



Vincotech

# 30-E312NIB400H710-PR49F07Z

datasheet

flowNPC E3BP

1200 V / 400 A

## Topology features

- Low side Kelvin Emitter for improved switching performance
- Neutral Point Clamped Topology (I-Type)
- Split topology
- Temperature sensor

## Component features

- High speed switching
- Low collector emitter saturation voltage
- Low turn-off losses
- Optimized for hard switching topologies
- Positive temperature coefficient

## Housing features

- Base isolation:  $\text{Al}_2\text{O}_3$
- Cu baseplate
- Convex shaped baseplate for superior thermal contact
- CTI600 housing material
- Baseplate with rough surface
- Thermo-mechanical push-and-pull force relief
- Solder pin

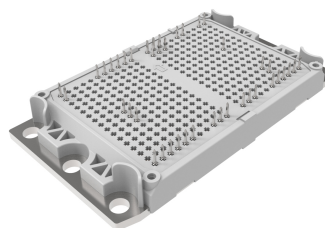
## Target applications

- Energy Storage Systems

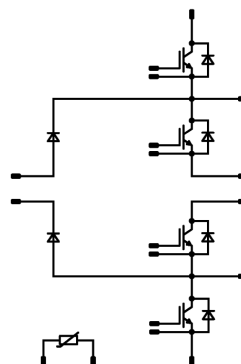
## Types

- 30-E312NIB400H710-PR49F07Z

## flow E3BP 12 mm housing



## Schematic





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## Maximum Ratings

$T_j = 25\text{ °C}$ , unless otherwise specified

| Parameter | Symbol | Conditions | Value | Unit |
|-----------|--------|------------|-------|------|
|-----------|--------|------------|-------|------|

### Buck Switch

|                                   |            |                                                  |          |    |
|-----------------------------------|------------|--------------------------------------------------|----------|----|
| Collector-emitter voltage         | $V_{CES}$  |                                                  | 1200     | V  |
| Collector current (DC current)    | $I_C$      | $T_j = T_{jmax}$ $T_s = 80\text{ °C}$            | 281      | A  |
| Repetitive peak collector current | $I_{CRM}$  | $t_p$ limited by $T_{jmax}$                      | 1200     | A  |
| Turn off safe operating area      |            | $T_j = 150\text{ °C}$ , $V_{CE} = 1200\text{ V}$ | 1200     | A  |
| Total power dissipation           | $P_{tot}$  | $T_j = T_{jmax}$ $T_s = 80\text{ °C}$            | 503      | W  |
| Gate-emitter voltage              | $V_{GES}$  |                                                  | $\pm 20$ | V  |
| Maximum junction temperature      | $T_{jmax}$ |                                                  | 175      | °C |

### Buck Diode

|                                 |            |                                       |      |    |
|---------------------------------|------------|---------------------------------------|------|----|
| Peak repetitive reverse voltage | $V_{RRM}$  |                                       | 1200 | V  |
| Forward current (DC current)    | $I_F$      | $T_j = T_{jmax}$ $T_s = 80\text{ °C}$ | 173  | A  |
| Repetitive peak forward current | $I_{FRM}$  | $t_p$ limited by $T_{jmax}$           | 1260 | A  |
| Total power dissipation         | $P_{tot}$  | $T_j = T_{jmax}$ $T_s = 80\text{ °C}$ | 310  | W  |
| Maximum junction temperature    | $T_{jmax}$ |                                       | 175  | °C |

### Boost Switch

|                                   |            |                                                  |          |    |
|-----------------------------------|------------|--------------------------------------------------|----------|----|
| Collector-emitter voltage         | $V_{CES}$  |                                                  | 1200     | V  |
| Collector current (DC current)    | $I_C$      | $T_j = T_{jmax}$ $T_s = 80\text{ °C}$            | 281      | A  |
| Repetitive peak collector current | $I_{CRM}$  | $t_p$ limited by $T_{jmax}$                      | 1200     | A  |
| Turn off safe operating area      |            | $T_j = 150\text{ °C}$ , $V_{CE} = 1200\text{ V}$ | 1200     | A  |
| Total power dissipation           | $P_{tot}$  | $T_j = T_{jmax}$ $T_s = 80\text{ °C}$            | 503      | W  |
| Gate-emitter voltage              | $V_{GES}$  |                                                  | $\pm 20$ | V  |
| Maximum junction temperature      | $T_{jmax}$ |                                                  | 175      | °C |



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## Maximum Ratings

$T_j = 25\text{ °C}$ , unless otherwise specified

| Parameter                       | Symbol     | Conditions                            | Value | Unit |
|---------------------------------|------------|---------------------------------------|-------|------|
| <b>Boost Diode</b>              |            |                                       |       |      |
| Peak repetitive reverse voltage | $V_{RRM}$  |                                       | 1200  | V    |
| Forward current (DC current)    | $I_F$      | $T_j = T_{jmax}$ $T_s = 80\text{ °C}$ | 173   | A    |
| Repetitive peak forward current | $I_{FRM}$  | $t_p$ limited by $T_{jmax}$           | 1260  | A    |
| Total power dissipation         | $P_{tot}$  | $T_j = T_{jmax}$ $T_s = 80\text{ °C}$ | 310   | W    |
| Maximum junction temperature    | $T_{jmax}$ |                                       | 175   | °C   |

## Boost Sw. Inv. Diode

|                                 |            |                                       |      |    |
|---------------------------------|------------|---------------------------------------|------|----|
| Peak repetitive reverse voltage | $V_{RRM}$  |                                       | 1200 | V  |
| Forward current (DC current)    | $I_F$      | $T_j = T_{jmax}$ $T_s = 80\text{ °C}$ | 173  | A  |
| Repetitive peak forward current | $I_{FRM}$  | $t_p$ limited by $T_{jmax}$           | 1260 | A  |
| Total power dissipation         | $P_{tot}$  | $T_j = T_{jmax}$ $T_s = 80\text{ °C}$ | 310  | W  |
| Maximum junction temperature    | $T_{jmax}$ |                                       | 175  | °C |

## Module Properties

### Thermal Properties

|                                                 |           |  |                            |    |
|-------------------------------------------------|-----------|--|----------------------------|----|
| Storage temperature                             | $T_{stg}$ |  | -40...+125                 | °C |
| Operation temperature under switching condition | $T_{jop}$ |  | -40...+( $T_{jmax} - 25$ ) | °C |

### Isolation Properties

|                            |            |                                     |       |    |
|----------------------------|------------|-------------------------------------|-------|----|
| Isolation voltage          | $V_{isol}$ | DC Test Voltage* $t_p = 2\text{ s}$ | 6800  | V  |
| Creepage distance          |            |                                     | >12,7 | mm |
| Clearance                  |            |                                     | >12,7 | mm |
| Comparative Tracking Index | CTI        |                                     | ≥ 600 |    |

\*100 % tested in production



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## Characteristic Values

| Parameter | Symbol | Conditions |                              |                                           |                                     |            | Values |     |     | Unit |
|-----------|--------|------------|------------------------------|-------------------------------------------|-------------------------------------|------------|--------|-----|-----|------|
|           |        |            | $V_{GE}$ [V]<br>$V_{GS}$ [V] | $V_{CE}$ [V]<br>$V_{DS}$ [V]<br>$V_F$ [V] | $I_C$ [A]<br>$I_D$ [A]<br>$I_F$ [A] | $T_j$ [°C] | Min    | Typ | Max |      |

### Buck Switch

#### Static

|                                      |               |                          |      |      |        |                  |     |                      |                     |    |
|--------------------------------------|---------------|--------------------------|------|------|--------|------------------|-----|----------------------|---------------------|----|
| Gate-emitter threshold voltage       | $V_{GE(th)}$  | $V_{CE} = V_{GE}$        |      |      | 0,0064 | 25               | 4,7 | 5,5                  | 6,2                 | V  |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ |                          | 15   |      | 400    | 25<br>125<br>150 |     | 1,78<br>1,94<br>1,98 | 2,15 <sup>(1)</sup> | V  |
| Collector-emitter cut-off current    | $I_{CES}$     |                          | 0    | 1200 |        | 25               |     |                      | 16                  | µA |
| Gate-emitter leakage current         | $I_{GES}$     |                          | 20   | 0    |        | 25               |     |                      | 400                 | nA |
| Internal gate resistance             | $r_g$         |                          |      |      |        |                  |     | None                 |                     | Ω  |
| Input capacitance                    | $C_{ies}$     | $f = 100 \text{ kHz}$    | 0    | 25   |        | 25               |     | 52000                |                     | pF |
| Output capacitance                   | $C_{oes}$     |                          |      |      |        |                  |     | 960                  |                     | pF |
| Reverse transfer capacitance         | $C_{res}$     |                          |      |      |        |                  |     | 288                  |                     | pF |
| Gate charge                          | $Q_g$         | $V_{CC} = 960 \text{ V}$ | 0/15 |      | 400    | 25               |     | 2856                 |                     | nC |

#### Thermal

|                                                    |               |                                               |  |  |  |  |  |      |  |     |
|----------------------------------------------------|---------------|-----------------------------------------------|--|--|--|--|--|------|--|-----|
| Thermal resistance junction to sink <sup>(2)</sup> | $R_{th(j-s)}$ | $\lambda_{paste} = 5,2 \text{ W/mK}$<br>(PTM) |  |  |  |  |  | 0,19 |  | K/W |
|----------------------------------------------------|---------------|-----------------------------------------------|--|--|--|--|--|------|--|-----|

#### Dynamic

|                             |              |                                                                 |          |     |     |                  |  |                            |  |     |
|-----------------------------|--------------|-----------------------------------------------------------------|----------|-----|-----|------------------|--|----------------------------|--|-----|
| Turn-on delay time          | $t_{d(on)}$  | $R_{gon} = 2 \text{ } \Omega$<br>$R_{goff} = 2 \text{ } \Omega$ | $\pm 15$ | 600 | 400 | 25<br>125<br>150 |  | 301,22<br>301,22<br>302,05 |  | ns  |
| Rise time                   | $t_r$        |                                                                 |          |     |     | 25<br>125<br>150 |  | 28,41<br>30,52<br>31,48    |  | ns  |
| Turn-off delay time         | $t_{d(off)}$ |                                                                 |          |     |     | 25<br>125<br>150 |  | 258,73<br>294,31<br>304,56 |  | ns  |
| Fall time                   | $t_f$        |                                                                 |          |     |     | 25<br>125<br>150 |  | 32,08<br>57,91<br>66,34    |  | ns  |
| Turn-on energy (per pulse)  | $E_{on}$     |                                                                 |          |     |     | 25<br>125<br>150 |  | 11,17<br>13,53<br>14,17    |  | mWs |
| Turn-off energy (per pulse) | $E_{off}$    |                                                                 |          |     |     | 25<br>125<br>150 |  | 11,34<br>19,54<br>22,08    |  | mWs |





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## Characteristic Values

| Parameter | Symbol | Conditions |                              |                                           |                                     |            | Values |     |     | Unit |
|-----------|--------|------------|------------------------------|-------------------------------------------|-------------------------------------|------------|--------|-----|-----|------|
|           |        |            | $V_{GE}$ [V]<br>$V_{GS}$ [V] | $V_{CE}$ [V]<br>$V_{DS}$ [V]<br>$V_F$ [V] | $I_C$ [A]<br>$I_D$ [A]<br>$I_F$ [A] | $T_j$ [°C] | Min    | Typ | Max |      |

### Buck Diode

#### Static

|                         |       |                |  |  |     |                  |  |                     |                  |    |
|-------------------------|-------|----------------|--|--|-----|------------------|--|---------------------|------------------|----|
| Forward voltage         | $V_F$ |                |  |  | 108 | 25<br>125<br>150 |  | 1,8<br>1,55<br>1,48 | 2 <sup>(1)</sup> | V  |
| Reverse leakage current | $I_R$ | $V_r = 1200$ V |  |  |     | 25               |  |                     | 12               | µA |

#### Thermal

|                                                    |               |                                       |  |  |  |  |  |      |  |     |
|----------------------------------------------------|---------------|---------------------------------------|--|--|--|--|--|------|--|-----|
| Thermal resistance junction to sink <sup>(2)</sup> | $R_{th(j-s)}$ | $\lambda_{paste} = 5,2$ W/mK<br>(PTM) |  |  |  |  |  | 0,31 |  | K/W |
|----------------------------------------------------|---------------|---------------------------------------|--|--|--|--|--|------|--|-----|

#### Dynamic

|                                       |                      |                                                                |          |     |     |                  |  |                                  |  |      |
|---------------------------------------|----------------------|----------------------------------------------------------------|----------|-----|-----|------------------|--|----------------------------------|--|------|
| Peak recovery current                 | $I_{RM}$             | $di/dt=10828$ A/µs<br>$di/dt=11980$ A/µs<br>$di/dt=12194$ A/µs | $\pm 15$ | 600 | 400 | 25<br>125<br>150 |  | 335,35<br>490,42<br>529,68       |  | A    |
| Reverse recovery time                 | $t_{rr}$             |                                                                |          |     |     | 25<br>125<br>150 |  | 64,15<br>134,69<br>151,99        |  | ns   |
| Recovered charge                      | $Q_r$                |                                                                |          |     |     | 25<br>125<br>150 |  | 10,83<br>26,49<br>31,81          |  | µC   |
| Reverse recovered energy              | $E_{rec}$            |                                                                |          |     |     | 25<br>125<br>150 |  | 3,79<br>11,07<br>13,55           |  | mWs  |
| Peak rate of fall of recovery current | $(di_{rr}/dt)_{max}$ |                                                                |          |     |     | 25<br>125<br>150 |  | 13589,49<br>12223,54<br>11782,06 |  | A/µs |



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## Characteristic Values

| Parameter | Symbol | Conditions |                              |                                           |                                     |            | Values |     |     | Unit |
|-----------|--------|------------|------------------------------|-------------------------------------------|-------------------------------------|------------|--------|-----|-----|------|
|           |        |            | $V_{GE}$ [V]<br>$V_{GS}$ [V] | $V_{CE}$ [V]<br>$V_{DS}$ [V]<br>$V_F$ [V] | $I_C$ [A]<br>$I_D$ [A]<br>$I_F$ [A] | $T_j$ [°C] | Min    | Typ | Max |      |

### Boost Switch

#### Static

|                                      |               |                          |      |      |        |                  |     |                      |                     |    |
|--------------------------------------|---------------|--------------------------|------|------|--------|------------------|-----|----------------------|---------------------|----|
| Gate-emitter threshold voltage       | $V_{GE(th)}$  | $V_{CE} = V_{GE}$        |      |      | 0,0064 | 25               | 4,7 | 5,5                  | 6,2                 | V  |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ |                          | 15   |      | 400    | 25<br>125<br>150 |     | 1,78<br>1,94<br>1,98 | 2,15 <sup>(1)</sup> | V  |
| Collector-emitter cut-off current    | $I_{CES}$     |                          | 0    | 1200 |        | 25               |     |                      | 16                  | µA |
| Gate-emitter leakage current         | $I_{GES}$     |                          | 20   | 0    |        | 25               |     |                      | 400                 | nA |
| Internal gate resistance             | $r_g$         |                          |      |      |        |                  |     | None                 |                     | Ω  |
| Input capacitance                    | $C_{ies}$     | $f = 100 \text{ kHz}$    | 0    | 25   |        | 25               |     | 52000                |                     | pF |
| Output capacitance                   | $C_{oes}$     |                          |      |      |        |                  |     | 960                  |                     | pF |
| Reverse transfer capacitance         | $C_{res}$     |                          |      |      |        |                  |     | 288                  |                     | pF |
| Gate charge                          | $Q_g$         | $V_{CC} = 960 \text{ V}$ | 0/15 |      | 400    | 25               |     | 2856                 |                     | nC |

#### Thermal

|                                                    |               |                                               |  |  |  |  |  |      |  |     |
|----------------------------------------------------|---------------|-----------------------------------------------|--|--|--|--|--|------|--|-----|
| Thermal resistance junction to sink <sup>(2)</sup> | $R_{th(j-s)}$ | $\lambda_{paste} = 5,2 \text{ W/mK}$<br>(PTM) |  |  |  |  |  | 0,19 |  | K/W |
|----------------------------------------------------|---------------|-----------------------------------------------|--|--|--|--|--|------|--|-----|

#### Dynamic

|                             |              |                                                                                                                               |          |     |     |                  |  |                           |  |     |
|-----------------------------|--------------|-------------------------------------------------------------------------------------------------------------------------------|----------|-----|-----|------------------|--|---------------------------|--|-----|
| Turn-on delay time          | $t_{d(on)}$  | $R_{gon} = 2 \text{ } \Omega$<br>$R_{goff} = 2 \text{ } \Omega$                                                               | $\pm 15$ | 600 | 300 | 25<br>125<br>150 |  | 304,8<br>304,82<br>305,45 |  | ns  |
| Rise time                   | $t_r$        |                                                                                                                               |          |     |     | 25<br>125<br>150 |  | 24,2<br>27,64<br>28,31    |  | ns  |
| Turn-off delay time         | $t_{d(off)}$ |                                                                                                                               |          |     |     | 25<br>125<br>150 |  | 268,7<br>309,52<br>320,94 |  | ns  |
| Fall time                   | $t_f$        |                                                                                                                               |          |     |     | 25<br>125<br>150 |  | 24,79<br>59,36<br>68,41   |  | ns  |
| Turn-on energy (per pulse)  | $E_{on}$     | $Q_{tFWD} = 10,04 \text{ } \mu\text{C}$<br>$Q_{tFWD} = 23,31 \text{ } \mu\text{C}$<br>$Q_{tFWD} = 27,75 \text{ } \mu\text{C}$ |          |     |     | 25<br>125<br>150 |  | 7,32<br>8,54<br>9,1       |  | mWs |
| Turn-off energy (per pulse) | $E_{off}$    |                                                                                                                               |          |     |     | 25<br>125<br>150 |  | 9,11<br>14,75<br>16,43    |  | mWs |



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## Characteristic Values

| Parameter | Symbol | Conditions |                              |                                           |                                     |            | Values |     |     | Unit |
|-----------|--------|------------|------------------------------|-------------------------------------------|-------------------------------------|------------|--------|-----|-----|------|
|           |        |            | $V_{GE}$ [V]<br>$V_{GS}$ [V] | $V_{CE}$ [V]<br>$V_{DS}$ [V]<br>$V_F$ [V] | $I_C$ [A]<br>$I_D$ [A]<br>$I_F$ [A] | $T_j$ [°C] | Min    | Typ | Max |      |

### Boost Diode

#### Static

|                         |       |                |  |  |     |                  |  |                     |                  |    |
|-------------------------|-------|----------------|--|--|-----|------------------|--|---------------------|------------------|----|
| Forward voltage         | $V_F$ |                |  |  | 108 | 25<br>125<br>150 |  | 1,8<br>1,55<br>1,48 | 2 <sup>(1)</sup> | V  |
| Reverse leakage current | $I_R$ | $V_r = 1200$ V |  |  |     | 25               |  |                     | 12               | µA |

#### Thermal

|                                                    |               |                                       |  |  |  |  |  |      |  |     |
|----------------------------------------------------|---------------|---------------------------------------|--|--|--|--|--|------|--|-----|
| Thermal resistance junction to sink <sup>(2)</sup> | $R_{th(j-s)}$ | $\lambda_{paste} = 5,2$ W/mK<br>(PTM) |  |  |  |  |  | 0,31 |  | K/W |
|----------------------------------------------------|---------------|---------------------------------------|--|--|--|--|--|------|--|-----|

#### Dynamic

|                                       |                      |                                                             |          |     |     |                  |  |                               |  |      |
|---------------------------------------|----------------------|-------------------------------------------------------------|----------|-----|-----|------------------|--|-------------------------------|--|------|
| Peak recovery current                 | $I_{RM}$             | $di/dt=9312$ A/µs<br>$di/dt=9452$ A/µs<br>$di/dt=9306$ A/µs | $\pm 15$ | 600 | 300 | 25<br>125<br>150 |  | 281,32<br>383,8<br>408,68     |  | A    |
| Reverse recovery time                 | $t_{rr}$             |                                                             |          |     |     | 25<br>125<br>150 |  | 68,97<br>137,34<br>156,91     |  | ns   |
| Recovered charge                      | $Q_r$                |                                                             |          |     |     | 25<br>125<br>150 |  | 10,04<br>23,31<br>27,75       |  | µC   |
| Reverse recovered energy              | $E_{rec}$            |                                                             |          |     |     | 25<br>125<br>150 |  | 3,36<br>8,75<br>10,5          |  | mWs  |
| Peak rate of fall of recovery current | $(di_{rr}/dt)_{max}$ |                                                             |          |     |     | 25<br>125<br>150 |  | 9994,86<br>8032,34<br>7808,03 |  | A/µs |



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## Characteristic Values

| Parameter | Symbol | Conditions                   |                                           |                                     |            |  | Values |     |     | Unit |
|-----------|--------|------------------------------|-------------------------------------------|-------------------------------------|------------|--|--------|-----|-----|------|
|           |        | $V_{GE}$ [V]<br>$V_{GS}$ [V] | $V_{CE}$ [V]<br>$V_{DS}$ [V]<br>$V_F$ [V] | $I_C$ [A]<br>$I_D$ [A]<br>$I_F$ [A] | $T_j$ [°C] |  | Min    | Typ | Max |      |

### Boost Sw. Inv. Diode

#### Static

|                         |       |                |  |  |     |                  |  |                     |           |    |
|-------------------------|-------|----------------|--|--|-----|------------------|--|---------------------|-----------|----|
| Forward voltage         | $V_F$ |                |  |  | 108 | 25<br>125<br>150 |  | 1,8<br>1,55<br>1,48 | $2^{(1)}$ | V  |
| Reverse leakage current | $I_R$ | $V_i = 1200$ V |  |  |     | 25               |  |                     | 12        | µA |

#### Thermal

|                                                    |               |                                       |  |  |  |  |  |      |  |     |
|----------------------------------------------------|---------------|---------------------------------------|--|--|--|--|--|------|--|-----|
| Thermal resistance junction to sink <sup>(2)</sup> | $R_{th(j-s)}$ | $\lambda_{paste} = 5,2$ W/mK<br>(PTM) |  |  |  |  |  | 0,31 |  | K/W |
|----------------------------------------------------|---------------|---------------------------------------|--|--|--|--|--|------|--|-----|

### Thermistor

#### Static

|                                |                |                    |  |  |  |     |    |      |   |      |
|--------------------------------|----------------|--------------------|--|--|--|-----|----|------|---|------|
| Rated resistance               | $R$            |                    |  |  |  | 25  |    | 22   |   | kΩ   |
| Deviation of R100              | $\Delta_{R/R}$ | $R_{100} = 1484$ Ω |  |  |  | 100 | -5 |      | 5 | %    |
| Power dissipation              | $P$            |                    |  |  |  | 25  |    | 130  |   | mW   |
| Power dissipation constant     | $d$            |                    |  |  |  | 25  |    | 1,5  |   | mW/K |
| B-value                        | $B_{(25/50)}$  | Tol. $\pm 1$ %     |  |  |  |     |    | 3962 |   | K    |
| B-value                        | $B_{(25/100)}$ | Tol. $\pm 1$ %     |  |  |  |     |    | 4000 |   | K    |
| Vincotech Thermistor Reference |                |                    |  |  |  |     |    |      | I |      |

<sup>(1)</sup> Value at chip level

<sup>(2)</sup> Only valid with pre-applied Vincotech thermal interface material.



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## Buck Switch Characteristics

figure 1. IGBT

Typical output characteristics

$$I_C = f(V_{CE})$$

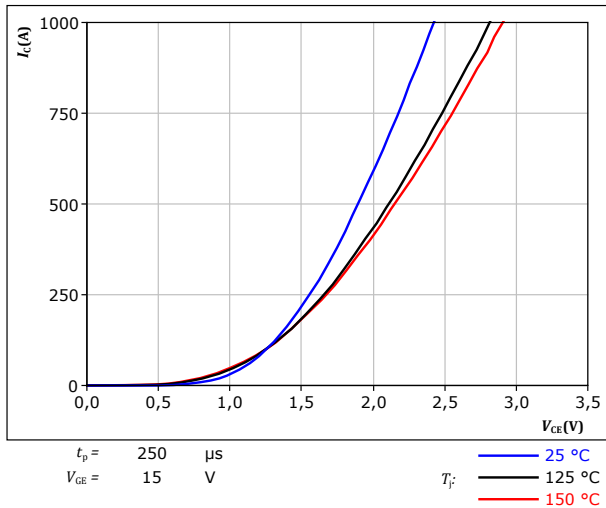


figure 2. IGBT

Typical output characteristics

$$I_C = f(V_{CE})$$

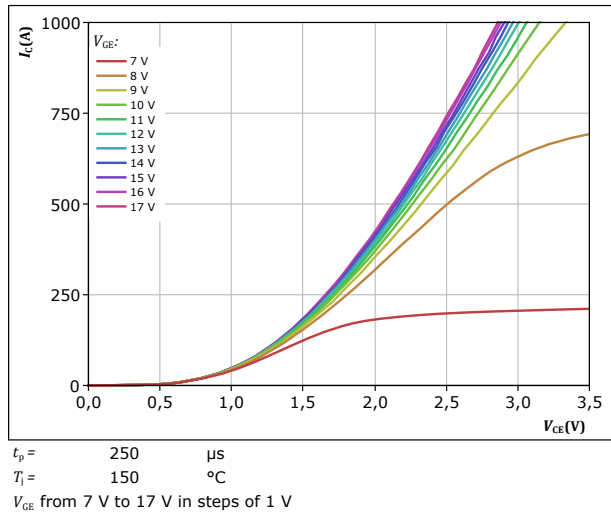


figure 3. IGBT

Typical transfer characteristics

$$I_C = f(V_{GE})$$

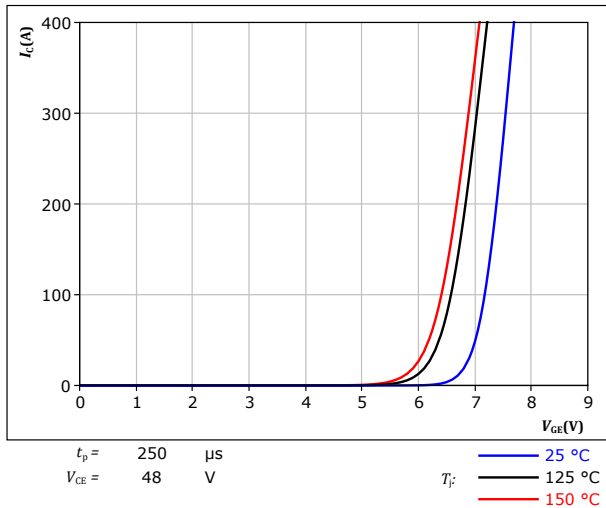
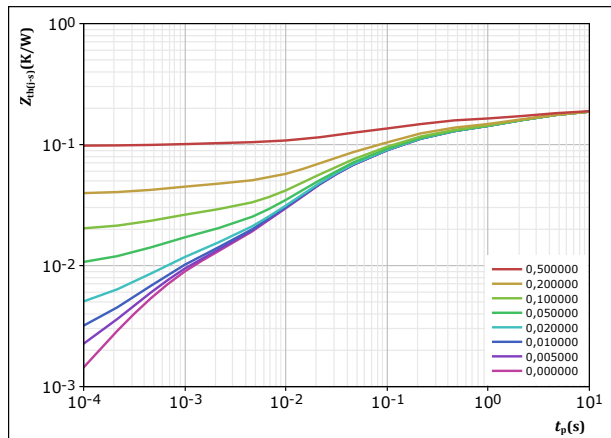


figure 4. IGBT

Transient thermal impedance as a function of pulse width

$$Z_{th(j-s)} = f(t_p)$$





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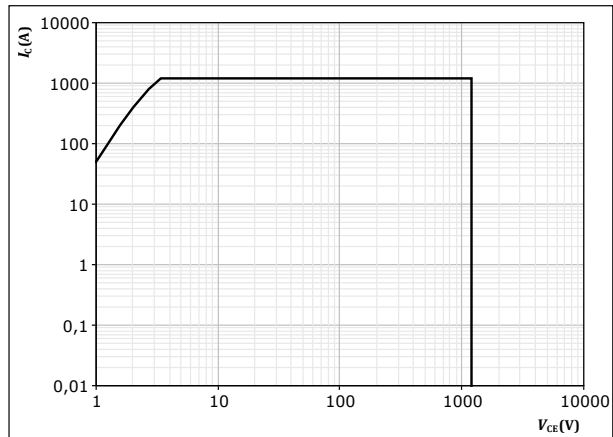
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## Buck Switch Characteristics

**figure 5.** IGBT

Safe operating area

$$I_C = f(V_{CE})$$

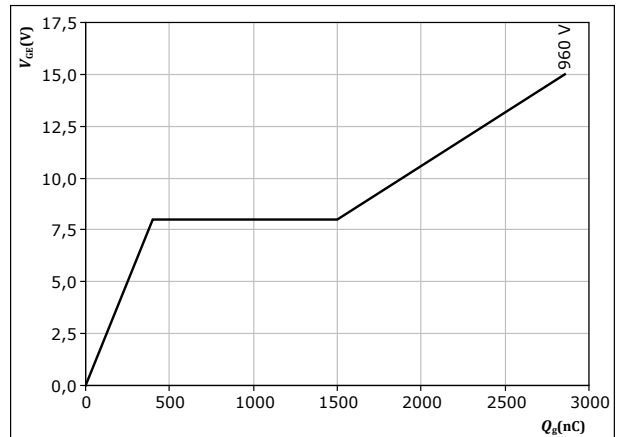


$D = \text{single pulse}$   
 $T_s = 80 \text{ } ^\circ\text{C}$   
 $V_{GE} = 15 \text{ V}$   
 $T_j = T_{jmax}$

**figure 6.** IGBT

Gate voltage vs gate charge

$$V_{GE} = f(Q_g)$$



$I_C = 400 \text{ A}$   
 $T_j = 25 \text{ } ^\circ\text{C}$



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## Buck Diode Characteristics

figure 7.

FWD

Typical forward characteristics

$$I_F = f(V_F)$$

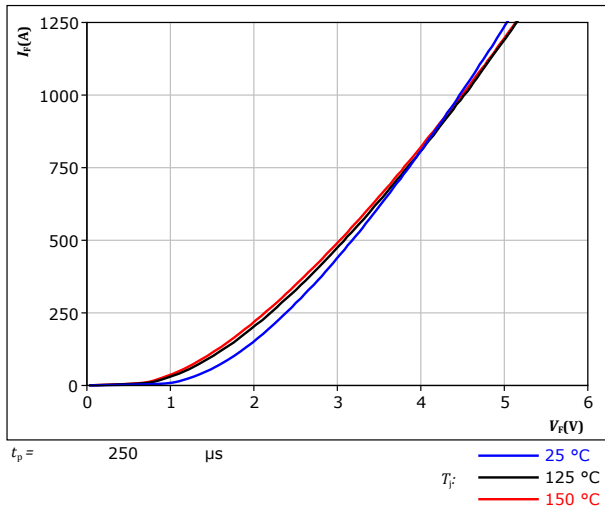
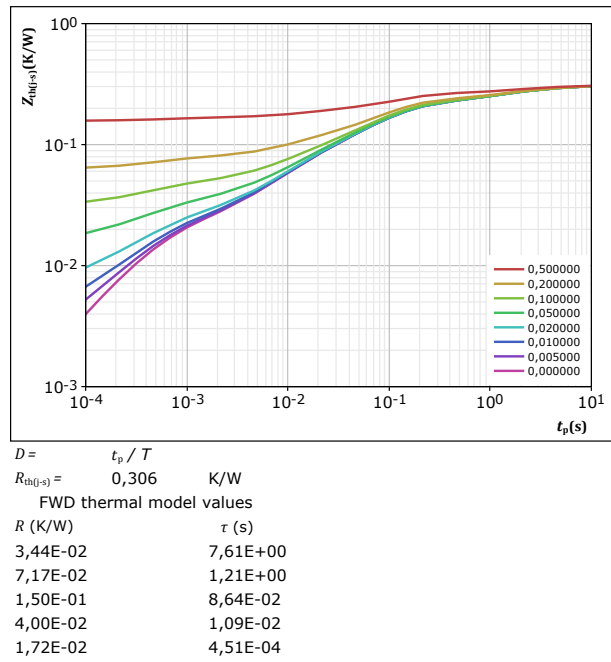


figure 8.

FWD

Transient thermal impedance as a function of pulse width

$$Z_{th(j-s)} = f(t_p)$$





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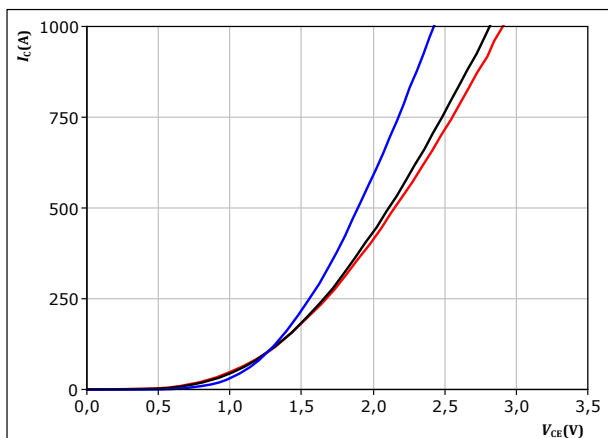
datasheet

## Boost Switch Characteristics

figure 9. IGBT

Typical output characteristics

$$I_C = f(V_{CE})$$

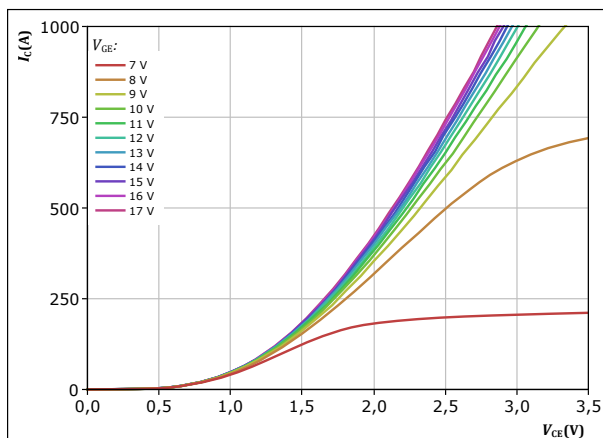


$t_p = 250 \mu s$   
 $V_{GE} = 15 V$   
 $T_j:$  25 °C, 125 °C, 150 °C

figure 10. IGBT

Typical output characteristics

$$I_C = f(V_{CE})$$

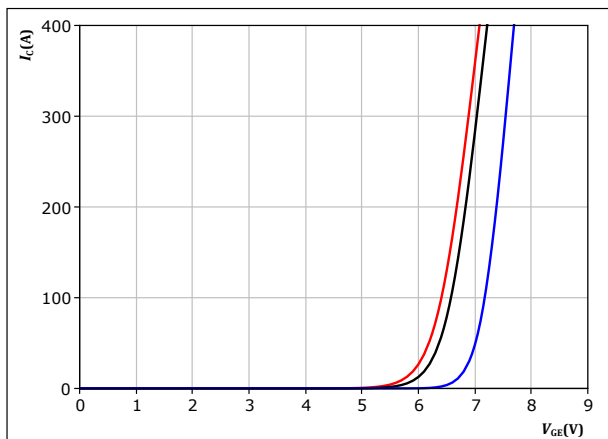


$t_p = 250 \mu s$   
 $T_j = 150 \text{ } ^\circ C$   
 $V_{GE}$  from 7 V to 17 V in steps of 1 V

figure 11. IGBT

Typical transfer characteristics

$$I_C = f(V_{GE})$$

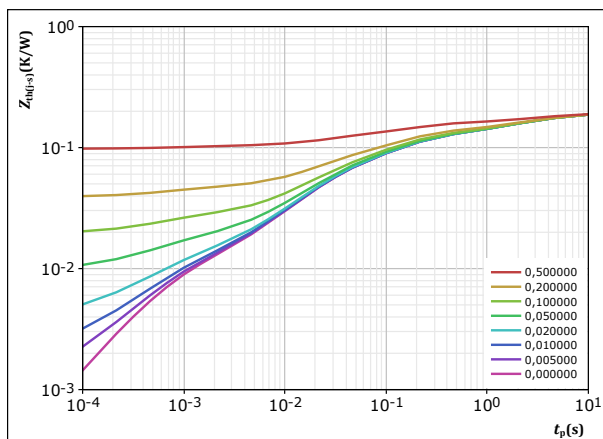


$t_p = 250 \mu s$   
 $V_{CE} = 48 V$   
 $T_j:$  25 °C, 125 °C, 150 °C

figure 12. IGBT

Transient thermal impedance as a function of pulse width

$$Z_{th(j-s)} = f(t_p)$$



$D = t_p / T$   
 $R_{th(j-s)} = 0,189 \text{ K/W}$   
IGBT thermal model values  

| $R \text{ (K/W)}$ | $\tau \text{ (s)}$ |
|-------------------|--------------------|
| 3,45E-02          | 6,76E+00           |
| 4,33E-02          | 1,55E+00           |
| 6,75E-02          | 1,27E-01           |
| 4,21E-02          | 2,01E-02           |
| 7,94E-03          | 6,24E-04           |





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datasheet

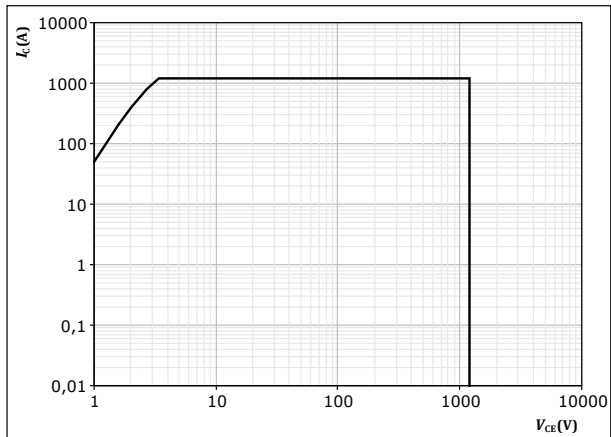
## Boost Switch Characteristics

figure 13.

IGBT

Safe operating area

$$I_C = f(V_{CE})$$



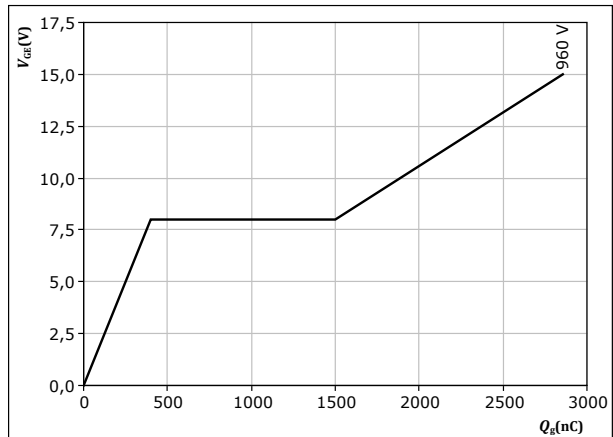
$D = \text{single pulse}$   
 $T_s = 80 \text{ } ^\circ\text{C}$   
 $V_{GE} = 15 \text{ V}$   
 $T_j = T_{jmax}$

figure 14.

IGBT

Gate voltage vs gate charge

$$V_{GE} = f(Q_g)$$



$I_C = 400 \text{ A}$   
 $T_j = 25 \text{ } ^\circ\text{C}$



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datasheet

## Boost Diode Characteristics

figure 15.

FWD

Typical forward characteristics

$$I_F = f(V_F)$$

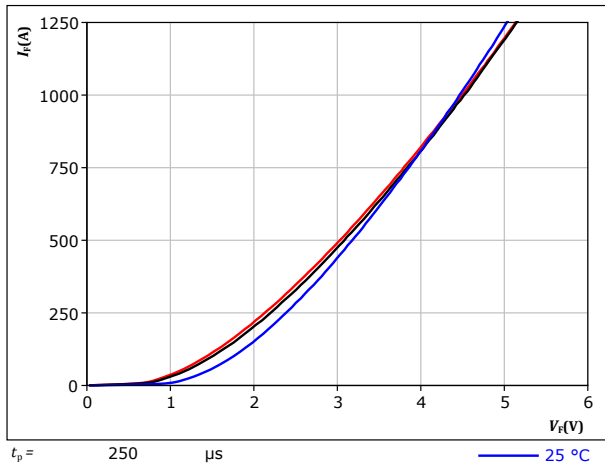
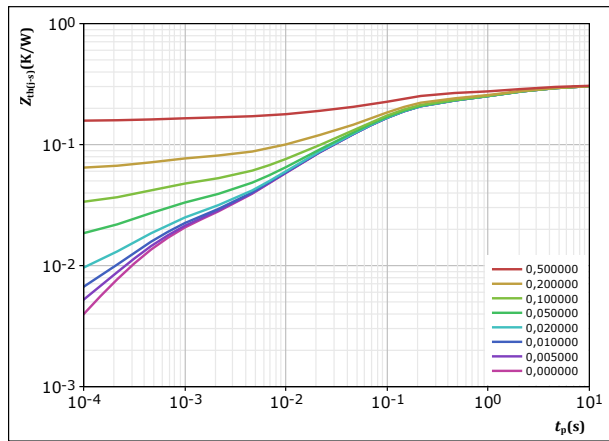


figure 16.

FWD

Transient thermal impedance as a function of pulse width

$$Z_{th(j-s)} = f(t_p)$$



|                          |            |
|--------------------------|------------|
| $D =$                    | $t_p / T$  |
| $R_{th(j-s)} =$          | 0,306 K/W  |
| FWD thermal model values |            |
| $R$ (K/W)                | $\tau$ (s) |
| 3,44E-02                 | 7,61E+00   |
| 7,17E-02                 | 1,21E+00   |
| 1,50E-01                 | 8,64E-02   |
| 4,00E-02                 | 1,09E-02   |
| 1,72E-02                 | 4,51E-04   |



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Boost Sw. Inv. Diode Characteristics

figure 17. FWD

Typical forward characteristics  
 $I_F = f(V_F)$

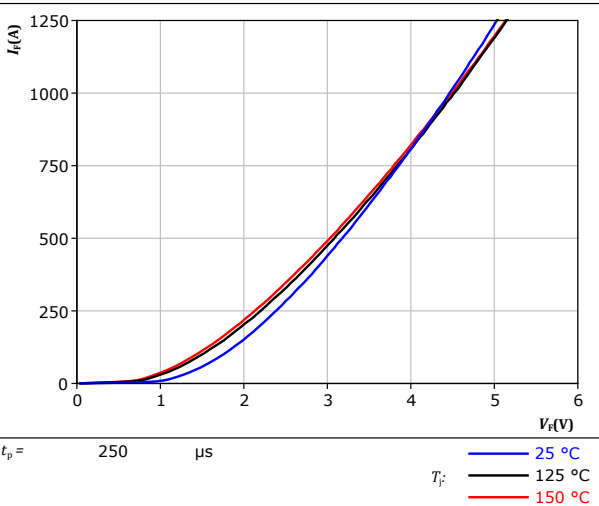
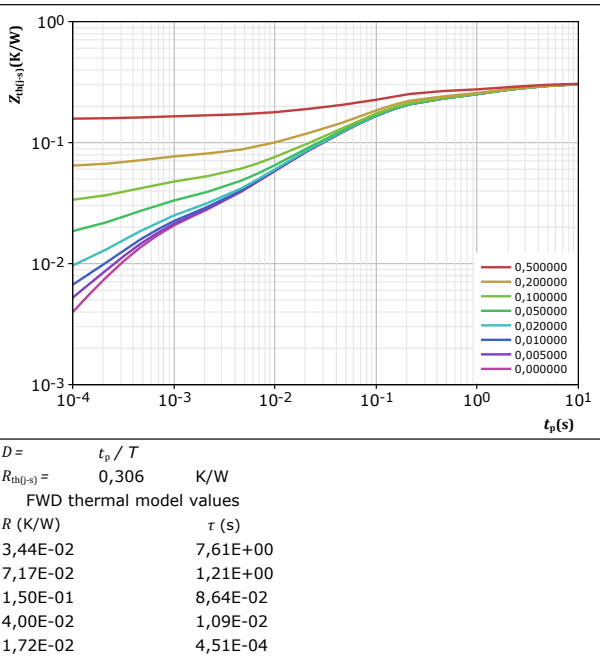


figure 18. FWD

Transient thermal impedance as a function of pulse width  
 $Z_{th(j-s)} = f(t_p)$





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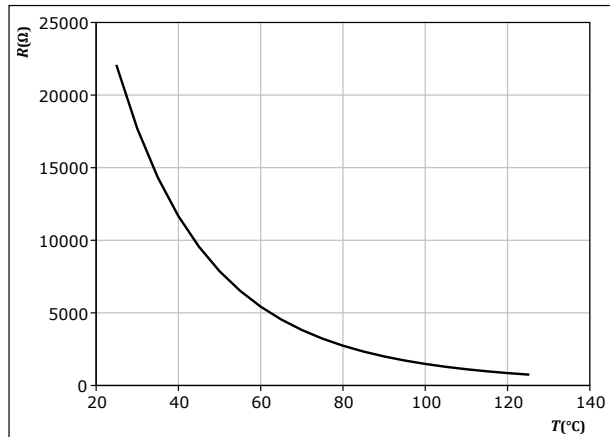
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datasheet

## Thermistor Characteristics

**figure 19.** Thermistor

Typical NTC characteristic as function of temperature

$$R_T = f(T)$$





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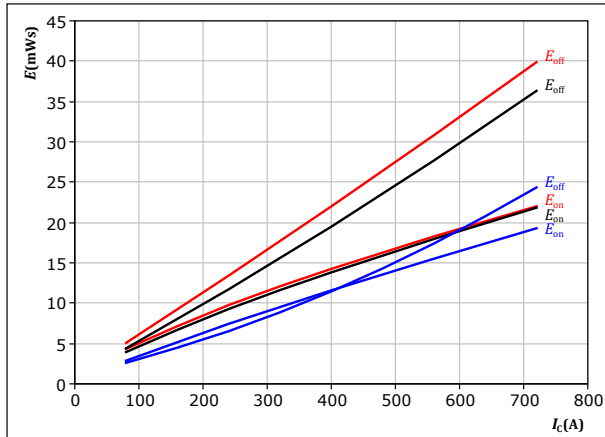
## Buck Switching Characteristics

figure 20.

IGBT

Typical switching energy losses as a function of collector current

$$E = f(I_C)$$



With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 2$   $\Omega$   
 $R_{goff} = 2$   $\Omega$

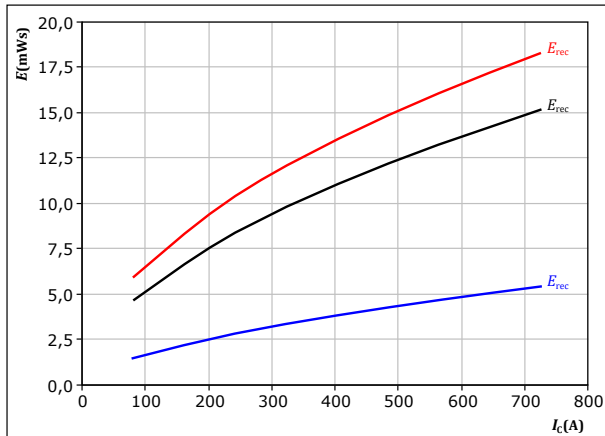
$T_j$ : 25 °C  
125 °C  
150 °C

figure 22.

FWD

Typical reverse recovered energy loss as a function of collector current

$$E_{rec} = f(I_C)$$



With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 2$   $\Omega$

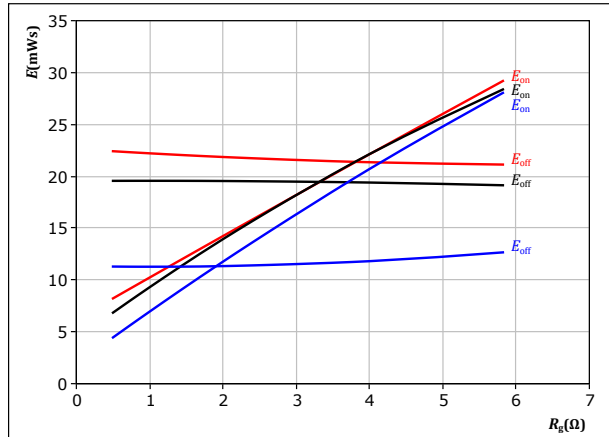
$T_j$ : 25 °C  
125 °C  
150 °C

figure 21.

IGBT

Typical switching energy losses as a function of IGBT turn on gate resistor

$$E = f(R_g)$$



With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_C = 400$  A

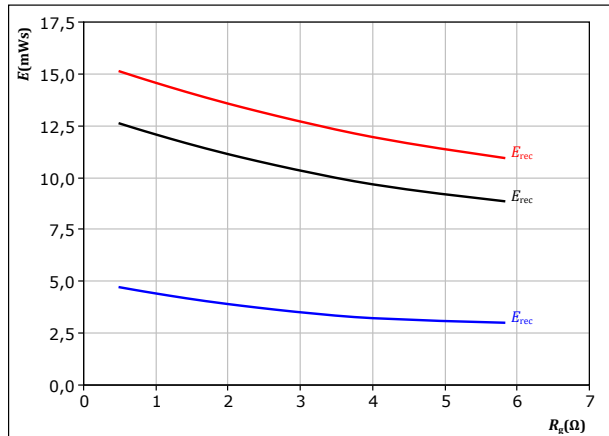
$T_j$ : 25 °C  
125 °C  
150 °C

figure 23.

FWD

Typical reverse recovered energy loss as a function of IGBT turn on gate resistor

$$E_{rec} = f(R_g)$$



With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_C = 400$  A

$T_j$ : 25 °C  
125 °C  
150 °C



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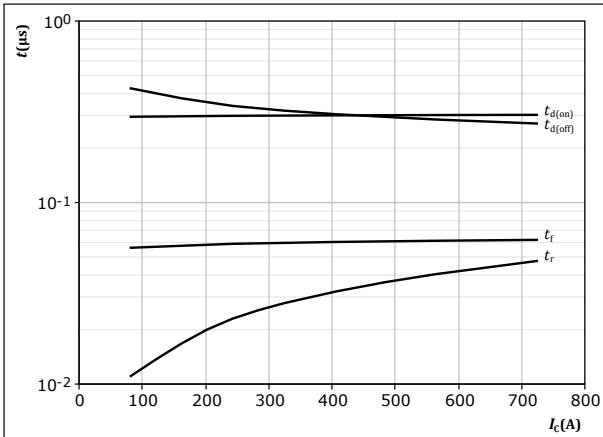
30-E312NIB400H710-PR49F07Z  
datasheet

## Buck Switching Characteristics

figure 24.

IGBT

Typical switching times as a function of collector current  
 $t = f(I_C)$



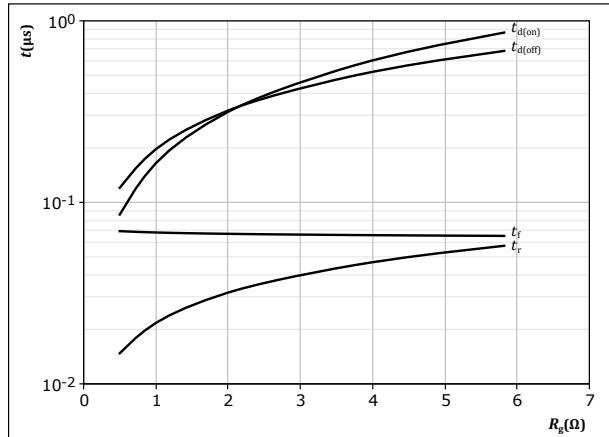
With an inductive load at

$T_j = 150$  °C  
 $V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 2$   $\Omega$   
 $R_{goff} = 2$   $\Omega$

figure 25.

IGBT

Typical switching times as a function of IGBT turn on gate resistor  
 $t = f(R_g)$



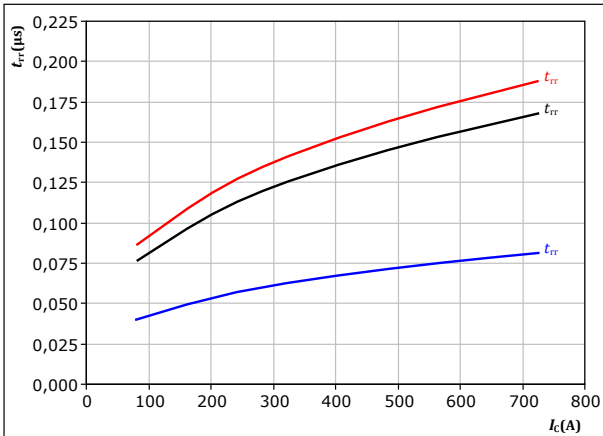
With an inductive load at

$T_j = 150$  °C  
 $V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_C = 400$  A

figure 26.

FWD

Typical reverse recovery time as a function of collector current  
 $t_{rr} = f(I_C)$



With an inductive load at

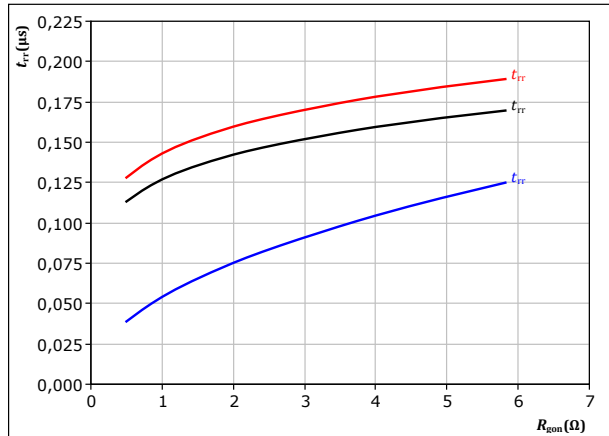
$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 2$   $\Omega$

$T_j$ : 25 °C  
125 °C  
150 °C

figure 27.

FWD

Typical reverse recovery time as a function of IGBT turn on gate resistor  
 $t_{rr} = f(R_{gon})$



With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_C = 400$  A

$T_j$ : 25 °C  
125 °C  
150 °C



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datasheet

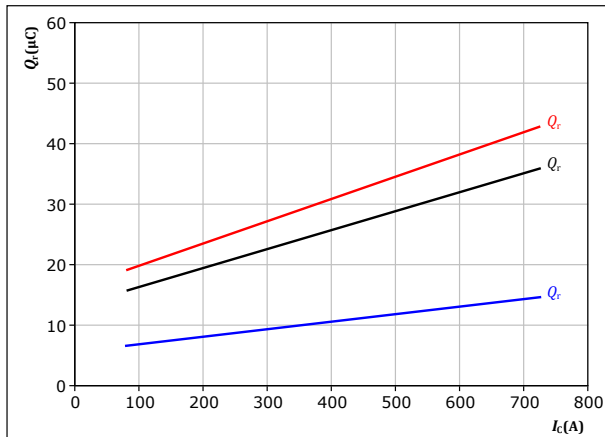
## Buck Switching Characteristics

figure 28.

FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$



With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 2$   $\Omega$

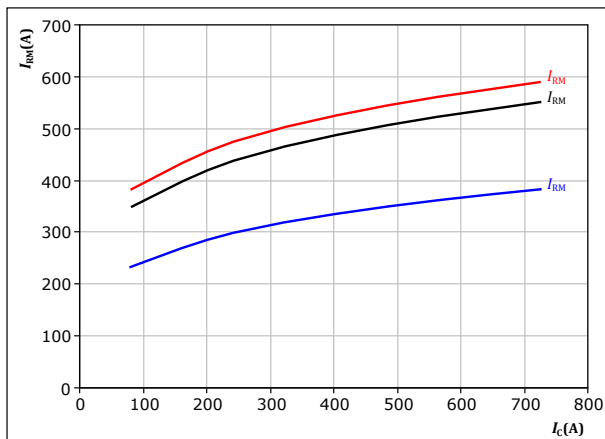
$T_j$ : 25 °C  
125 °C  
150 °C

figure 30.

FWD

Typical peak reverse recovery current as a function of collector current

$$I_{RM} = f(I_c)$$



With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 2$   $\Omega$

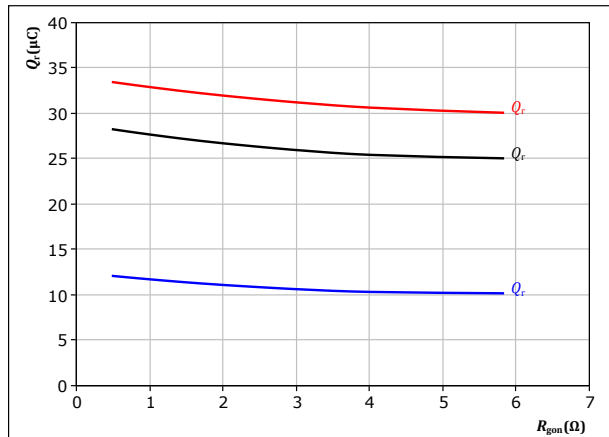
$T_j$ : 25 °C  
125 °C  
150 °C

figure 29.

FWD

Typical recovered charge as a function of IGBT turn on gate resistor

$$Q_r = f(R_{gon})$$



With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_c = 400$  A

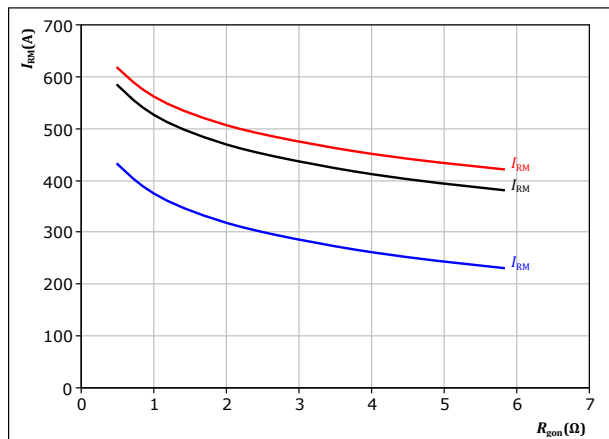
$T_j$ : 25 °C  
125 °C  
150 °C

figure 31.

FWD

Typical peak reverse recovery current as a function of IGBT turn on gate resistor

$$I_{RM} = f(R_{gon})$$



With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_c = 400$  A

$T_j$ : 25 °C  
125 °C  
150 °C



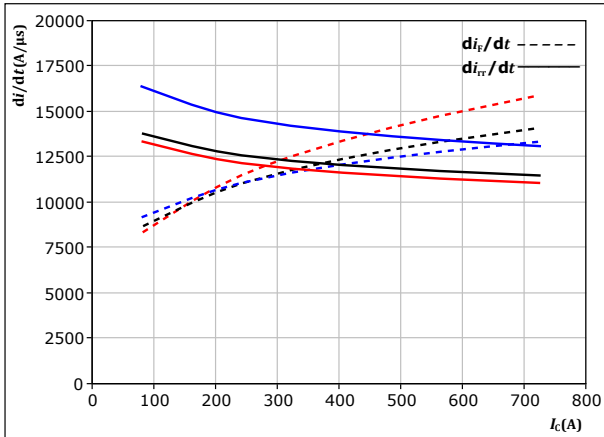
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datasheet

## Buck Switching Characteristics

figure 32. FWD

Typical rate of fall of forward and reverse recovery current as a function of collector current  
 $di_f/dt, di_r/dt = f(I_C)$



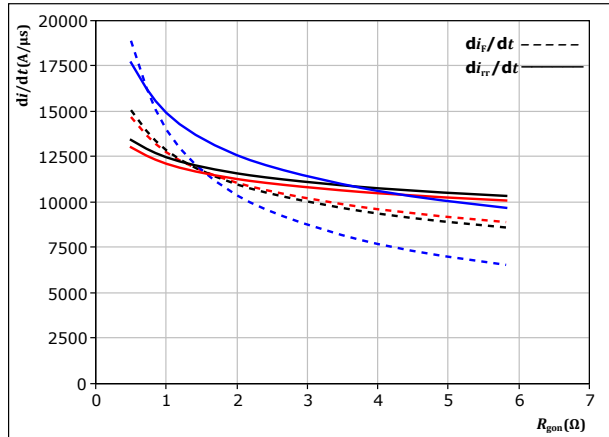
With an inductive load at

$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 2 \text{ } \Omega$

$T_j:$  — 25 °C  
— 125 °C  
— 150 °C

figure 33. FWD

Typical rate of fall of forward and reverse recovery current as a function of turn on gate resistor  
 $di_f/dt, di_r/dt = f(R_{gon})$



With an inductive load at

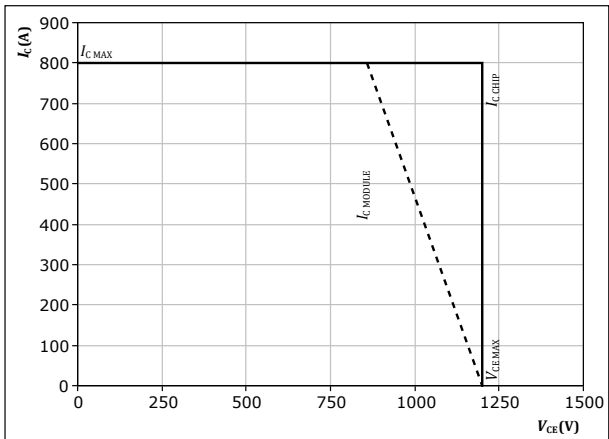
$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_C = 400 \text{ A}$

$T_j:$  — 25 °C  
— 125 °C  
— 150 °C

figure 34. IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$



At  $T_j = 150 \text{ } ^\circ\text{C}$   
 $R_{gon} = 2 \text{ } \Omega$   
 $R_{goff} = 2 \text{ } \Omega$





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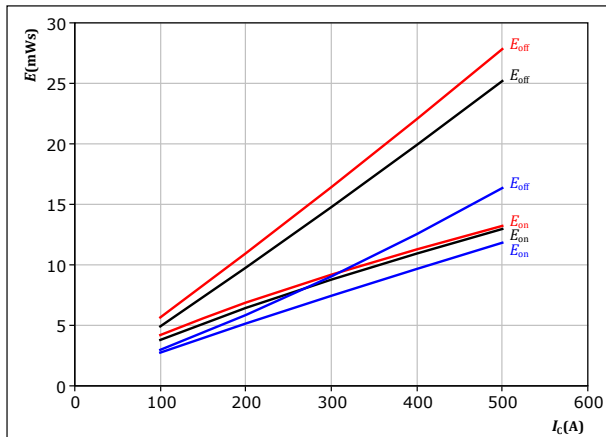
30-E312NIB400H710-PR49F07Z  
datasheet

## Boost Switching Characteristics

figure 35. IGBT

Typical switching energy losses as a function of collector current

$$E = f(I_c)$$



With an inductive load at

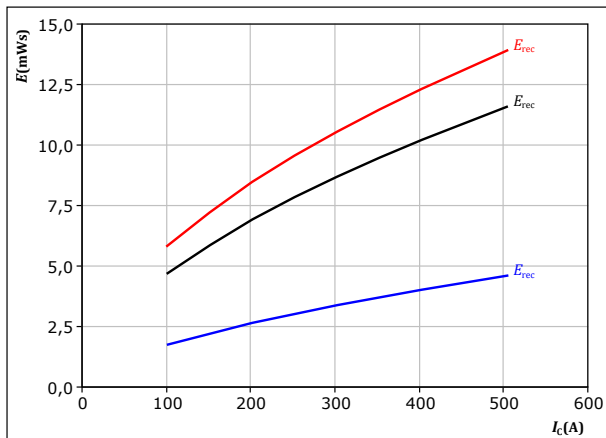
$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 2$   $\Omega$   
 $R_{goff} = 2$   $\Omega$

$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 37. FWD

Typical reverse recovered energy loss as a function of collector current

$$E_{rec} = f(I_c)$$



With an inductive load at

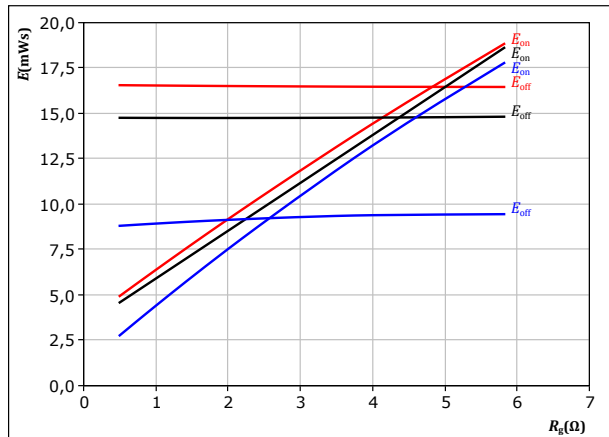
$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 2$   $\Omega$

$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 36. IGBT

Typical switching energy losses as a function of IGBT turn on gate resistor

$$E = f(R_g)$$



With an inductive load at

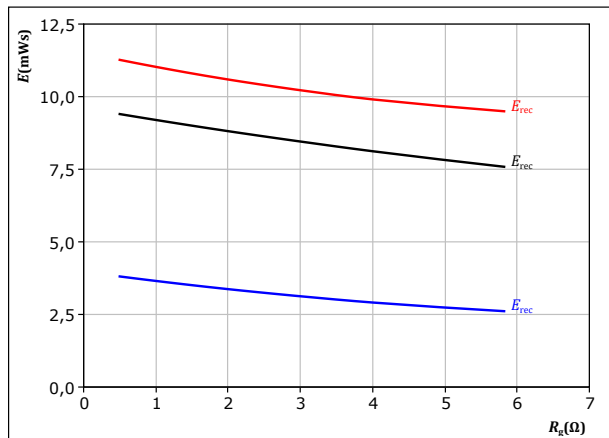
$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_c = 300$  A

$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 38. FWD

Typical reverse recovered energy loss as a function of IGBT turn on gate resistor

$$E_{rec} = f(R_g)$$



With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_c = 300$  A

$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C



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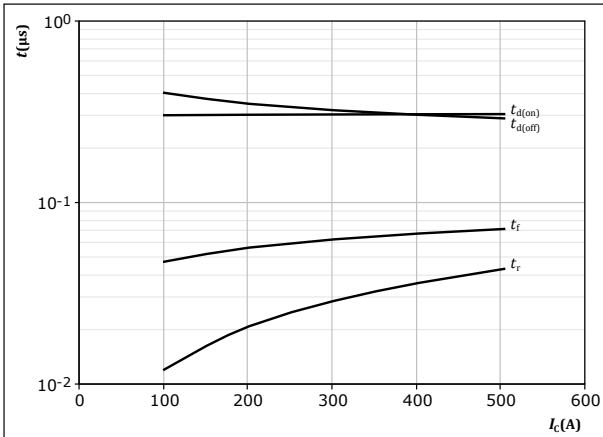
**30-E312NIB400H710-PR49F07Z**  
datasheet

## Boost Switching Characteristics

figure 39.

IGBT

Typical switching times as a function of collector current  
 $t = f(I_C)$



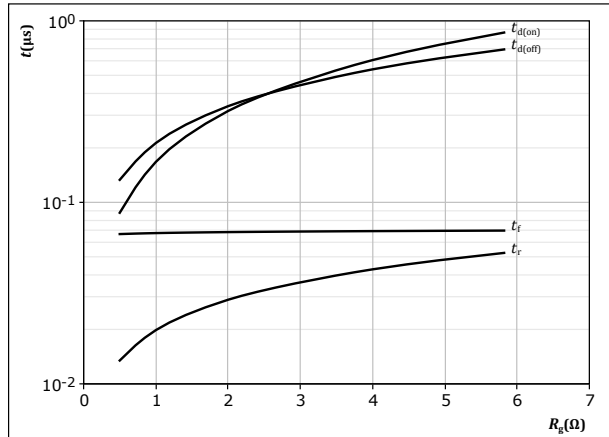
With an inductive load at

$T_j = 150 \text{ } ^\circ\text{C}$   
 $V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 2 \text{ } \Omega$   
 $R_{goff} = 2 \text{ } \Omega$

figure 40.

IGBT

Typical switching times as a function of IGBT turn on gate resistor  
 $t = f(R_g)$



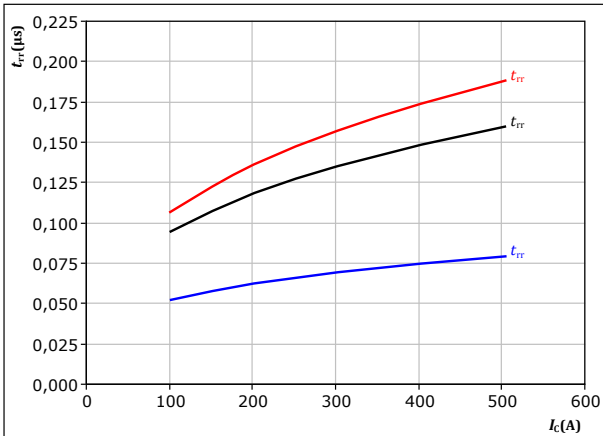
With an inductive load at

$T_j = 150 \text{ } ^\circ\text{C}$   
 $V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_C = 300 \text{ A}$

figure 41.

FWD

Typical reverse recovery time as a function of collector current  
 $t_{rr} = f(I_C)$



With an inductive load at

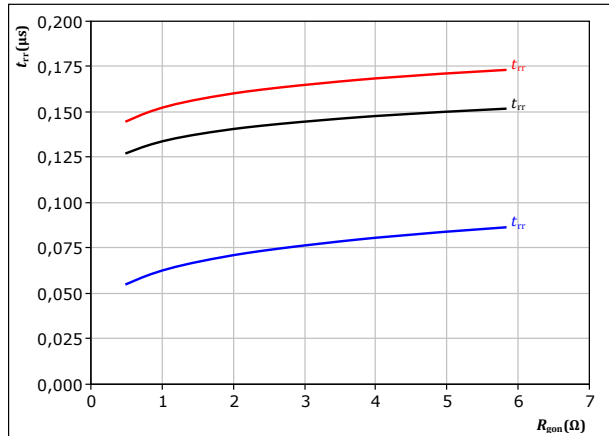
$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 2 \text{ } \Omega$

$T_j$ : — 25 °C  
— 125 °C  
— 150 °C

figure 42.

FWD

Typical reverse recovery time as a function of IGBT turn on gate resistor  
 $t_{rr} = f(R_{gon})$



With an inductive load at

$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_C = 300 \text{ A}$

$T_j$ : — 25 °C  
— 125 °C  
— 150 °C



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datasheet

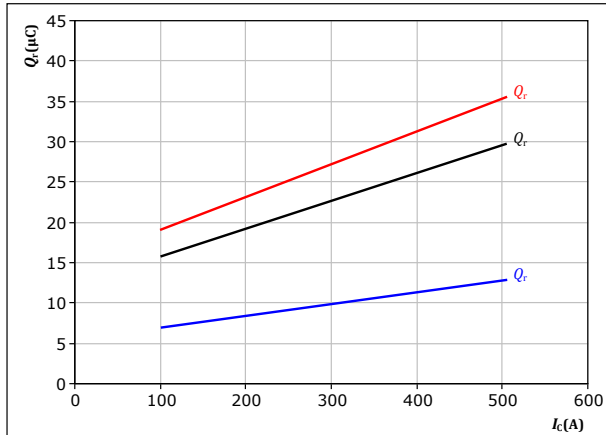
## Boost Switching Characteristics

figure 43.

FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_C)$$



With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 2$   $\Omega$

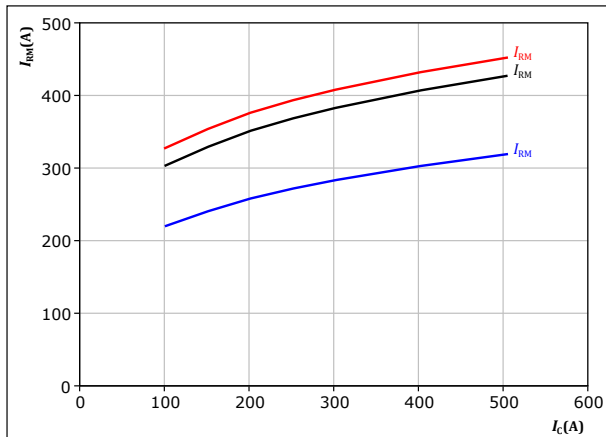
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 45.

FWD

Typical peak reverse recovery current as a function of collector current

$$I_{RM} = f(I_C)$$



With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 2$   $\Omega$

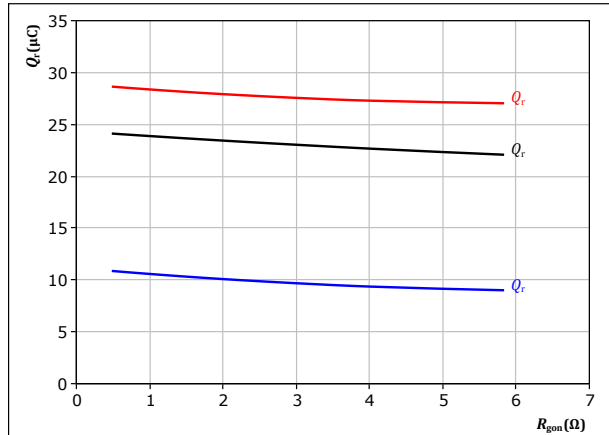
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 44.

FWD

Typical recovered charge as a function of IGBT turn on gate resistor

$$Q_r = f(R_{gon})$$



With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_C = 300$  A

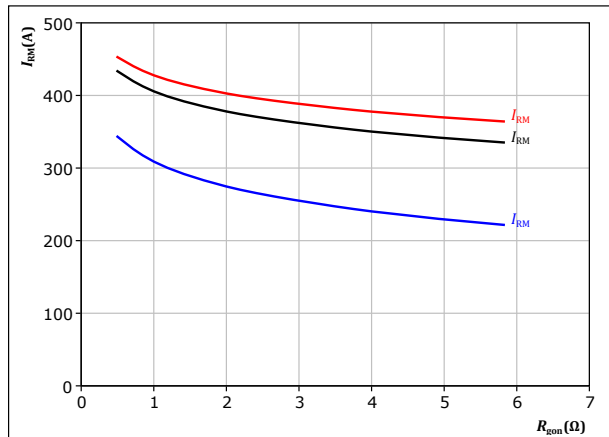
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 46.

FWD

Typical peak reverse recovery current as a function of IGBT turn on gate resistor

$$I_{RM} = f(R_{gon})$$



With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_C = 300$  A

$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C



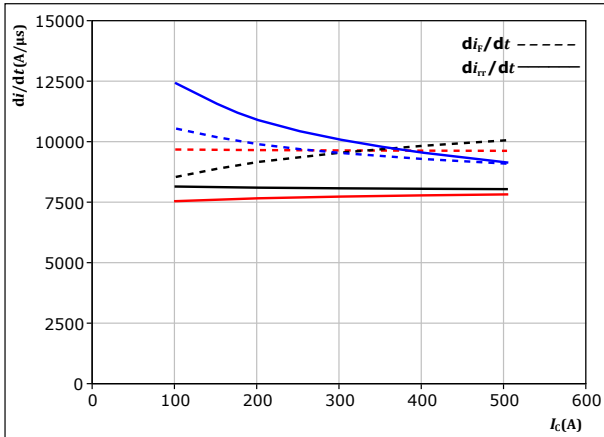
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datasheet

## Boost Switching Characteristics

figure 47. FWD

Typical rate of fall of forward and reverse recovery current as a function of collector current  
 $di_f/dt, di_r/dt = f(I_C)$



With an inductive load at

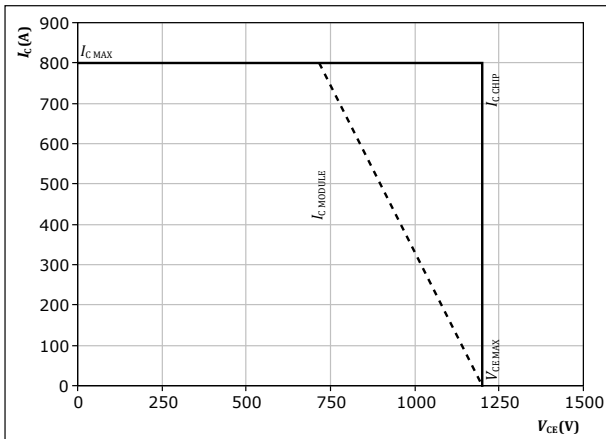
$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 2 \text{ } \Omega$

$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 48. FWD

Reverse bias safe operating area

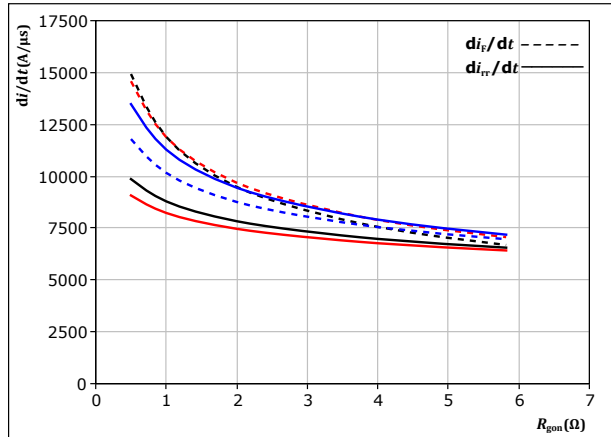
$I_C = f(V_{CE})$



At  $T_j = 150 \text{ } ^\circ\text{C}$   
 $R_{gon} = 2 \text{ } \Omega$   
 $R_{goff} = 2 \text{ } \Omega$

figure 48. FWD

Typical rate of fall of forward and reverse recovery current as a function of turn on gate resistor  
 $di_f/dt, di_r/dt = f(R_{gon})$



With an inductive load at

$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_C = 300 \text{ A}$

$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C



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## Switching Definitions

figure 50. IGBT

Turn-off Switching Waveforms & definition of  $t_{doff}$ ,  $t_{Eoff}$  ( $t_{Eoff}$  = integrating time for  $E_{off}$ )

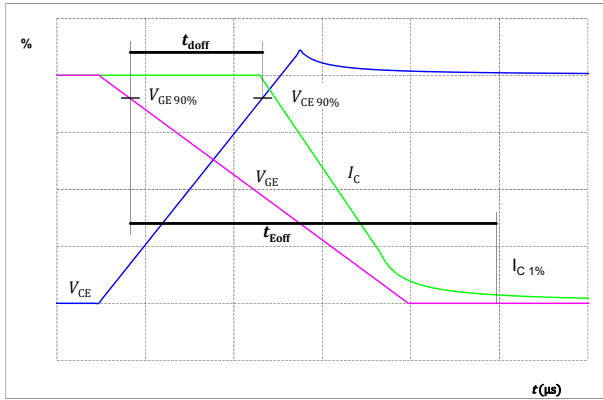


figure 51. IGBT

Turn-on Switching Waveforms & definition of  $t_{don}$ ,  $t_{Eon}$  ( $t_{Eon}$  = integrating time for  $E_{on}$ )

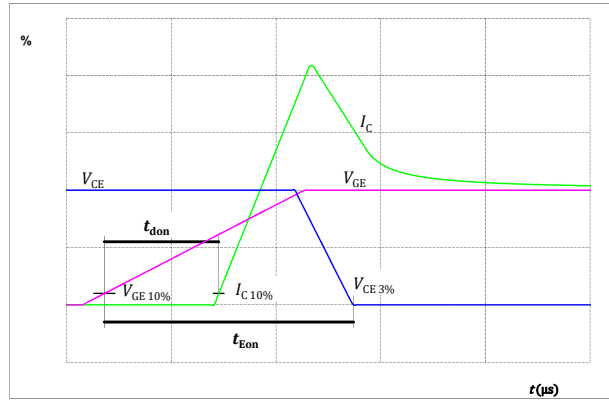


figure 52. IGBT

Turn-off Switching Waveforms & definition of  $t_f$

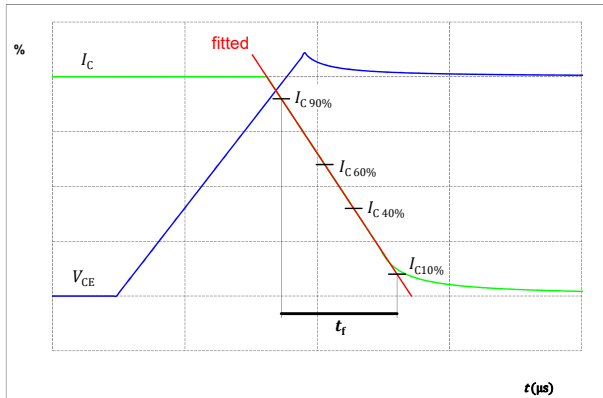
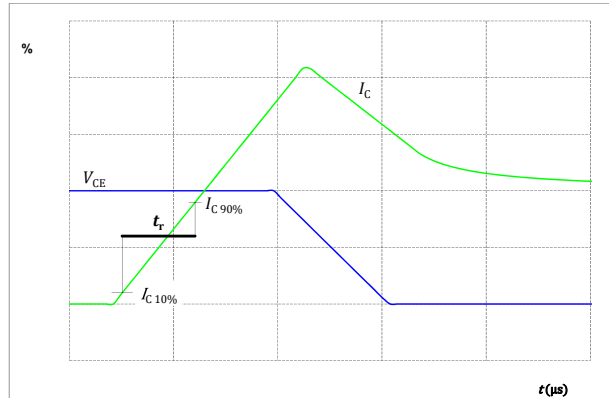


figure 53. IGBT

Turn-on Switching Waveforms & definition of  $t_r$





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## Switching Definitions

figure 54.

FWD

Turn-off Switching Waveforms & definition of  $t_{rr}$

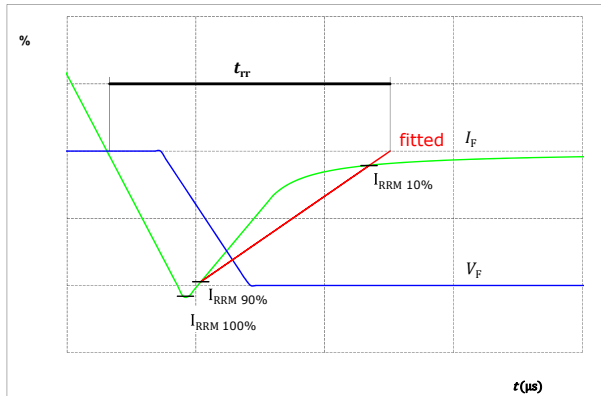
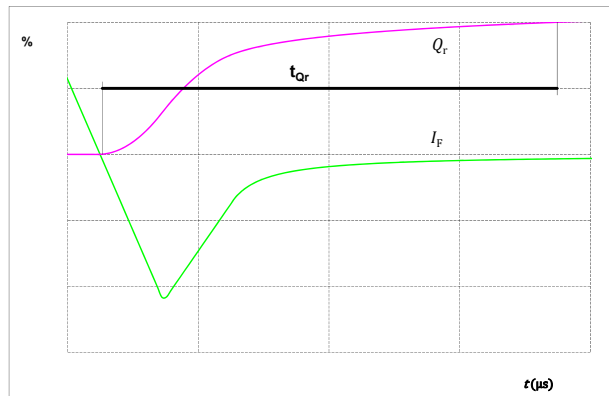


figure 55.

FWD

Turn-on Switching Waveforms & definition of  $t_{Qr}$  ( $t_{Qr}$  = integrating time for  $Q_r$ )





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# 30-E312NIB400H710-PR49F07Z

datasheet

| Ordering Code                            |                                |
|------------------------------------------|--------------------------------|
| Version                                  | Ordering Code                  |
| Without thermal paste                    | 30-E312NIB400H710-PR49F07Z     |
| With thermal paste (5,2 W/mK, PTM6000HV) | 30-E312NIB400H710-PR49F07Z-/7/ |

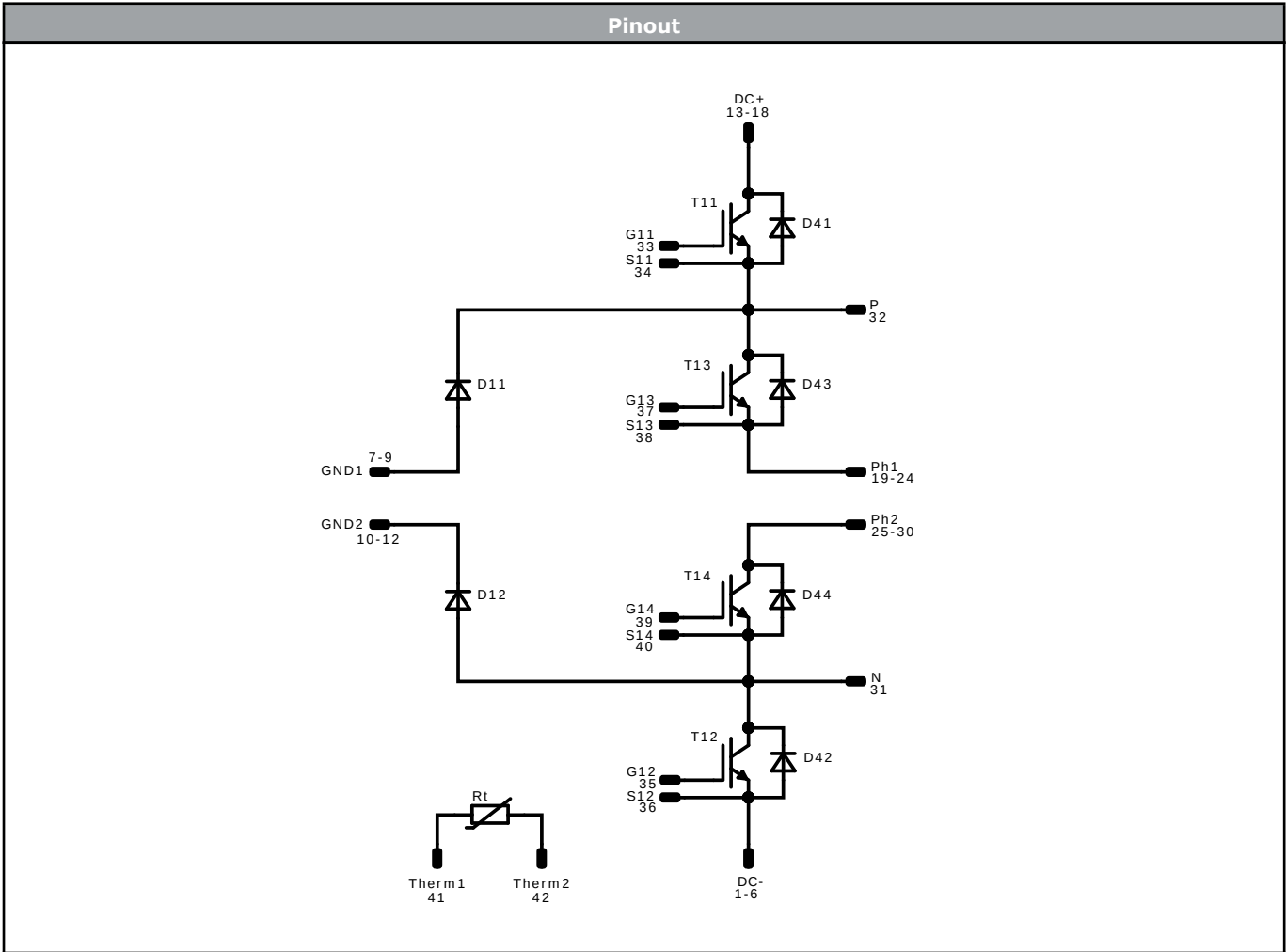
| Marking |            |                              |            |           |           |        |
|---------|------------|------------------------------|------------|-----------|-----------|--------|
|         | Text       | Name                         |            | Date code | UL & VIN  | Lot    |
|         |            | NN-NNNNNNNNNNNNNNNN- TTTTUVV |            | WWYY      | UL VIN    | LLLL   |
|         | Datamatrix | Type&Ver                     | Lot number | Serial    | Date code | Serial |
|         |            | TTTTTUVV                     | LLLLL      | SSSS      | WWYY      | SSSS   |

| Outline        |       |      |  |          |
|----------------|-------|------|--|----------|
| Pin table [mm] |       |      |  | Function |
| Pin            | X     | Y    |  |          |
| 1              | 56,16 | 0    |  | DC-      |
| 2              | 59,36 | 0    |  | DC-      |
| 3              | 62,56 | 0    |  | DC-      |
| 4              | 65,76 | 0    |  | DC-      |
| 5              | 68,96 | 0    |  | DC-      |
| 6              | 72,16 | 0    |  | DC-      |
| 7              | 25,6  | 0    |  | GND1     |
| 8              | 28,8  | 0    |  | GND1     |
| 9              | 32    | 0    |  | GND1     |
| 10             | 40,16 | 0    |  | GND2     |
| 11             | 43,36 | 0    |  | GND2     |
| 12             | 46,56 | 0    |  | GND2     |
| 13             | 0     | 0    |  | DC+      |
| 14             | 3,2   | 0    |  | DC+      |
| 15             | 6,4   | 0    |  | DC+      |
| 16             | 9,6   | 0    |  | DC+      |
| 17             | 12,8  | 0    |  | DC+      |
| 18             | 16    | 0    |  | DC+      |
| 19             | 16    | 48   |  | Ph1      |
| 20             | 19,2  | 48   |  | Ph1      |
| 21             | 22,4  | 48   |  | Ph1      |
| 22             | 25,6  | 48   |  | Ph1      |
| 23             | 28,8  | 48   |  | Ph1      |
| 24             | 32    | 48   |  | Ph1      |
| 25             | 40,16 | 44,8 |  | Ph2      |
| 26             | 43,36 | 44,8 |  | Ph2      |
| 27             | 46,56 | 44,8 |  | Ph2      |
| 28             | 40,16 | 48   |  | Ph2      |
| 29             | 43,36 | 48   |  | Ph2      |
| 30             | 46,56 | 48   |  | Ph2      |
| 31             | 62,56 | 28,8 |  | N        |
| 32             | 9,6   | 25,6 |  | P        |
| 33             | 9,6   | 19,2 |  | G11      |
| 34             | 9,6   | 22,4 |  | S11      |
| 35             | 62,56 | 9,6  |  | G12      |
| 36             | 62,56 | 6,4  |  | S12      |
| 37             | 0     | 44,8 |  | G13      |
| 38             | 0     | 48   |  | S13      |
| 39             | 72,16 | 48   |  | G14      |
| 40             | 68,96 | 48   |  | S14      |
| 41             | 56,16 | 48   |  | Therm1   |
| 42             | 59,36 | 48   |  | Therm2   |



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| Identification |            |         |         |                      |         |
|----------------|------------|---------|---------|----------------------|---------|
| ID             | Component  | Voltage | Current | Function             | Comment |
| T11, T12       | IGBT       | 1200 V  | 400 A   | Buck Switch          |         |
| D11, D12       | FWD        | 1200 V  | 420 A   | Buck Diode           |         |
| T13, T14       | IGBT       | 1200 V  | 400 A   | Boost Switch         |         |
| D42, D41       | FWD        | 1200 V  | 420 A   | Boost Diode          |         |
| D43, D44       | FWD        | 1200 V  | 420 A   | Boost Sw. Inv. Diode |         |
| Rt             | Thermistor |         |         | Thermistor           |         |





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datasheet

| Packaging instruction                                                                                                                                                                                                           |      |          |      |                                                                                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|----------|------|-------------------------------------------------------------------------------------|
| Standard packaging quantity (SPQ) 24                                                                                                                                                                                            | >SPQ | Standard | <SPQ | Sample                                                                              |
| Handling instruction                                                                                                                                                                                                            |      |          |      |                                                                                     |
| Handling instructions for <i>flow</i> E3BP packages see vincotech.com website.                                                                                                                                                  |      |          |      |                                                                                     |
| Package data                                                                                                                                                                                                                    |      |          |      |                                                                                     |
| Package data for <i>flow</i> E3BP packages see vincotech.com website.                                                                                                                                                           |      |          |      |                                                                                     |
| Vincotech thermistor reference                                                                                                                                                                                                  |      |          |      |                                                                                     |
| See Vincotech thermistor reference table at vincotech.com website.                                                                                                                                                              |      |          |      |                                                                                     |
| UL recognition and file number                                                                                                                                                                                                  |      |          |      |                                                                                     |
| This device is UL 1557 recognized under E192116 up to a junction temperature under switching condition $T_{j,sp}=175^{\circ}\text{C}$ and up to 4000VAC/1min isolation voltage. For more information see vincotech.com website. |      |          |      |  |

| Document No.:                    | Date:        | Modification:   | Pages |
|----------------------------------|--------------|-----------------|-------|
| 30-E312NIB400H710-PR49F07Z-D1-14 | 29 Apr. 2025 | Initial Release |       |

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