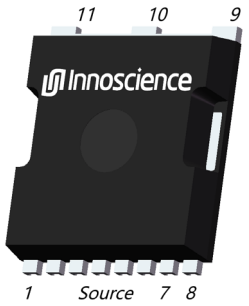
# INN650TA050C

## 1. General description

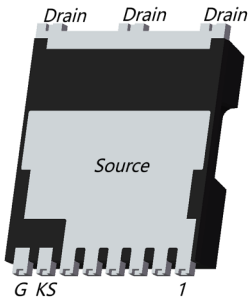
**650V GaN-on-Silicon Enhancement-mode Power Transistor in TOLL package**

## 2. Features




- Enhancement mode transistor-Normally off power switch
- Ultra high switching frequency
- No reverse-recovery charge
- Low gate charge, low output charge
- Qualified for industrial applications according to JEDEC Standards
- ESD safeguard
- RoHS, Pb-free, REACH-compliant

## 3. Applications

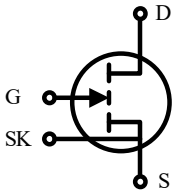



- AC-DC converters & DC-DC converters for PSU and power supplies
- High power density DC-DC modules
- Totem pole PFC
- Resonant and soft-switching converters

## 4. Key performance parameters

**Table 1 Key performance parameters at $T_j$ = 25 °C**

| Parameter | Value | Unit |
|---|---|---|
| $V_{DS,max}$ | 650 | V |
| $R_{DS(on),max}$ @ $V_{GS}$ = 6 V | 50 | mΩ |
| $Q_{G,typ}$ @ $V_{DS}$ = 400 V | 9.4 | nC |
| $I_{D,pulse}$ | 77 | A |
| $Q_{OSS}$ @ $V_{DS}$ = 400 V | 107 | nC |
| $Q_{rr}$ @ $V_{DS}$ = 400 V | 0 | nC |




## 5. Pin information

**Table 2 Pin information**

| Gate | Drain | Kelvin Source | Source |
|---|---|---|---|
| 8 | 9, 10, 11 | 7 | 1, 2, 3, 4, 5, 6 |

**Table 3 Ordering information**

| Type/Ordering Code | Package | Product Code | Carrier | Package base Qty. |
|---|---|---|---|---|
| INN650TA050C | TOLL | 65TA050C | Tape & Reel | 1200 |

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## 6. Maximum ratings

at $T_j$ = 25 °C unless otherwise specified

Exceeding the maximum ratings may destroy the device. For further information, contact Innoscience sales office

**Table 4 Maximum ratings**

| Parameter | Symbol | Values | Unit | Note/Test Condition |
|---|---|---|---|---|
| Drain source voltage | $V_{DS,max}$ | 650 | V | $V_{GS}$ = 0 V,<br>$T_j$ = -55 °C to 150 °C |
| Drain source voltage transient [1] | $V_{DS,transient}$ | 800 | V | $V_{GS}$ = 0 V |
| Drain source voltage, pulsed [2] | $V_{DS,pulse}$ | 750 | V | $T_j$ = 25 °C; total time < 10 h |
| | | | | $T_j$ = 125 °C; total time < 1 h |
| Continuous current, drain source | $I_D$ | 38.5 | A | $T_c$ = 25 °C |
| Continuous current, drain source | $I_D$ | 21.5 | A | $T_c$ = 125 °C |
| Pulsed current, drain source [3] | $I_{D,pulse}$ | 77 | A | $T_c$ = 25 °C; $V_G$ = 6 V;<br>$t_{PULSE}$ = 10 µs |
| Pulsed current, drain source [3] | $I_{D,pulse}$ | 38.5 | A | $T_c$ = 125 °C; $V_G$ = 6 V;<br>$t_{PULSE}$ = 10 µs |
| Gate source voltage, continuous | $V_{GS}$ | -6 to +7 | V | $T_j$ = -55 °C to 150 °C |
| Gate source voltage, pulsed | $V_{GS,pulse}$ | -20 to +10 | V | $T_j$ = -55 °C to 150 °C;<br>$t_{PULSE}$ = 50 ns, f = 100 kHz;<br>open drain |
| Power dissipation | $P_{tot}$ | 255 | W | $T_c$ = 25 °C |
| Operating temperature | $T_j$ | -55 to +150 | ˚C | |
| Storage temperature | $T_{stg}$ | -55 to +150 | ˚C | |

1 $V_{DS,transient}$ is intended for non-repetitive events, $t_{PULSE}$ < 200 µs

2 $V_{DS,pulse}$ is intended for repetitive pulse, $t_{PULSE}$ < 100 ns

3 Limit was extracted from characterization test, not measured during production and guaranteed by design.

## 7. Thermal characteristics

**Table 5 Thermal characteristics**

| Parameter | Symbol | Values | Unit | Note/Test Condition |
|---|---|---|---|---|
| Thermal Resistance Junction to ambient | $R_{thJA}$[1] | 56.50 | °C/W | |
| Thermal resistance, junction-case (bottom) | $R_{thJC}$ | 0.49 | °C/W | |
| Maximum reflow soldering temperature | $T_{sold}$ | 260 | °C | MSL3 |

1. Rthja is determined with the device mounted on one square inch of copper pad, single layer 2oz copper on FR4 board

## 8. Electric characteristics

at $T_j$ = 25 °C, unless specified otherwise

**Table 6 Static characteristics**

| Parameter | Symbol | Values | | | Unit | Note/Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Gate threshold voltage | $V_{GS(th)}$ | 1.2 | 1.7 | 2.5 | V | $I_D$ = 46.8 mA; $V_{DS}$ = $V_{GS}$; $T_j$ = 25 °C |
| | | - | 1.6 | - | | $I_D$ = 46.8 mA; $V_{DS}$ = $V_{GS}$; $T_j$ = 125 °C |
| Drain-source leakage current | $I_{DSS}$ | - | 8 | 100 | μA | $V_{DS}$ = 650 V; $V_{GS}$ = 0 V; $T_j$ = 25 °C |
| | | - | 20 | - | | $V_{DS}$ = 650 V; $V_{GS}$ = 0 V; $T_j$ = 125 °C |
| Gate-source leakage current | $I_{GSS}$ | - | 250 | - | μA | $V_{GS}$ = 6 V; $V_{DS}$ = 0 V |
| Drain-source on-state resistance | $R_{DS(on)}$ | - | 38.5 | 50 | mΩ | $V_{GS}$ = 6 V; $I_D$ = 0.5 A; $T_j$ = 25 °C |
| | | - | 38.5 | - | mΩ | $V_{GS}$ = 6 V; $I_D$ = 18 A; $T_j$ = 25 °C |
| | | - | 74.6 | - | mΩ | $V_{GS}$ = 6 V; $I_D$ = 18 A; $T_j$ = 125 °C |
| Gate resistance | $R_G$ | - | 1.5 | - | Ω | f = 5 MHz; open drain |

**Table 7 Dynamic characteristics**

| Parameter | Symbol | Values | | | Unit | Note/Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Input capacitance | $C_{iss}$ | - | 342 | - | pF | $V_{GS}$ = 0 V; $V_{DS}$ = 400 V; f = 100 kHz |
| Output capacitance | $C_{oss}$ | - | 125 | - | pF | $V_{GS}$ = 0 V; $V_{DS}$ = 400 V; f = 100 kHz |
| Reverse transfer Capacitance | $C_{rss}$ | - | 1.52 | - | pF | $V_{GS}$ = 0 V; $V_{DS}$ = 400 V; f = 100 kHz |
| Effective output capacitance, energy related [1] | $C_{o(er)}$ | - | 189 | - | pF | $V_{GS}$ = 0 V; $V_{DS}$ = 0 to 400 V |
| Effective output capacitance, time related [2] | $C_{o(tr)}$ | - | 269 | - | pF | $V_{GS}$ = 0 V; $V_{DS}$ = 0 to 400 V |
| Output charge | $Q_{OSS}$ | - | 107 | - | nC | $V_{GS}$ = 0 V; $V_{DS}$ = 0 to 400 V |
| Turn-on delay time | $t_{d(on)}$ | - | 9.6 | - | ns | $V_{DS}$ = 400V; $I_D$ = 15A; L= 230μH; $V_{GS}$ = -3V/6V; Rgon = 10Ω; Rgoff = 2.2Ω; See Figure 22 |
| Turn-off delay time | $t_{d(off)}$ | - | 10.5 | - | ns | |
| Rise time | $t_r$ | - | 13.3 | - | ns | |
| Fall time | $t_f$ | - | 9.0 | - | ns | |

1. $C_{O(er)}$ is the fixed capacitance that gives the same stored energy as $C_{OSS}$ while $V_{DS}$ is rising from 0 to 400 V
2. $C_{O(tr)}$ is the fixed capacitance that gives the same charging time as $C_{OSS}$ while $V_{DS}$ is rising from 0 to 400 V

**Table 8 Gate charge characteristics**

| Parameter | Symbol | Values | | | Unit | Note/Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Gate charge | $Q_G$ | - | 9.4 | - | nC | $V_{GS}$ = 0 to 6 V; $V_{DS}$ = 400 V; $I_D$ = 18 A |
| Gate-source charge | $Q_{GS}$ | - | 0.9 | - | nC | |
| Gate-drain charge | $Q_{GD}$ | - | 4 | - | nC | |
| Gate Plateau Voltage | $V_{Plat}$ | - | 2.5 | - | V | $V_{DS}$ = 400 V; $I_D$ = 18 A |

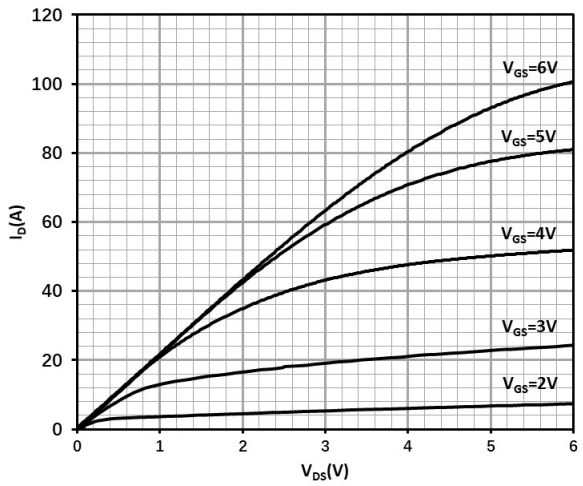
**Table 9 Reverse conduction characteristics**

| Parameter | Symbol | Values | | | Unit | Note/Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Source-Drain reverse voltage | $V_{SD}$ | - | 2.9 | - | V | $V_{GS}$ = 0 V; $I_S$ = 18 A |
| Pulsed current, reverse | $I_{S,pulse}$ | - | - | 88 | A | $V_{GS}$ = 6 V; $t_{PULSE}$ = 10 µs |
| Reverse recovery charge | $Q_{rr}$ | - | 0 | - | nC | $V_R$ = 400 V, $I_S$ = 18 A |
| Reverse recovery time | $t_{rr}$ | - | 0 | - | ns | |
| Peak reverse recovery current | $I_{rrm}$ | - | 0 | - | A | |

## 9. Electric characteristics diagrams

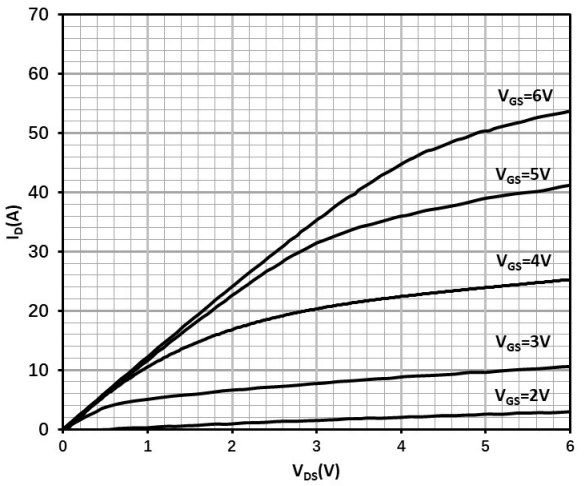
at $T_j$ = 25 °C, unless specified otherwise

Figure 1 Typ. output characteristics



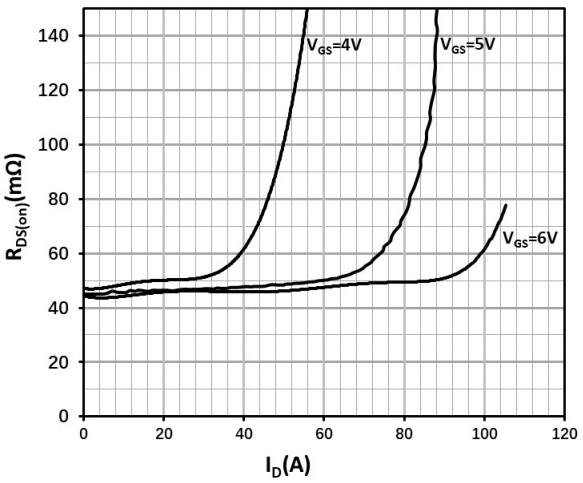

$I_D = f(V_{DS},V_{GS})$; $T_j$ = 25 °C

Figure 2 Typ. output characteristics



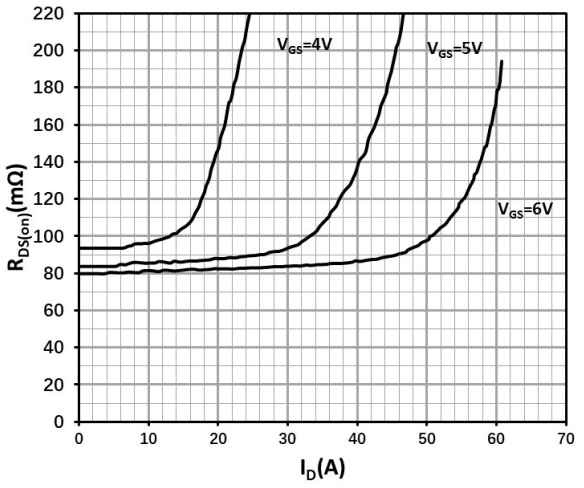

$I_D = f(V_{DS},V_{GS})$; $T_j$ = 125 °C

Figure 3 Typ. Drain-source on-state resistance

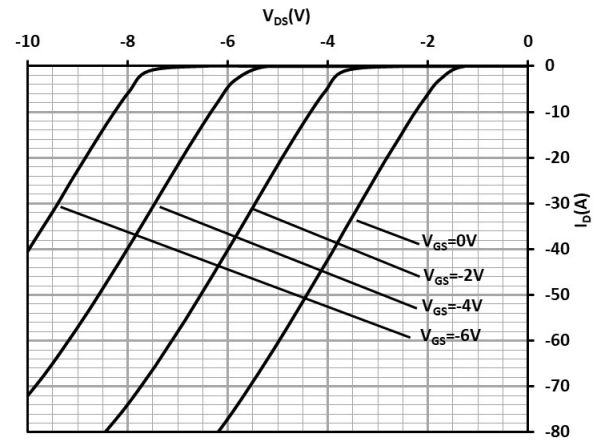
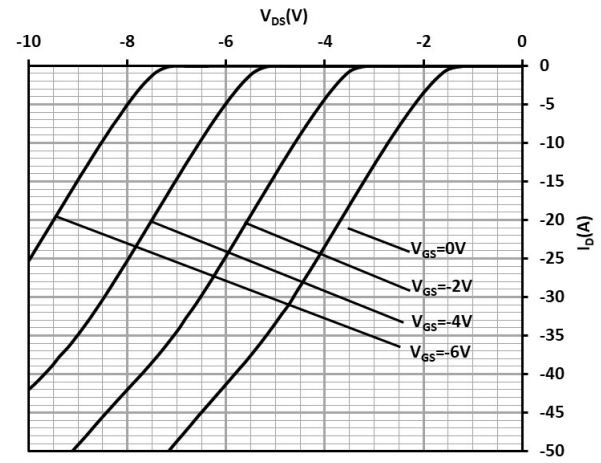



$R_{DS(on)} = f(I_D,V_{GS})$; $T_j$ = 25 °C

Figure 4 Typ. Drain-source on-state resistance




$R_{DS(on)} = f(I_D,V_{GS})$; $T_j$ = 125 °C

| Figure 5 Typ. channel reverse characteristics | Figure 6 Typ. channel reverse characteristics |
|---|---|
|  |  |
| $I_D = f(V_{DS}, V_{GS})$; $T_j$= 25 °C | $I_D = f(V_{DS}, V_{GS})$; $T_j$ = 125 °C |

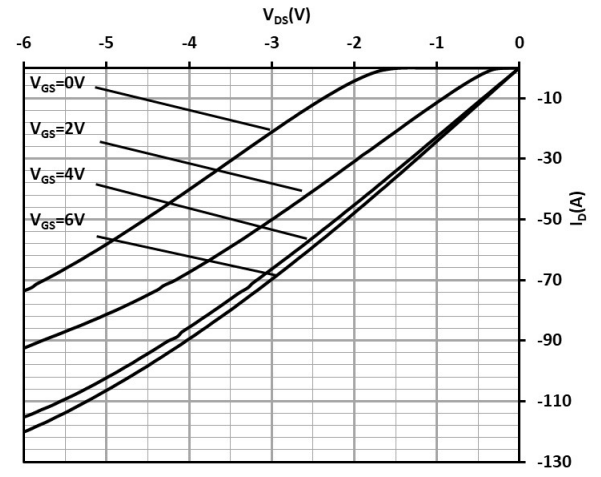
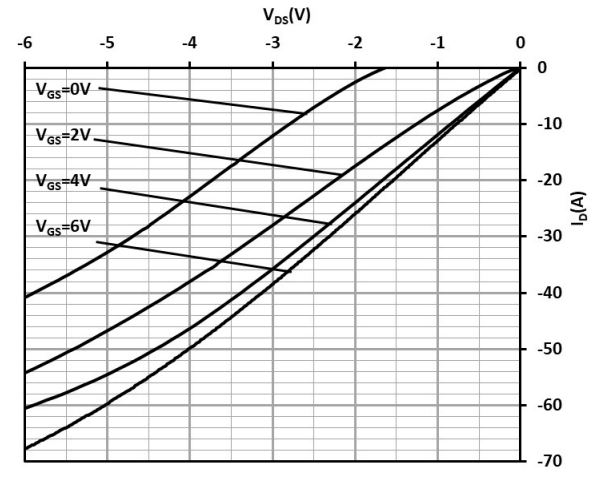
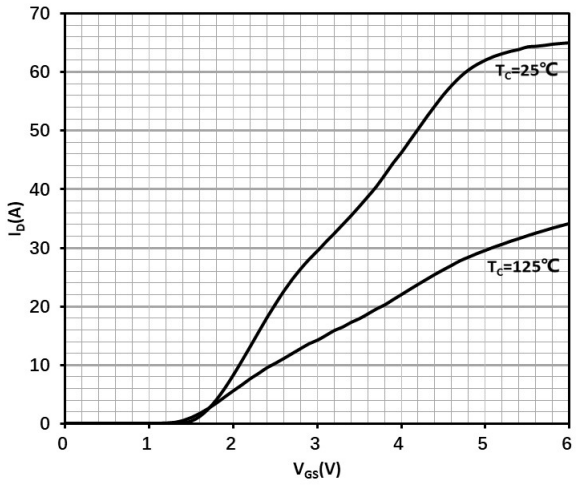
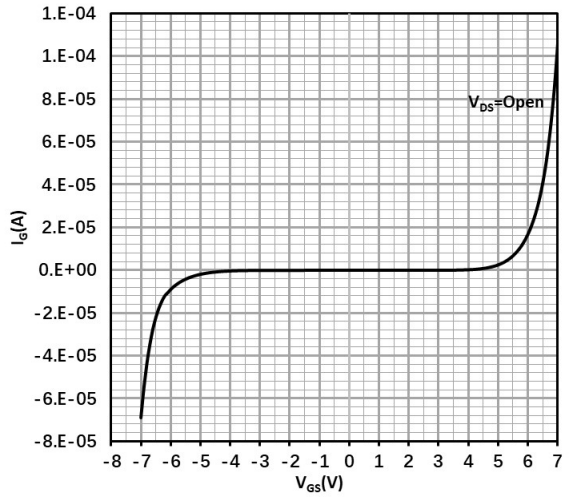
| Figure 7 Typ. channel reverse characteristics | Figure 8 Typ. channel reverse characteristics |
|---|---|
|  |  |
| $I_D = f(V_{DS}, V_{GS})$; $T_j$ = 25 °C | $I_D = f(V_{DS}, V_{GS})$; $T_j$ = 125 °C |

Figure 9 Typ. transfer characteristics



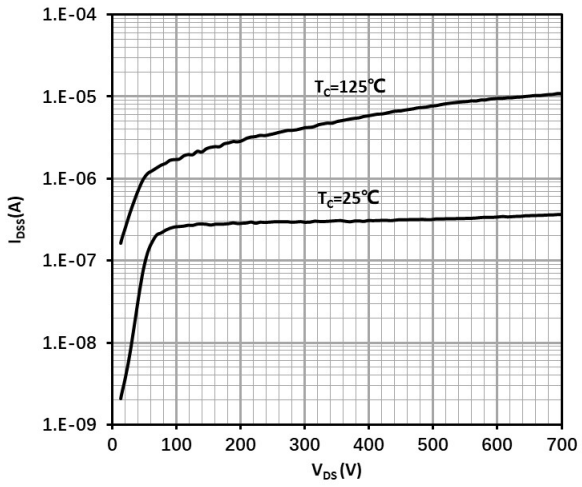

$I_D = f(V_{GS})$; $V_{DS}$= 3 V

Figure 10 Typ. Gate-to-Source leakage



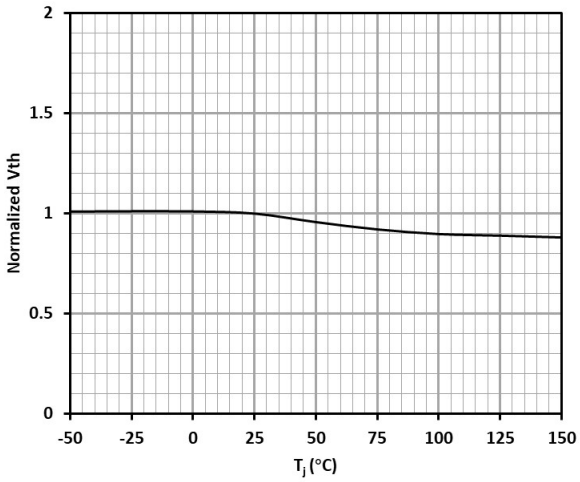

$I_G = f(V_{GS})$;

Figure 11 Drain-source leakage characteristics



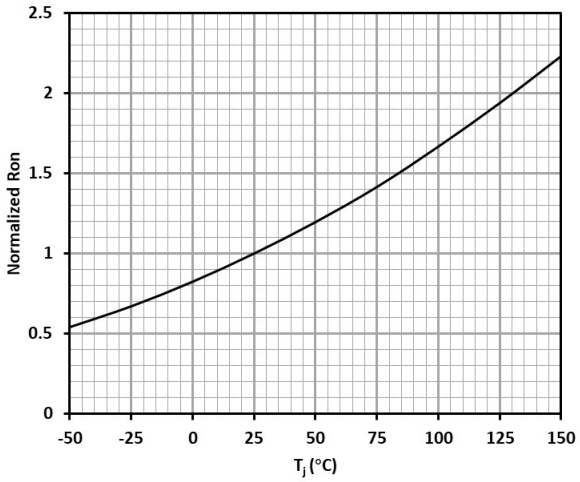

$I_{DSS} = f(V_{DS})$; $V_{GS}$ = 0 V

Figure 12 Gate threshold voltage



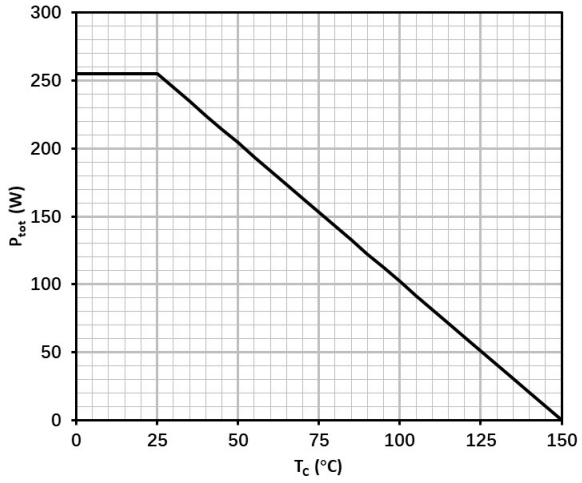

$V_{TH} = f(T_j)$; $V_{GS} = V_{DS}$; $I_D$ = 46.8 mA

Figure 13 Drain-source on-state resistance



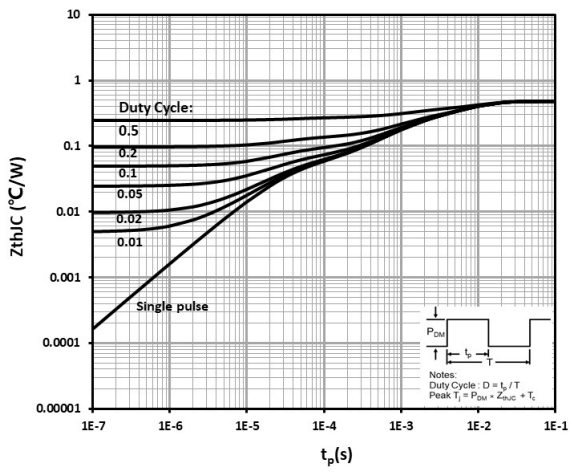

$R_{DS(on)} = f(T_j)$; $I_D$ = 18 A; $V_{GS}$=6V

Figure 14 Power dissipation



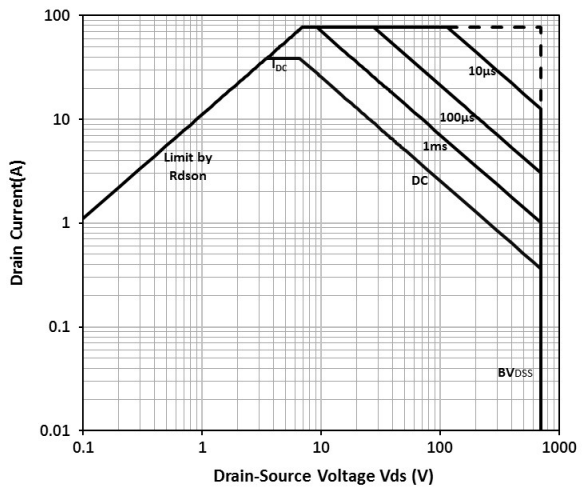

$P_{tot} = f(T_C)$

Figure 15 Max.transient thermal impedance



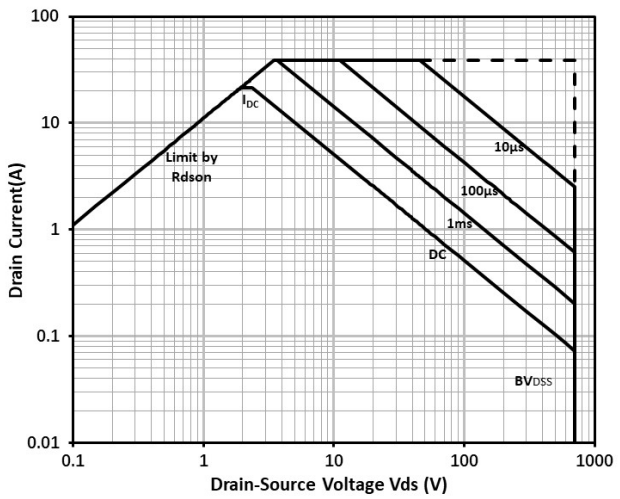

$Z_{thJC} = f(t_P, D)$

Figure 16 Safe operating area



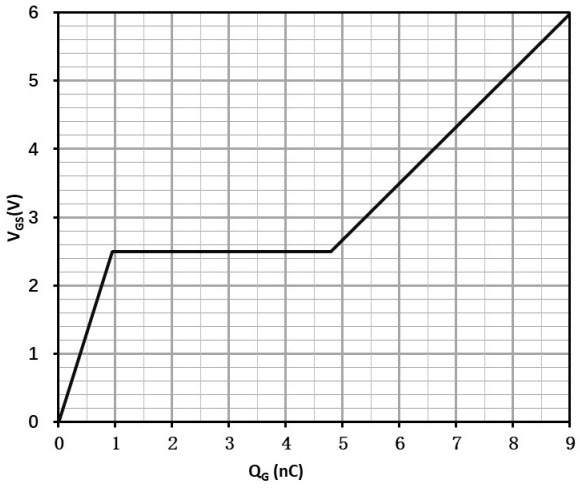

$I_D = f(V_{DS})$; $T_C = 25$ °C

Figure 17 Safe operating area



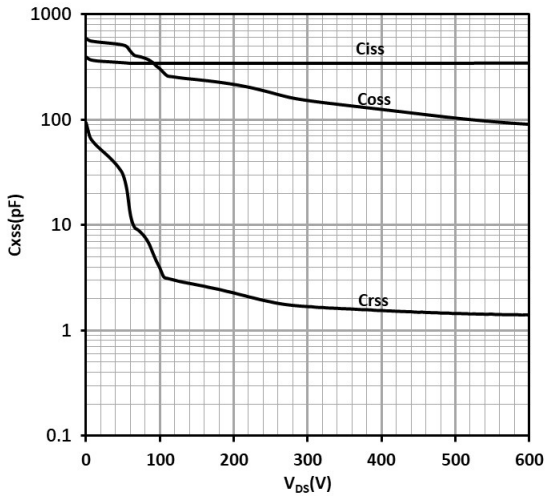

$I_D = f(V_{DS})$; $T_C = 125$ °C

Figure 18 Typ. gate charge



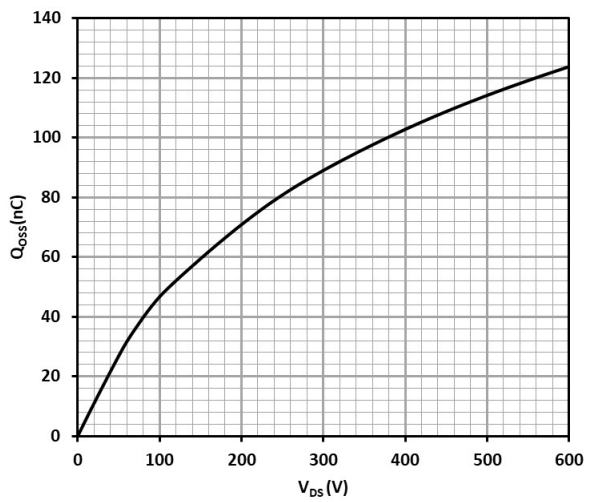

$V_{GS} = f(Q_G)$; $V_{DCLINK} = 400$ V; $I_D = 18$ A

Figure 19 Typ. capacitances



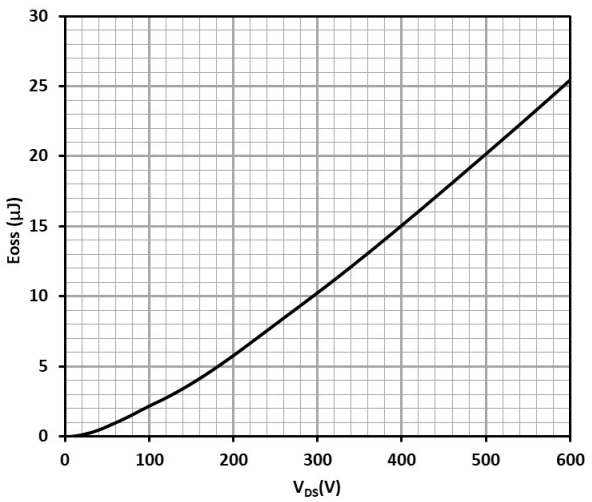

$C_{XSS} = f(V_{DS})$; Freq. = 100 kHz

Figure 20 Typ. output charge



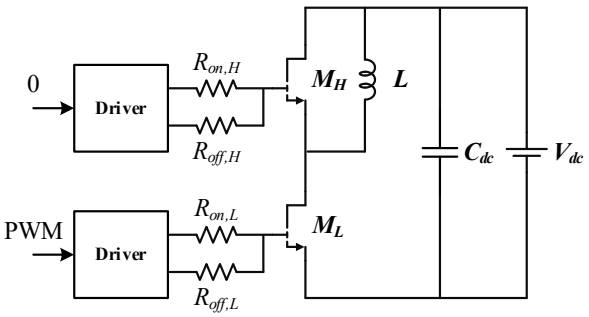

$Q_{OSS}$ = f($V_{DS}$); Freq. = 100 kHz

Figure 21 Typ. $C_{OSS}$ stored Energy



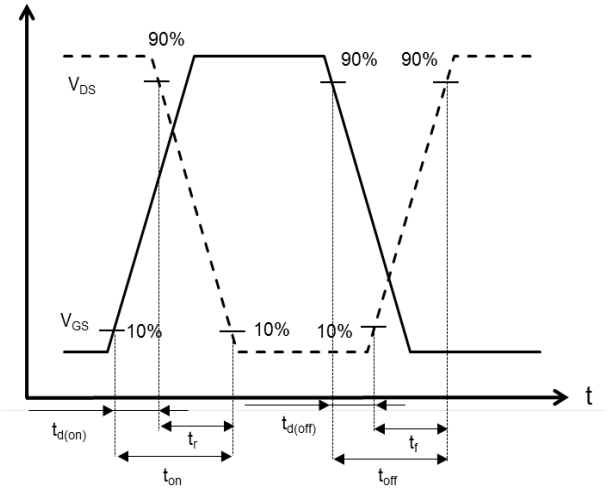

$E_{OSS}$ = f($V_{DS}$); Freq. = 100 kHz

Figure 22 Typ.Switching times with inductive load

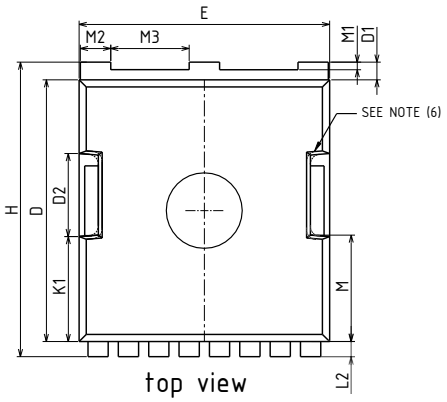


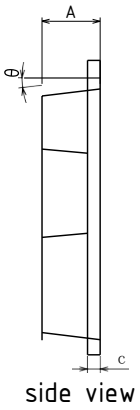

$V_{DS}$ = 400V; $I_D$ = 15A; L= 230µH; $V_{GS}$ = -3/6V;
Rgon = 10Ω; Rgoff = 2.2Ω;

Figure 23 Typ.Switching times waveform

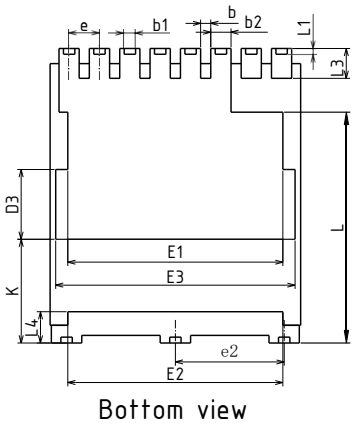


## 10. Package outlines

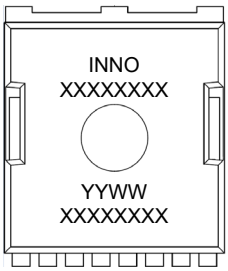






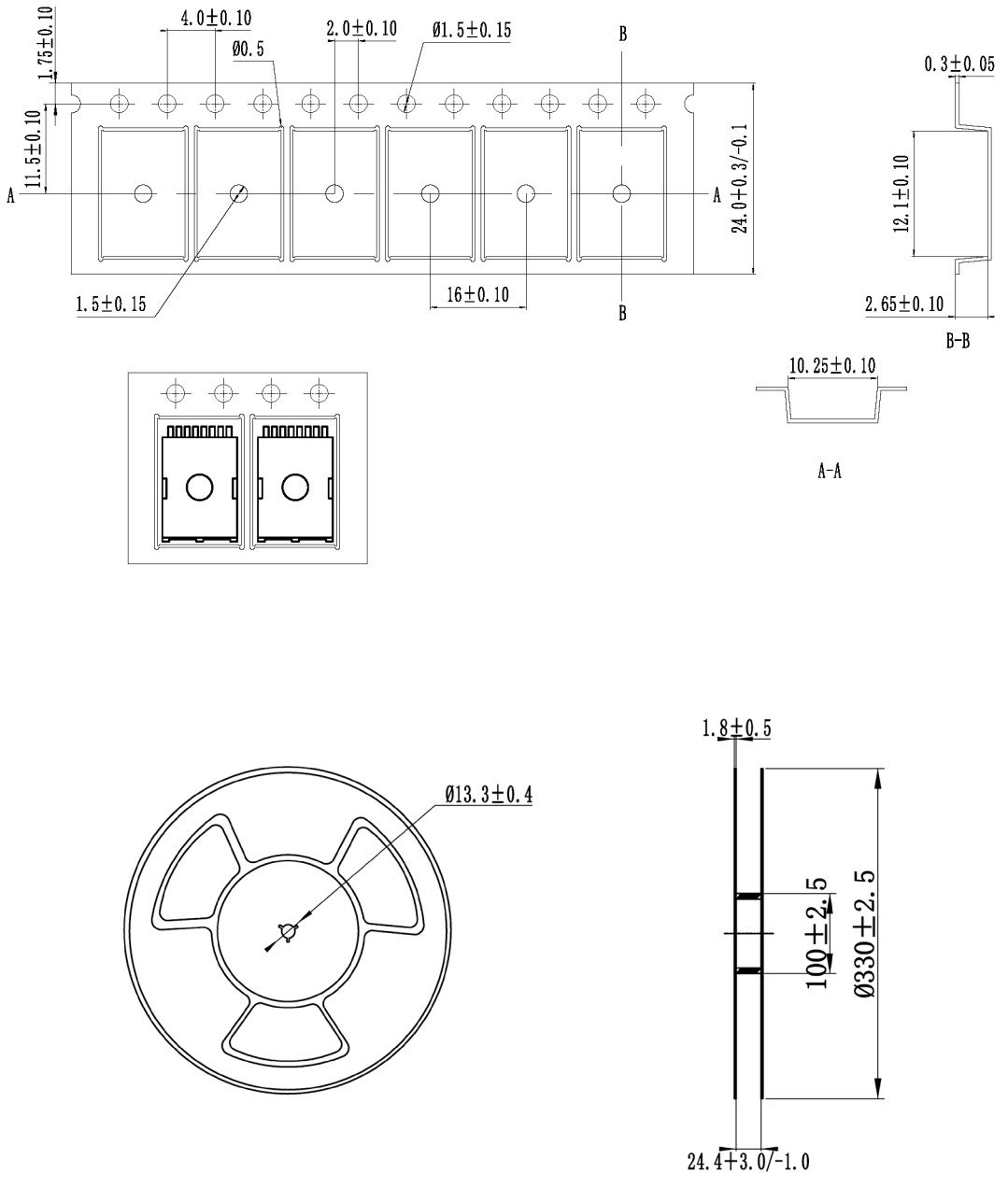

| SYMBOL | MILLIMETER | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 2.15 | 2.30 | 2.45 |
| b | 0.30 | 0.40 | 0.50 |
| b1 | 0.31 | 0.43 | 0.55 |
| b2 | 0.65 | 0.80 | 0.90 |
| c | 0.40 | 0.50 | 0.60 |
| D | 10.18 | 10.38 | 10.58 |
| D1 | 0.50 | 0.70 | 0.90 |
| D2 | 3.30REF | | |
| D3 | 2.77REF | | |
| E | 9.70 | 9.90 | 10.10 |
| E1 | 8.50REF | | |
| E2 | 8.50REF | | |
| E3 | 9.46REF | | |
| e | 1.10 | 1.20 | 1.30 |
| e2 | 4.20 | 4.30 | 4.40 |
| H | 11.48 | 11.68 | 11.88 |
| K | 4.08REF | | |
| K1 | 4.18REF | | |
| L | 9.13REF | | |
| L1 | 0.23REF | | |
| L2 | 0.50 | 0.60 | 0.70 |
| L3 | 1.00 | 1.20 | 1.40 |
| L4 | 1.00 | 1.20 | 1.40 |
| M | 4.18REF | | |
| M1 | 0.26REF | | |
| M2 | 1.10 | 1.20 | 1.30 |
| M3 | 3.10REF | | |
| Θ | 10.00REF | | |



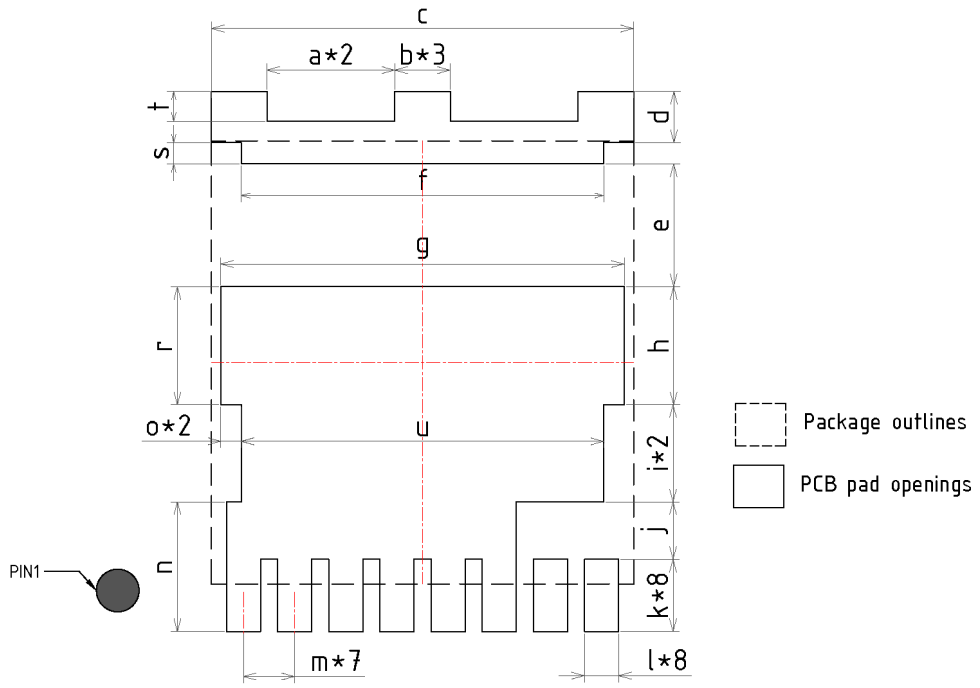

| Row | Description | Example |
|---|---|---|
| Row1 | Company name | INNO |
| Row2 | Product code (In short) | XXXXXXXX |
| Row3 | Date code | YYWW |
| Row4 | ASSY lot No. | XXXXXXXX |

(1) Dimensioning and tolerancing confirm to ASME Y14.5M-1994
(2) All dimensions are in millimeters, angles are in degrees
(3) Coplanarity applies to the exposed heat slug as well as the terminal
(4) Radius on terminal is optional
(5) General tolerance: ± 0.10 mm
(6) Supplier dependent mold cavity , filleted corners or square corners

## 11. Reel information



## 12. Recommended PCB footprint




| SYMBOL | DIMENSION | SYMBOL | DIMENSION |
|---|---|---|---|
| a | 3.00 | k | 1.70 |
| b | 1.30 | l | 0.80 |
| c | 9.90 | m | 1.20 |
| d | 1.20 | n | 3.05 |
| e | 2.88 | o | 0.48 |
| f | 8.50 | r | 2.77 |
| g | 9.46 | s | 0.50 |
| h | 2.77 | t | 0.70 |
| i | 2.28 | u | 8.50 |
| j | 1.35 | / | / |

Notes:
(1)All dimension are in millimeters.
(2)Drawing is not to scale.

## 13. Revision history

**Major changes since the last revision**

| Revision | Date | Description of changes |
|---|---|---|
| 1.0 | 2025-05-20 | 1.0 version release |

## Important Notice

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