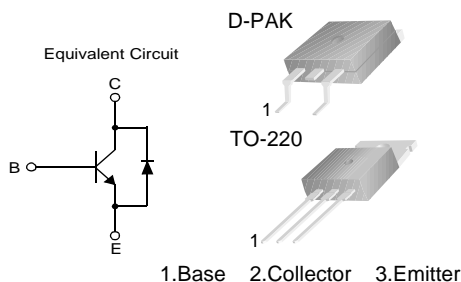


## KSC5402D/KSC5402DT

### High Voltage High Speed Power Switch Application

- Wide Safe Operating Area
- Built-in Free Wheeling Diode
- Suitable for Electronic Ballast Application
- Small Variance in Storage Time
- Two Package Choices; D-PAK or TO-220



### NPN Silicon Transistor Planar Silicon Transistor

#### Absolute Maximum Ratings $T_C=25^\circ\text{C}$ unless otherwise noted

| Symbol    | Parameter   | Value      | Units            |
|-----------|---|------------|------------------|
| $V_{CBO}$ | Collector-Base Voltage  | 1000       | V                |
| $V_{CEO}$ | Collector-Emitter Voltage   | 450        | V                |
| $V_{EBO}$ | Emitter-Base Voltage  | 12         | V                |
| $I_C$     | Collector Current (DC)  | 2          | A                |
| $I_{CP}$  | *Collector Current (Pulse)  | 5          | A                |
| $I_B$     | Base Current (DC)   | 1          | A                |
| $I_{BP}$  | *Base Current (Pulse)   | 2          | A                |
| $P_C$     | Power Dissipation( $T_C=25^\circ\text{C}$ ) : D-PAK *<br>: TO-220 | 30<br>50   | W                |
| $T_J$     | Junction Temperature  | 150        | $^\circ\text{C}$ |
| $T_{STG}$ | Storage Temperature   | - 65 ~ 150 | $^\circ\text{C}$ |

\* Pulse Test: Pulse Width=5ms, Duty Cycle  $\leq$  10%

#### Thermal Characteristics $T_C=25^\circ\text{C}$ unless otherwise noted

| Symbol          | Characteristics  | Rating              |       | Unit   |                           |
|-----------------|--|---------------------|-------|--------|---------------------------|
|                 |  | TO-220              | D-PAK |        |                           |
| $R_{\theta jc}$ | Thermal Resistance   | Junction to Case    | 2.5   | 4.17 * | $^\circ\text{C}/\text{W}$ |
| $R_{\theta ja}$ |  | Junction to Ambient | 62.5  | 50     |                           |
| $T_L$           | Maximum Lead Temperature for Soldering Purpose<br>; 1/8" from Case for 5 Seconds |                     | 270   | 270    | $^\circ\text{C}$          |

\* Mounted on 1" square PCB (FR4 ro G-10 Material)

**Electrical Characteristics**  $T_C=25^\circ\text{C}$  unless otherwise noted

| Symbol        | Parameter                            | Test Condition                            | Min.                    | Typ. | Max. | Units         |
|---------------|--------------------------------------|---|-------------------------|------|------|---------------|
| $BV_{CBO}$    | Collector-Base Breakdown Voltage     | $I_C=1\text{mA}, I_E=0$                   | 1000                    | 1090 |      | V             |
| $BV_{CEO}$    | Collector-Emitter Breakdown Voltage  | $I_C=5\text{mA}, I_B=0$                   | 450                     | 525  |      | V             |
| $BV_{EBO}$    | Emitter-Base Breakdown Voltage       | $I_E=1\text{mA}, I_C=0$                   | 12                      | 14   |      | V             |
| $I_{CES}$     | Collector Cut-off Current            | $V_{CES}=1000\text{V}, I_{EB}=0$          | $T_C=25^\circ\text{C}$  | 0.03 | 100  | $\mu\text{A}$ |
|               |                                      |   | $T_C=125^\circ\text{C}$ | 1.2  | 500  |               |
| $I_{CEO}$     | Collector Cut-off Current            | $V_{CE}=450\text{V}, V_B=0$               | $T_C=25^\circ\text{C}$  | 0.3  | 100  | $\mu\text{A}$ |
|               |                                      |   | $T_C=125^\circ\text{C}$ | 15   | 500  |               |
| $I_{EBO}$     | Emitter Cut-off Current              | $V_{EB}=10\text{V}, I_C=0$                |                         | 0.01 | 100  | $\mu\text{A}$ |
| $h_{FE}$      | DC Current Gain                      | $V_{CE}=1\text{V}, I_C=0.4\text{A}$       | $T_C=25^\circ\text{C}$  | 14   | 29   |               |
|               |                                      |   | $T_C=125^\circ\text{C}$ | 8    | 17   |               |
|               |                                      | $V_{CE}=1\text{V}, I_C=1\text{A}$         | $T_C=25^\circ\text{C}$  | 6    | 9    |               |
|               |                                      |   | $T_C=125^\circ\text{C}$ | 4    | 6    |               |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage | $I_C=0.4, I_B=0.04\text{A}$               | $T_C=25^\circ\text{C}$  | 0.25 | 0.6  |               |
|               |                                      |   | $T_C=125^\circ\text{C}$ | 0.4  | 1.0  |               |
|               |                                      | $I_C=1\text{A}, I_B=0.2\text{A}$          | $T_C=25^\circ\text{C}$  | 0.3  | 0.75 | V             |
|               |                                      |   | $T_C=125^\circ\text{C}$ | 0.65 | 1.2  | V             |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage      | $I_C=0.4\text{A}, I_B=0.04\text{A}$       | $T_C=25^\circ\text{C}$  | 0.78 | 1.0  | V             |
|               |                                      |   | $T_C=125^\circ\text{C}$ | 0.65 | 0.9  | V             |
|               |                                      | $I_C=1\text{A}, I_B=0.2\text{A}$          | $T_C=25^\circ\text{C}$  | 0.85 | 1.1  | V             |
|               |                                      |   | $T_C=125^\circ\text{C}$ | 0.75 | 1.0  | V             |
| $C_{ib}$      | Input Capacitance                    | $V_{EB}=8\text{V}, I_C=0, f=1\text{MHz}$  |                         | 330  | 500  | pF            |
| $C_{ob}$      | Output Capacitance                   | $V_{CB}=10\text{V}, I_E=0, f=1\text{MHz}$ |                         | 35   | 100  | pF            |
| $f_T$         | Current Gain Bandwidth Product       | $I_C=0.5\text{A}, V_{CE}=10\text{V}$      |                         | 11   |      | MHz           |
| $V_F$         | Diode Forward Voltage                | $I_F=1\text{A}$                           | $T_C=25^\circ\text{C}$  | 0.86 | 1.5  | V             |
|               |                                      |   | $T_C=125^\circ\text{C}$ | 0.75 | 1.2  | V             |
|               |                                      | $I_F=0.2\text{A}$                         | $T_C=25^\circ\text{C}$  | 0.6  |      | V             |
|               |                                      |   | $T_C=125^\circ\text{C}$ | 0.8  | 1.3  | V             |
|               |                                      |   | $T_C=125^\circ\text{C}$ | 0.65 |      | V             |

**Electrical Characteristics**  $T_C=25^\circ\text{C}$  unless otherwise noted

| Symbol  | Parameter   | Test Condition   | Min                     | Typ. | Max. | Units |               |
|---|---|--|-------------------------|------|------|-------|---------------|
| $t_{fr}$  | Diode Forward Recovery Time<br>( $di/dt=10\text{A}/\mu\text{s}$ ) | $I_F=0.2\text{A}$  |                         | 540  |      | ns    |               |
|   |   | $I_F=0.4\text{A}$  |                         | 520  |      | ns    |               |
|   |   | $I_F=1\text{A}$  |                         | 480  |      | ns    |               |
| $V_{CE(DSAT)}$  | Dynamic Saturation Voltage  | $I_C=0.4\text{A}$ ,<br>$I_{B1}=40\text{mA}$<br>$V_{CC}=300\text{V}$  | @ $1\mu\text{s}$        |      | 7.5  |       | V             |
|   |   |  | @ $3\mu\text{s}$        |      | 2.5  |       | V             |
|   |   | $I_C=1\text{A}$ ,<br>$I_{B1}=200\text{mA}$<br>$V_{CC}=300$           | @ $1\mu\text{s}$        |      | 11.5 |       | V             |
|   |   |  | @ $3\mu\text{s}$        |      | 1.5  |       | V             |
| RESISTIVE LOAD SWITCHING (D.C. $\leq 10\%$ , Pulse Width= $20\mu\text{s}$ ) |   |  |                         |      |      |       |               |
| $t_{ON}$  | Turn On Time  | $I_C=1\text{A}$ ,<br>$I_{B1}=200\text{mA}$                           | $T_C=25^\circ\text{C}$  |      | 110  | 150   | ns            |
|   |   |  | $T_C=125^\circ\text{C}$ |      | 135  |       | ns            |
| $t_{OFF}$   | Turn Off Time   | $I_{B2}=150\text{mA}$<br>$V_{CC}=300\text{V}$<br>$R_L = 300\Omega$   | $T_C=25^\circ\text{C}$  | 0.95 |      | 1.25  | $\mu\text{s}$ |
|   |   |  | $T_C=125^\circ\text{C}$ |      | 1.4  |       | $\mu\text{s}$ |
| INDUCTIVE LOAD SWITCHING ( $V_{CC}=15\text{V}$ )                            |   |  |                         |      |      |       |               |
| $t_{STG}$   | Storage Time  | $I_C=0.4\text{A}$ ,<br>$I_{B1}=40\text{mA}$                          | $T_C=25^\circ\text{C}$  |      | 0.56 | 0.65  | $\mu\text{s}$ |
|   |   |  | $T_C=125^\circ\text{C}$ |      | 0.7  |       | $\mu\text{s}$ |
| $t_F$   | Fall Time   | $I_{B2}=200\text{mA}$ ,<br>$V_Z=300\text{V}$<br>$L_C=200\text{H}$    | $T_C=25^\circ\text{C}$  |      | 60   | 175   | ns            |
|   |   |  | $T_C=125^\circ\text{C}$ |      | 75   |       | ns            |
| $t_C$   | Cross-over Time   |  | $T_C=25^\circ\text{C}$  |      | 90   | 175   | ns            |
|   |   |  | $T_C=125^\circ\text{C}$ |      | 90   |       | ns            |
| $t_{STG}$   | Storage Time  | $I_C=0.8\text{A}$ ,<br>$I_{B1}=160\text{mA}$                         | $T_C=25^\circ\text{C}$  |      |      | 2.75  | $\mu\text{s}$ |
|   |   |  | $T_C=125^\circ\text{C}$ |      | 3    |       | $\mu\text{s}$ |
| $t_F$   | Fall Time   | $I_{B2}=160\text{mA}$ ,<br>$V_Z=300\text{V}$<br>$L_C=200\text{H}$    | $T_C=25^\circ\text{C}$  |      | 110  | 175   | ns            |
|   |   |  | $T_C=125^\circ\text{C}$ |      | 180  |       | ns            |
| $t_C$   | Cross-over Time   |  | $T_C=25^\circ\text{C}$  |      | 125  | 350   | ns            |
|   |   |  | $T_C=125^\circ\text{C}$ |      | 185  |       | ns            |
| $t_{STG}$   | Storage Time  | $I_C=1\text{A}$ ,<br>$I_{B1}=200\text{mA}$                           | $T_C=25^\circ\text{C}$  |      | 1.1  | 1.2   | $\mu\text{s}$ |
|   |   |  | $T_C=125^\circ\text{C}$ |      | 1.35 |       | $\mu\text{s}$ |
| $t_F$   | Fall Time   | $I_{B2}=500\text{mA}$ ,<br>$V_Z=300\text{V}$<br>$L_C=200\mu\text{H}$ | $T_C=25^\circ\text{C}$  |      | 105  | 150   | ns            |
|   |   |  | $T_C=125^\circ\text{C}$ |      | 75   |       | ns            |
| $t_C$   | Cross-over Time   |  | $T_C=25^\circ\text{C}$  |      | 125  | 150   | ns            |
|   |   |  | $T_C=125^\circ\text{C}$ |      | 100  |       | ns            |

# Typical Characteristics

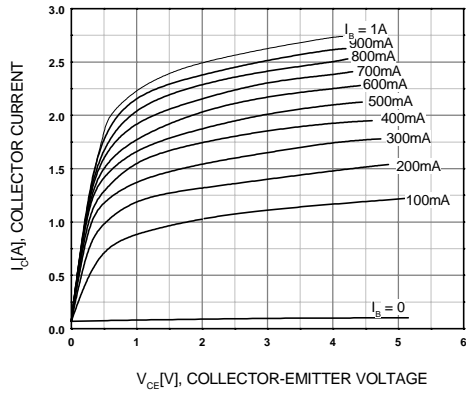


Figure 1. Static Characteristic

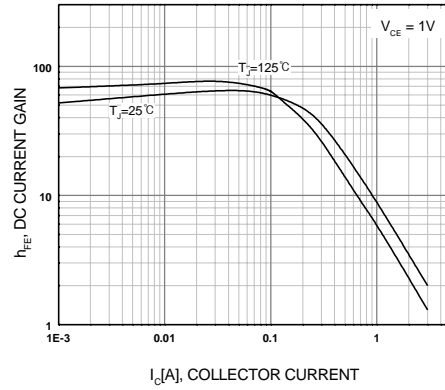


Figure 2. DC current Gain

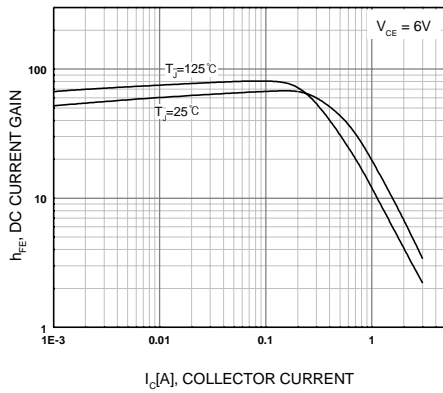


Figure 3. DC current Gain

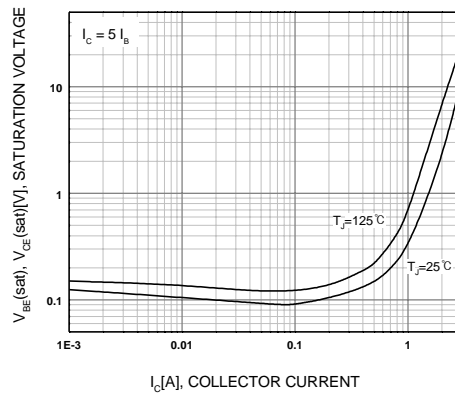


Figure 4. Collector-Emitter Saturation Voltage

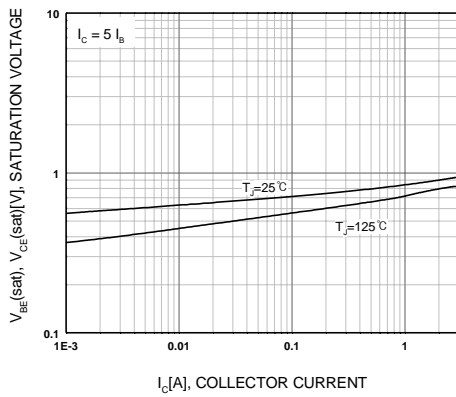


Figure 5. Base-Emitter Saturation Voltage

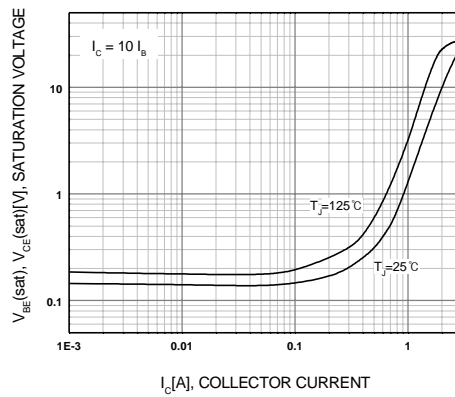


Figure 6. Collector-Emitter Saturation Voltage

Typical Characteristics (Continued)

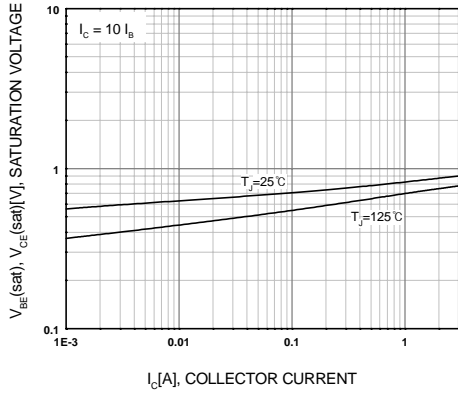


Figure 7. Base-Emitter Saturation Voltage

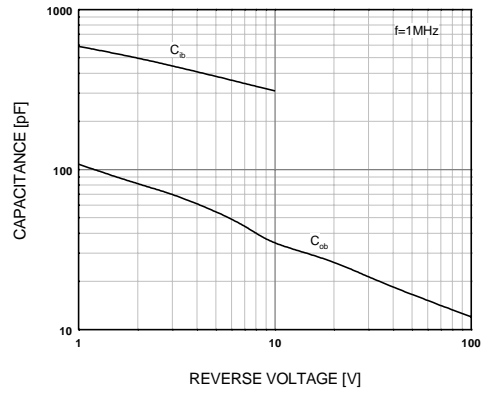


Figure 8. Collector Output Capacitance

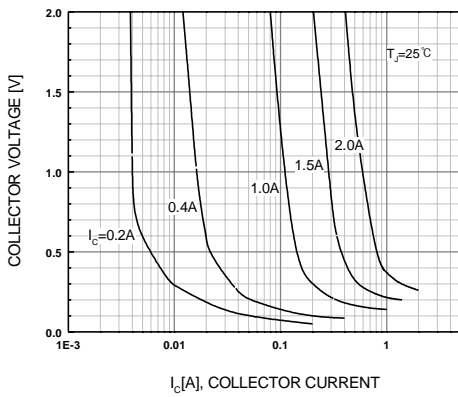


Figure 9. Typical Collector Saturation Region

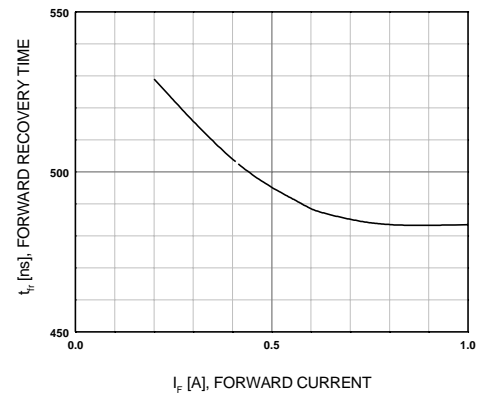


Figure 10. Forward Recovery Time

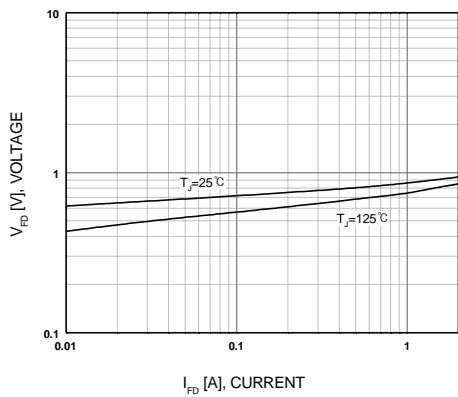


Figure 11. Diode Forward Voltage

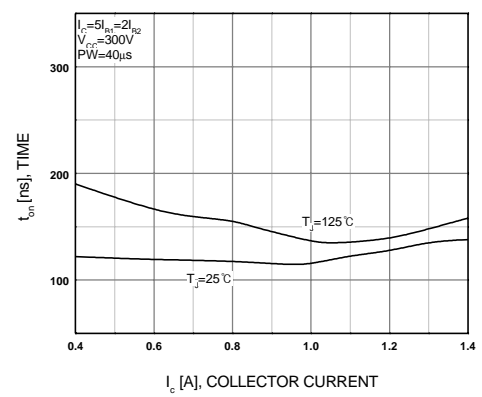


Figure 12. Resistive Switching Time,  $t_{on}$

Typical Characteristics (Continued)

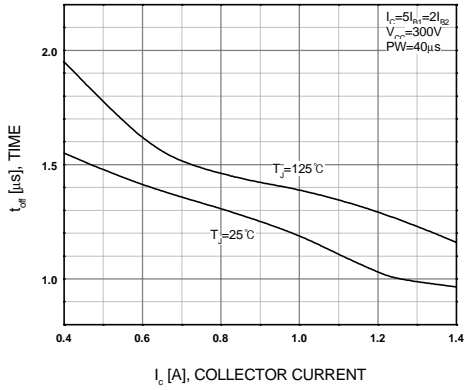


Figure 13. Resistive Switching Time,  $t_{off}$

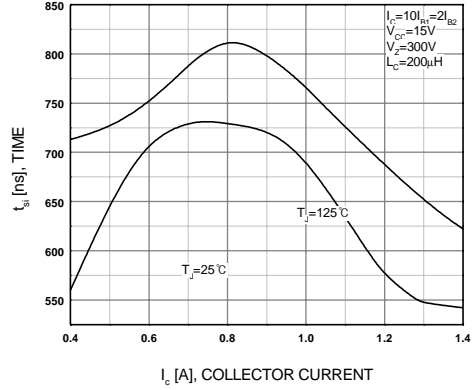


Figure 14. Inductive Switching Time,  $t_{si}$

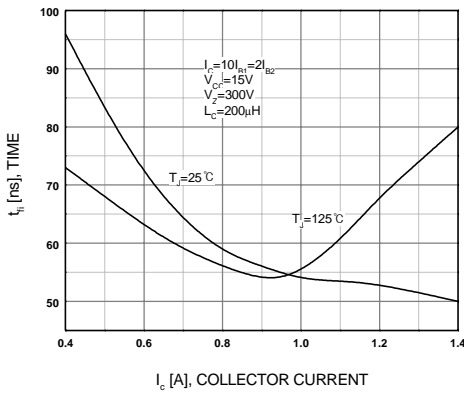


Figure 15. Inductive Switching Time,  $t_{fi}$

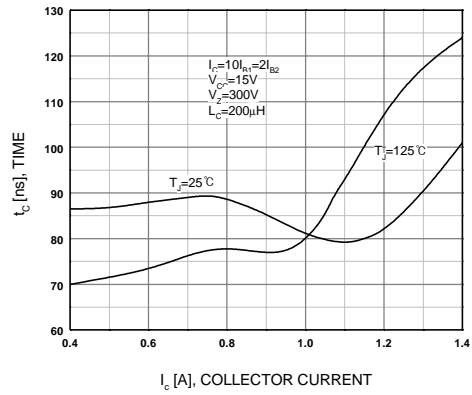


Figure 16. Inductive Switching Time,  $t_c$

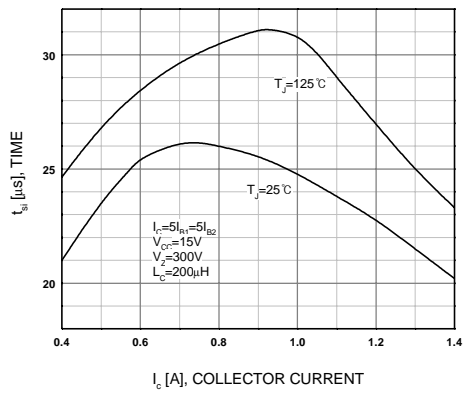


Figure 17. Inductive Switching Time,  $t_{si}$

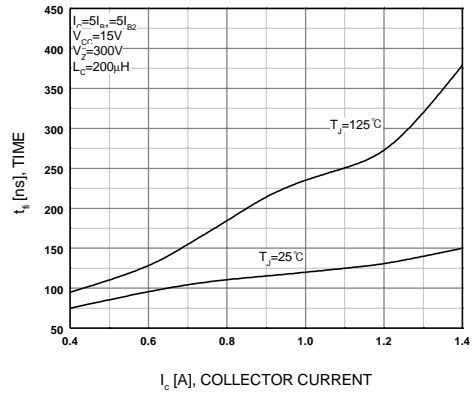


Figure 18. Inductive Switching Time,  $t_{fi}$

Typical Characteristics (Continued)

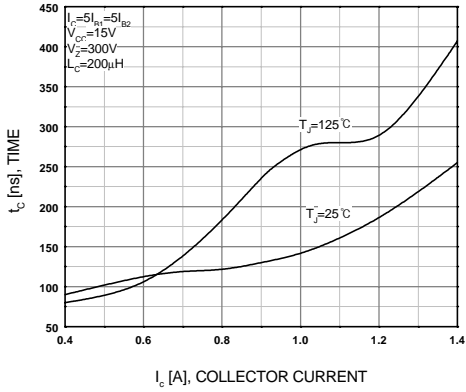


Figure 19. Inductive Switching Time,  $t_c$

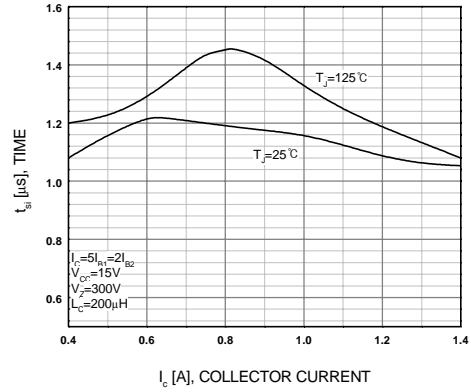


Figure 20. Inductive Switching Time,  $t_{si}$

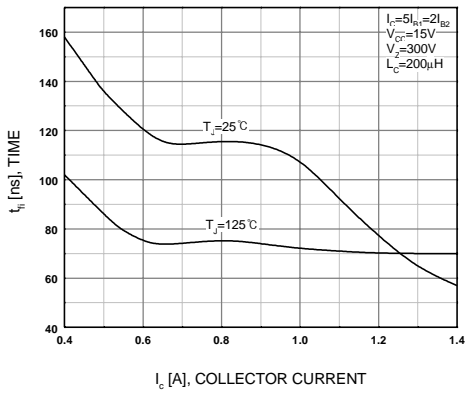


Figure 21. Inductive Switching Time,  $t_{fi}$

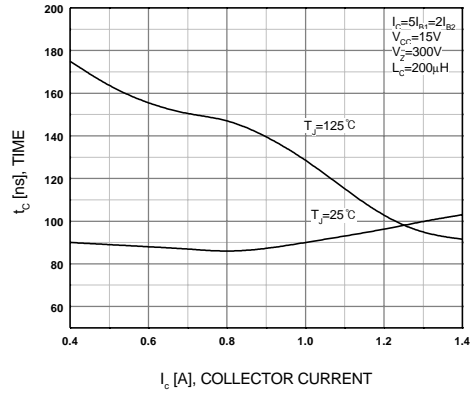


Figure 22. Inductive Switching Time,  $t_c$

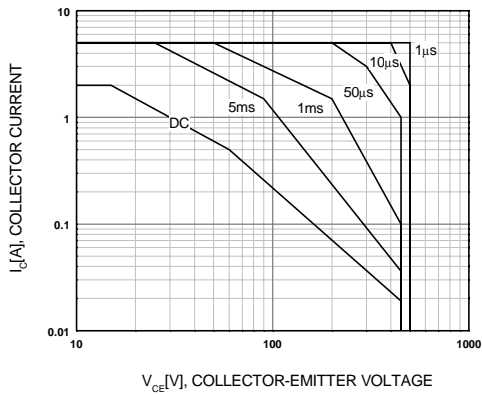


Figure 23. Forward Bias Safe Operating Area

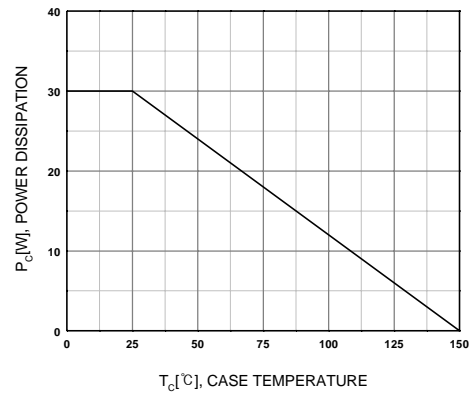
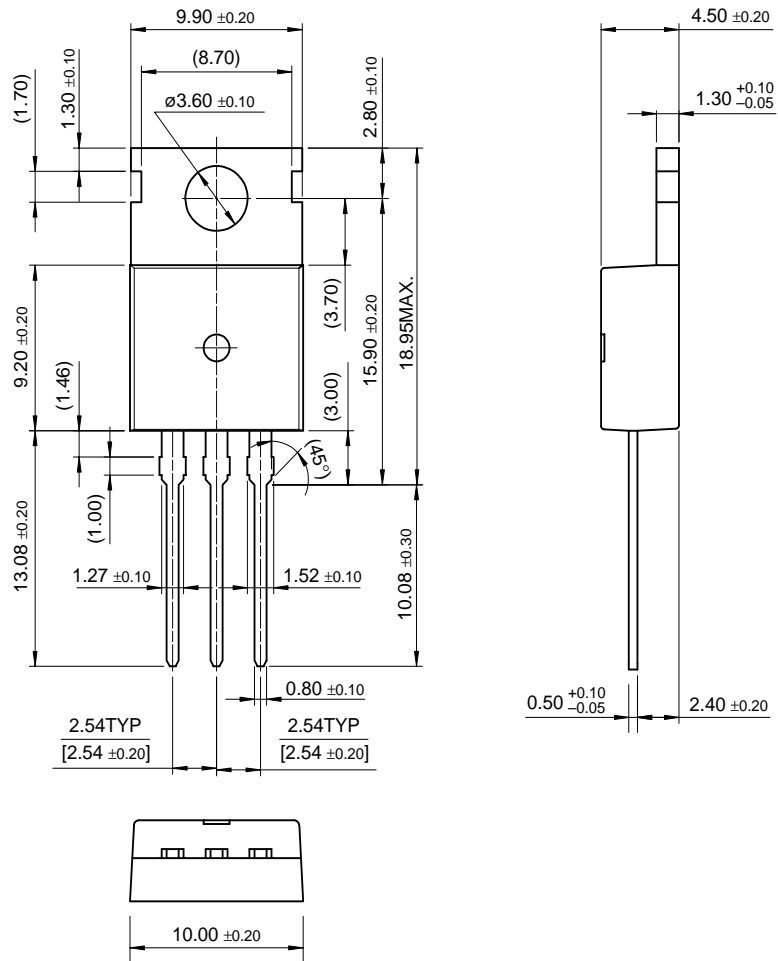


Figure 24. Power Derating

# Package Dimensions

## TO-220



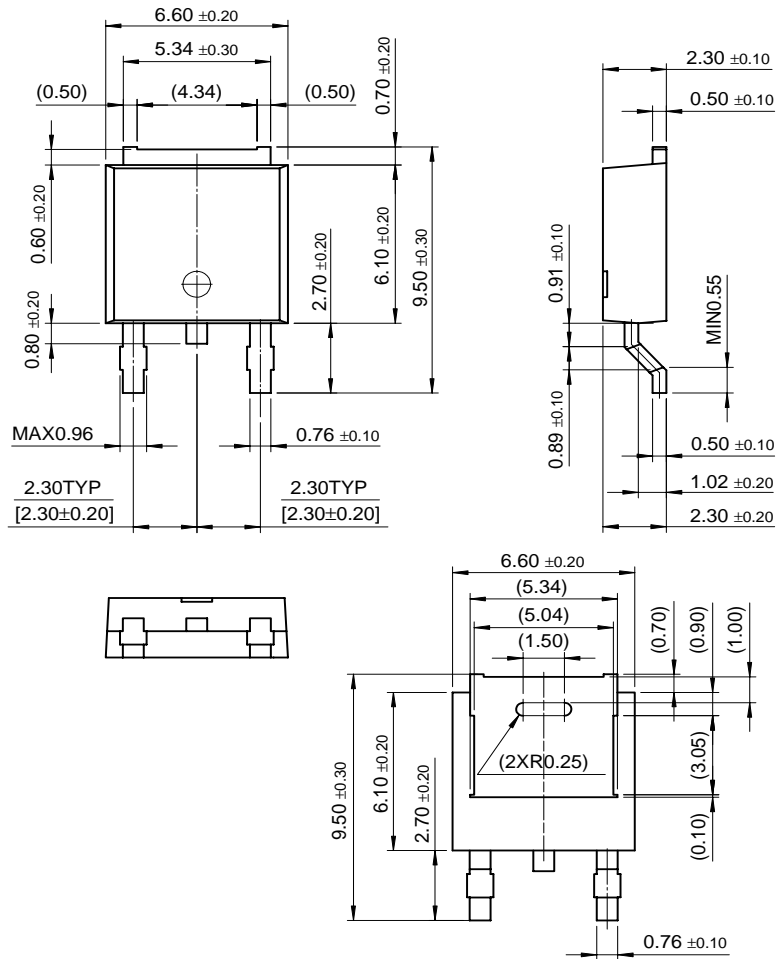
Dimensions in Millimeters

KSC5402D/KSC5402DT



# Package Dimensions (Continued)

## D-PAK



Dimensions in Millimeters

KSC5402D/KSC5402DT

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|--|---------------------------------|--------------------------------|---------------------------------|-----------------------------|
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| ActiveArray <sup>™</sup>                         | FACT Quiet series <sup>™</sup>  | ISOPLANAR <sup>™</sup>         | POP <sup>™</sup>                | Stealth <sup>™</sup>        |
| Bottomless <sup>™</sup>                          | FAST <sup>®</sup>               | LittleFET <sup>™</sup>         | Power247 <sup>™</sup>           | SuperSOT <sup>™</sup> -3    |
| CoolFET <sup>™</sup>                             | FAST <sup>™</sup>               | MicroFET <sup>™</sup>          | PowerTrench <sup>®</sup>        | SuperSOT <sup>™</sup> -6    |
| CROSSVOLT <sup>™</sup>                           | FRFET <sup>™</sup>              | MicroPak <sup>™</sup>          | QFET <sup>™</sup>               | SuperSOT <sup>™</sup> -8    |
| DOMET <sup>™</sup>                               | GlobalOptoisolator <sup>™</sup> | MICROWIRE <sup>™</sup>         | QS <sup>™</sup>                 | SyncFET <sup>™</sup>        |
| EcoSPARK <sup>™</sup>                            | GTO <sup>™</sup>                | MSX <sup>™</sup>               | QT Optoelectronics <sup>™</sup> | TinyLogic <sup>™</sup>      |
| E <sup>2</sup> CMOS <sup>™</sup>                 | HiSeC <sup>™</sup>              | MSXPro <sup>™</sup>            | Quiet Series <sup>™</sup>       | TruTranslation <sup>™</sup> |
| EnSigna <sup>™</sup>                             | I <sup>2</sup> C <sup>™</sup>   | OCX <sup>™</sup>               | RapidConfigure <sup>™</sup>     | UHC <sup>™</sup>            |
| Across the board. Around the world. <sup>™</sup> |                                 | OCXPro <sup>™</sup>            | RapidConnect <sup>™</sup>       | UltraFET <sup>®</sup>       |
| The Power Franchise <sup>™</sup>                 |                                 | OPTOLOGIC <sup>®</sup>         | SILENT SWITCHER <sup>®</sup>    | VCX <sup>™</sup>            |
| Programmable Active Droop <sup>™</sup>           |                                 | OPTOPLANAR <sup>™</sup>        | SMART START <sup>™</sup>        |                             |

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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### Definition of Terms

| Datasheet Identification | Product Status         | Definition  |
|--------------------------|------------------------|---|
| Advance Information      | Formative or In Design | This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.  |
| Preliminary              | First Production       | This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design. |
| No Identification Needed | Full Production        | This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.   |
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