

# Auto SPM<sup>®</sup> Series Automotive 3-Phase IGBT Smart Power Module

## FAM65V05DF1

### General Description

FAM65V05DF1 is an advanced Auto SPM module providing a fully-featured high-performance auxiliary inverter output stage for hybrid and electric vehicles. These modules integrate optimized gate drive of the built-in IGBTs to minimize EMI and losses, while also providing various protection features, in a compact 12 cm<sup>2</sup> footprint.

### Features

- Automotive SPM in 27 Pin DIP Package
- 650 V/50 A 3-phase IGBT Module with Low Loss IGBTs and Soft Recovery Diodes Optimized for Motor Control Applications
- Integrated Gate Drivers with Internal VS connection, Under Voltage lockout, Over-current shutdown, Temperature Sensing Unit and Fault reporting
- Electrically Isolated AlN Substrate with Low R<sub>θjc</sub>
- Module Serialization for Full Traceability
- UL Certified No. E209204 (UL 1557)
- Pb-Free, Halid Free and RoHS Compliant
- AEC & AQG324 Qualified and PPAP Capable

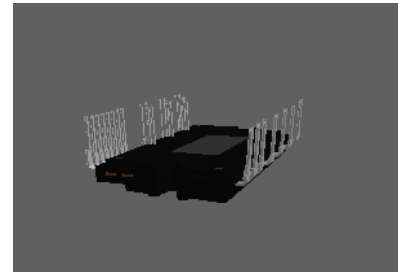
### Applications and Benefits

Automotive high voltage auxiliary motors such as air conditioning compressor and oil pump.

- Compact Design
- Simplified PCB Layout and Low EMI
- Simplified Assembly
- High Reliability

### Related Resources

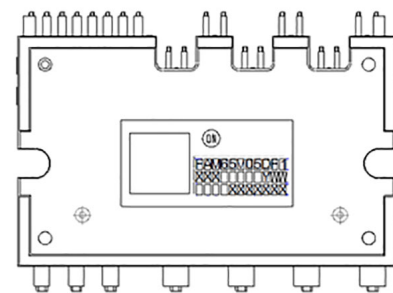
- [AN-8422](#) – 650 V Auto SPM Series; Automotive 3-Phase IGBT Smart Power Module User's Guide



3D Package Drawing  
(Click to Activate 3D Content)

ASPM27-CCA  
CASE MODCB

### MARKING DIAGRAM



|             |                        |
|-------------|------------------------|
| ON          | = onsemi Logo          |
| FAM65V05DF1 | = Specific Device Code |
| XXX         | = Lot Number           |
| Y           | = Year                 |
| WW          | = Work Week            |
| 0000001     | = Serial Number        |

### ORDERING INFORMATION

See detailed ordering and shipping information on page 7 of this data sheet.

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## PIN CONFIGURATION

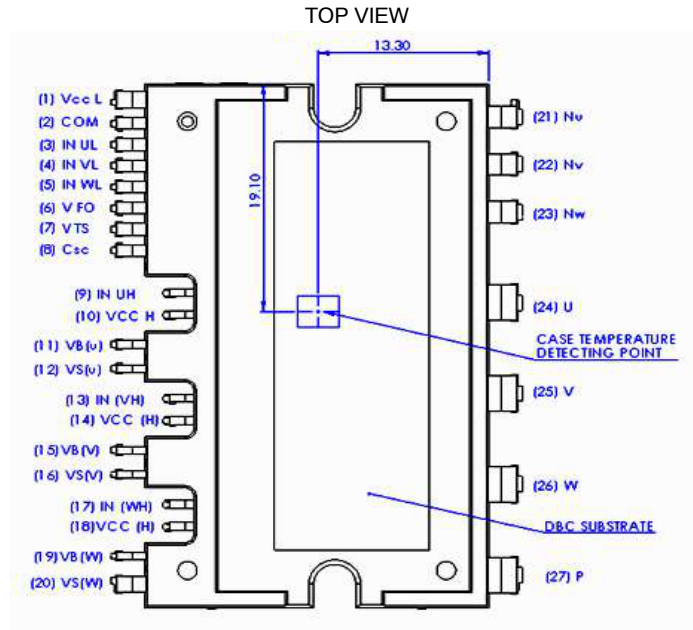


Figure 1. Pin Configuration

## PIN DESCRIPTION

| Pin Number | Name    | Description                                                   |
|------------|---------|---------------------------------------------------------------|
| 1          | VCC (L) | Low-side Common Bias Voltage for IC and IGBTs Driving         |
| 2          | COM     | Common Supply Ground                                          |
| 3          | IN (UL) | Signal Input for Low-side U Phase                             |
| 4          | IN (VL) | Signal Input for Low-side V Phase                             |
| 5          | IN (WL) | Signal Input for Low-side W Phase                             |
| 6          | VFO     | Fault Output                                                  |
| 7          | VTS     | Output for LVIC temperature sense                             |
| 8          | CSC     | Capacitor (Low-pass Filter) for Short-Current Detection Input |
| 9          | IN (UH) | Signal Input for High-side U Phase                            |
| 10         | VCC (H) | High-side Common Bias Voltage for IC and IGBTs Driving        |
| 11         | VB (U)  | High-side Bias Voltage for U Phase IGBT Driving               |
| 12         | VS (U)  | High-side Bias Voltage Ground for U Phase IGBT Driving        |
| 13         | IN (VH) | Signal Input for High-side V Phase                            |
| 14         | VCC (H) | High-side Common Bias Voltage for IC and IGBTs Driving        |
| 15         | VB (V)  | High-side Bias Voltage for V Phase IGBT Driving               |
| 16         | VS (V)  | High-side Bias Voltage Ground for V Phase IGBT Driving        |
| 17         | IN (WH) | Signal Input for High-side W Phase                            |
| 18         | VCC (H) | High-side Common Bias Voltage for IC and IGBTs Driving        |
| 19         | VB (W)  | High-side Bias Voltage for W Phase IGBT Driving               |
| 20         | VS (W)  | High-side Bias Voltage Ground for W Phase IGBT Driving        |
| 21         | NU      | Negative DC-Link Input for U Phase                            |
| 22         | NV      | Negative DC-Link Input for V Phase                            |

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## PIN DESCRIPTION (continued)

| Pin Number | Name | Description                        |
|------------|------|------------------------------------|
| 23         | NW   | Negative DC-Link Input for W Phase |
| 24         | U    | Output for U Phase                 |
| 25         | V    | Output for V Phase                 |
| 26         | W    | Output for W Phase                 |
| 27         | P    | Positive DC-Link Input             |

## INTERNAL EQUIVALENT CIRCUIT AND INPUT/OUTPUT PINS

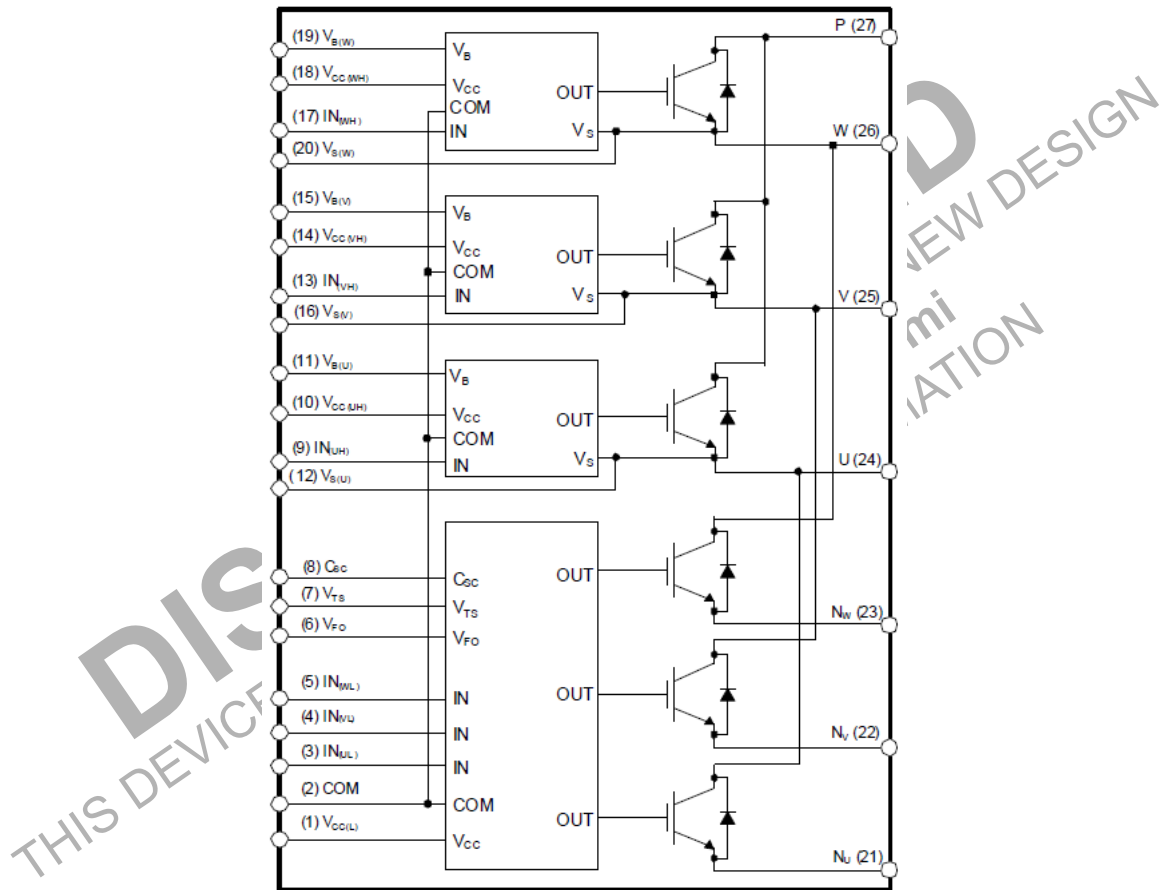


Figure 2. Schematic

## GATE DRIVERS BLOCK DIAGRAM

### High Side Gate Driver (x3 Single Channel)

- Control circuit under-voltage (UV) protection
- 3.3 V/5 V CMOS/LSTTL compatible, Schmitt trigger input

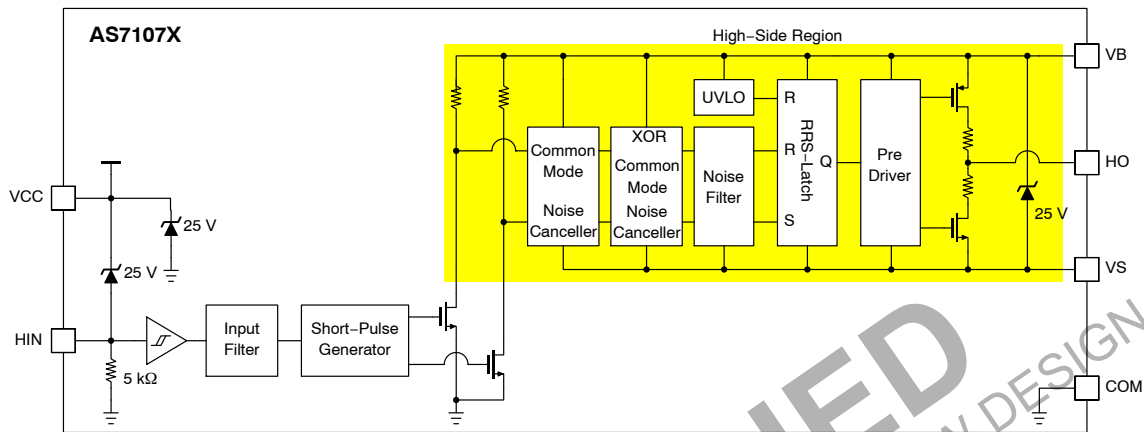


Figure 3. High Side Gate Drivers (Block Diagram)

### Low Side Gate Driver (x1 Monolithic Three-Channel)

- Control circuit under-voltage (UV) protection
- Short circuit protection (SC)
- Temperature sensing unit
- Fault Output
- 3.3 V/5 V CMOS/LSTTL compatible, Schmitt trigger input

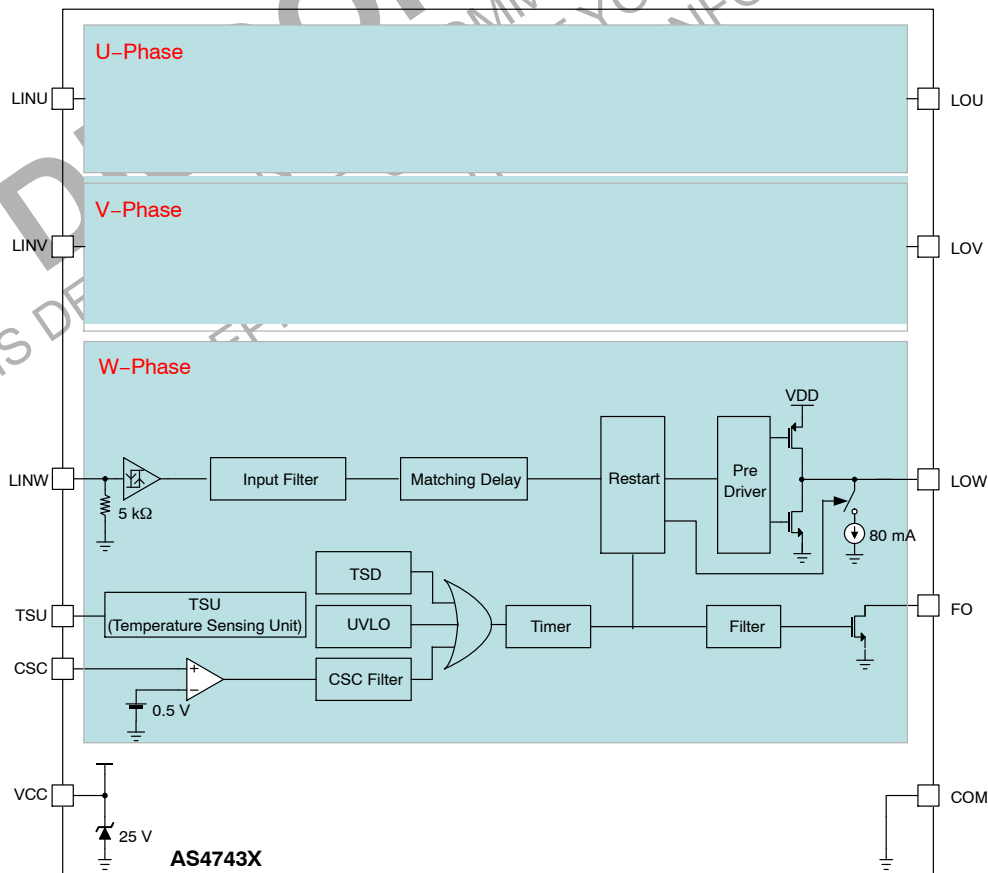


Figure 4. Low Side Gate Drivers (Block Diagram)

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

| Symbol                 | Parameter                                   | Conditions                                                                                                                            | Rating          | Unit               |
|------------------------|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------|
| <b>INVERTER PART</b>   |                                             |                                                                                                                                       |                 |                    |
| $V_{PN}$               | Supply Voltage                              | Applied between P– $N_U$ , $N_V$ , $N_W$                                                                                              | 500             | V                  |
| $V_{PN(\text{Surge})}$ | Supply Voltage (Surge)                      | Applied between P– $N_U$ , $N_V$ , $N_W$<br>$di/dt \leq 3 \text{ A/ns}$                                                               | 575             | V                  |
| $V_{CES}$              | Collector–Emitter Voltage at the IGBT/Diode | $T_J = 25^{\circ}\text{C}$                                                                                                            | 650             | V                  |
| $\pm I_C$              | IGBT Continuous Collector Current           | $T_C = 100^{\circ}\text{C}$ , $T_{J\text{max}} = 175^{\circ}\text{C}$ (Note 1)                                                        | 50              | A                  |
| $\pm I_{CP}$           | IGBT Peak Collector Pulse Current           | $T_C = 100^{\circ}\text{C}$ , $T_{J\text{max}} = 175^{\circ}\text{C}$ ,<br>$V_{CC} = V_{BS} = 15 \text{ V}$ , less than 1 ms (Note 6) | 150             | A                  |
| $P_C$                  | Collector Dissipation                       | $T_C = 25^{\circ}\text{C}$ per IGBT                                                                                                   | 333             | W                  |
| $T_J$                  | Junction Temperature                        | IGBT/Diode                                                                                                                            | $-40 \sim +175$ | $^{\circ}\text{C}$ |
|                        |                                             | Driver IC                                                                                                                             | $-40 \sim +150$ | $^{\circ}\text{C}$ |

## CONTROL PART

|          |                                |                                                                                                                   |                               |    |
|----------|--------------------------------|-------------------------------------------------------------------------------------------------------------------|-------------------------------|----|
| $V_{CC}$ | Control Supply Voltage         | Applied between $V_{CC(H)}$ , $V_{CC(L)} - \text{COM}$                                                            | 20                            | V  |
| $V_{BS}$ | High–side Control Bias Voltage | Applied between $V_{B(U)} - V_{S(U)}$ ,<br>$V_{B(V)} - V_{S(V)}$ , $V_{B(W)} - V_{S(W)}$                          | 20                            | V  |
| $V_{IN}$ | Input Signal Voltage           | Applied between $IN_{(UH)}$ , $IN_{(VH)}$ , $IN_{(WH)}$ ,<br>$IN_{(UL)}$ , $IN_{(VL)}$ , $IN_{(WL)} - \text{COM}$ | $-0.3 \sim V_{CC} + 0.3$      | V  |
| $V_{FO}$ | Fault Output Supply Voltage    | Applied between $V_{FO} - \text{COM}$                                                                             | $-0.3 \sim V_{CC} + 0.3$      | V  |
| $I_{FO}$ | Fault Output Current           | Sink Current at $V_{FO}$ Pin                                                                                      | 5                             | mA |
| $V_{SC}$ | Current Sensing Input Voltage  | Applied between $C_{SC} - \text{COM}$                                                                             | $-0.3 \sim V_{CC} + 0.3$      | V  |
| $V_{TS}$ | Temperature Sense Unit         |                                                                                                                   | $-0.3 \sim 2/3 \times V_{CC}$ | V  |

## TOTAL SYSTEM

|            |                                                                     |                                                                       |                |                    |
|------------|---------------------------------------------------------------------|-----------------------------------------------------------------------|----------------|--------------------|
| $T_{STG}$  | Storage Temperature                                                 |                                                                       | $-40 \sim 125$ | $^{\circ}\text{C}$ |
| $V_{ISO}$  | Isolation Voltage                                                   | 60 Hz, Sinusoidal, AC 1 minute,<br>Connection Pins to heat sink plate | 2500           | $V_{rms}$          |
| $T_{LEAD}$ | Max Lead Temperature at the Base of the Package During pcb Assembly | No remelt of internal solder joints                                   | 200            | $^{\circ}\text{C}$ |

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.

## PACKAGE CHARACTERISTICS

| Symbol         | Parameter                                    | Conditions                          | Typ | Max  | Unit                 |
|----------------|----------------------------------------------|-------------------------------------|-----|------|----------------------|
| $R_{th(j-c)Q}$ | Junction to Case Thermal Resistance (Note 2) | Inverter IGBT part (per IGBT)       | –   | 0.45 | $^{\circ}\text{C/W}$ |
| $R_{th(j-c)F}$ |                                              | Inverter FWD part (per DIODE)       | –   | 0.85 | $^{\circ}\text{C/W}$ |
| $L_{\sigma}$   | Package Stray Inductance                     | P to $N_U$ , $N_V$ , $N_W$ (Note 3) | 24  | –    | nH                   |

1. Current limited by package terminal, defined by design.
2. Case temperature measured below the package at the chip center, compliant with MIL STD 883–1012.1 (single chip heating), DBC discoloration allowed, please refer to application note [AN-9190](#) (Impact of DBC Oxidation on SPM Module Performance).
3. Stray inductance per phase measured per IEC 60747–15.

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## ELECTRICAL CHARACTERISTICS

| Symbol                                      |                     | Parameter                                                        | Test Conditions                                                                                                                                                                                             | Min | Typ  | Max  | Unit |
|---------------------------------------------|---------------------|------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|------|------|
| INVERTER PART (T <sub>J</sub> as specified) |                     |                                                                  |                                                                                                                                                                                                             |     |      |      |      |
| V <sub>CE(SAT)</sub>                        |                     | Collector-Emitter Leakage Current                                | V <sub>CC</sub> = V <sub>BS</sub> = 15 V, V <sub>IN</sub> = 5 V<br>I <sub>C</sub> = 50 A, T <sub>J</sub> = 25°C                                                                                             | –   | 1.65 | –    | V    |
|                                             |                     |                                                                  | V <sub>CC</sub> = V <sub>BS</sub> = 15 V, V <sub>IN</sub> = 5 V<br>I <sub>C</sub> = 50 A, T <sub>J</sub> = 125°C                                                                                            | –   | 1.9  | 2.4  | V    |
| V <sub>F</sub>                              |                     | FWD Forward Voltage                                              | V <sub>IN</sub> = 0 V, I <sub>F</sub> = 30 A, T <sub>J</sub> = 25°C                                                                                                                                         | –   | 2.1  | –    | V    |
|                                             |                     |                                                                  | V <sub>IN</sub> = 0 V, I <sub>F</sub> = 30 A, T <sub>J</sub> = 125°C                                                                                                                                        | –   | 1.9  | 2.5  | V    |
| HS                                          | t <sub>ON</sub>     | High Side Switching Times                                        | V <sub>PN</sub> = 300 V, V <sub>CC</sub> = V <sub>BS</sub> = 15 V<br>I <sub>C</sub> = 50 A<br>V <sub>IN</sub> = 0 V ↔ 5 V, L <sub>s</sub> = 55 nH,<br>Inductive Load<br>T <sub>J</sub> = 25°C (Notes 4, 5)  | –   | 0.73 | –    | μs   |
|                                             | t <sub>C(ON)</sub>  |                                                                  |                                                                                                                                                                                                             | –   | 0.12 | –    |      |
|                                             | t <sub>OFF</sub>    |                                                                  |                                                                                                                                                                                                             | –   | 0.80 | –    |      |
|                                             | t <sub>C(OFF)</sub> |                                                                  |                                                                                                                                                                                                             | –   | 0.14 | –    |      |
|                                             | t <sub>rr</sub>     |                                                                  |                                                                                                                                                                                                             | –   | 0.10 | –    |      |
|                                             | t <sub>ON</sub>     | High Side Switching Times                                        | V <sub>PN</sub> = 300 V, V <sub>CC</sub> = V <sub>BS</sub> = 15 V<br>I <sub>C</sub> = 50 A<br>V <sub>IN</sub> = 0 V ↔ 5 V, L <sub>s</sub> = 55 nH,<br>Inductive Load<br>T <sub>J</sub> = 125°C (Notes 4, 5) | –   | 0.70 | –    | μs   |
|                                             | t <sub>C(ON)</sub>  |                                                                  |                                                                                                                                                                                                             | –   | 0.15 | –    |      |
|                                             | t <sub>OFF</sub>    |                                                                  |                                                                                                                                                                                                             | –   | 0.87 | –    |      |
|                                             | t <sub>C(OFF)</sub> |                                                                  |                                                                                                                                                                                                             | –   | 0.19 | –    |      |
|                                             | t <sub>rr</sub>     |                                                                  |                                                                                                                                                                                                             | –   | 0.20 | –    |      |
| LS                                          | t <sub>ON</sub>     | Low Side Switching Times                                         | V <sub>PN</sub> = 300 V, V <sub>CC</sub> = V <sub>BS</sub> = 15 V<br>I <sub>C</sub> = 50 A<br>V <sub>IN</sub> = 0 V ↔ 5 V, L <sub>s</sub> = 55 nH,<br>Inductive Load<br>T <sub>J</sub> = 25°C (Notes 4, 5)  | –   | 0.68 | –    | μs   |
|                                             | t <sub>C(ON)</sub>  |                                                                  |                                                                                                                                                                                                             | –   | 0.20 | –    |      |
|                                             | t <sub>OFF</sub>    |                                                                  |                                                                                                                                                                                                             | –   | 0.86 | –    |      |
|                                             | t <sub>C(OFF)</sub> |                                                                  |                                                                                                                                                                                                             | –   | 0.19 | –    |      |
|                                             | t <sub>rr</sub>     |                                                                  |                                                                                                                                                                                                             | –   | 0.14 | –    |      |
|                                             | t <sub>ON</sub>     | Low Side Switching Times                                         | V <sub>PN</sub> = 300 V, V <sub>CC</sub> = V <sub>BS</sub> = 15 V<br>I <sub>C</sub> = 50 A<br>V <sub>IN</sub> = 0 V ↔ 5 V, L <sub>s</sub> = 55 nH,<br>Inductive Load<br>T <sub>J</sub> = 125°C (Notes 4, 5) | –   | 0.64 | –    | μs   |
|                                             | t <sub>C(ON)</sub>  |                                                                  |                                                                                                                                                                                                             | –   | 0.24 | –    |      |
|                                             | t <sub>OFF</sub>    |                                                                  |                                                                                                                                                                                                             | –   | 0.88 | –    |      |
|                                             | t <sub>C(OFF)</sub> |                                                                  |                                                                                                                                                                                                             | –   | 0.23 | –    |      |
|                                             | t <sub>rr</sub>     |                                                                  |                                                                                                                                                                                                             | –   | 0.20 | –    |      |
| SCWT                                        |                     | Short Circuit Withstand Time (Note 6)                            | V <sub>CC</sub> = V <sub>BS</sub> = 15 V, V <sub>PN</sub> = 450 V,<br>T <sub>J</sub> = 25°C, Non-repetitive                                                                                                 | –   | 5    | –    | μs   |
| I <sub>CES</sub>                            |                     | Collector-Emitter Leakage Current for IGBT and Diode in Parallel | T <sub>J</sub> = 25°C, V <sub>CE</sub> = 650 V                                                                                                                                                              | –   | 3    | –    | μA   |
|                                             |                     |                                                                  | T <sub>J</sub> = 125°C, V <sub>CE</sub> = 650 V                                                                                                                                                             | –   | 150  | 1500 | μA   |

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## ELECTRICAL CHARACTERISTICS (continued)

| Symbol                                                                                                                         | Parameter                                | Test Conditions                                                                                                                                      | Min                                                                                                                     | Typ  | Max  | Unit |    |
|--------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|------|------|------|----|
| CONTROL PART (T <sub>J</sub> = −40°C to 150°C, unless otherwise specified, typical values specified at T <sub>J</sub> = 125°C) |                                          |                                                                                                                                                      |                                                                                                                         |      |      |      |    |
| I <sub>QCCL</sub>                                                                                                              | Quiescent V <sub>CC</sub> Supply Current | V <sub>CC</sub> = 15 V,<br>I <sub>N(UL, VL, WL)</sub> = 0 V                                                                                          | V <sub>CC(L)</sub> – COM                                                                                                | –    | –    | 5    | mA |
| I <sub>QCCH</sub>                                                                                                              |                                          | V <sub>CC</sub> = 15 V,<br>I <sub>N(UH, VH, WH)</sub> = 0 V                                                                                          | V <sub>CC(H)</sub> – COM                                                                                                | –    | –    | 150  | μA |
| I <sub>PCCH</sub>                                                                                                              | Operating V <sub>CC</sub> Supply Current | V <sub>CC(UH, VH, WH)</sub> = 15 V<br>f <sub>PWM</sub> = 20 kHz<br>Duty = 50%, applied to<br>one PWM signal input<br>for high-side                   | V <sub>CC(UH)</sub> – COM<br>V <sub>CC(VH)</sub> – COM<br>V <sub>CC(WH)</sub> – COM                                     | –    | –    | 0.30 | mA |
| I <sub>QCCL</sub>                                                                                                              |                                          | V <sub>CC(UH, VH, WH)</sub> = 15 V<br>f <sub>PWM</sub> = 20 kHz<br>Duty = 50%, applied to<br>one PWM signal input<br>for low-side                    | V <sub>CC(L)</sub> – COM                                                                                                | –    | –    | 8.5  | mA |
| I <sub>QBS</sub>                                                                                                               | Quiescent V <sub>BS</sub> Supply Current | V <sub>BS</sub> = 15 V,<br>I <sub>N(UH, VH, WH)</sub> = 0 V                                                                                          | V <sub>B(U)</sub> – V <sub>S(U)</sub><br>V <sub>B(V)</sub> – V <sub>S(V)</sub><br>V <sub>B(W)</sub> – V <sub>S(W)</sub> | –    | –    | 150  | μA |
| I <sub>PBS</sub>                                                                                                               | Operating V <sub>BS</sub> Supply Current | V <sub>CC</sub> = V <sub>BC</sub> = 15 V<br>I <sub>N(UH, VH, WH)</sub> = 0 V                                                                         | V <sub>B(U)</sub> – V <sub>S(U)</sub><br>V <sub>B(V)</sub> – V <sub>S(V)</sub><br>V <sub>B(W)</sub> – V <sub>S(W)</sub> | –    | –    | 4.5  | mA |
| V <sub>FOH</sub>                                                                                                               | Fault Output Voltage                     | V <sub>SC</sub> = 0 V, V <sub>FO</sub> Circuit: 4.7 kΩ to 5 V Pull-up                                                                                | 4.5                                                                                                                     | –    | –    | –    | V  |
| V <sub>FOL</sub>                                                                                                               |                                          | V <sub>SC</sub> = 1 V, V <sub>FO</sub> Circuit: 4.7 kΩ to 5 V Pull-up                                                                                | –                                                                                                                       | –    | 0.5  | –    | V  |
| V <sub>SC(ref)</sub>                                                                                                           | Short-Circuit Trip Level                 | V <sub>CC</sub> = 15 V (Note 7)                                                                                                                      | C <sub>SC</sub> – COM                                                                                                   | 0.45 | 0.52 | 0.59 | V  |
| UV <sub>CCD</sub>                                                                                                              | Supply Circuit Under-Voltage Protection  | Detection Level, T <sub>J</sub> = 125°C                                                                                                              | 10.6                                                                                                                    | –    | 13.2 | –    | V  |
| UV <sub>CCR</sub>                                                                                                              |                                          | Reset Level, T <sub>J</sub> = 125°C                                                                                                                  | 11.0                                                                                                                    | –    | 13.8 | –    | V  |
| UV <sub>BSD</sub>                                                                                                              |                                          | Detection Level, T <sub>J</sub> = 125°C                                                                                                              | 10.5                                                                                                                    | –    | 13   | –    | V  |
| UV <sub>BSR</sub>                                                                                                              |                                          | Reset Level, T <sub>J</sub> = 125°C                                                                                                                  | 10.8                                                                                                                    | –    | 13.3 | –    | V  |
| t <sub>FOD</sub>                                                                                                               | Fault-out Pulse Width                    |                                                                                                                                                      | –                                                                                                                       | 60   | –    | –    | μs |
| V <sub>TS</sub>                                                                                                                | LVIC Temperature Sensing Voltage Output  | V <sub>CC(L)</sub> = 15 V, T <sub>LVIC</sub> = 125°C (Note 8)                                                                                        | –                                                                                                                       | 2.4  | –    | –    | V  |
| V <sub>IN(ON)</sub>                                                                                                            | ON Threshold Voltage                     | Applied between I <sub>N(UH)</sub> , I <sub>N(VH)</sub> , I <sub>N(WH)</sub> ,<br>I <sub>N(UL)</sub> , I <sub>N(VL)</sub> , I <sub>N(WL)</sub> – COM | –                                                                                                                       | 2.6  | 3.1  | –    | V  |
| V <sub>IN(OFF)</sub>                                                                                                           | OFF Threshold Voltage                    |                                                                                                                                                      | 0.9                                                                                                                     | 1.2  | –    | –    | V  |

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.

- $t_{ON}$  and  $t_{OFF}$  include the propagation delay time of the internal drive IC.  $t_{C(ON)}$  and  $t_{C(OFF)}$  are the switching times of IGBT itself under the given gate driving condition internally. Refer to Figure 6 for detailed information.
- Stray inductance  $L_s$  is sum of stray inductance of module & setup.
- Verified by design and bench-testing only.
- Short-circuit current protection is functional only for low side.
- $T_{LVIC}$  is the junction temperature of the LVIC itself.

## PACKAGE MARKING AND ORDERING INFORMATION

| Part Number | Top Marking | Package    | Shipping      |
|-------------|-------------|------------|---------------|
| FAM65V05DF1 | FAM65V05DF1 | ASPM27-CCA | 10 Units/Tube |

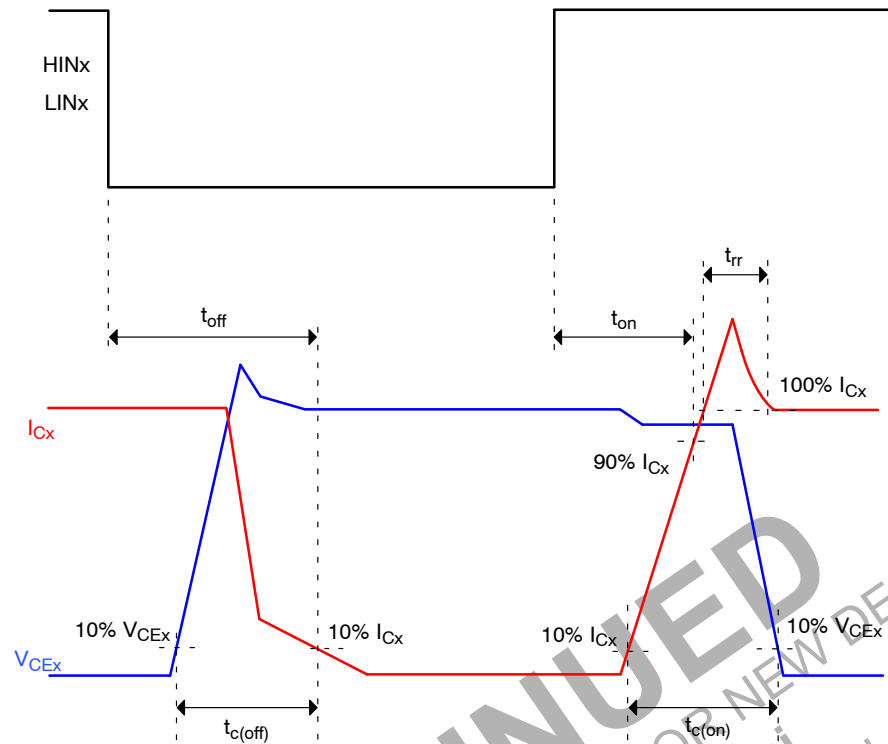


Figure 5. Switching Time Definition

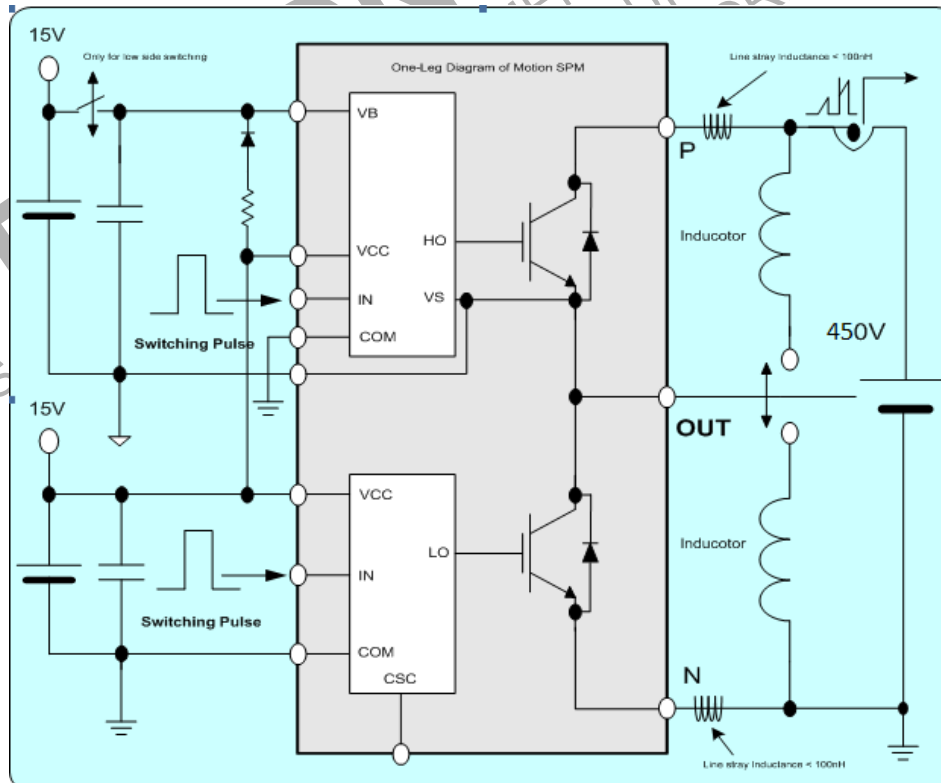


Figure 6. Switching Evaluation Circuit

## RECOMMENDED OPERATING CONDITIONS

| Symbol                         | Parameter                              | Conditions                                                                               | Min  | Max | Max  | Unit             |
|--------------------------------|----------------------------------------|------------------------------------------------------------------------------------------|------|-----|------|------------------|
| $V_{PN}$                       | Supply Voltage                         | Applied between P – $N_U$ , $N_V$ , $N_W$                                                | –    | 450 | 500  | V                |
| $V_{CC}$                       | Control Supply Voltage                 | Applied between $V_{CC(H)}$ , $V_{CC(L)}$ – COM                                          | 13.5 | 15  | 16.5 | V                |
| $V_{BS}$                       | High-side Bias Voltage                 | Applied between $V_{B(U)} - V_{S(U)}$ ,<br>$V_{B(V)} - V_{S(V)}$ , $V_{B(W)} - V_{S(W)}$ | 13.3 | 15  | 18.5 | V                |
| $dV_{CC}/dt$ ,<br>$dV_{BS}/dt$ | Control Supply Variation               |                                                                                          | –1   | –   | 1    | V/ $\mu$ s       |
| $t_{dead}$                     | Blanking Time for Preventing Arm-short | For Each Input Signal                                                                    | 1.0  | –   | –    | $\mu$ s          |
| $f_{PWM}$                      | PWM Input Signal                       | $T_C = 125^\circ\text{C}$                                                                | –    | –   | 20   | kHz              |
| $V_{SEN}$                      | Voltage for Current Sensing            | Applied between $N_U$ , $N_V$ , $N_W$ – COM (Including surge voltage)                    | –4   | –   | 4    | V                |
| $T_J$                          | Junction Temperature                   |                                                                                          | –40  | –   | 150  | $^\circ\text{C}$ |

## MECHANICAL CHARACTERISTICS AND RATINGS

| Parameter       | Conditions           | Conditions           | Limits |      |      | Unit    |
|-----------------|----------------------|----------------------|--------|------|------|---------|
|                 |                      |                      | Min    | Typ  | Max  |         |
| Mounting Torque | Mounting Screw: – M3 | Recommended 0.62 N·m | 0.52   | 0.62 | 0.80 | N·m     |
| Device Flatness |                      |                      | –      | –    | +150 | $\mu$ m |
| Weight          |                      |                      | –      | 15   | –    | g       |

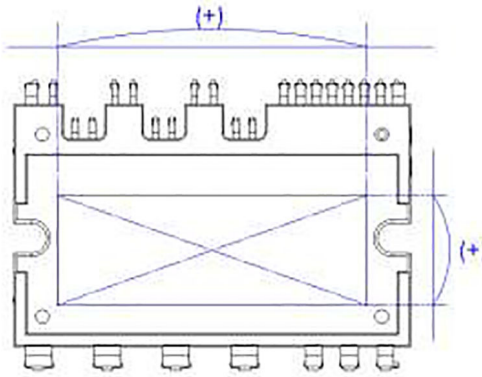
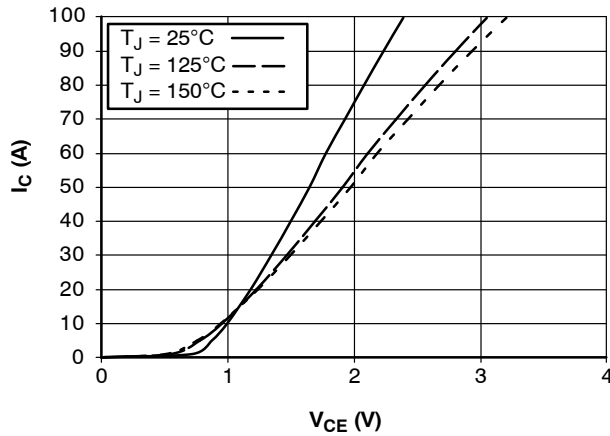
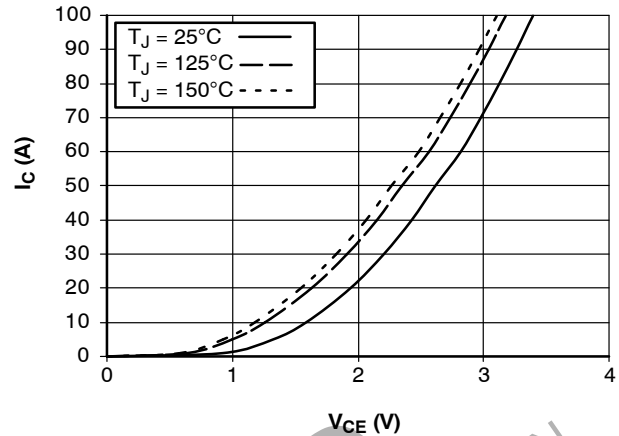


Figure 7. Flatness Measurement Position

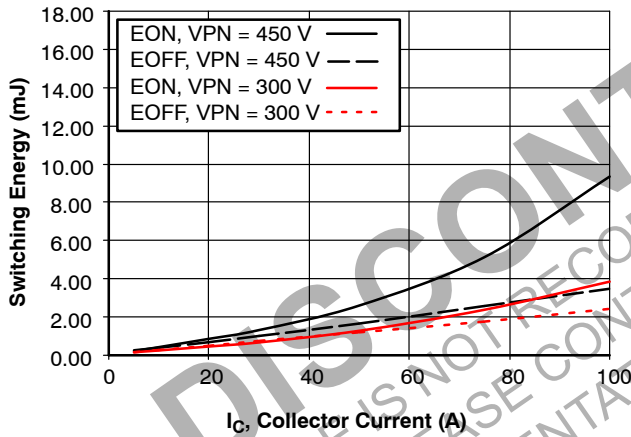
TYPICAL INVERTER CHARACTERISTICS



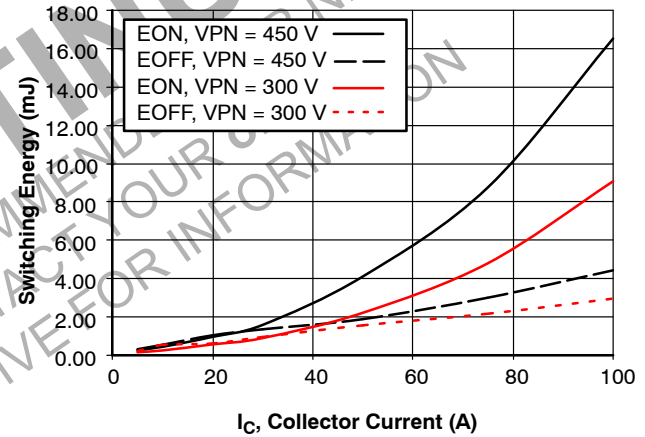
**Figure 8. Output Characteristics IGBT Inverter (Typical)**  
 $V_{CC} = V_{BS} = 15 \text{ V}$ ,  $V_{IN} = 5 \text{ V}$



**Figure 9. Forward Characteristics DIODE Inverter (Typical)**  
 $V_{IN} = 0 \text{ V}$



**Figure 10. Switching Losses IGBT Inverter High-Side (Typical) versus Collector Current**  
 $V_{CC} = V_{BS} = 15 \text{ V}$   
 $V_{IN} = 0 \text{ V} \leftrightarrow 5 \text{ V}$ ,  $L_s = 55 \text{ nH}$ , Inductive Load,  $T_J = 125^\circ\text{C}$



**Figure 11. Switching Losses IGBT Inverter Low-Side (Typical) versus Collector Current**  
 $V_{CC} = V_{BS} = 15 \text{ V}$   
 $V_{IN} = 0 \text{ V} \leftrightarrow 5 \text{ V}$ ,  $L_s = 55 \text{ nH}$ , Inductive Load,  $T_J = 125^\circ\text{C}$

TYPICAL INVERTER CHARACTERISTICS (continued)

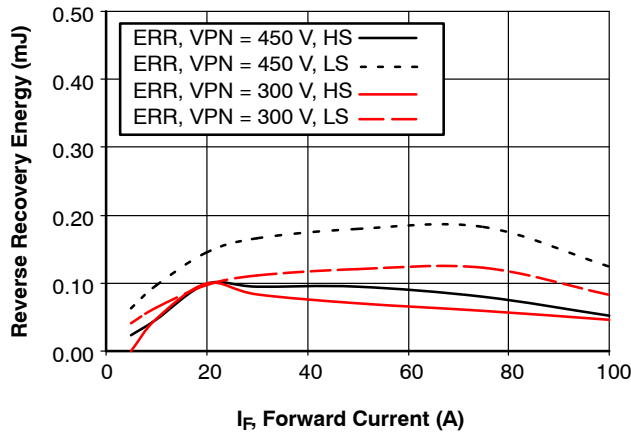


Figure 12. Reverse Recovery Energy DIODE Inverter (Typical) versus Forward Current

$V_{CC} = V_{BS} = 15\text{ V}$   
 $V_{IN} = 0\text{ V} \leftrightarrow 5\text{ V}$ ,  $L_s = 55\text{ nH}$ , Inductive Load,  $T_J = 125^\circ\text{C}$

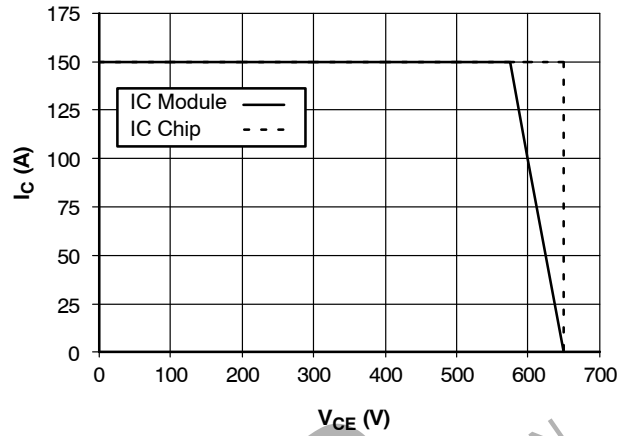


Figure 13. Reverse Bias Safe Operating Area IGBT (RBSOA) Inverter

$V_{CC} = V_{BS} = 15\text{ V}$ ,  $T_J = 150^\circ\text{C}$

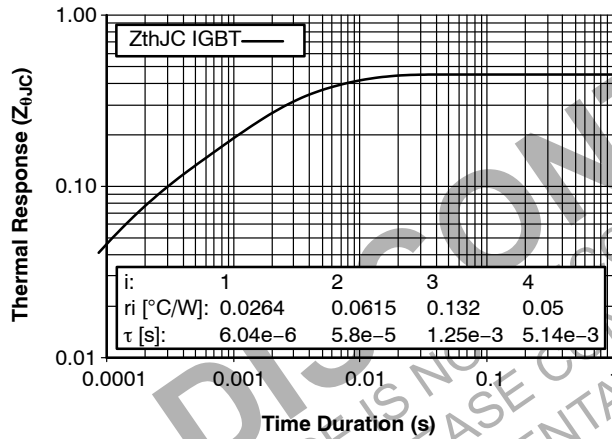


Figure 14. Transient Thermal Impedance IGBT Inverter

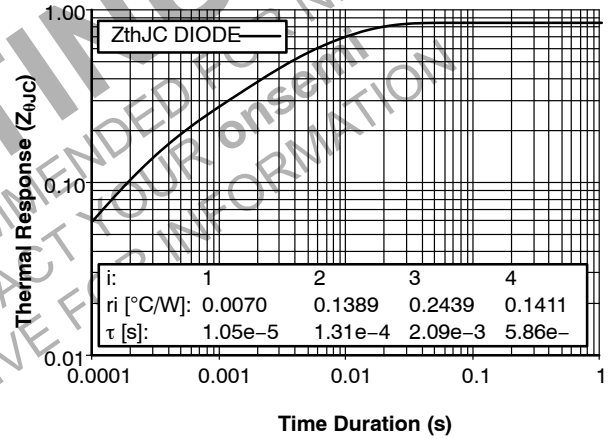


Figure 15. Transient Thermal Impedance DIODE Inverter

TYPICAL CONTROLLER CHARACTERISTICS

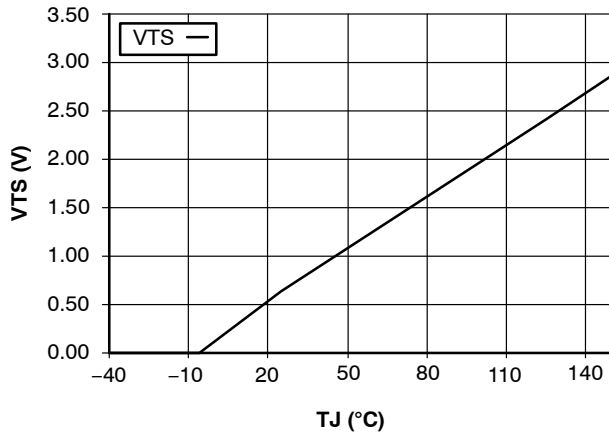


Figure 16. Temperature Profile of  $V_{TS}$  (Typical)

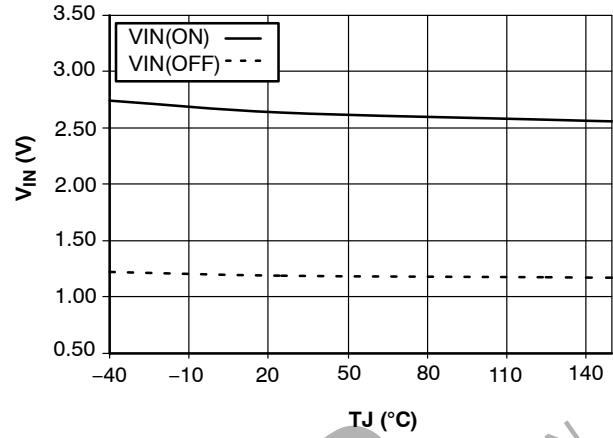


Figure 17. Threshold Voltage versus Temperature

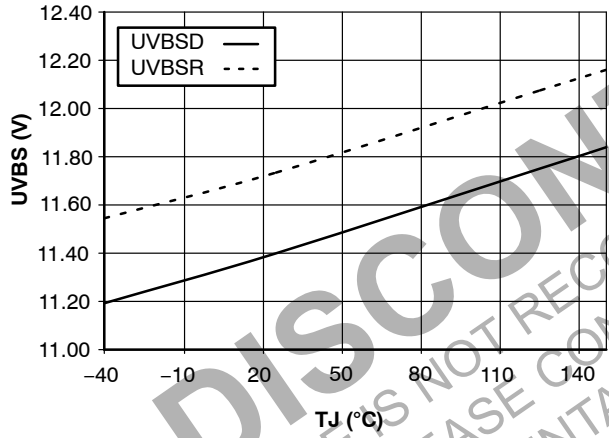


Figure 18. Supply Under-Voltage Protection High-Side (Typical)

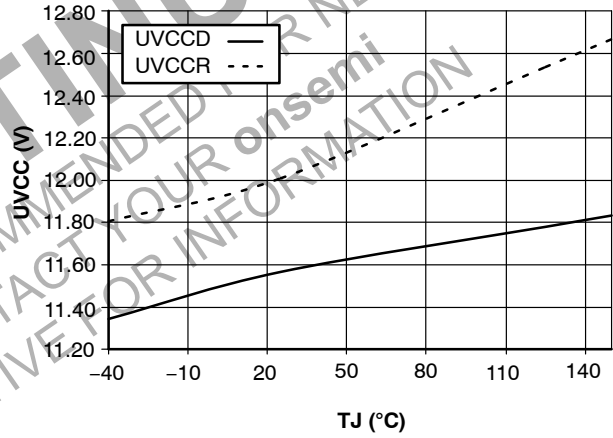
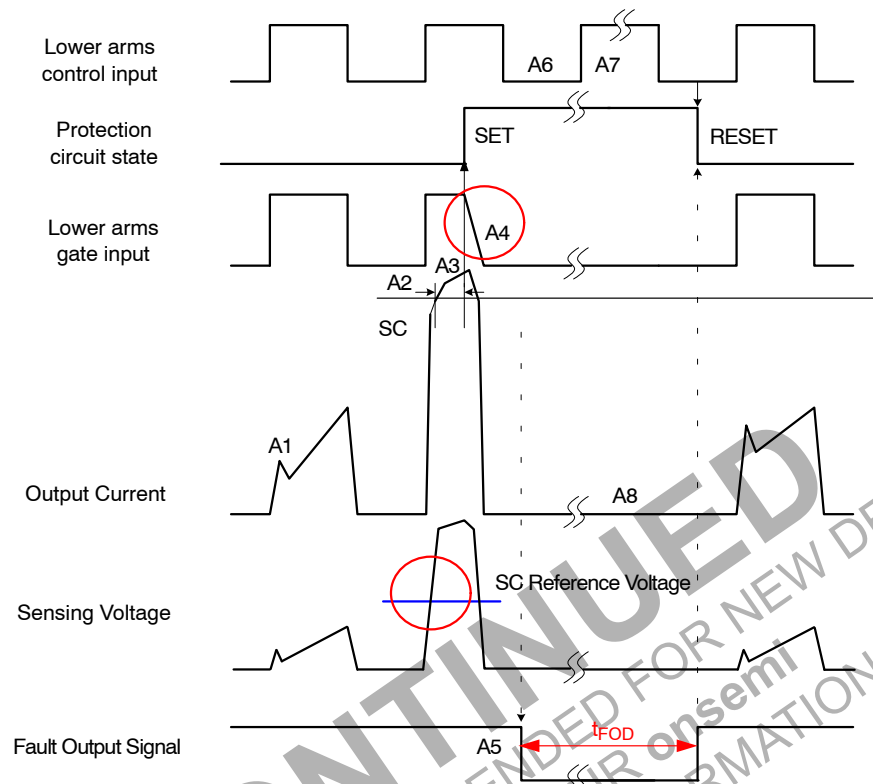


Figure 19. Supply Under-Voltage Protection Low-Side (Typical)

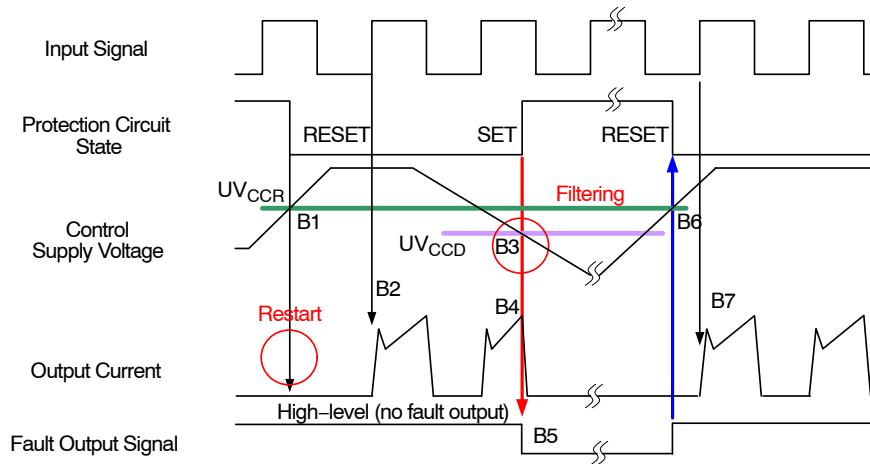
## TIMING CHART PROTECTIVE FUNCTION



| Step | Description                                                                 |
|------|-----------------------------------------------------------------------------|
| A1   | Normal operation, IGBT on and carrying current                              |
| A2   | Short-circuit current threshold reached                                     |
| A3   | Protection function triggered                                               |
| A4   | IGBT turns off with soft turn-off                                           |
| A5   | Fault output activated (initial delay 2 $\mu$ s, $t_{FOD}$ min. 50 $\mu$ s) |
| A6   | IGBT "LO" input                                                             |
| A7   | IGBT "HI" input is ignored                                                  |
| A8   | Current stays at zero during fault state                                    |

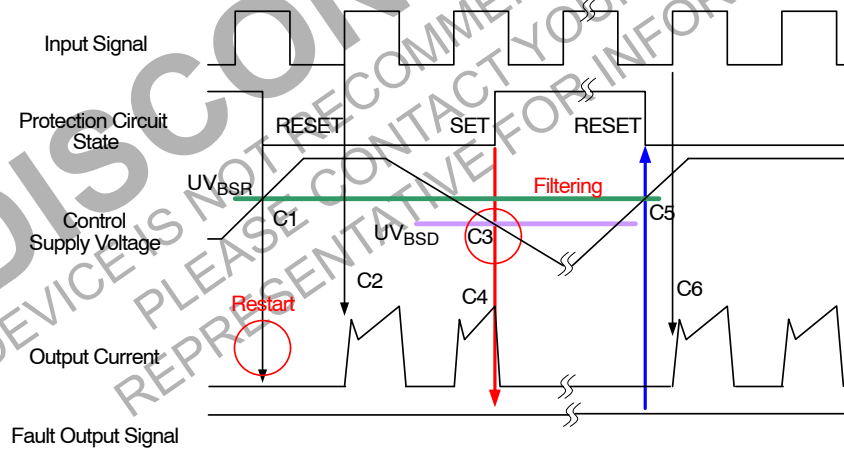
Figure 20. Short-Circuit Current Protection

# FAM65V05DF1



| Step | Description                                                                     |
|------|---------------------------------------------------------------------------------|
| B1   | Control supply voltage rises above reset voltage $UV_{CCR}$                     |
| B2   | Normal operation. IGBT on and carrying current                                  |
| B3   | Control supply voltage falls below detection voltage $UV_{CCD}$                 |
| B4   | Filtered supply voltage falls below $UV_{CCD}$ and IGBT turns off               |
| B5   | Fault output activated (initial delay 2 $\mu$ s, $t_{FOD}$ min. 50ms)           |
| B6   | Control supply voltage rises above reset voltage $UV_{CCR}$                     |
| B7   | IGBT "HI" input is followed after fault output duration and supply voltage rise |

Figure 21. Under-Voltage Protection (Low-side)

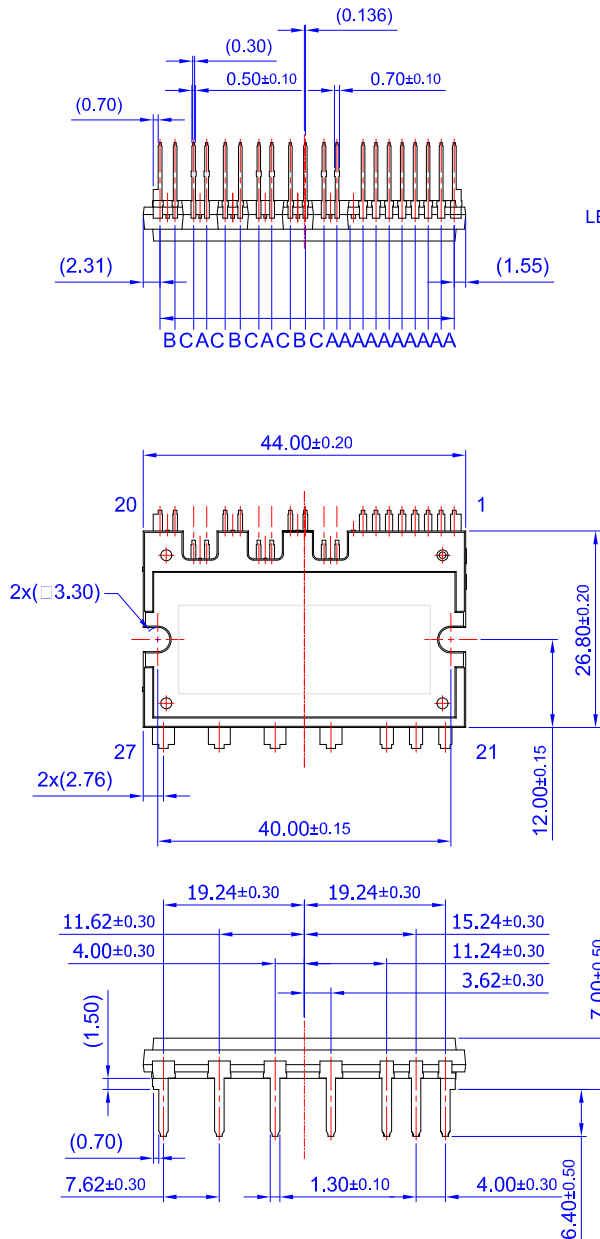


| Step | Description                                                       |
|------|-------------------------------------------------------------------|
| C1   | Control supply voltage rises above reset voltage $UV_{CCR}$       |
| C2   | Normal operation. IGBT on and carrying current                    |
| C3   | Control supply voltage falls below detection voltage $UV_{CCD}$   |
| C4   | Filtered supply voltage falls below $UV_{CCD}$ and IGBT turns off |
| C5   | Control supply voltage rises above reset voltage $UV_{CCR}$       |
| C6   | IGBT "HI" input is followed after supply voltage rise             |

Figure 22. Under-Voltage Protection (High-side)

**27LD MODULE PDD STD**  
**CASE MODCB**  
**ISSUE A**

DATE 30 JAN 2023



LEAD PITCH (TOLERANCE :  $\pm 0.30$ )

A : 1.778

B : 2.050

C : 2.531

NOTES: UNLESS OTHERWISE SPECIFIED

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TO ANY CURRENT PACKAGING STANDARD

B) ALL DIMENSIONS ARE IN MILLIMETERS.

C) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.

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