

## MOSFET

### 950V CoolMOS™ P7 SJ Power Device

The latest 950V CoolMOS™ P7 series sets a new benchmark in 950V super junction technologies and combines best-in-class performance with state of the art ease-of-use, resulting from Infineon's over 18 years pioneering super junction technology innovation.

#### Features

- Best-in-class FOM  $R_{DS(on)} * E_{oss}$ ; reduced  $Q_g$ ,  $C_{iss}$ , and  $C_{oss}$
- Best-in-class  $V_{GS(th)}$  of 3V and smallest  $V_{GS(th)}$  variation of  $\pm 0.5V$
- Integrated Zener Diode ESD protection
- Best-in-class CoolMOS™ quality and reliability
- Fully optimized portfolio

#### Benefits

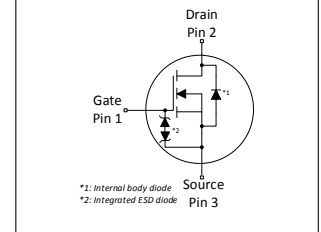
- Best-in-class performance
- Enabling higher power density designs, BOM savings and lower assembly costs
- Easy to drive and to parallel
- Better production yield by reducing ESD related failures
- Less production issues and reduced field returns
- Easy to select right parts for fine tuning of designs

#### Potential applications

Recommended for flyback topologies for LED Lighting, low power Chargers and Adapters, Smart Meter, AUX power and Industrial power. Also suitable for PFC stage in Consumer and Solar applications.

**Product Validation:** Fully qualified acc. JEDEC for Industrial Applications

*Please note: For MOSFET paralleling the use of ferrite beads on the gate or separate totem poles is generally recommended.*



**Table 1 Key Performance Parameters**

| Parameter                  | Value | Unit     |
|----------------------------|-------|----------|
| $V_{DS} @ T_j=25^{\circ}C$ | 950   | V        |
| $R_{DS(on),max}$           | 1.2   | $\Omega$ |
| $Q_{g,typ}$                | 15    | nC       |
| $I_D$                      | 6     | A        |
| $E_{oss} @ 500V$           | 1.3   | $\mu J$  |
| $V_{GS(th),typ}$           | 3     | V        |
| ESD class (HBM)            | 2     | -        |

| Type / Ordering Code | Package           | Marking  | Related Links  |
|----------------------|-------------------|----------|----------------|
| IPA95R1K2P7          | PG-TO 220 FullPAK | 95R1K2P7 | see Appendix A |

## Table of Contents

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## 1 Maximum ratings

at  $T_j = 25^\circ\text{C}$ , unless otherwise specified

**Table 2 Maximum ratings**

| Parameter                                                                    | Symbol        | Values |      |          | Unit             | Note / Test Condition                                                                         |
|------------------------------------------------------------------------------|---------------|--------|------|----------|------------------|-----------------------------------------------------------------------------------------------|
|                                                                              |               | Min.   | Typ. | Max.     |                  |                                                                                               |
| Continuous drain current <sup>1)</sup>                                       | $I_D$         | -      | -    | 6<br>3.7 | A                | $T_C=25^\circ\text{C}$<br>$T_C=100^\circ\text{C}$                                             |
| Pulsed drain current <sup>2)</sup>                                           | $I_{D,pulse}$ | -      | -    | 16       | A                | $T_C=25^\circ\text{C}$                                                                        |
| Avalanche energy, single pulse                                               | $E_{AS}$      | -      | -    | 11       | mJ               | $I_D=0.7\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10                                        |
| Avalanche energy, repetitive                                                 | $E_{AR}$      | -      | -    | 0.14     | mJ               | $I_D=0.7\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10                                        |
| Application (Flyback) relevant avalanche current, single pulse <sup>3)</sup> | $I_{AS}$      | -      | 3.0  | -        | A                | measured with standard leakage inductance of transformer of $10\mu\text{H}$                   |
| MOSFET dv/dt ruggedness                                                      | dv/dt         | -      | -    | 100      | V/ns             | $V_{DS}=0\dots400\text{V}$                                                                    |
| Gate source voltage (static)                                                 | $V_{GS}$      | -20    | -    | 20       | V                | static;                                                                                       |
| Gate source voltage (dynamic)                                                | $V_{GS}$      | -30    | -    | 30       | V                | AC ( $f>1\text{ Hz}$ )                                                                        |
| Power dissipation                                                            | $P_{tot}$     | -      | -    | 27       | W                | $T_C=25^\circ\text{C}$                                                                        |
| Storage temperature                                                          | $T_{stg}$     | -55    | -    | 150      | $^\circ\text{C}$ | -                                                                                             |
| Operating junction temperature                                               | $T_j$         | -55    | -    | 150      | $^\circ\text{C}$ | -                                                                                             |
| Mounting torque                                                              | -             | -      | -    | 50       | Ncm              | M2.5 screws                                                                                   |
| Continuous diode forward current                                             | $I_S$         | -      | -    | 2.9      | A                | $T_C=25^\circ\text{C}$                                                                        |
| Diode pulse current <sup>2)</sup>                                            | $I_{S,pulse}$ | -      | -    | 16       | A                | $T_C=25^\circ\text{C}$                                                                        |
| Reverse diode dv/dt <sup>4)</sup>                                            | dv/dt         | -      | -    | 1        | V/ns             | $V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq 1.4\text{A}$ , $T_j=25^\circ\text{C}$<br>see table 8 |
| Maximum diode commutation speed                                              | di/dt         | -      | -    | 50       | A/ $\mu\text{s}$ | $V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq 1.4\text{A}$ , $T_j=25^\circ\text{C}$<br>see table 8 |
| Insulation withstand voltage                                                 | $V_{ISO}$     | -      | -    | 2500     | V                | $V_{rms}$ , $T_C=25^\circ\text{C}$ , $t=1\text{min}$                                          |

<sup>1)</sup> Limited by  $T_{j,max}$ . Maximum Duty Cycle  $D = 0.5$ ; IPAK equivalent.

<sup>2)</sup> Pulse width  $t_p$  limited by  $T_{j,max}$

<sup>3)</sup> For further explanation please read AN - CoolMOS™ 700V P7 & 950V P7

<sup>4)</sup> Identical low side and high side switch with identical  $R_G$

## 2 Thermal characteristics

**Table 3 Thermal characteristics**

| Parameter                                                  | Symbol     | Values |      |      | Unit | Note / Test Condition               |
|------------------------------------------------------------|------------|--------|------|------|------|-------------------------------------|
|                                                            |            | Min.   | Typ. | Max. |      |                                     |
| Thermal resistance, junction - case                        | $R_{thJC}$ | -      | -    | 4.7  | °C/W | -                                   |
| Thermal resistance, junction - ambient                     | $R_{thJA}$ | -      | -    | 62   | °C/W | leaded                              |
| Thermal resistance, junction - ambient for SMD version     | $R_{thJA}$ | -      | -    | -    | °C/W | -                                   |
| Soldering temperature, wavesoldering only allowed at leads | $T_{sold}$ | -      | -    | 260  | °C   | 1.6mm (0.063 in.) from case for 10s |

### 3 Electrical characteristics

at  $T_j=25^\circ\text{C}$ , unless otherwise specified

**Table 4 Static characteristics**

| Parameter                        | Symbol        | Values |               |      | Unit     | Note / Test Condition                                                                             |
|----------------------------------|---------------|--------|---------------|------|----------|---------------------------------------------------------------------------------------------------|
|                                  |               | Min.   | Typ.          | Max. |          |                                                                                                   |
| Drain-source breakdown voltage   | $V_{(BR)DSS}$ | 950    | -             | -    | V        | $V_{GS}=0V$ , $I_D=1mA$                                                                           |
| Gate threshold voltage           | $V_{(GS)th}$  | 2.5    | 3             | 3.5  | V        | $V_{DS}=V_{GS}$ , $I_D=0.14mA$                                                                    |
| Zero gate voltage drain current  | $I_{DSS}$     | -      | -             | 1    | $\mu A$  | $V_{DS}=950V$ , $V_{GS}=0V$ , $T_j=25^\circ C$<br>$V_{DS}=950V$ , $V_{GS}=0V$ , $T_j=150^\circ C$ |
| Gate-source leakage current      | $I_{GSS}$     | -      | -             | 1000 | nA       | $V_{GS}=20V$ , $V_{DS}=0V$                                                                        |
| Drain-source on-state resistance | $R_{DS(on)}$  | -      | 1.03<br>2.289 | 1.2  | $\Omega$ | $V_{GS}=10V$ , $I_D=2.7A$ , $T_j=25^\circ C$<br>$V_{GS}=10V$ , $I_D=2.7A$ , $T_j=150^\circ C$     |
| Gate resistance                  | $R_G$         | -      | 1             | -    | $\Omega$ | $f=250kHz$ , open drain                                                                           |

**Table 5 Dynamic characteristics**

| Parameter                                                  | Symbol       | Values |      |      | Unit | Note / Test Condition                                                         |
|------------------------------------------------------------|--------------|--------|------|------|------|-------------------------------------------------------------------------------|
|                                                            |              | Min.   | Typ. | Max. |      |                                                                               |
| Input capacitance                                          | $C_{iss}$    | -      | 478  | -    | pF   | $V_{GS}=0V$ , $V_{DS}=400V$ , $f=250kHz$                                      |
| Output capacitance                                         | $C_{oss}$    | -      | 7    | -    | pF   | $V_{GS}=0V$ , $V_{DS}=400V$ , $f=250kHz$                                      |
| Effective output capacitance, energy related <sup>1)</sup> | $C_{o(er)}$  | -      | 12   | -    | pF   | $V_{GS}=0V$ , $V_{DS}=0...400V$                                               |
| Effective output capacitance, time related <sup>2)</sup>   | $C_{o(tr)}$  | -      | 120  | -    | pF   | $I_D=constant$ , $V_{GS}=0V$ , $V_{DS}=0...400V$                              |
| Turn-on delay time                                         | $t_{d(on)}$  | -      | 7    | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=2.7A$ ,<br>$R_G=10.2\Omega$ ; see table 9 |
| Rise time                                                  | $t_r$        | -      | 10   | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=2.7A$ ,<br>$R_G=10.2\Omega$ ; see table 9 |
| Turn-off delay time                                        | $t_{d(off)}$ | -      | 36   | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=2.7A$ ,<br>$R_G=10.2\Omega$ ; see table 9 |
| Fall time                                                  | $t_f$        | -      | 12   | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=2.7A$ ,<br>$R_G=10.2\Omega$ ; see table 9 |

**Table 6 Gate charge characteristics**

| Parameter             | Symbol        | Values |      |      | Unit | Note / Test Condition                            |
|-----------------------|---------------|--------|------|------|------|--------------------------------------------------|
|                       |               | Min.   | Typ. | Max. |      |                                                  |
| Gate to source charge | $Q_{gs}$      | -      | 2    | -    | nC   | $V_{DD}=760V$ , $I_D=2.7A$ , $V_{GS}=0$ to $10V$ |
| Gate to drain charge  | $Q_{gd}$      | -      | 5    | -    | nC   | $V_{DD}=760V$ , $I_D=2.7A$ , $V_{GS}=0$ to $10V$ |
| Gate charge total     | $Q_g$         | -      | 15   | -    | nC   | $V_{DD}=760V$ , $I_D=2.7A$ , $V_{GS}=0$ to $10V$ |
| Gate plateau voltage  | $V_{plateau}$ | -      | 4.4  | -    | V    | $V_{DD}=760V$ , $I_D=2.7A$ , $V_{GS}=0$ to $10V$ |

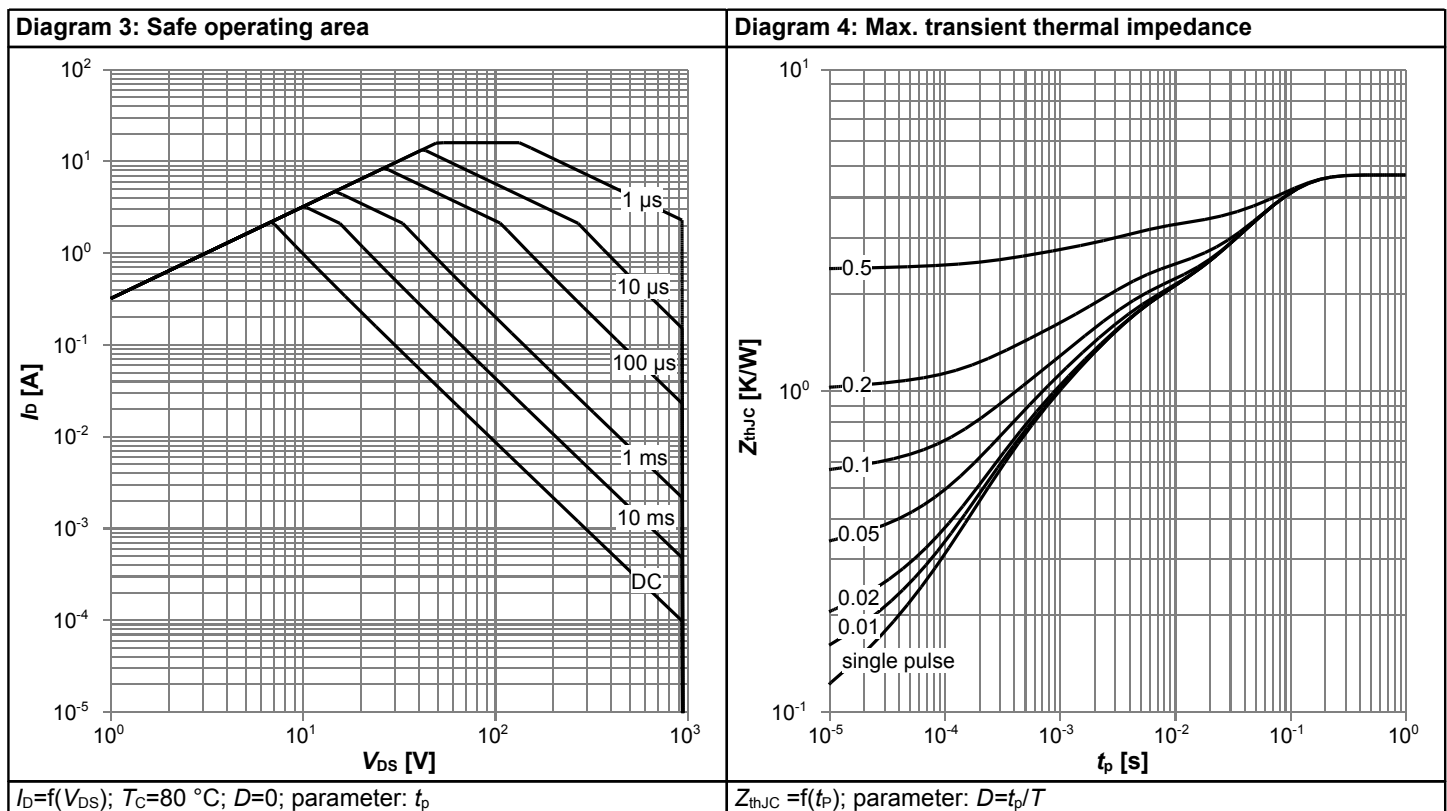
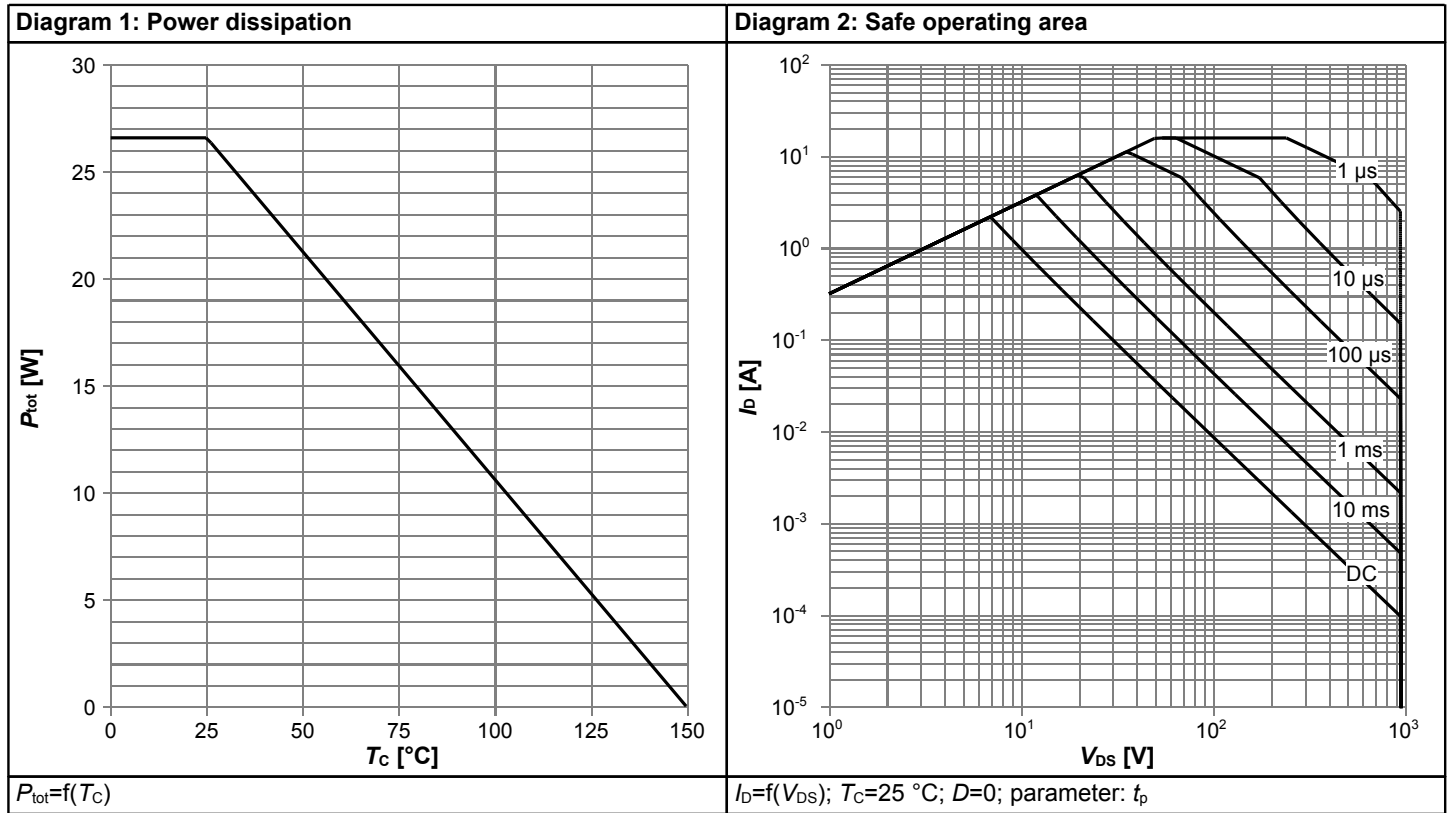
<sup>1)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 400V

<sup>2)</sup>  $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 400V

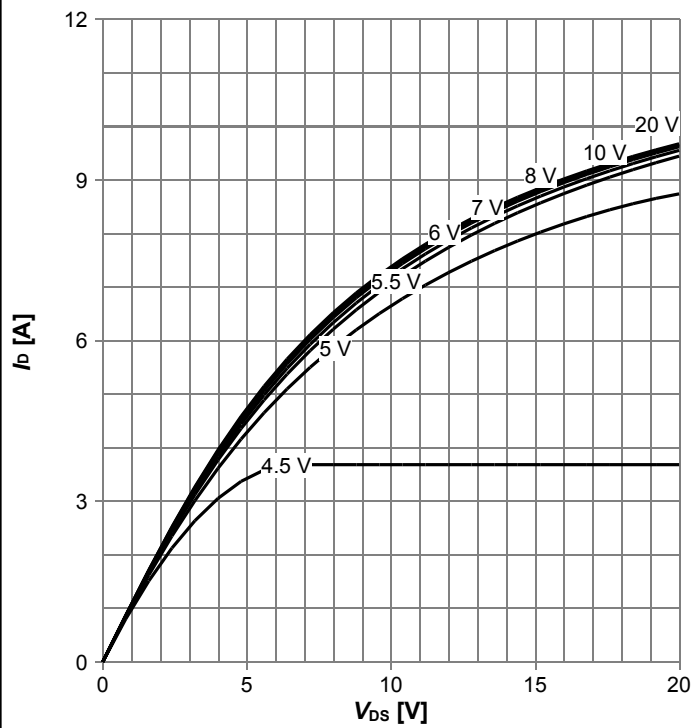
**Table 7 Reverse diode characteristics**

| Parameter                     | Symbol    | Values |      |      | Unit    | Note / Test Condition                                       |
|-------------------------------|-----------|--------|------|------|---------|-------------------------------------------------------------|
|                               |           | Min.   | Typ. | Max. |         |                                                             |
| Diode forward voltage         | $V_{SD}$  | -      | 0.9  | -    | V       | $V_{GS}=0V$ , $I_F=2.7A$ , $T_j=25^{\circ}C$                |
| Reverse recovery time         | $t_{rr}$  | -      | 560  | -    | ns      | $V_R=400V$ , $I_F=1.4A$ , $di_F/dt=50A/\mu s$ ; see table 8 |
| Reverse recovery charge       | $Q_{rr}$  | -      | 3    | -    | $\mu C$ | $V_R=400V$ , $I_F=1.4A$ , $di_F/dt=50A/\mu s$ ; see table 8 |
| Peak reverse recovery current | $I_{rrm}$ | -      | 8    | -    | A       | $V_R=400V$ , $I_F=1.4A$ , $di_F/dt=50A/\mu s$ ; see table 8 |

## 4 Electrical characteristics diagrams

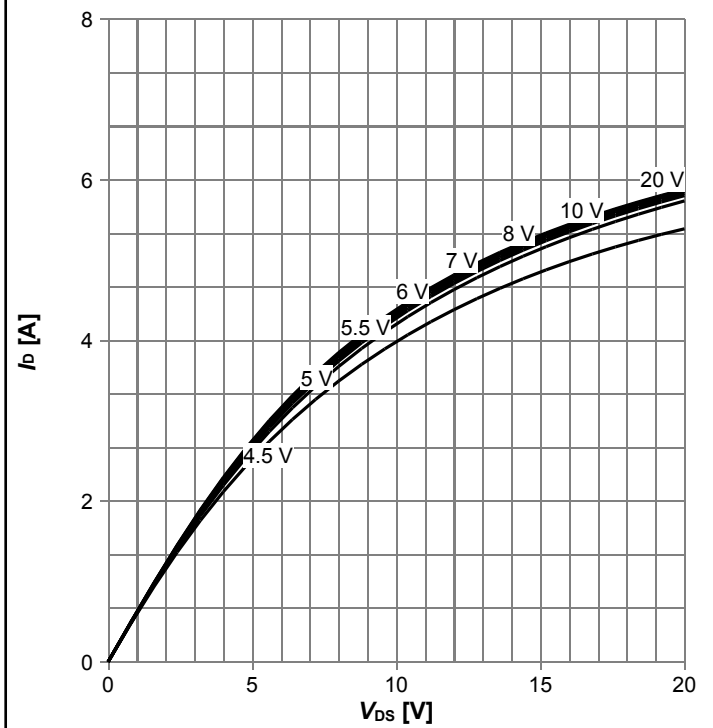


**Diagram 5: Typ. output characteristics**



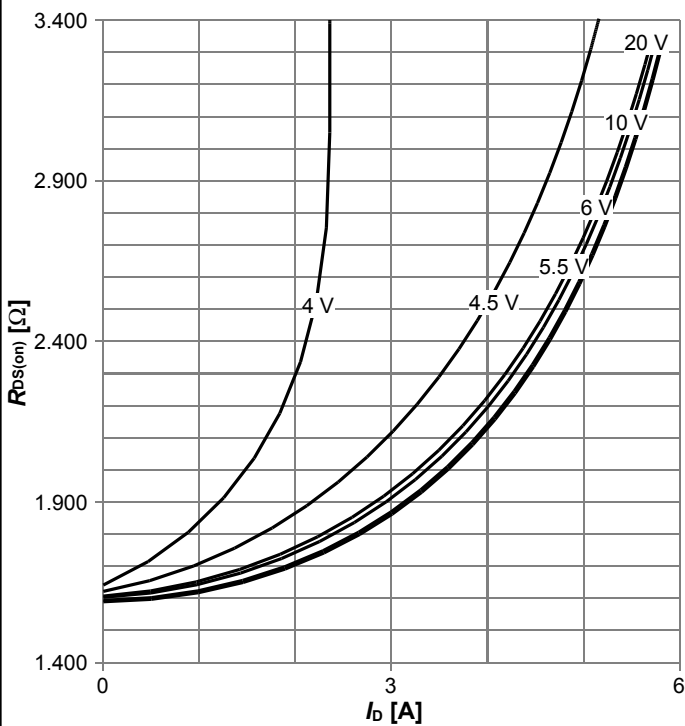
$I_D = f(V_{DS})$ ;  $T_j = 25\text{ °C}$ ; parameter:  $V_{GS}$

**Diagram 6: Typ. output characteristics**



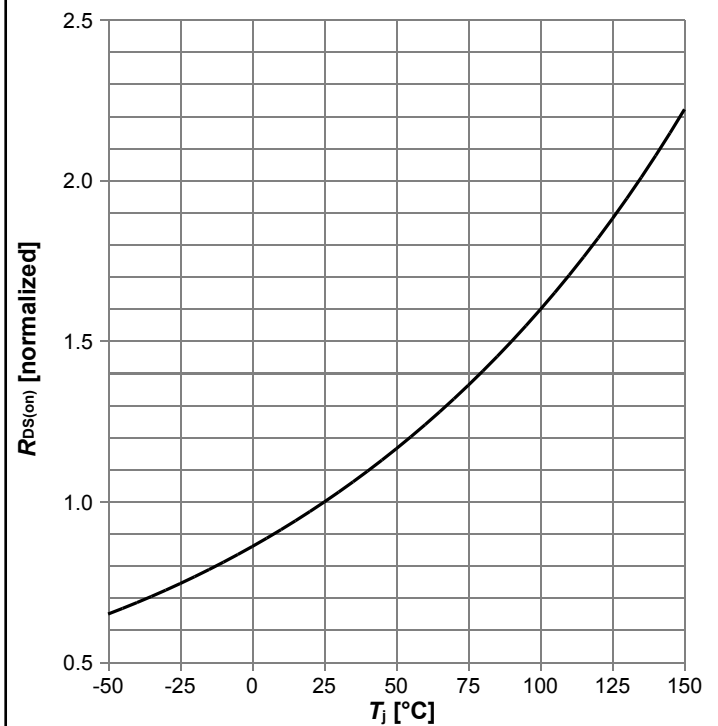
$I_D = f(V_{DS})$ ;  $T_j = 125\text{ °C}$ ; parameter:  $V_{GS}$

**Diagram 7: Typ. drain-source on-state resistance**



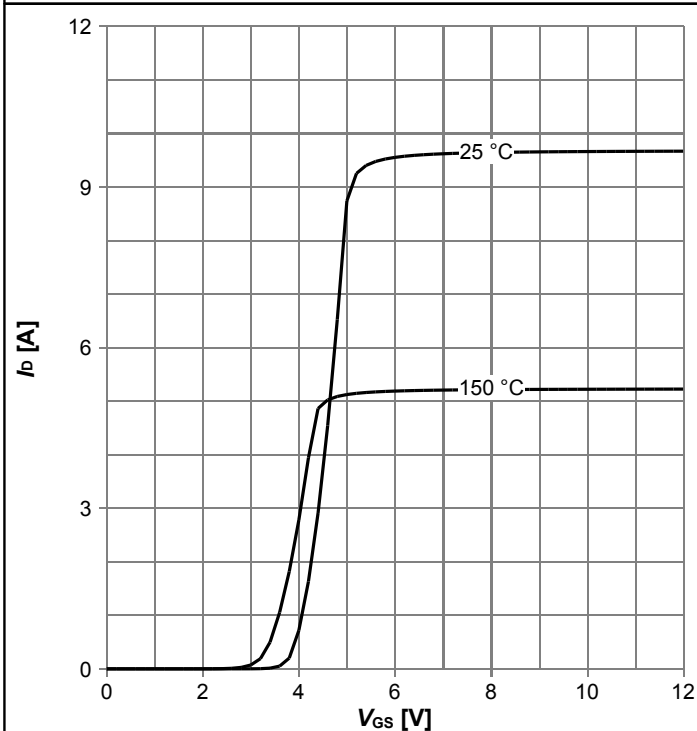
$R_{DS(on)} = f(I_D)$ ;  $T_j = 125\text{ °C}$ ; parameter:  $V_{GS}$

**Diagram 8: Drain-source on-state resistance**



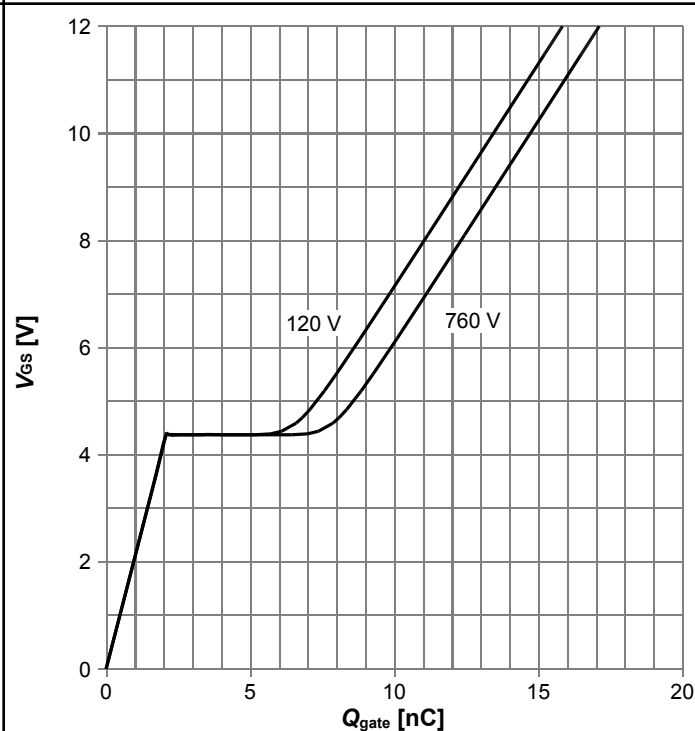
$R_{DS(on)} = f(T_j)$ ;  $I_D = 2.7\text{ A}$ ;  $V_{GS} = 10\text{ V}$

**Diagram 9: Typ. transfer characteristics**



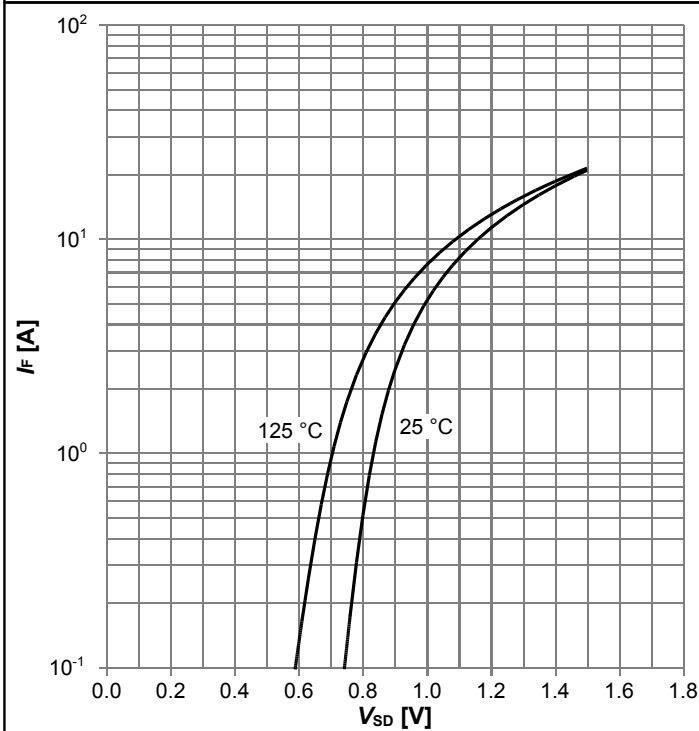
$I_D = f(V_{GS})$ ;  $V_{DS} = 20V$ ; parameter:  $T_j$

**Diagram 10: Typ. gate charge**



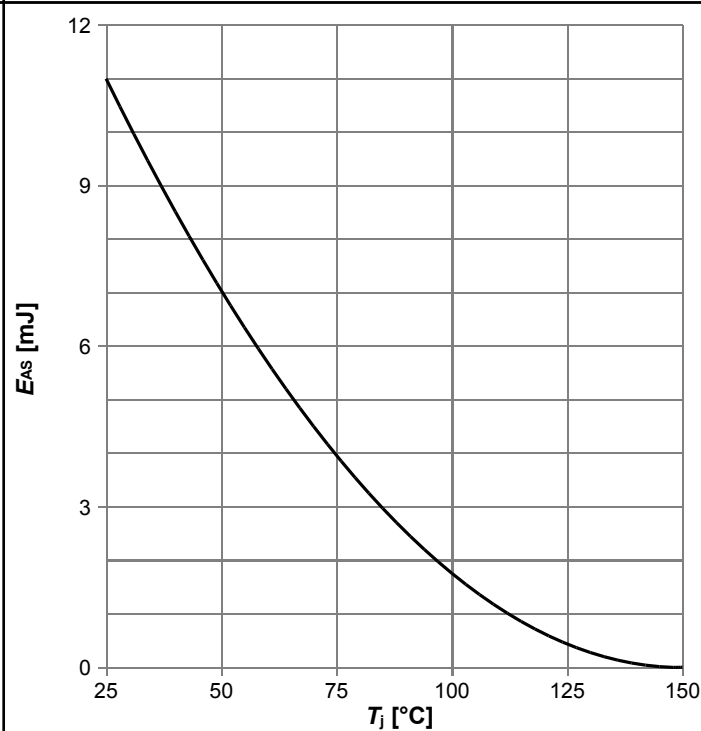
$V_{GS} = f(Q_{gate})$ ;  $I_D = 2.7$  A pulsed; parameter:  $V_{DD}$

**Diagram 11: Forward characteristics of reverse diode**



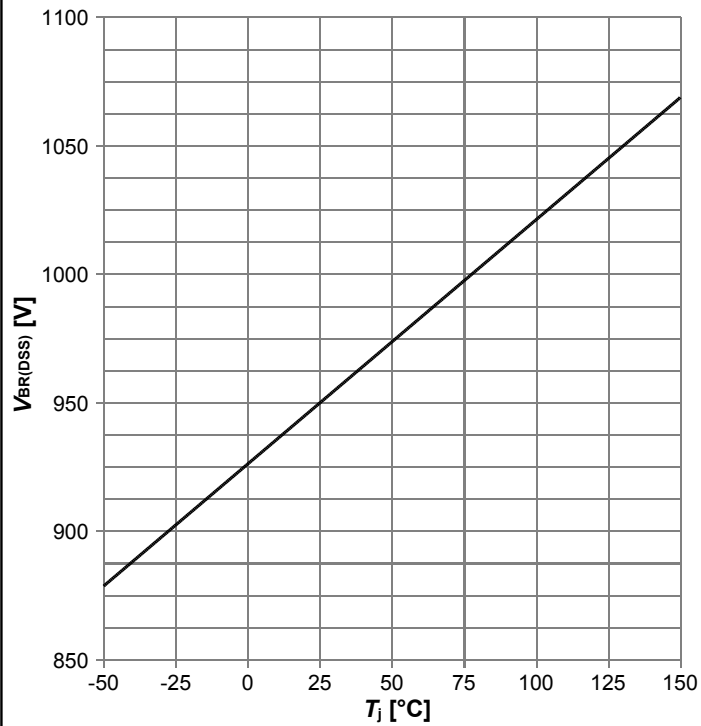
$I_F = f(V_{SD})$ ; parameter:  $T_j$

**Diagram 12: Avalanche energy**



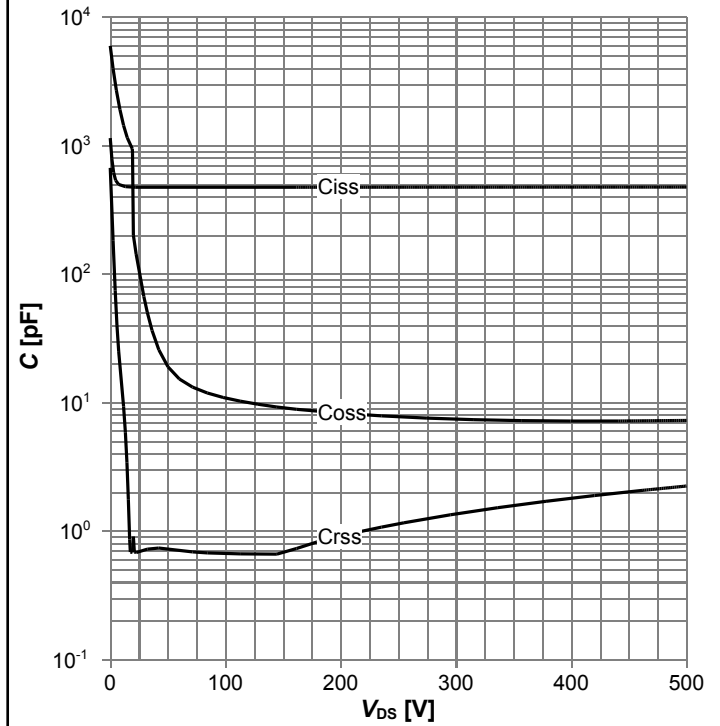
$E_{AS} = f(T_j)$ ;  $I_D = 0.7$  A;  $V_{DD} = 50$  V

**Diagram 13: Drain-source breakdown voltage**



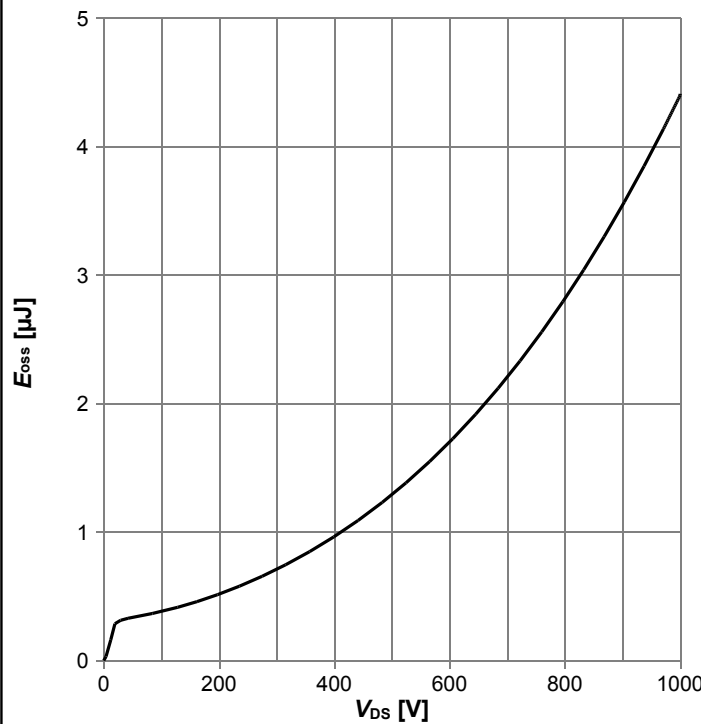
$V_{BR(DSS)} = f(T_J); I_D = 1 \text{ mA}$

**Diagram 14: Typ. capacitances**



$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 250 \text{ kHz}$

**Diagram 15: Typ. Coss stored energy**



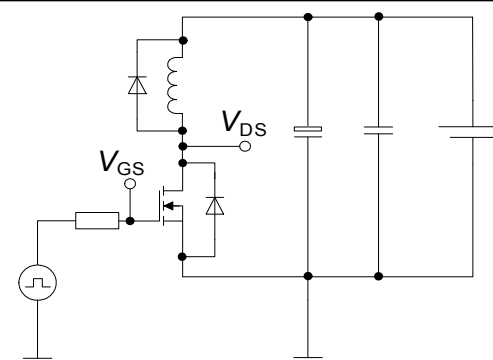
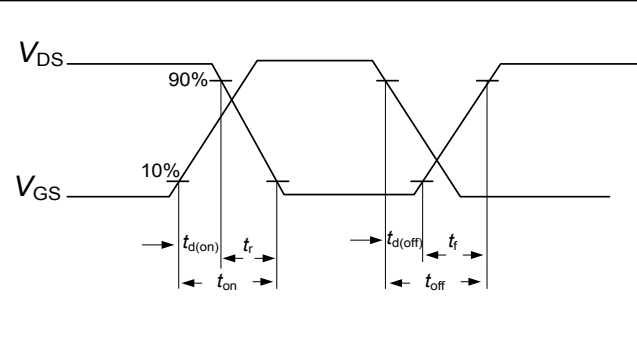
$E_{oss} = f(V_{DS})$

## 5 Test Circuits

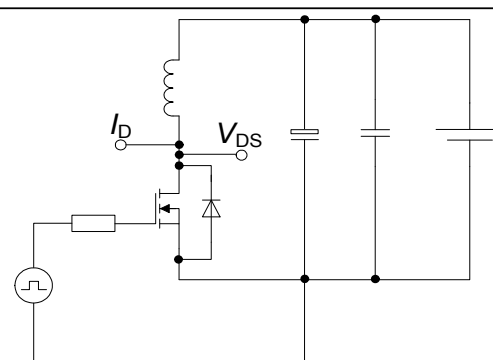
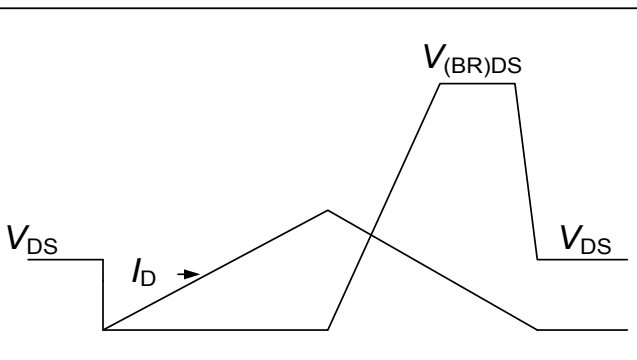
**Table 8 Diode characteristics**

| Test circuit for diode characteristics                                                                                | Diode recovery waveform                                                            |
|-----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
|  <p><math>R_{g1} = R_{g2}</math></p> |  |

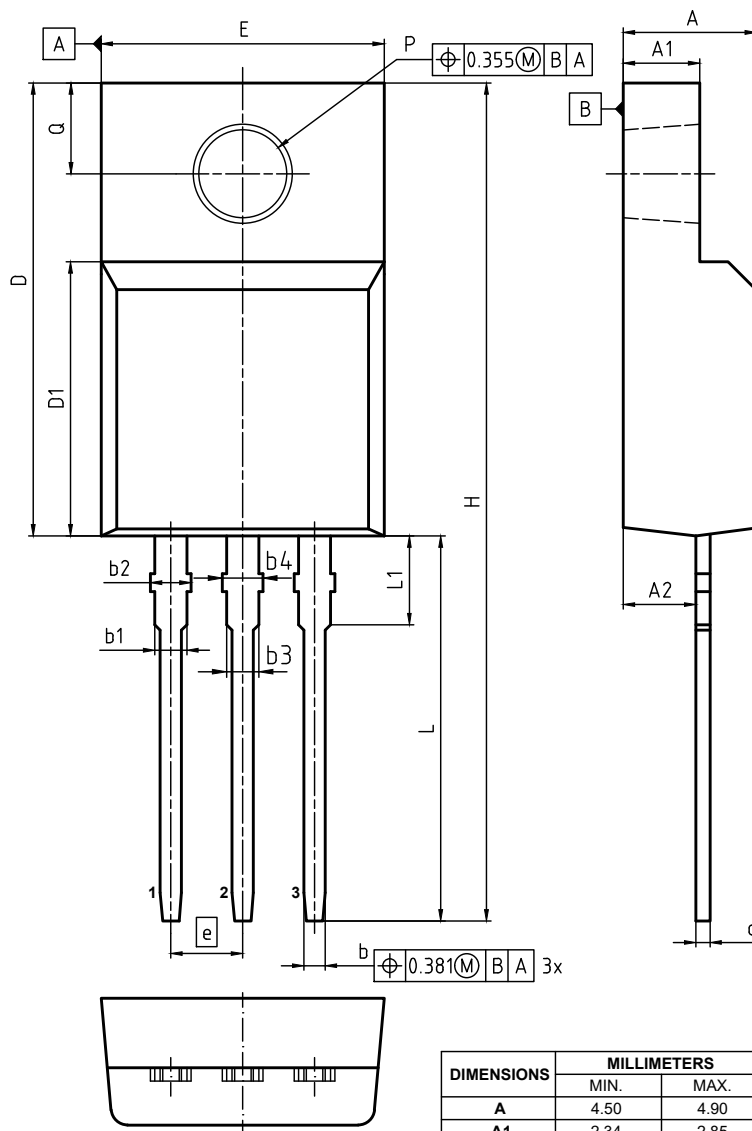
**Table 9 Switching times**

| Switching times test circuit for inductive load                                    | Switching times waveform                                                            |
|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|  |  |

**Table 10 Unclamped inductive load**

| Unclamped inductive load test circuit                                               | Unclamped inductive waveform                                                         |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
|  |  |

## 6 Package Outlines



NOTES:  
DIMENSIONS DO NOT INCLUDE MOLD FLASH, PRO-  
TRUSIONS OR GATE BURRS  
GATE BURRS ARE LESS THAN 0.5 mm

| DIMENSIONS | MILLIMETERS |       |
|------------|-------------|-------|
|            | MIN.        | MAX.  |
| A          | 4.50        | 4.90  |
| A1         | 2.34        | 2.85  |
| A2         | 2.42        | 2.86  |
| b          | 0.65        | 0.90  |
| b1         | 0.95        | 1.38  |
| b2         | 0.95        | 1.51  |
| b3         | 0.65        | 1.38  |
| b4         | 0.65        | 1.51  |
| c          | 0.40        | 0.63  |
| D          | 15.67       | 16.15 |
| D1         | 8.97        | 9.83  |
| E          | 10.00       | 10.65 |
| e          | 2.54        |       |
| H          | 28.70       | 29.75 |
| L          | 12.78       | 13.75 |
| L1         | 2.83        | 3.45  |
| øP         | 3.00        | 3.30  |
| Q          | 3.15        | 3.50  |

|                             |
|-----------------------------|
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| REVISION<br>09              |
| ISSUE DATE<br>23.07.2018    |
| SCALE 5:1<br>0 1 2 3 4 5mm  |
| EUROPEAN PROJECTION<br>     |

Figure 1 Outline PG-TO 220 FullPAK, dimensions in mm/inches

## **7 Appendix A**

### **Table 11 Related Links**

- **IFX CoolMOS P7 Webpage:** [www.infineon.com](http://www.infineon.com)
- **IFX CoolMOS P7 application note:** [www.infineon.com](http://www.infineon.com)
- **IFX CoolMOS P7 simulation model:** [www.infineon.com](http://www.infineon.com)
- **IFX Design tools:** [www.infineon.com](http://www.infineon.com)

## Revision History

IPA95R1K2P7

**Revision: 2018-07-24, Rev. 2.2**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 2.0      | 2018-05-30 | Release of final version                     |
| 2.1      | 2018-06-04 | Final                                        |
| 2.2      | 2018-07-24 | Corrected package drawing text               |

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