

# Silicon Carbide (SiC) MOSFET – EliteSiC, 12.7 mohm, 650 V, M3S, T2PAK

## NVT2012N065M3S

### Features

- Typ.  $R_{DS(on)} = 12.7 \text{ m}\Omega @ V_{GS} = 18 \text{ V}$
- Low Effective Output Capacitance
- Ultra Low Gate Charge
- 100% UIS Tested
- Qualified According to AECQ101
- RoHS Compliant

### Applications

- Automotive On and Off Board Charger
- Automotive DC-DC Converter for EV-HEV

### MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

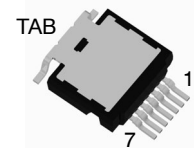
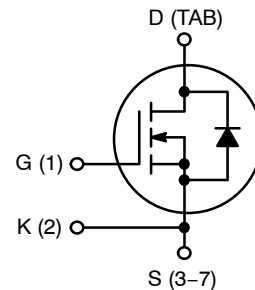
| Parameter                                                                                  | Symbol                                                                         | Value       | Unit             |
|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|-------------|------------------|
| Drain-to-Source Voltage                                                                    | $V_{DSS}$                                                                      | 650         | V                |
| Gate-to-Source Voltage                                                                     | $V_{GS}$                                                                       | -10/+22     | V                |
| Continuous Drain Current                                                                   | $T_C = 25^\circ\text{C}$                                                       | $I_D$       | 112              |
| Power Dissipation                                                                          |                                                                                |             |                  |
| Continuous Drain Current                                                                   | $T_C = 100^\circ\text{C}$                                                      | $I_D$       | 81               |
| Power Dissipation                                                                          |                                                                                |             |                  |
| Pulsed Drain Current (Note 1)                                                              | $T_C = 25^\circ\text{C}$<br>$t_p = 100 \mu\text{s}$                            | $I_{DM}$    | 237              |
| Continuous Source-Drain Current (Body Diode)                                               | $T_C = 25^\circ\text{C}$<br>$V_{GS} = -3 \text{ V}$                            | $I_S$       | 64               |
|                                                                                            | $T_C = 100^\circ\text{C}$<br>$V_{GS} = -3 \text{ V}$                           |             | 38               |
| Pulsed Source-Drain Current (Body Diode) (Note 1)                                          | $T_C = 25^\circ\text{C}$<br>$V_{GS} = -3 \text{ V}$<br>$t_p = 100 \mu\text{s}$ | $I_{SM}$    | 259              |
| Single Pulse Avalanche Energy ( $I_{LPK} = 72 \text{ A}$ , $L = 0.1 \text{ mH}$ ) (Note 2) | $E_{AS}$                                                                       | 259         | mJ               |
| Operating Junction and Storage Temperature Range                                           | $T_J, T_{stg}$                                                                 | -55 to +175 | $^\circ\text{C}$ |
| Lead Temperature for Soldering Purposes (1/8" from case for 10 seconds)                    | $T_L$                                                                          | 245         | $^\circ\text{C}$ |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Single pulse, limited by max junction temperature.
2.  $E_{AS}$  of 259 mJ is based on starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.1 \text{ mH}$ ,  $I_{AS} = 72 \text{ A}$ ,  $V_{DD} = 100 \text{ V}$ ,  $V_{GS} = 18 \text{ V}$ .

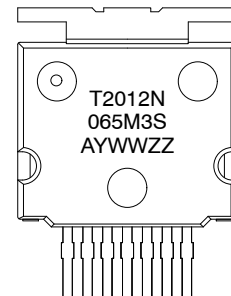
| $V_{(BR)DSS}$ | $R_{DS(on)}$ TYP                        | $I_D$ MAX |
|---------------|-----------------------------------------|-----------|
| 650 V         | 12.7 m $\Omega @ V_{GS} = 18 \text{ V}$ | 112 A     |

### N-CHANNEL MOSFET



T2PAK  
CASE 763AC

### MARKING DIAGRAM



NVT2012N065M3S = Specific Device Code  
A = Assembly Site  
WW = Work Week Number  
Y = Year of Production, Last Number  
ZZ = Assembly Lot Number, Last Two Numbers

### ORDERING INFORMATION

| Device         | Package  | Shipping <sup>†</sup> |
|----------------|----------|-----------------------|
| NVT2012N065M3S | T2PAK-7L | 800 / Tape & Reel     |

<sup>†</sup> For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, [BRD8011/D](#).

## THERMAL CHARACTERISTICS

| Parameter                                     | Symbol          | Value | Unit |
|-----------------------------------------------|-----------------|-------|------|
| Thermal Resistance, Junction-to-Case (Note 3) | $R_{\theta JC}$ | 0.35  | °C/W |

3. The entire application environment impacts the thermal resistance values shown, they are not constants and are only valid for the particular conditions noted.

## RECOMMENDED OPERATING CONDITIONS

| Parameter                                  | Symbol     | Value  | Unit |
|--------------------------------------------|------------|--------|------|
| Operation Values of Gate-to-Source Voltage | $V_{GSop}$ | -3/+18 | V    |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

ELECTRICAL CHARACTERISTICS ( $T_J = 25\text{ °C}$  unless otherwise specified)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|-----------|--------|-----------------|-----|-----|-----|------|
|-----------|--------|-----------------|-----|-----|-----|------|

## OFF CHARACTERISTICS

|                                                           |                                   |                                                              |     |    |     |       |
|-----------------------------------------------------------|-----------------------------------|--------------------------------------------------------------|-----|----|-----|-------|
| Drain-to-Source Breakdown Voltage                         | $V_{(BR)DSS}$                     | $V_{GS} = 0\text{ V}, I_D = 1\text{ mA}, T_J = 25\text{ °C}$ | 650 | -  | -   | V     |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | $\Delta V_{(BR)DSS} / \Delta T_J$ | $I_D = 1\text{ mA}$ , Referenced to 25 °C (Note 5)           | -   | 86 | -   | mV/°C |
| Zero Gate Voltage Drain Current                           | $I_{DSS}$                         | $V_{DS} = 650\text{ V}, T_J = 25\text{ °C}$                  | -   | -  | 10  | μA    |
|                                                           |                                   | $V_{DS} = 650\text{ V}, T_J = 175\text{ °C}$ (Note 5)        | -   | -  | 500 | μA    |
| Gate-to-Source Leakage Current                            | $I_{GSS}$                         | $V_{GS} = -10\text{ V}, V_{DS} = 0\text{ V}$                 | -1  | -  | -   | μA    |
|                                                           |                                   | $V_{GS} = +22\text{ V}, V_{DS} = 0\text{ V}$                 | -   | -  | 1   | μA    |

## ON CHARACTERISTICS

|                               |              |                                                                         |     |      |      |    |
|-------------------------------|--------------|-------------------------------------------------------------------------|-----|------|------|----|
| Drain-to-Source On Resistance | $R_{DS(on)}$ | $V_{GS} = 18\text{ V}, I_D = 40\text{ A}, T_J = 25\text{ °C}$           | -   | 12.7 | 16.8 | mΩ |
|                               |              | $V_{GS} = 18\text{ V}, I_D = 40\text{ A}, T_J = 175\text{ °C}$ (Note 5) | -   | 18   | -    |    |
|                               |              | $V_{GS} = 15\text{ V}, I_D = 40\text{ A}, T_J = 25\text{ °C}$           | -   | 15   | -    |    |
|                               |              | $V_{GS} = 15\text{ V}, I_D = 40\text{ A}, T_J = 175\text{ °C}$ (Note 5) | -   | 20   | -    |    |
| Gate Threshold Voltage        | $V_{GS(TH)}$ | $V_{GS} = V_{DS}, I_D = 20\text{ mA}, T_J = 25\text{ °C}$               | 2.0 | 2.7  | 4.0  | V  |
| Forward Transconductance      | $g_{FS}$     | $V_{DS} = 10\text{ V}, I_D = 40\text{ A}$ (Note 5)                      | -   | 26   | -    | S  |

## CHARGES, CAPACITANCES &amp; GATE RESISTANCE

|                              |              |                                                                              |   |      |   |    |
|------------------------------|--------------|------------------------------------------------------------------------------|---|------|---|----|
| Input Capacitance            | $C_{ISS}$    | $V_{DS} = 400\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$ (Note 5)      | - | 3610 | - | pF |
| Output Capacitance           | $C_{OSS}$    |                                                                              | - | 281  | - |    |
| Reverse Transfer Capacitance | $C_{RSS}$    |                                                                              | - | 24   | - |    |
| Total Gate Charge            | $Q_{G(TOT)}$ | $V_{DD} = 400\text{ V}, I_D = 40\text{ A}, V_{GS} = -3/18\text{ V}$ (Note 5) | - | 135  | - | nC |
| Gate-to-Source Charge        | $Q_{GS}$     |                                                                              | - | 35   | - |    |
| Gate-to-Drain Charge         | $Q_{GD}$     |                                                                              | - | 29   | - |    |
| Gate Resistance              | $R_G$        | $f = 1\text{ MHz}$                                                           | - | 1.6  | - | Ω  |

## SWITCHING CHARACTERISTICS

|                         |              |                                                                                                                                                    |   |      |   |    |
|-------------------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------|---|------|---|----|
| Turn-On Delay Time      | $t_{d(ON)}$  | $V_{GS} = -3/18\text{ V}, I_D = 40\text{ A}, V_{DD} = 400\text{ V}, R_G = 4.7\text{ Ω}, L_{stray} = 13\text{ nH}, T_J = 25\text{ °C}$ (Notes 4, 5) | - | 38   | - | ns |
| Turn-Off Delay Time     | $t_{d(OFF)}$ |                                                                                                                                                    | - | 48   | - |    |
| Rise Time               | $t_r$        |                                                                                                                                                    | - | 17.7 | - |    |
| Fall Time               | $t_f$        |                                                                                                                                                    | - | 10.9 | - |    |
| Turn-On Switching Loss  | $E_{ON}$     |                                                                                                                                                    | - | 179  | - | μJ |
| Turn-Off Switching Loss | $E_{OFF}$    |                                                                                                                                                    | - | 95   | - |    |
| Total Switching Loss    | $E_{TOT}$    |                                                                                                                                                    | - | 274  | - |    |

4.  $E_{ON}/E_{OFF}$  result is with body diode.

5. Defined by design, not subject to production test.



**ELECTRICAL CHARACTERISTICS** ( $T_J = 25\text{ }^{\circ}\text{C}$  unless otherwise specified) (continued)

| Parameter                        | Symbol       | Test Conditions                                                                                                                                                                                | Min | Typ | Max | Unit          |
|----------------------------------|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|---------------|
| <b>SWITCHING CHARACTERISTICS</b> |              |                                                                                                                                                                                                |     |     |     |               |
| Turn-On Delay Time               | $t_{d(ON)}$  | $V_{GS} = -3/18\text{ V}$ , $I_D = 40\text{ A}$ ,<br>$V_{DD} = 400\text{ V}$ , $R_G = 4.7\text{ }\Omega$ ,<br>$L_{stray} = 13\text{ nH}$ , $T_J = 175\text{ }^{\circ}\text{C}$<br>(Notes 4, 5) | –   | 29  | –   | ns            |
| Turn-Off Delay Time              | $t_{d(OFF)}$ |                                                                                                                                                                                                | –   | 67  | –   |               |
| Rise Time                        | $t_r$        |                                                                                                                                                                                                | –   | 18  | –   |               |
| Fall Time                        | $t_f$        |                                                                                                                                                                                                | –   | 12  | –   |               |
| Turn-On Switching Loss           | $E_{ON}$     |                                                                                                                                                                                                | –   | 178 | –   | $\mu\text{J}$ |
| Turn-Off Switching Loss          | $E_{OFF}$    |                                                                                                                                                                                                | –   | 110 | –   |               |
| Total Switching Loss             | $E_{TOT}$    |                                                                                                                                                                                                | –   | 288 | –   |               |

**SOURCE-TO-DRAIN DIODE CHARACTERISTICS**

|                               |           |                                                                                                                                                                  |   |     |     |               |
|-------------------------------|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----|-----|---------------|
| Forward Diode Voltage         | $V_{SD}$  | $I_{SD} = 40\text{ A}$ , $V_{GS} = -3\text{ V}$ , $T_J = 25\text{ }^{\circ}\text{C}$                                                                             | – | 4.5 | 6.0 | V             |
|                               |           | $I_{SD} = 40\text{ A}$ , $V_{GS} = -3\text{ V}$ , $T_J = 175\text{ }^{\circ}\text{C}$<br>(Note 5)                                                                | – | 4.2 | –   |               |
| Reverse Recovery Time         | $t_{RR}$  | $V_{GS} = -3\text{ V}$ , $I_S = 40\text{ A}$ ,<br>$di/dt = 1000\text{ A}/\mu\text{s}$ , $V_{DS} = 400\text{ V}$ ,<br>$T_J = 25\text{ }^{\circ}\text{C}$ (Note 5) | – | 26  | –   | ns            |
| Charge Time                   | $t_a$     |                                                                                                                                                                  | – | 15  | –   |               |
| Discharge Time                | $t_b$     |                                                                                                                                                                  | – | 11  | –   |               |
| Reverse Recovery Charge       | $Q_{RR}$  |                                                                                                                                                                  | – | 195 | –   | nC            |
| Reverse Recovery Energy       | $E_{REC}$ |                                                                                                                                                                  | – | 16  | –   | $\mu\text{J}$ |
| Peak Reverse Recovery Current | $I_{RRM}$ |                                                                                                                                                                  | – | 13  | –   | A             |

4.  $E_{ON}/E_{OFF}$  result is with body diode.

5. Defined by design, not subject to production test.

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.



TYPICAL CHARACTERISTICS

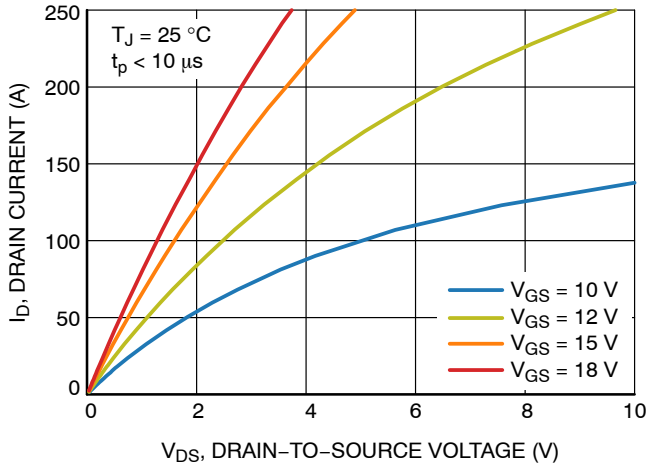


Figure 1. Output Characteristics

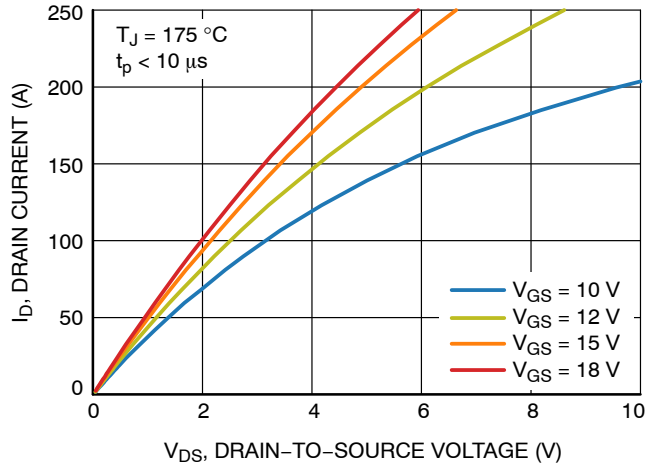


Figure 2. Output Characteristics

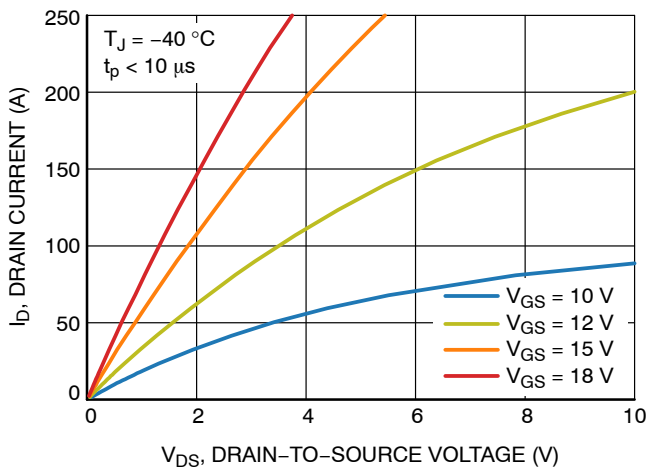


Figure 3. Output Characteristics

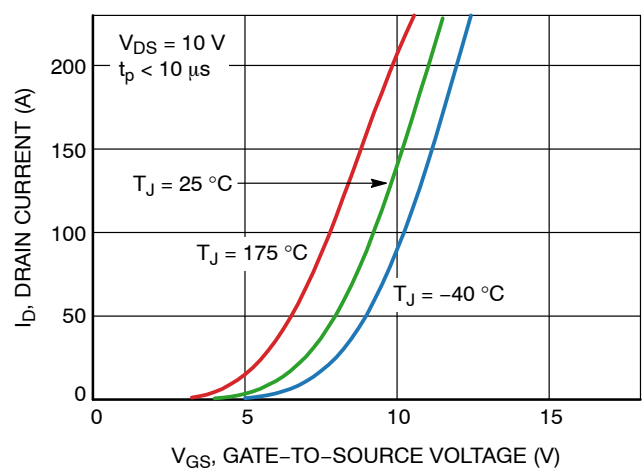


Figure 4.  $I_D$  vs.  $V_{GS}$

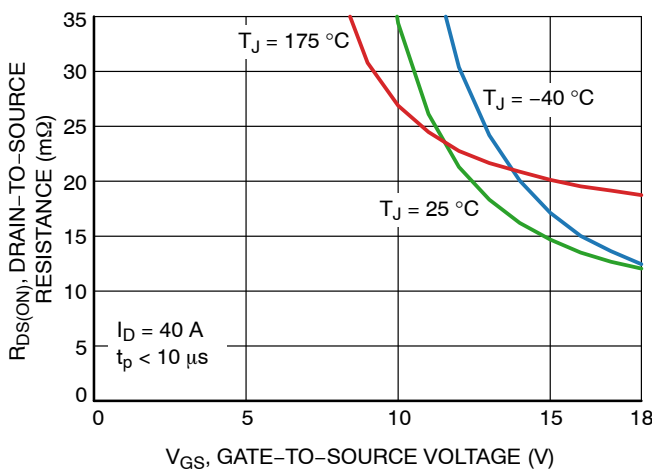


Figure 5.  $R_{DS(ON)}$  vs.  $V_{GS}$

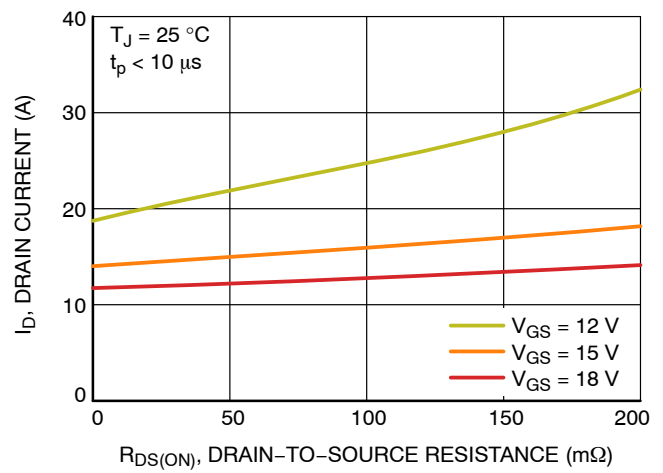


Figure 6.  $I_D$  vs.  $R_{DS(ON)}$

TYPICAL CHARACTERISTICS

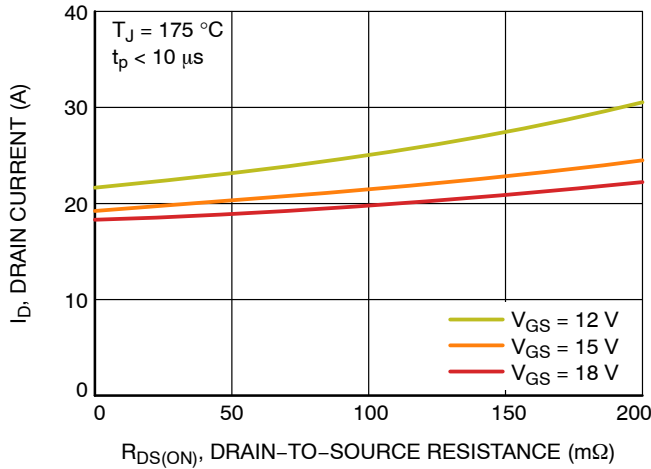


Figure 7.  $I_D$  vs.  $R_{DS(ON)}$

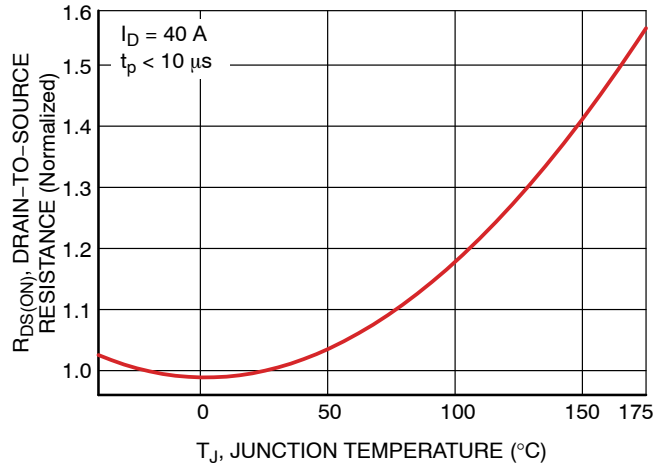


Figure 8.  $R_{DS(ON)}$  vs.  $T_J$

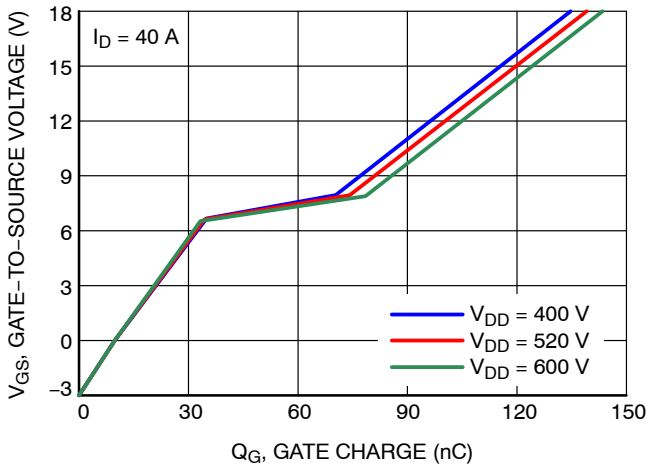


Figure 9. Gate Charge Characteristics

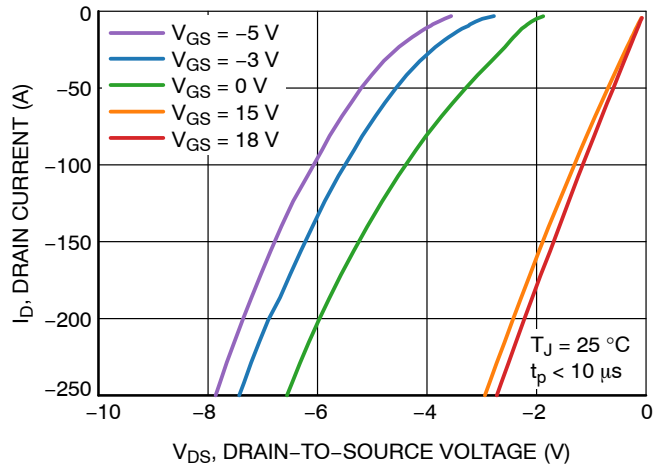


Figure 10.  $I_D$  vs.  $V_{DS}$

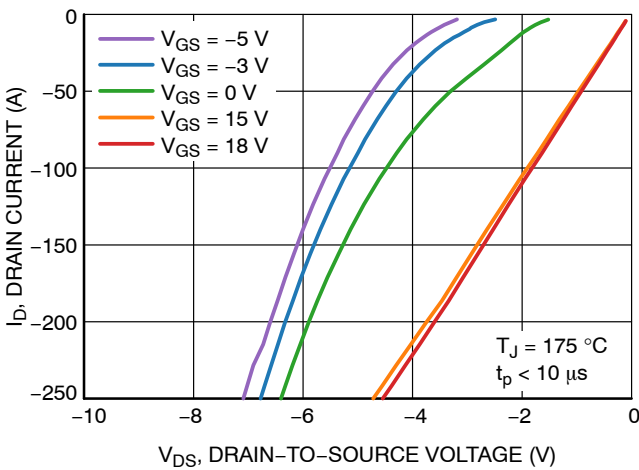


Figure 11.  $I_D$  vs.  $V_{DS}$

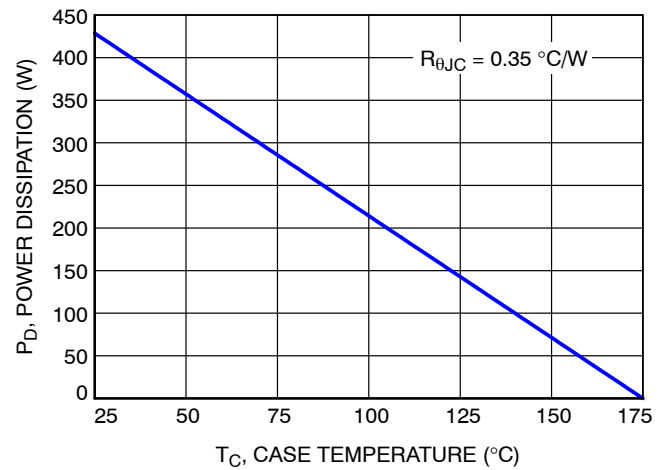


Figure 12. Maximum Power Dissipation vs. Case Temperature

TYPICAL CHARACTERISTICS

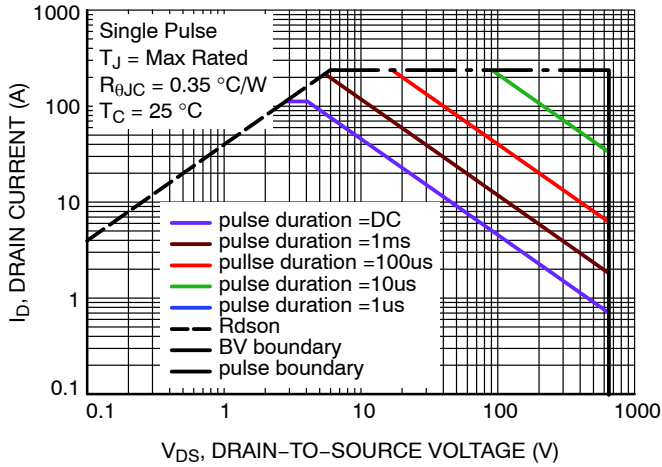


Figure 13. Safe Operating Area

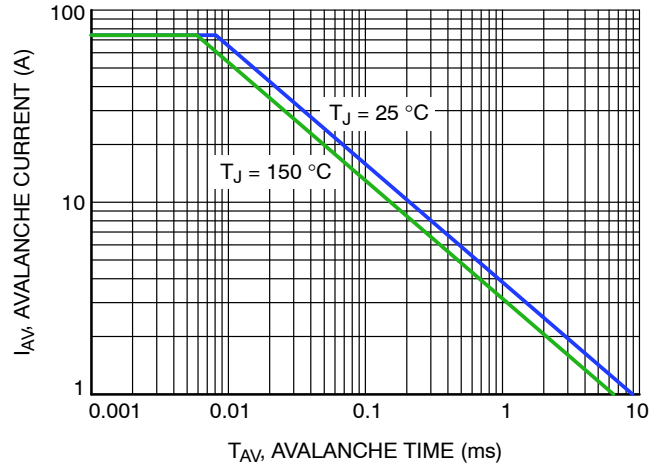


Figure 14. Avalanche Current vs. Pulse Time (UIS)

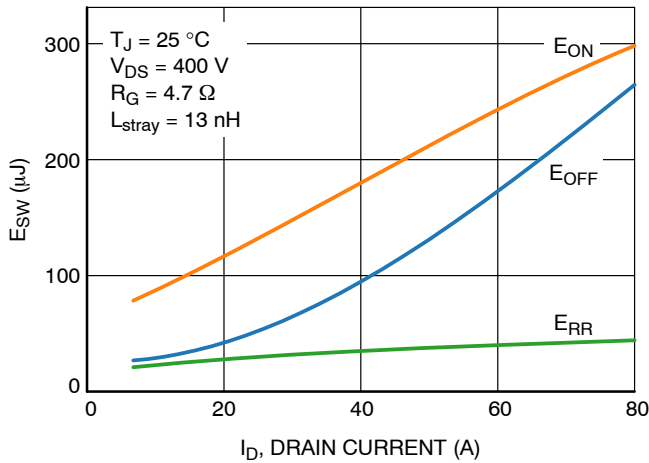


Figure 15.  $E_{SW}$  vs.  $I_D$

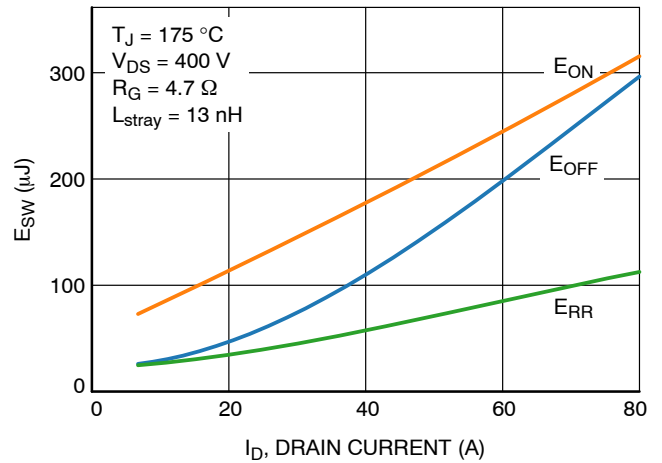


Figure 16.  $E_{SW}$  vs.  $I_D$

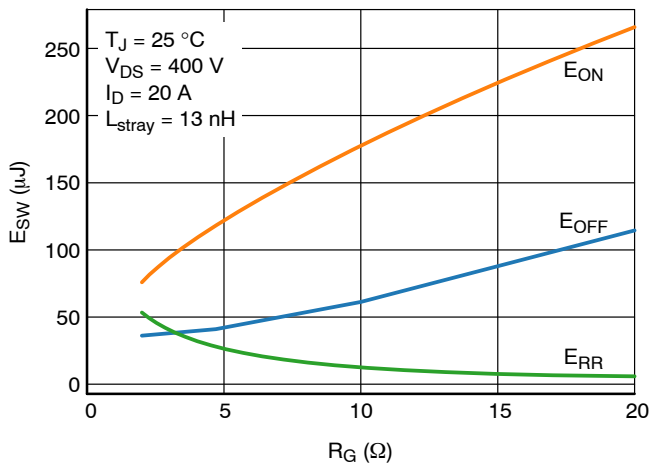


Figure 17.  $E_{SW}$  vs.  $R_G$

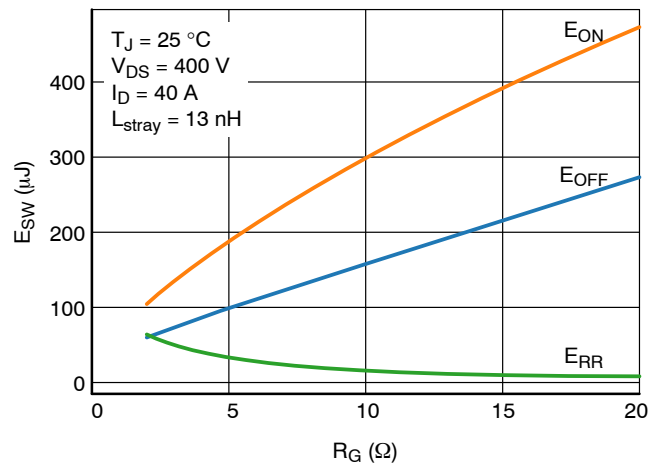


Figure 18.  $E_{SW}$  vs.  $R_G$

TYPICAL CHARACTERISTICS

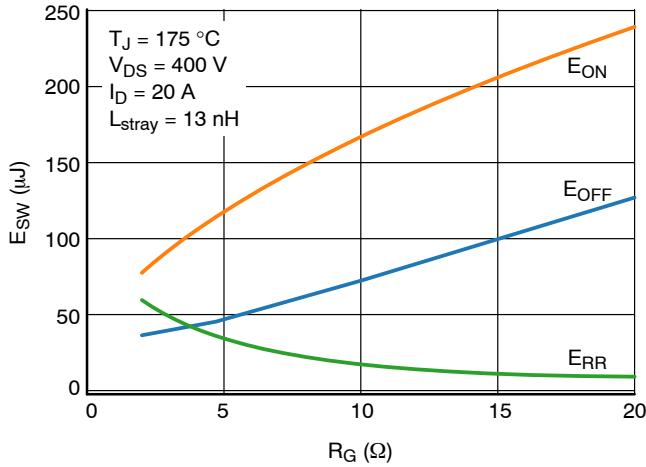


Figure 19.  $E_{sw}$  vs.  $R_g$

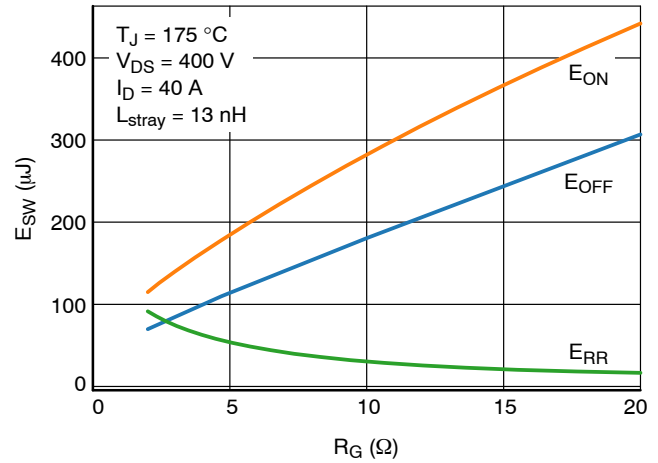


Figure 20.  $E_{sw}$  vs.  $R_g$

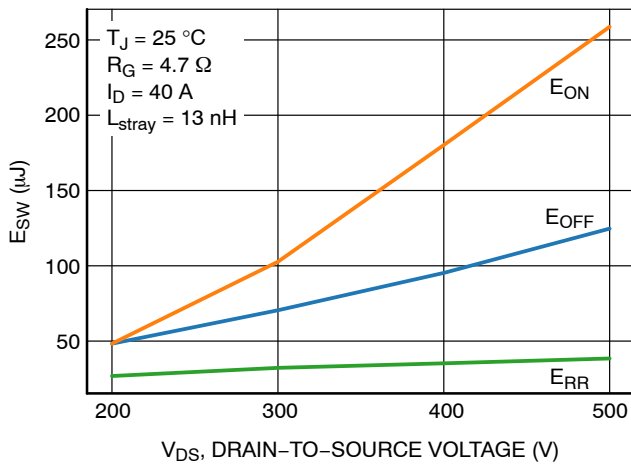


Figure 21.  $E_{sw}$  vs.  $V_{DS}$

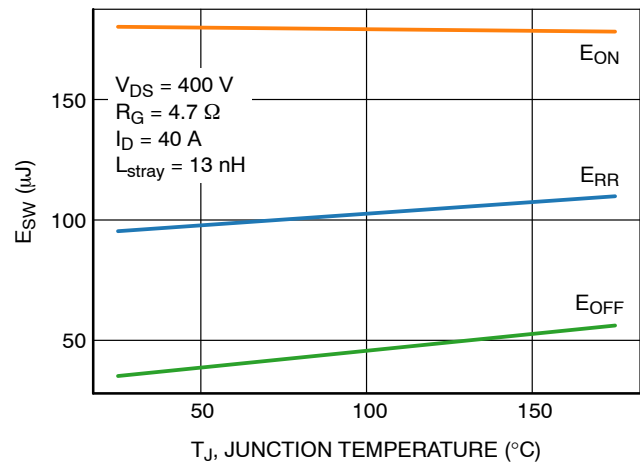


Figure 22.  $E_{sw}$  vs.  $T_J$

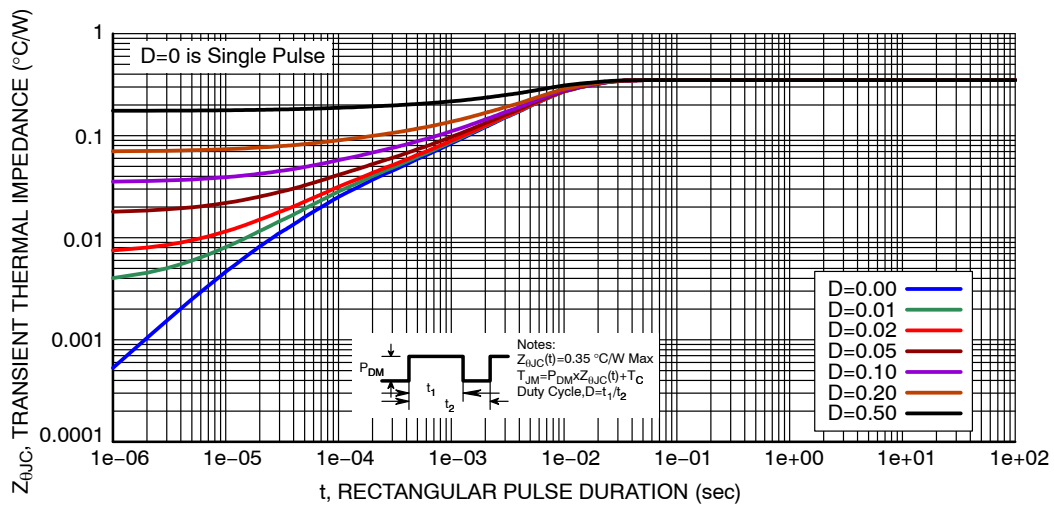


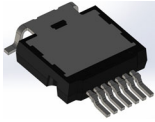
Figure 23. Transient Thermal Response

## NVT2012N065M3S

### REVISION HISTORY

| Revision | Description of Changes                                             | Date       |
|----------|--------------------------------------------------------------------|------------|
| 0        | Initial data sheet release                                         | 9/29/2025  |
| 1        | Figure 16 update                                                   | 10/16/2025 |
| 2        | Typ. $R_{DS(on)}$ update in the Features section on the front page | 10/29/2025 |





T2PAK-7 11.80x14.00x3.50, 1.27P  
CASE 763AC  
ISSUE A

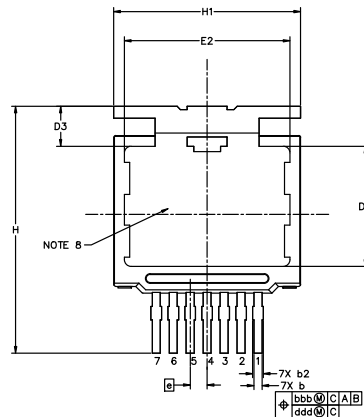
DATE 20 JUN 2025

NOTES:

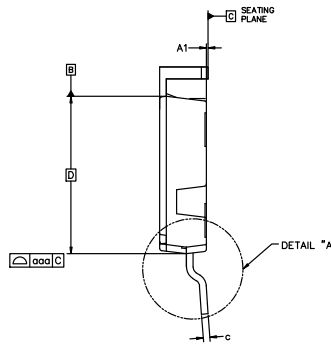
1. DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M, 2018.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSIONS b, b2, b3 AND c TO BE MEASURED ON FLAT SECTION OF THE LEAD BETWEEN 0.13 AND 0.25mm FROM LEAD TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.
5. POSITIONAL TOLERANCE APPLIES TO THE TERMINALS AND EXPOSED PAD.
6. A1 IS DEFINED AS THE VERTICAL DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT OF THE PACKAGE BODY.
7. DIMENSIONS D AND E ARE DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
8. ALLOWABLE ENCROACHED FLASH ON HEAT SINK AREA MAXIMUM OF 0.05mm.
9. EJECTOR PINS  $\phi 12.5$ mm REF.

| MILLIMETERS |           |       |       |
|-------------|-----------|-------|-------|
| DIM         | MIN       | NOM   | MAX   |
| A           | 3.53      | 3.63  | 3.73  |
| A1          | 0.07      | 0.13  | 0.18  |
| A2          | 3.40      | 3.50  | 3.60  |
| b           | 0.50      | 0.60  | 0.70  |
| b2          | 0.50      | 0.75  | 1.00  |
| b3          | 0.80      | 0.90  | 1.00  |
| c           | 0.40      | 0.50  | 0.60  |
| c2          | 0.40      | 0.50  | 0.60  |
| D           | 11.80 BSC |       |       |
| D2          | 8.90      | 9.00  | 9.10  |
| D3          | 3.00      | 3.10  | 3.20  |
| D4          | 3.80      | 3.90  | 4.00  |
| D5          | 2.10      | 2.20  | 2.30  |
| E           | 14.00 BSC |       |       |
| E2          | 12.30     | 12.40 | 12.50 |
| e           | 1.27 BSC  |       |       |

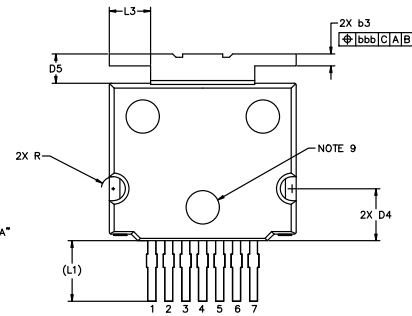
| MILLIMETERS                 |          |       |       |
|-----------------------------|----------|-------|-------|
| DIM                         | MIN      | NOM   | MAX   |
| H                           | 18.00    | 18.50 | 19.00 |
| H1                          | 13.80    | 14.00 | 14.20 |
| L                           | 2.42     | 2.52  | 2.62  |
| L1                          | 4.53 REF |       |       |
| L2                          | 0.25 BSC |       |       |
| L3                          | 3.00     | 3.10  | 3.20  |
| R                           | 0.80     | ---   | 1.00  |
| $\theta$                    | 0°       | ---   | 8°    |
| $\phi 1$                    | 0°       | ---   | 8°    |
| TOLERANCE FORM AND POSITION |          |       |       |
| aaa                         | 0.10     |       |       |
| bbb                         | 0.10     |       |       |
| ccc                         | 0.10     |       |       |
| ddd                         | 0.05     |       |       |
| eee                         | 0.05     |       |       |



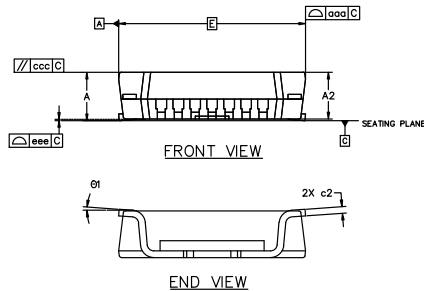
TOP VIEW



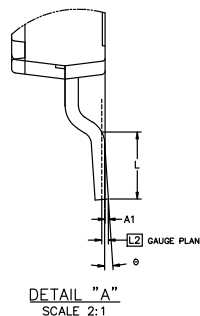
SIDE VIEW



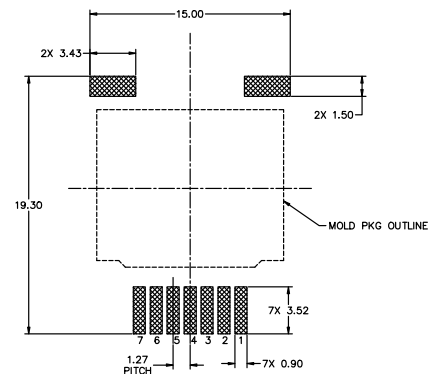
BOTTOM VIEW



END VIEW



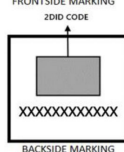
DETAIL "A"  
SCALE 2:1



RECOMMENDED MOUNTING FOOTPRINT

\*For additional information on our Pb-Free strategy and soldering details, please download the onsemi Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

GENERIC  
MARKING DIAGRAM\*



XXXX = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
ZZ = Assembly Lot Code

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "•", may or may not be present. Some products may not follow the Generic Marking.

|                  |                                 |                                                                                                                                                                                  |
|------------------|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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