

**650V 10mΩ SiC MOSFET****Features:**

- High blocking voltage with low  $R_{ds(on)}$
- High frequency operation with low capacitance
- Simple to drive with -4V/+18V gate
- Robust body diode with low  $Q_{rr}$
- 100% Avalanche Tested

**Benefits**

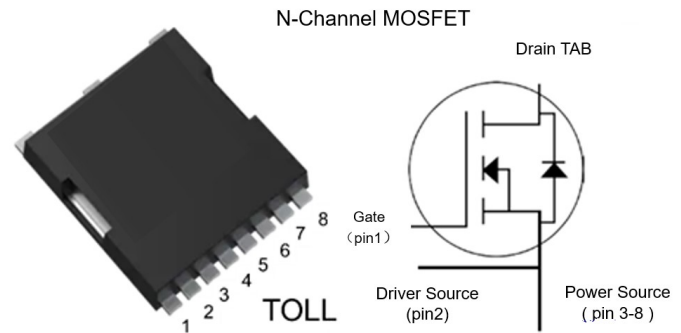
- Superior robustness and system reliability
- Higher system efficiency
- Easier paralleling without thermal runaway
- Capable of high temperature application
- Faster and more efficient switching

**Applications:**

- Solar inverters
- SMPS
- Energy storage systems
- High Performance DC-DC converters
- UPS
- Motor drivers

**Key Performance and Package Parameters**

| Type         | V <sub>DS</sub> | R <sub>DS(ON)</sub> | I <sub>D</sub> @25°C | I <sub>D</sub> @100°C | Marking      | Package |
|--------------|-----------------|---------------------|----------------------|-----------------------|--------------|---------|
| PH010S065JNC | 650V            | 10mΩ                | 172A                 | 122A                  | PH010S065JNC | TOLL    |

**Circuit Diagram****Absolute Maximum Ratings( $T_C=25^\circ\text{C}$  unless otherwise specified)**

| Parameter                                             | Symbols        | Conditions                                                                      | Value      | Unit             |
|-------------------------------------------------------|----------------|---------------------------------------------------------------------------------|------------|------------------|
| Drain - source voltage                                | $V_{DS(max)}$  | $V_{GS}=0V$ , $I_D=100\mu A$                                                    | 650        | V                |
| Gate - source voltage                                 | $V_{GS(max)}$  | AC ( $f>1\text{Hz}$ , duty cycle $<1\%$ , pulse width $<200\text{ns}$ )         | -9 / +23   | V                |
| Gate – source voltage                                 | $V_{GS(op)}$   | Recommend operation                                                             | -4 / +18   | V                |
| Continuous drain current<br>(limited by $T_{J,max}$ ) | $I_D$          | $V_{GS}=18V$ , $T_C=25^\circ\text{C}$<br>$V_{GS}=18V$ , $T_C=100^\circ\text{C}$ | 172<br>122 | A                |
| Pulsed drain current                                  | $I_{D(pulse)}$ | $T_C=25^\circ\text{C}$                                                          | 518        | A                |
| Total power dissipation                               | $P_D$          | $T_C=25^\circ\text{C}$                                                          | 600        | W                |
| Operating junction temperature                        | $T_J$          |                                                                                 | -55 to 175 | $^\circ\text{C}$ |
| Storage temperature                                   | $T_{STG}$      |                                                                                 | -55 to 175 | $^\circ\text{C}$ |
| Soldering temperature                                 | $T_L$          |                                                                                 | 260        | $^\circ\text{C}$ |
| Avalanche capability, single pulse*                   | $I_{AV}$       | $V_{DD}=100V$ , $V_{GS}=10V$ , $L=2\text{mH}$                                   | 55         | A                |
| Avalanche capability, single pulse**                  | $E_{AV}$       | $V_{DD}=100V$ , $V_{GS}=10V$ , $L=2\text{mH}$                                   | 3025       | mJ               |

\*100% tested in 60% rating

\*\*100% tested in 36% rating

### Electrical Characteristics at Tc= 25°C (unless otherwise specified)

| Parameter                        | Symbols       | Conditions                                                                                          | Value |      |     | Unit      |
|----------------------------------|---------------|-----------------------------------------------------------------------------------------------------|-------|------|-----|-----------|
|                                  |               |                                                                                                     | Min   | Typ  | Max |           |
| Drain-source breakdown voltage   | $V_{(BR)DSS}$ | $V_{GS}=0V, I_D=100\mu A$                                                                           | 650   | -    | -   | V         |
| Gate threshold voltage           | $V_{GS(th)}$  | $V_{DS}=V_{GS}, I_D=30mA$                                                                           | 2.6   | 3.1  | 4.2 | V         |
|                                  |               | $V_{DS}=V_{GS}, I_D=30mA, T_J=150^\circ C$                                                          | -     | 2.4  | -   | V         |
|                                  |               | $V_{DS}=V_{GS}, I_D=30mA, T_J=175^\circ C$                                                          | -     | 2.3  | -   | V         |
| Zero gate voltage drain current  | $I_{DSS}$     | $V_{DS}=650V, V_{GS}=0V$                                                                            | 0     | 0.5  | 60  | $\mu A$   |
|                                  |               | $V_{DS}=650V, V_{GS}=0V, T_J=175^\circ C$                                                           | 0     | 5    | 200 | $\mu A$   |
| Gate-source leakage current      | $I_{GSS}$     | $V_{GS}=18V, V_{DS}=0V$                                                                             | 0     | 5    | 100 | nA        |
| Gate-source leakage current      | $I_{GSS}$     | $V_{GS}=-4V, V_{DS}=0V$                                                                             | -100  | -5   | 0   | nA        |
| Drain-source on-state resistance | $R_{DS(on)}$  | $V_{GS}=18V, I_D=90A$                                                                               | -     | 10   | 14  | $m\Omega$ |
|                                  |               | $V_{GS}=18V, I_D=90A, T_J=175^\circ C$                                                              | -     | 12   | -   | $m\Omega$ |
| Transconductance                 | $g_{fs}$      | $V_{DS}=20V, I_D=90A$                                                                               | -     | 78   | -   | S         |
|                                  |               | $V_{DS}=20V, I_D=90A, T_J=175^\circ C$                                                              | -     | 69   | -   | S         |
| Input capacitance                | $C_{iss}$     | $V_{DS}=400V, V_{GS}=0V$<br>$f=100kHz, V_{AC}=25mV$                                                 | -     | 5345 | -   | pF        |
| Output capacitance               | $C_{oss}$     |                                                                                                     | -     | 434  | -   | pF        |
| Reverse transfer capacitance     | $C_{rss}$     |                                                                                                     | -     | 38   | -   | pF        |
| Coss stored energy               | $E_{oss}$     |                                                                                                     | -     | 44   | -   | $\mu J$   |
| Turn-on switching energy         | $E_{ON}$      | $V_{DS}=400V, V_{GS}=-4V/18V$<br>$I_D=90A, R_{G(ext)}=2\Omega,$<br>$R_{G(int)}=9\Omega, L=200\mu H$ | -     | 550  | -   | $\mu J$   |
| Turn-off switching energy        | $E_{OFF}$     |                                                                                                     | -     | 434  | -   | $\mu J$   |
| Turn-on delay time               | $t_{d(on)}$   | $V_{DS}=400V, V_{GS}=-4V/18V$<br>$I_D=90A, R_{G(ext)}=2\Omega,$<br>$R_{G(int)}=9\Omega, L=200\mu H$ | -     | 43   | -   | ns        |
| Rise time                        | $t_r$         |                                                                                                     | -     | 59   | -   | ns        |
| Turn-off delaytime               | $t_{d(off)}$  |                                                                                                     | -     | 127  | -   | ns        |
| Fall time                        | $t_f$         |                                                                                                     | -     | 27   | -   | ns        |
| Total gate charge                | $Q_g$         | $V_{DS}=400V, V_{GS}=-4V/18V$<br>$I_D=90A$                                                          | -     | 263  | -   | nC        |
| Gate-source charge               | $Q_{gs}$      |                                                                                                     | -     | 70   | -   | nC        |
| Gate-drain charge                | $Q_{gd}$      |                                                                                                     | -     | 104  | -   | nC        |
| Internal gate input resistance   | $R_{g(int)}$  | $f=1MHz, I_D=0A$                                                                                    | -     | 9    | -   | $\Omega$  |

\*\*\*Turn-off with -4V gate bias is highly recommended

### Reverse Diode Characteristics at Tc= 25°C (unless otherwise specified)

| Parameter                        | Symbols   | Conditions                                                          | Value |     |     | Unit |
|----------------------------------|-----------|---------------------------------------------------------------------|-------|-----|-----|------|
|                                  |           |                                                                     | Min   | Typ | Max |      |
| Diode forward voltage            | $V_{SD}$  | $V_{GS}=0V, I_{SD}=50A, T_J=25^\circ C$                             | -     | 3.3 | -   | V    |
|                                  |           | $V_{GS}=0V, I_{SD}=50A, T_J=175^\circ C$                            | -     | 2.9 | -   | V    |
| Continuous diode forward current | $I_S$     | $V_{GS}=-4V, T_J=25^\circ C$                                        | -     | 124 | -   | A    |
| Reverse recovery time            | $t_{rr}$  | $V_{GS}=-4V, I_{SD}=90A, V_R=400V,$<br>$L=200\mu H, di/dt=1639A/us$ | -     | 32  | -   | ns   |
| Reverse recovery charge          | $Q_{rr}$  |                                                                     | -     | 760 | -   | nC   |
| Peak reverse recovery current    | $I_{rrm}$ |                                                                     | -     | 40  | -   | A    |

### Thermal Characteristics

| Parameter          | Symbols       | Conditions       | Value |      |      | Unit         |
|--------------------|---------------|------------------|-------|------|------|--------------|
|                    |               |                  | Min   | Typ  | Max  |              |
| Thermal resistance | $R_{th(j-c)}$ | Junction to case | -     | 0.22 | 0.30 | $^\circ C/W$ |

## Typical Characteristics

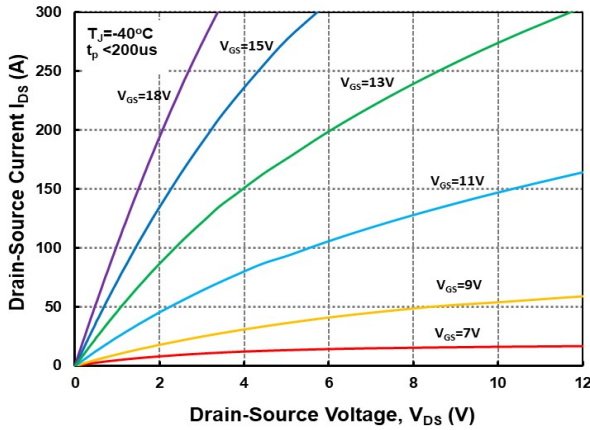


Figure 1: Output Characteristics,  $T_J = -40^\circ\text{C}$

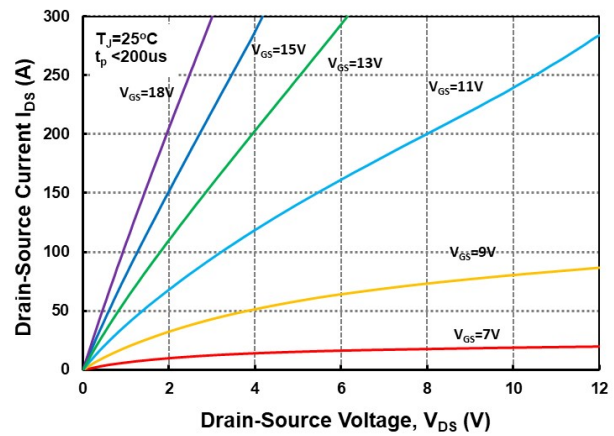


Figure 2: Output Characteristics,  $T_J = 25^\circ\text{C}$

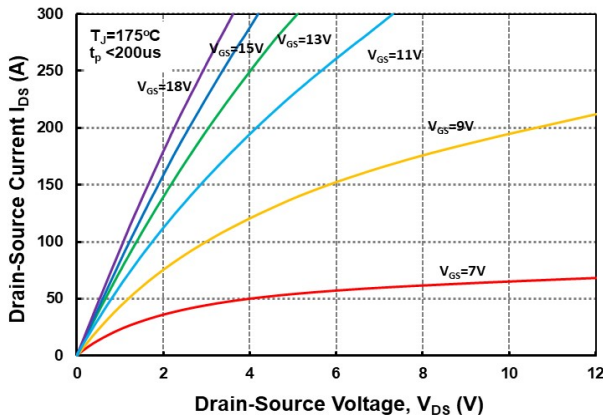


Figure 3: Output Characteristics,  $T_J = 175^\circ\text{C}$

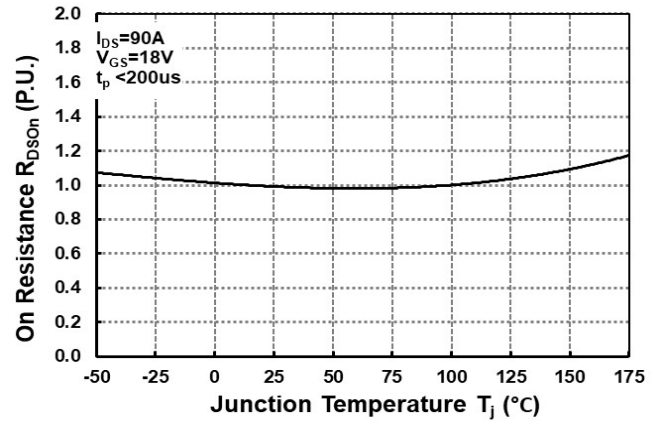


Figure 4: Normalized On-Resistance vs. Temperature

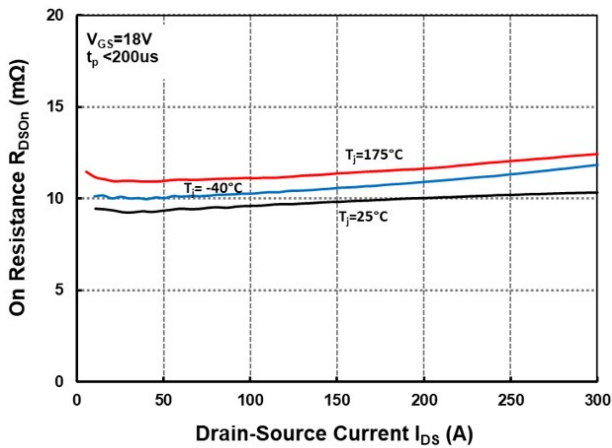


Figure 5: On-Resistance vs. Drain Current for Various Temperatures

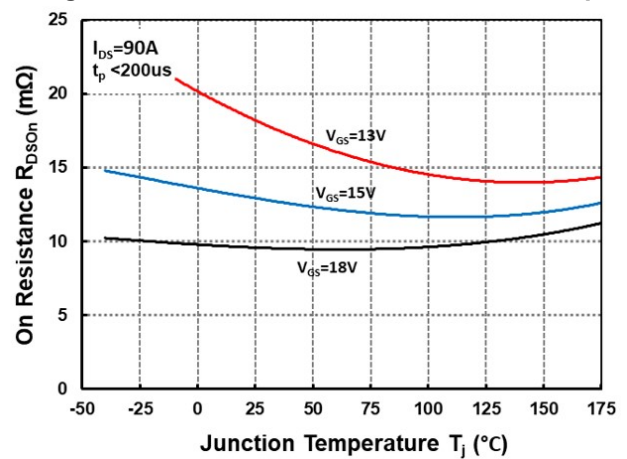


Figure 6: On-Resistance vs. Temperature for Various Gate Voltage

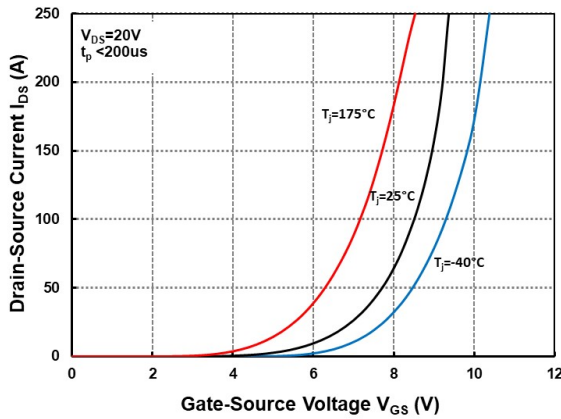


Figure 7: Transfer Characteristic for Various Junction Temperatures

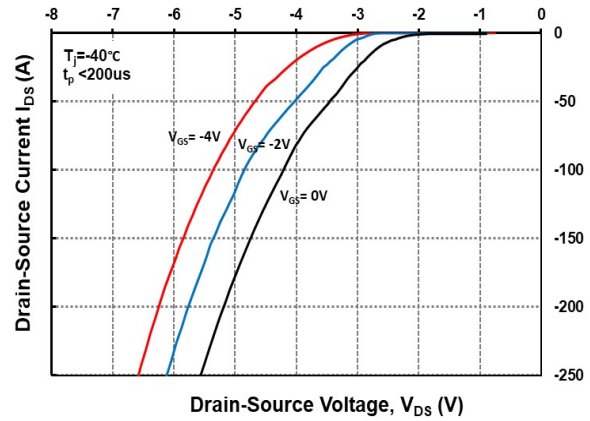


Figure 8: Body Diode Characteristics @ -40°C

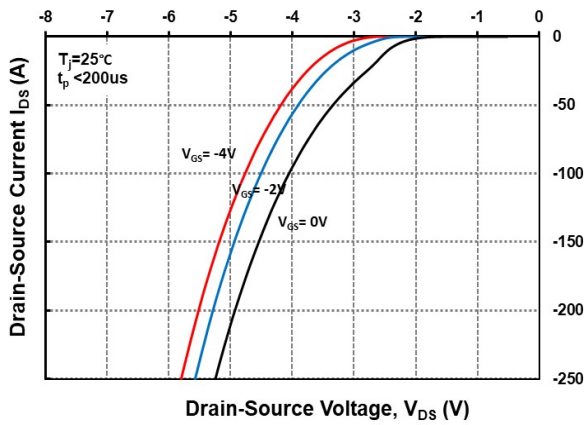


Figure 9: Body Diode Characteristics @ 25°C

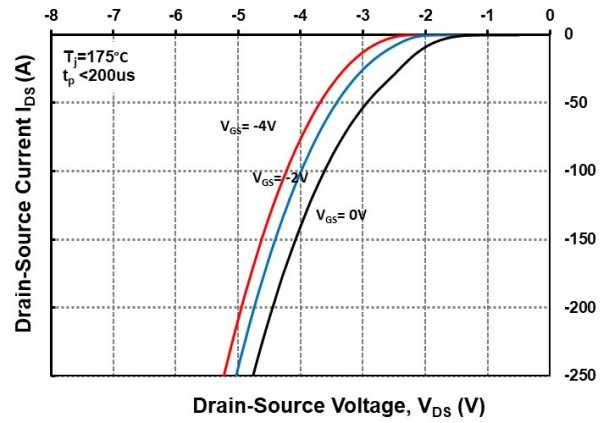


Figure 10: Body Diode Characteristics @ 175°C

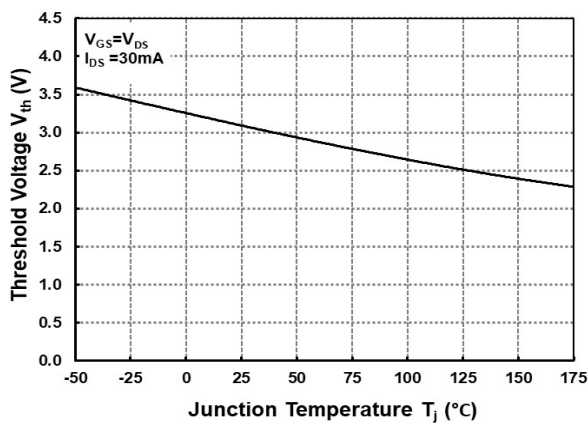


Figure 11: Threshold Voltage vs. Temperature

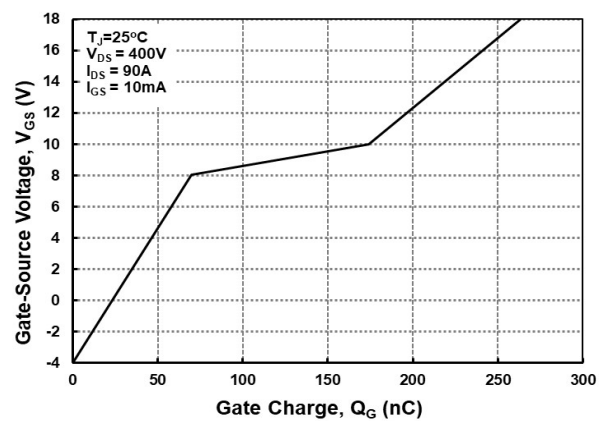


Figure 12: Gate Charge Characteristics

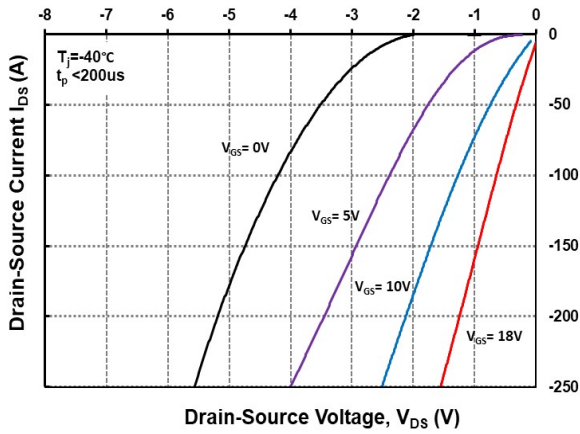


Figure 13: 3<sup>rd</sup> Quadrant Characteristics @ -40°C

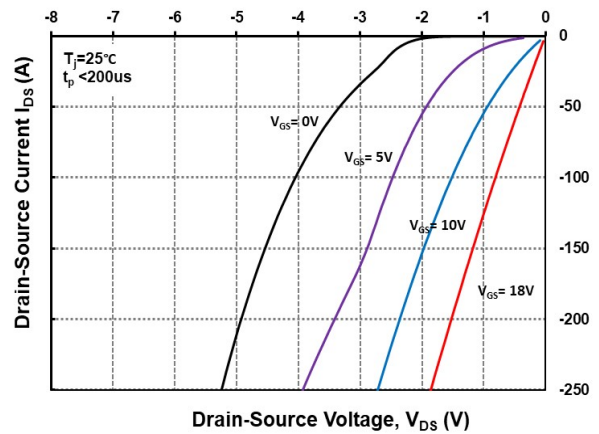


Figure 14: 3<sup>rd</sup> Quadrant Characteristics @ 25°C

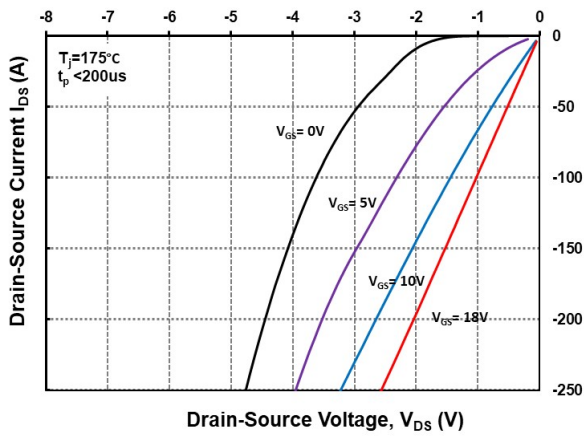


Figure 15: 3<sup>rd</sup> Quadrant Characteristics @ 175°C

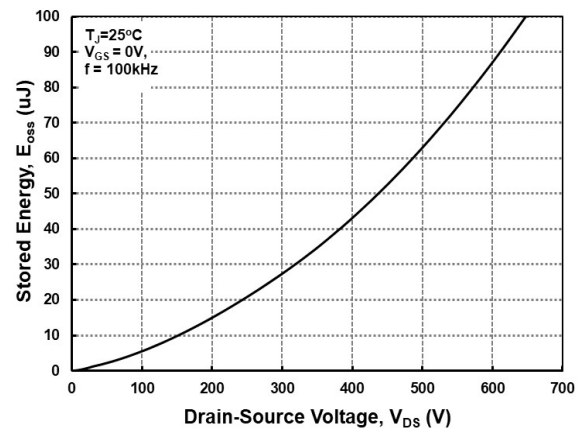


Figure 16: Output Capacitor Stored Energy

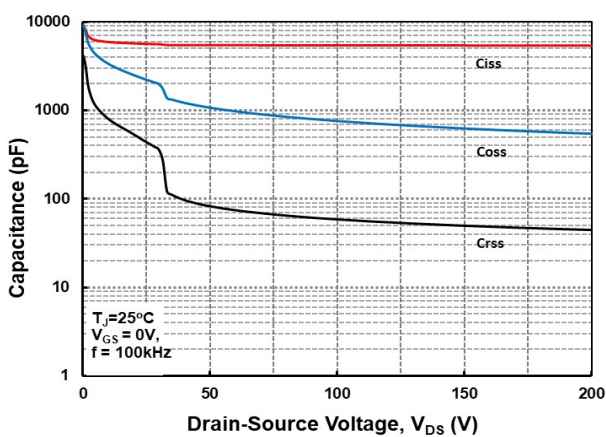


Figure 17: Capacitances vs. Drain-Source Voltage (0-200V)

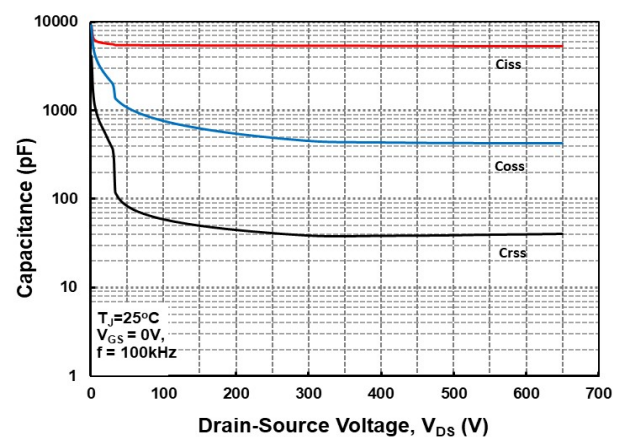


Figure 18: Capacitances vs. Drain-Source Voltage (0-650V)

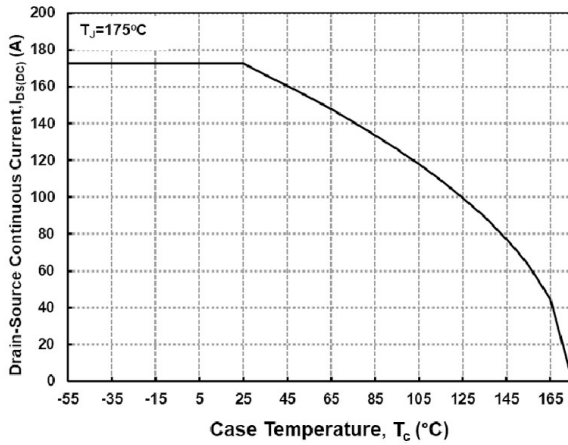


Figure 19: Continuous Drain Current Derating vs. Case Temperature

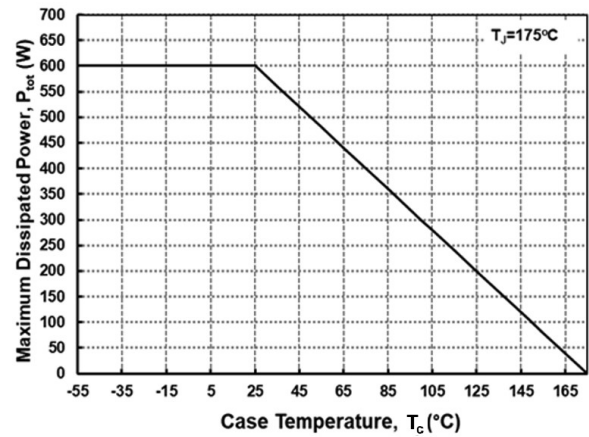


Figure 20: Maximum Power Dissipation Derating vs. Case Temperature

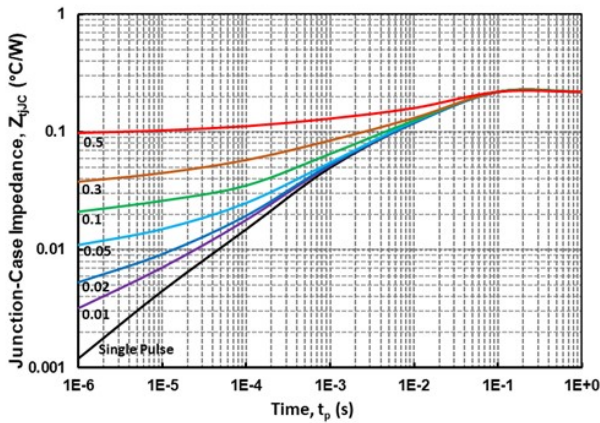


Figure 21: Transient Thermal Impedance (Junction - Case)

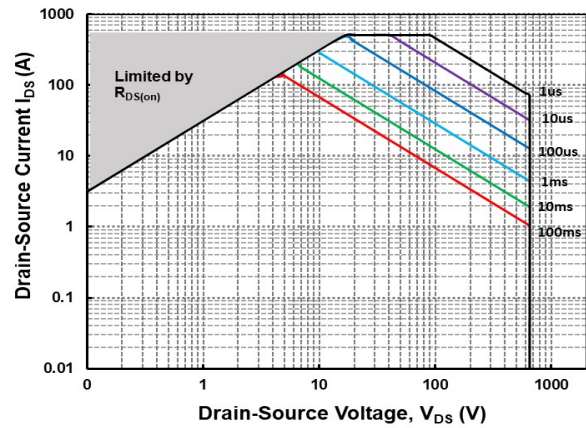


Figure 22: Safe Operating Area

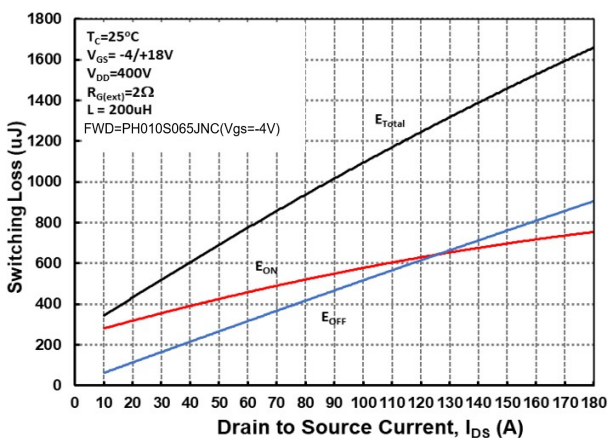


Figure 23: Clamped inductive Switching Energy vs Drain Current (VDD= 400V)

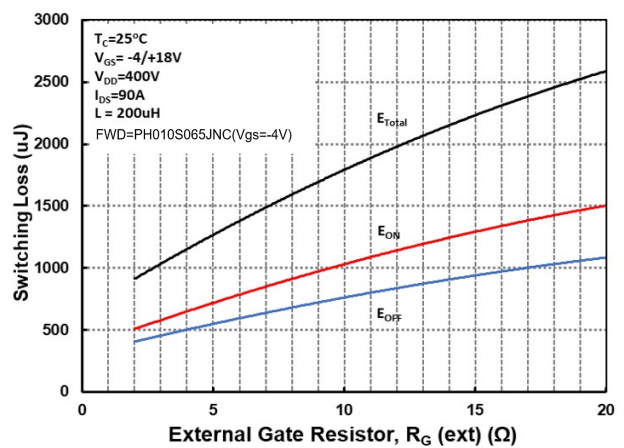


Figure 24: Clamped inductive Switching Energy vs External Gate Resistor  $R_{G(ext)}$

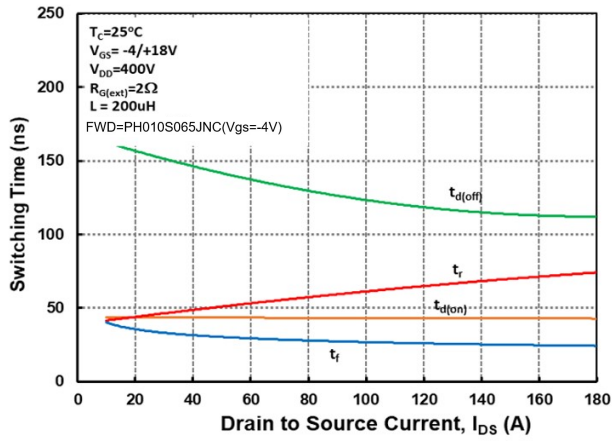


Figure 25: Switching Times vs Drain Current( $V_{DD}=400V$ )

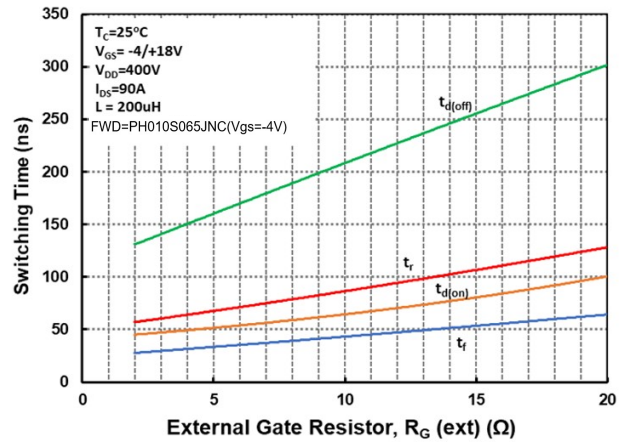
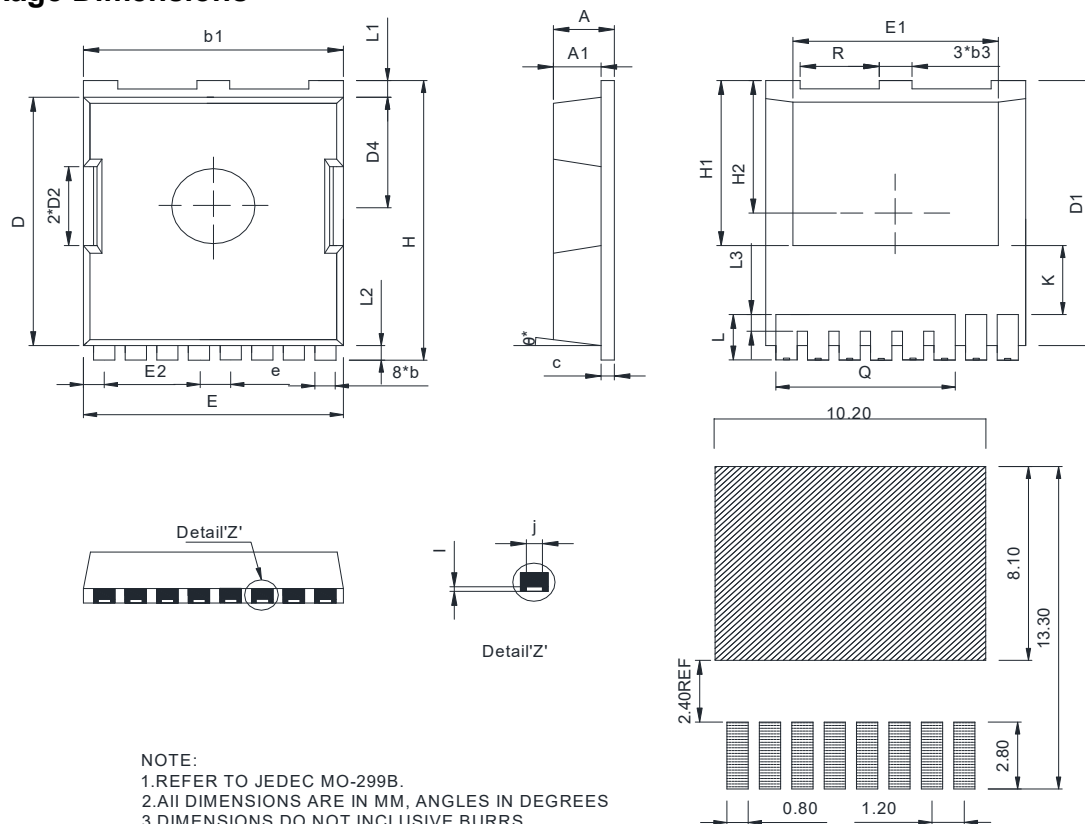


Figure 26: Switching Times vs External Gate Resistor  $R_{G(ext)}$

## Package Dimensions

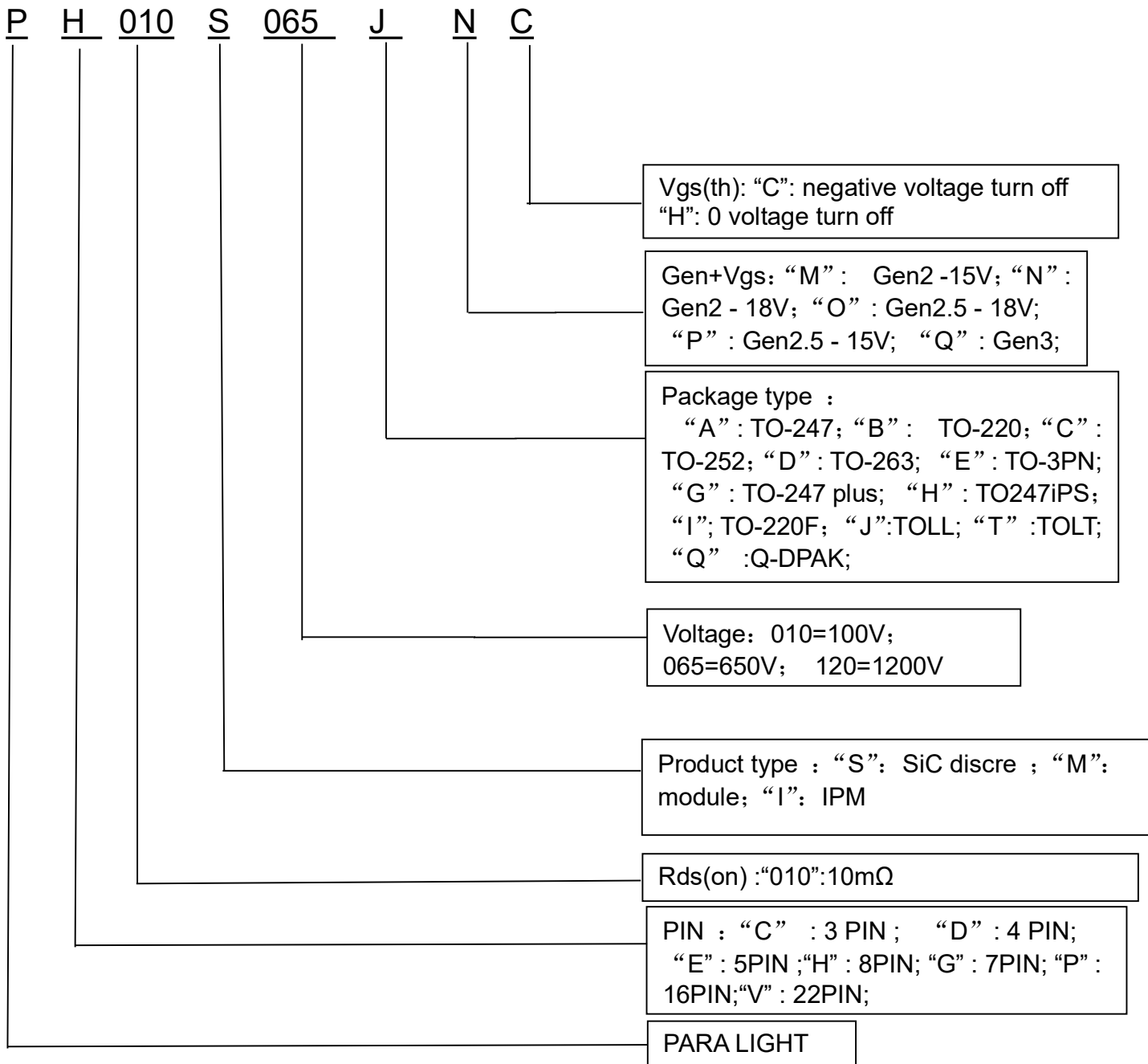


NOTE:  
1.REFER TO JEDEC MO-299B.  
2.ALL DIMENSIONS ARE IN MM, ANGLES IN DEGREES  
3.DIMENSIONS DO NOT INCLUSIVE BURRS  
AND MOLD FLASH.  
4. "\*" IS FOR REFERENCE,

Recommended Solder Pad Layout

| Common dimensions(mm) |         |       |       |        |          |       |       |
|-----------------------|---------|-------|-------|--------|----------|-------|-------|
| Symbol                | Min     | Typ   | Max   | Symbol | Min      | Typ   | Max   |
| A                     | 2.20    | 2.30  | 2.40  | H      | 11.58    | 11.68 | 11.78 |
| A1                    | 1.70    | 1.80  | 1.90  | H1     | 6.95BSC  |       |       |
| b                     | 0.70    | 0.80  | 0.90  | H2     | 5.89BSC  |       |       |
| b1                    | 9.70    | 9.80  | 9.90  | I      | 0.10REF. |       |       |
| b3                    | 1.10    | 1.20  | 1.30  | j      | 0.46REF. |       |       |
| c                     | 0.40    | 0.50  | 0.60  | K      | 2.80REF. |       |       |
| D                     | 10.28   | 10.38 | 10.48 | L      | 1.40     | 1.90  | 2.10  |
| D1                    | 10.98   | 11.08 | 11.18 | L1     | 0.60     | 0.70  | 0.80  |
| D2                    | 3.20    | 3.30  | 3.40  | L2     | 0.50     | 0.60  | 0.70  |
| D4                    | 4.45    | 4.55  | 4.65  | L3     | 0.30     | 0.70  | 0.80  |
| E                     | 9.80    | 9.90  | 10.00 | N      | 8        |       |       |
| E1                    | 8.00    | 8.10  | 8.20  | Q      | 6.80REF. |       |       |
| E2                    | 0.60    | 0.70  | 0.80  | R      | 3.00     | 3.10  | 3.20  |
| e                     | 1.20BSC |       |       | θ      | 10° REF. |       |       |

**PART NO. SYSTEM :**



## Revision history

### Document revision history

| Date       | Version | Changes           |
|------------|---------|-------------------|
| 2025.09.17 | A / 0   | First release.    |
| 2025.10.31 | A / 1   | Error correction. |
| 2025.12.22 | A / 2   | Version Upgrade.  |
|            |         |                   |
|            |         |                   |