipation can be calculated is:

$$P_p = \frac{T_j - T_{amb} - P_S \times R_{th\ j-a}}{Z_{th\ t} + d\,(R_{th\ c-a})}$$

where $Z_{th\ t}$ and δ are given in Fig.4 and $R_{th\ c-a}$ is the thermal resistance between case and ambient for a case rated device. For a mounting-base rated device, it is equal to $R_{th\ h} + R_{th\ i}$ and is zero for a free-air rated device because the effect of the temperature rise of the case over the ambient for a pulse train is already included in $Z_{th\ t}$.

Temperature ratings

$T_{j\ max}$ The maximum permissible junction temperature which is used as the basis for the calculation of power ratings. Unless otherwise stated, the continuous value is implied.

$T_{j\ max}$ (continuous operation): indicates the maximum permissible continuous value.

$T_{j\ max}$ (intermittent operation): indicates the maximum permissible instantaneous junction temperature usually allowed for a total duration of 200 hours.

T_{mb} The temperature of the surface in contact with the heatsink. This is confined to devices where a flange or stud for fixing onto a heatsink forms an integral part of the package.

T_{case} The temperature of the package. This is confined to devices that may have a clip-on cooling fin attachment.

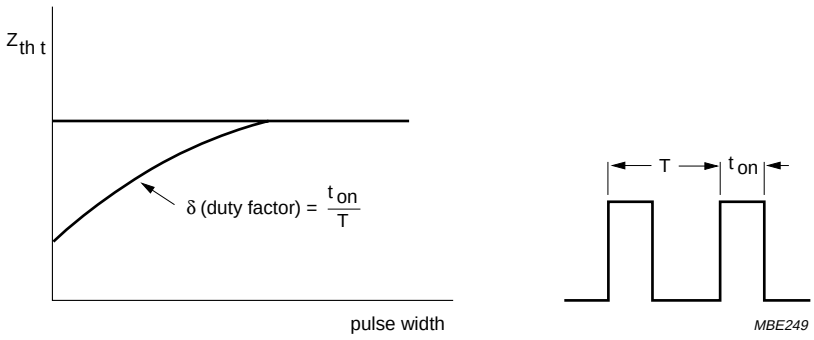

Fig.4 Pulse power operation.

SUNSTAR 商斯达实业集团是集研发、生产、工程、销售、代理经销 、技术咨询、信息服务等为一体的高科技企业，是专业高科技电子产品生产厂家，是具有 10 多年历史的专业电子元器件供应商，是中国最早和最大的仓储式连锁规模经营大型综合电子零部件代理分销商之一,是一家专业代理和分銷世界各大品牌 IC 芯片和電子元器件的连锁经营綜合性国际公司，专业经营进口、国产名厂名牌电子元件，型号、种类齐全。在香港、北京、深圳、上海、西安、成都等全国主要电子市场设有直属分公司和产品展示展销窗口门市部专卖店及代理分销商,已在全国范围内建成强大统一的供货和代理分销网络。 我们专业代理经销、开发生产电子元器件、集成电路、传感器、微波光电元器件、工控机/DOC/DOM 电子盘、专用电路、单片机开发、MCU/DSP/ARM/FPGA 软件硬件、二极管、三极管、模块等，是您可靠的一站式现货配套供应商、方案提供商、部件功能模块开发配套商。商斯达实业公司拥有庞大的资料库，有数位毕业于著名高校——有中国电子工业摇篮之称的西安电子科技大学（西军电）并长期从事国防尖端科技研究的高级工程师为您精挑细选、量身订做各种高科技电子元器件，并解决各种技术问题。

微波光电部专业代理经销高频、微波、光纤、光电元器件、组件、部件、模块、整机；电磁兼容元器件、材料、设备；微波 CAD、EDA 软件、开发测试仿真工具；微波、光纤仪器仪表。欢迎国外高科技微波、光纤厂商将优秀产品介绍到中国、共同开拓市场。长期大量现货专业批发高频、微波、卫星、光纤、电视、CATV 器件： 晶振、VCO、连接器、PIN 开关、变容二极管、开关二极管、低噪晶体管、功率电阻及电容、放大器、功率管、MMIC、混频器、耦合器、功分器、振荡器、合成器、衰减器、滤波器、隔离器、环行器、移相器、调制解调器；光电子元器件和组件：红外发射管、红外接收管、光电开关、光敏管、发光二极管和发光二极管组件、半导体激光二极管和激光器组件、光电探测器和光接收组件、光发射接收模块、光纤激光器和光放大器、光调制器、光开关、DWDM 用光发射和接收器件、用户接入系统光光收发器件与模块、光纤连接器、光纤跳线/尾纤、光衰减器、光纤适 配器、光隔离器、光耦合器、光环行器、光复用器/转换器；无线收发芯片和模组、蓝牙芯片和模组。

更多产品请看本公司产品专用销售网站:

商斯达中国传感器科技信息网：http://www.sensor-ic.com/

商斯达工控安防网：http://www.pc-ps.net/

商斯达电子元器件网：http://www.sunstare.com/

商斯达微波光电产品网:HTTP://www.rfoe.net/

商斯达消费电子产品网://www.icasic.com/

商斯达实业科技产品网://www.sunstars.cn/ 微波元器件销售热线：

地址：深圳市福田区福华路福庆街鸿图大厦 1602 室

电话：0755-82884100 83397033 83396822 83398585

传真：0755-83376182 （0）13823648918 MSN: SUNS8888@hotmail.com

邮编：518033 E-mail:szss20@163.com QQ: 195847376

深圳赛格展销部：深圳华强北路赛格电子市场 2583 号 电话：0755-83665529 25059422

技术支持: 0755-83394033 13501568376

欢迎索取免费详细资料、设计指南和光盘 ；产品凡多，未能尽录，欢迎来电查询。

北京分公司：北京海淀区知春路 132 号中发电子大厦 3097 号

TEL：010-81159046 82615020 13501189838 FAX：010-62543996

上海分公司：上海市北京东路 668 号上海赛格电子市场 D125 号

TEL：021-28311762 56703037 13701955389 FAX：021-56703037

西安分公司：西安高新开发区 20 所(中国电子科技集团导航技术研究所)

西安劳动南路 88 号电子商城二楼 D23 号

TEL：029-81022619 13072977981 FAX:029-88789382