

3-Phase Inverter Automotive Power Module

FTCO3V455A1

General Description

The FTCO3V455A1 is a 40 V low $R_{DS(ON)}$ automotive qualified power module featuring a 3-phase MOSFET inverter optimized for 12 V battery systems. It includes a precision shunt resistor for current sensing an NTC for temperature sensing and an RC snubber circuit.

The module utilizes onsemi's trench MOSFET technology and it is designed to provide a very compact and high performance variable speed motor drive for applications like electric power steering, electro-hydraulic power steering, electric water pumps, electric oil pumps. The power module is 100% lead free, RoHS and UL compliant.

Features

- 40 V – 150 A 3-phase Trench MOSFET Inverter Bridge
- 1% Precision Shunt Current Sensing
- Temperature Sensing
- DBC Substrate
- 100% Lead Free and RoHS Compliant with 2000/53/C Directive
- UL94V-0 Compliant
- Isolation Rating of 2500 V rms/min
- Mounting Through Screws
- Automotive Qualified

Benefits

- Low Junction-sink Thermal Resistance
- Low Inverter Electrical Resistance
- High Current Handling
- Compact Motor Design
- Highly Integrated Compact Design
- Better EMC and Electrical Isolation
- Easy and Reliable Installation
- Improved Overall System Reliability

Applications

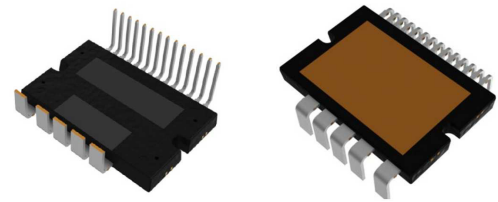
- Electric and Electro-Hydraulic Power Steering
- Electric Water Pump
- Electric Oil Pump
- Electric Fan

Flammability Information

- All Materials Present in the Power Module Meet UL Flammability Rating Class 94 V-0 or Higher

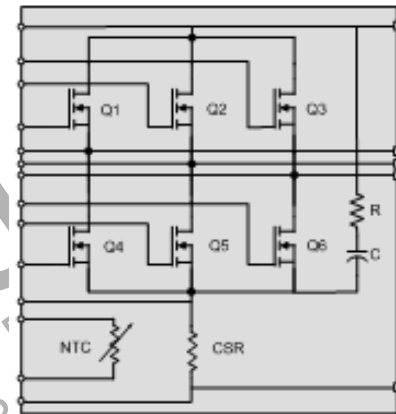
Solder

- Solder Used is a Lead Free SnAgCu Alloy

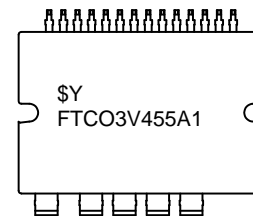


APMCB-A19
 CASE MODCG

ELECTRICAL CONNECTION



MARKING DIAGRAM



\$Y = ON Semiconductor
 FTCO3V455A1 = Specific Device Code

ORDERING INFORMATION

See detailed ordering and shipping information on page 8 of this data sheet.

FTCO3V455A1

ABSOLUTE MAXIMUM RATINGS (T_J = 25°C, Unless Otherwise Specified)

| Symbol | Parameter | Rating | Unit |
|-------------------------|--|--------|------|
| V _{DS} (Q1-Q6) | Drain to Source Voltage | 40 | V |
| V _{GS} (Q1-Q6) | Gate to Source Voltage | ±20 | V |
| I _D (Q1-Q6) | Drain Current Continuous (T _C = 25°C, V _{GS} = 10 V) | 150 | A |
| E _{AS} (Q1-Q6) | Single Pulse Avalanche Energy (Note 1) | 947 | mJ |
| P _D | Power Dissipation | 115 | W |
| T _J | Maximum Junction Temperature | 175 | °C |
| T _{STG} | Storage Temperature | 125 | °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.

THERMAL RESISTANCE

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|---|------------------------------|------|------|------|------|
| R _{thjc} Thermal Resistance Junction to case, Single Inverter FET, chip center (Note 2) | Q1 Thermal Resistance J-C | - | 0.8 | 1.1 | °C/W |
| | Q2 Thermal Resistance J-C | - | 0.8 | 1.1 | °C/W |
| | Q3 Thermal Resistance J-C | - | 0.8 | 1.1 | °C/W |
| | Q4 Thermal Resistance J-C | - | 0.8 | 1.1 | °C/W |
| | Q5 Thermal Resistance J-C | - | 0.8 | 1.1 | °C/W |
| | Q6 Thermal Resistance J-C | - | 0.8 | 1.1 | °C/W |
| T _J | Maximum Junction Temperature | - | - | 175 | °C |
| T _S | Operating Sink Temperature | -40 | - | 120 | °C |
| T _{STG} | Storage Temperature | -40 | - | 125 | °C |

1. Starting T_J = 25°C, V_{DS} = 20 V, I_{AS} = 64 A, L = 480 μH.

2. These values are based on Thermal simulations and PV level measurements.

These values assume a single MOSFET is on, and the test condition for referenced temperature is "Chip Center".

This means that the DT is measured between the T_J of each MOSFET and the temperature of the case located immediately under the center of the chip.

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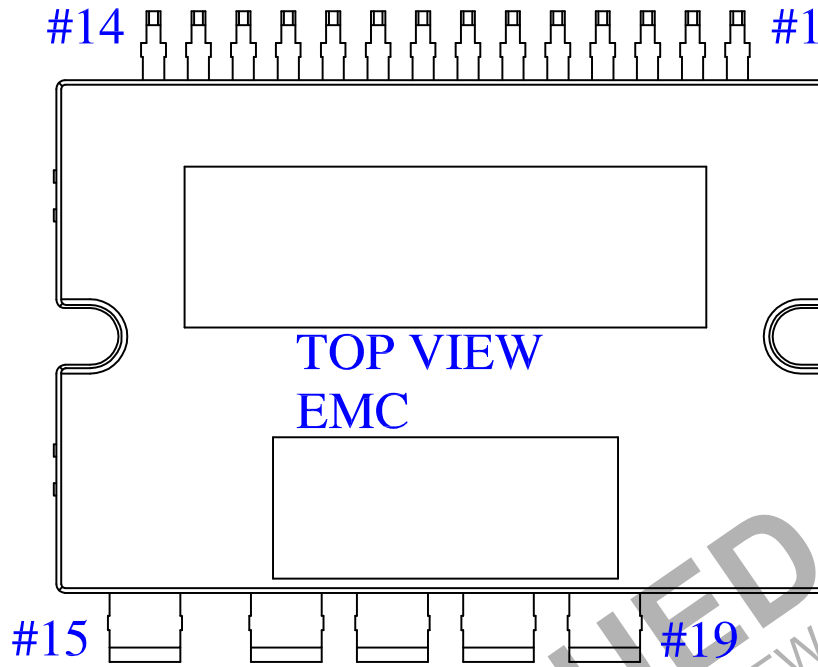


Figure 1. Pin Configuration

PIN DESCRIPTION

| Pin Number | Pin Name | Pin Descriptions |
|------------|---------------|---------------------------------------|
| 1 | TEMP 1 | NTC Thermistor Terminal 1 |
| 2 | TEMP 2 | NTC Thermistor Terminal 2 |
| 3 | PHASE W SENSE | Source of HS W and Drain of LS W |
| 4 | GATE HS W | Gate of HS phase W MOSFET |
| 5 | GATE LS W | Gate of LS phase W MOSFET |
| 6 | PHASE V SENSE | Source of HS V and Drain of LS V |
| 7 | GATE HS V | Gate of HS phase V MOSFET |
| 8 | GATE LS V | Gate of LS phase V MOSFET |
| 9 | PHASE U SENSE | Source of HS U and Drain of LS U |
| 10 | GATE HS U | Gate of HS phase U MOSFET |
| 11 | VBAT SENSE | Drain of HS U, V and W MOSFET |
| 12 | GATE LS U | Gate of LS phase U MOSFET |
| 13 | SHUNT P | Source of LS U, V W MOSFETS / Shunt + |
| 14 | SHUNT N | Negative shunt terminal (shunt -) |
| 15 | VBAT | Positive battery terminal |
| 16 | GND | Negative battery terminal |
| 17 | PHASE U | Motor phase U |
| 18 | PHASE V | Motor phase V |
| 19 | PHASE W | Motor phase W |

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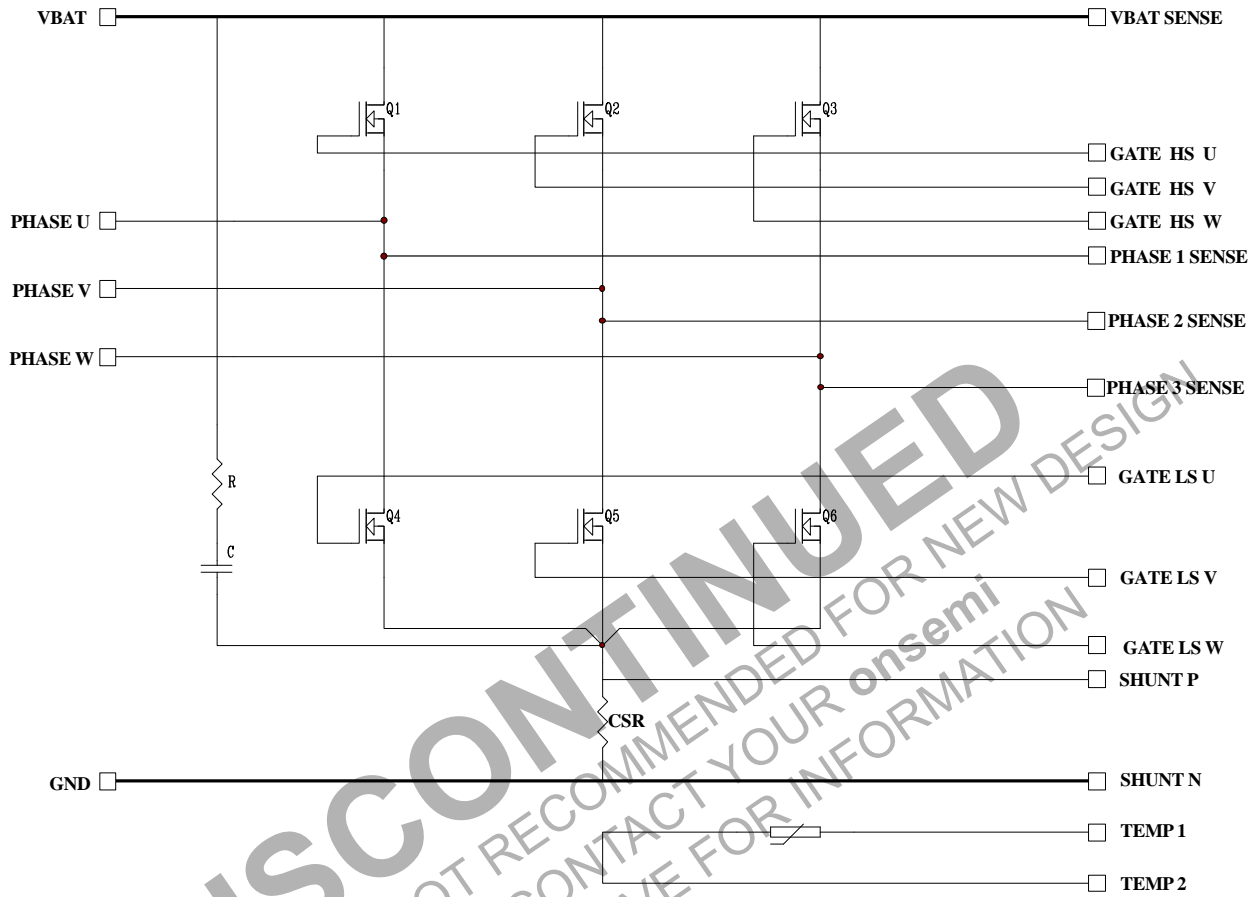


Figure 2. Internal Equivalent Circuit

DISCONTINUED
 THIS DEVICE IS NOT RECOMMENDED FOR NEW DESIGN
 PLEASE CONTACT YOUR onsemi
 REPRESENTATIVE FOR INFORMATION

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ELECTRICAL CHARACTERISTICS (T_J = 25°C, Unless Otherwise Specified)

| Symbol | Parameter | Test Condition | Min | Typ | Max | Unit |
|---|--|--|-----|------|------|------|
| BV _{DSS} | D-S Breakdown Voltage (Inverter MOSFETs) | V _{GS} = 0, I _D = 250 μA | 40 | – | – | V |
| V _{GS} | Gate to Source Voltage (Inverter MOSFETs) | | –20 | – | 20 | V |
| V _{TH} | Threshold Voltage (Inverter MOSFETs) | V _{GS} = V _{DS} , I _D = 250 μA, T _J = 25°C | 2.0 | 2.8 | 4.0 | V |
| V _{SD} | MOSFET Body Diode Forward Voltage | V _{GS} = 0 V, I _S = 80 A, T _J = 25°C | | 0.8 | 1.28 | V |
| R _{DS(ON)Q1} | Inverter High Side MOSFETs Q1 (See Note 3) | V _{GS} = 10 V, I _D = 80 A, T _J = 25°C | – | 1.15 | 1.66 | mΩ |
| R _{DS(ON)Q2} | Inverter High Side MOSFETs Q2 (See Note 3) | V _{GS} = 10 V, I _D = 80 A, T _J = 25°C | – | 1.22 | 1.73 | mΩ |
| R _{DS(ON)Q3} | Inverter High Side MOSFETs Q3 (See Note 3) | V _{GS} = 10 V, I _D = 80 A, T _J = 25°C | – | 1.31 | 1.82 | mΩ |
| R _{DS(ON)Q4} | Inverter Low Side MOSFETs Q4 (See Note 3) | V _{GS} = 10 V, I _D = 80 A, T _J = 25°C | – | 1.36 | 1.87 | mΩ |
| R _{DS(ON)Q5} | Inverter Low Side MOSFETs Q5 (See Note 3) | V _{GS} = 10 V, I _D = 80 A, T _J = 25°C | – | 1.57 | 2.08 | mΩ |
| R _{DS(ON)Q6} | Inverter Low Side MOSFETs Q6 (See Note 3) | V _{GS} = 10 V, I _D = 80 A, T _J = 25°C | – | 1.86 | 2.32 | mΩ |
| I _{DSS} | Inverter MOSFETs (UH,UL,VH,VL,WH,WL) | V _{GS} = 0 V, V _{DS} = 32 V, T _J = 25°C | – | – | 1.0 | μA |
| I _{GSS} | Inverter MOSFETs Gate to Source Leakage Current | V _{GS} = ±20 V | – | – | ±100 | nA |
| Total loop resistance VLINK(+) – V0 (–) | | V _{GS} = 10 V, I _D = 80 A, T _J = 25°C | – | 4.69 | 5.5 | mΩ |

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.

3. All MOSFETs have same die size and R_{DS(ON)}. The different R_{DS(ON)} values listed in the datasheet are due to the different access points available inside the module for R_{DS(ON)} measurement. While the high side MOSFETs (Q1, Q2, Q3) have source sense wire bonds, the low side MOSFETs (Q4, Q5, Q6) do not have source sense wire bonds, thus resulting in higher R_{DS(ON)} values.

TEMPERATURE SENSE (NTC Thermistor)

| Symbol | Test Conditions | Test Time | Min | Typ | Max | Unit |
|---------|------------------------------------|------------|-----|-----|-----|------|
| Voltage | Current = 1 mA, Temperature = 25°C | T = 0.5 ms | 7.5 | – | 12 | V |

CURRENT SENSE RESISTOR

| Symbol | Test Conditions | Test Time | Min | Typ | Max | Unit |
|------------|---------------------------------------|------------|------|-----|------|------|
| Resistance | Current Sense resistor current = 80 A | T = 0.5 ms | 0.46 | – | 0.53 | mΩ |

TYPICAL CHARACTERISTICS

(Generated using MOSFETs assembled in a TO263 package, for reference purposes only.)

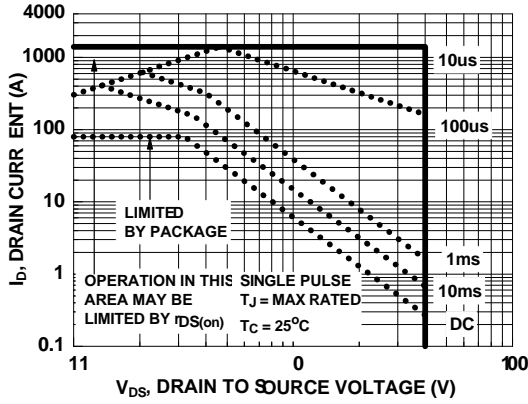
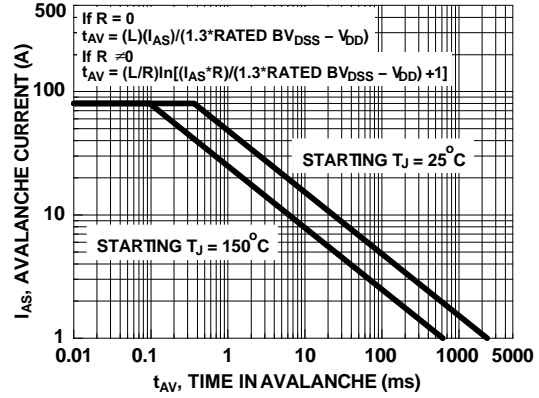


Figure 3. Forward Bias Safe Operating Area



NOTE: Refer to Application Notes AN7514 and AN7515

Figure 4. Unclamped Inductive Switching Capability

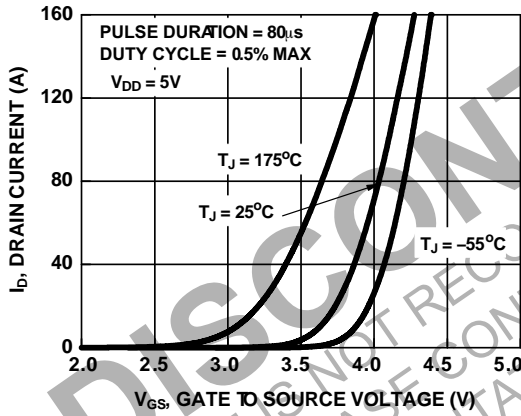


Figure 5. Transfer Characteristics

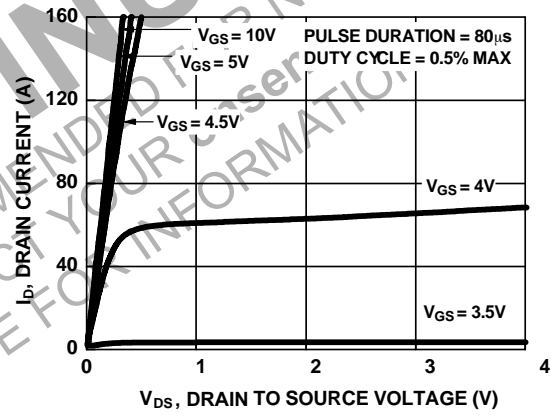


Figure 6. Saturation Characteristics

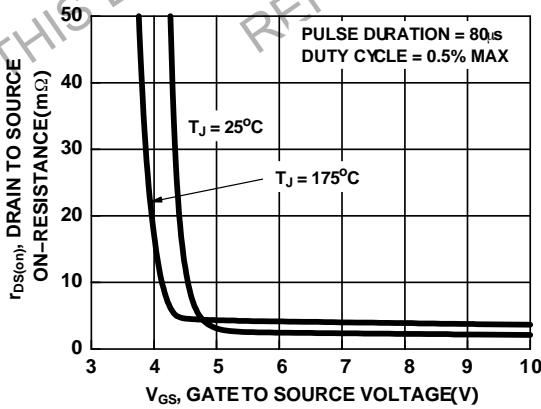


Figure 7. Drain to Source On-Resistance Variation vs Gate to Source Voltage

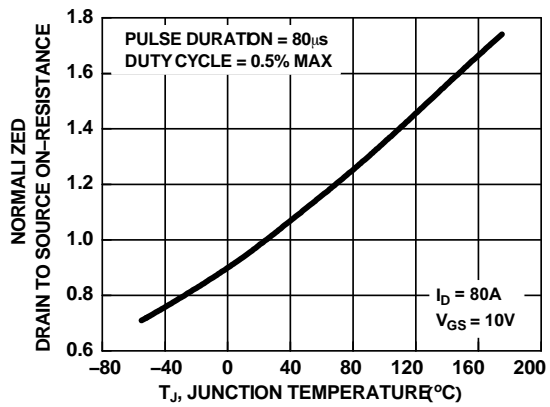


Figure 8. Normalized Drain to Source On Resistance vs Junction Temperature

TYPICAL CHARACTERISTICS

(Generated using MOSFETs assembled in a TO263 package, for reference purposes only.)

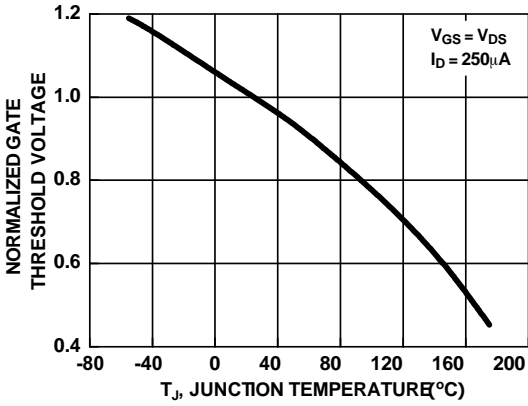


Figure 9. Normalized Gate Threshold Voltage vs Junction Temperature

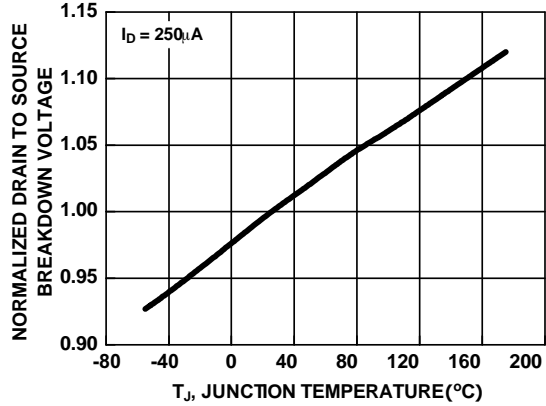


Figure 10. Normalized Drain to Source Breakdown Voltage vs Junction Temperature

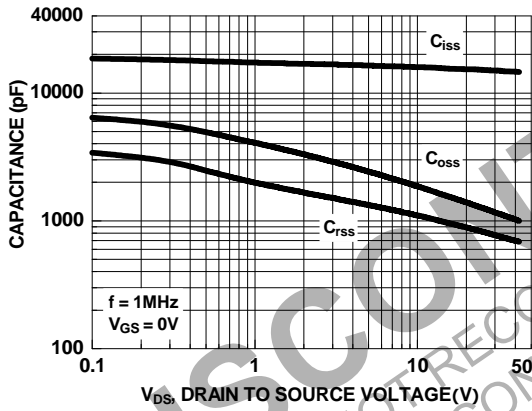


Figure 11. Capacitance vs Drain to Source Voltage

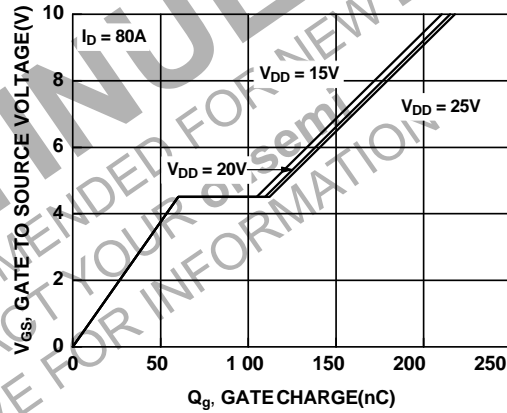
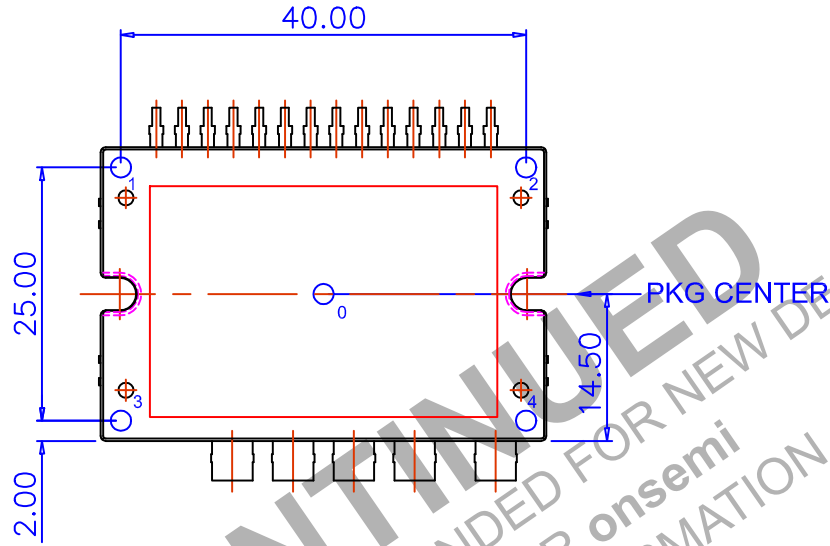


Figure 12. Gate Charge vs Gate to Source Voltage

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MECHANICAL CHARACTERISTICS AND RATINGS

| Parameter | Condition | Limits | | | Unit |
|-----------------|---|--------|-----|------|------|
| | | Min | Typ | Max | |
| Device Flatness | Note Figure 13. | 0 | - | +200 | μm |
| Mounting Torque | Mounting Screw: - M3, Recommended 0.7 N.m | 0.6 | 0.7 | 0.8 | N.m |
| Weight | | - | 20 | - | g |



FLATNESS : MAX, 200μm

— MEASURING AT INDICATING POINTS 1, 2, 3, AND 4 (BASED ON "0")

Figure 13. Flatness Measurement Position

ORDERING INFORMATION

| Device Marking | MOSFET | Packing Type | Quantity |
|----------------|----------|--------------|----------|
| FTCO3V455A1 | PCF33478 | Tube | 11 |

FTCO3V455A1

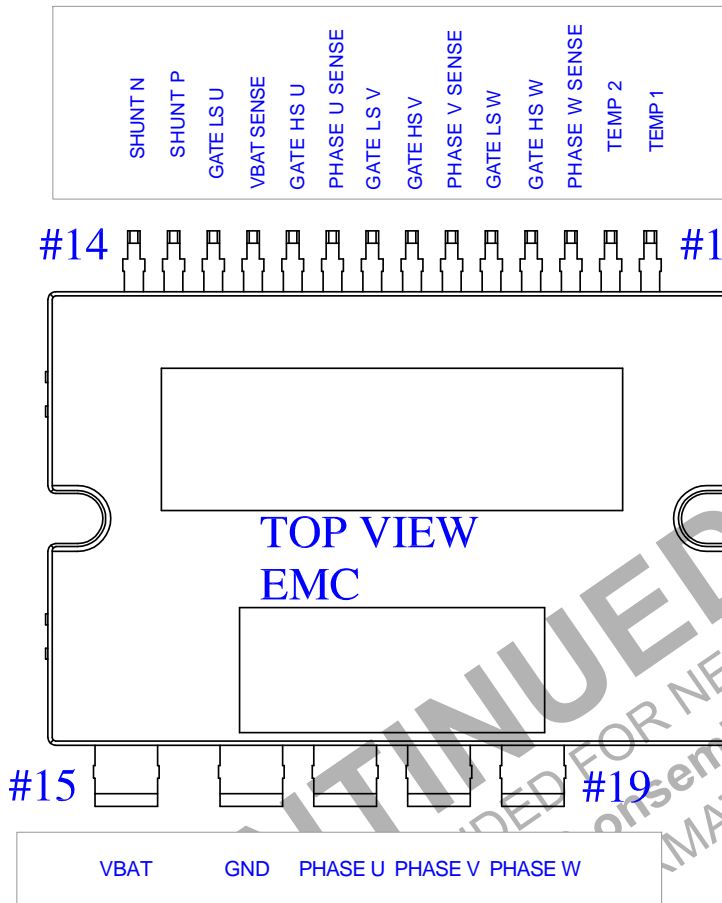
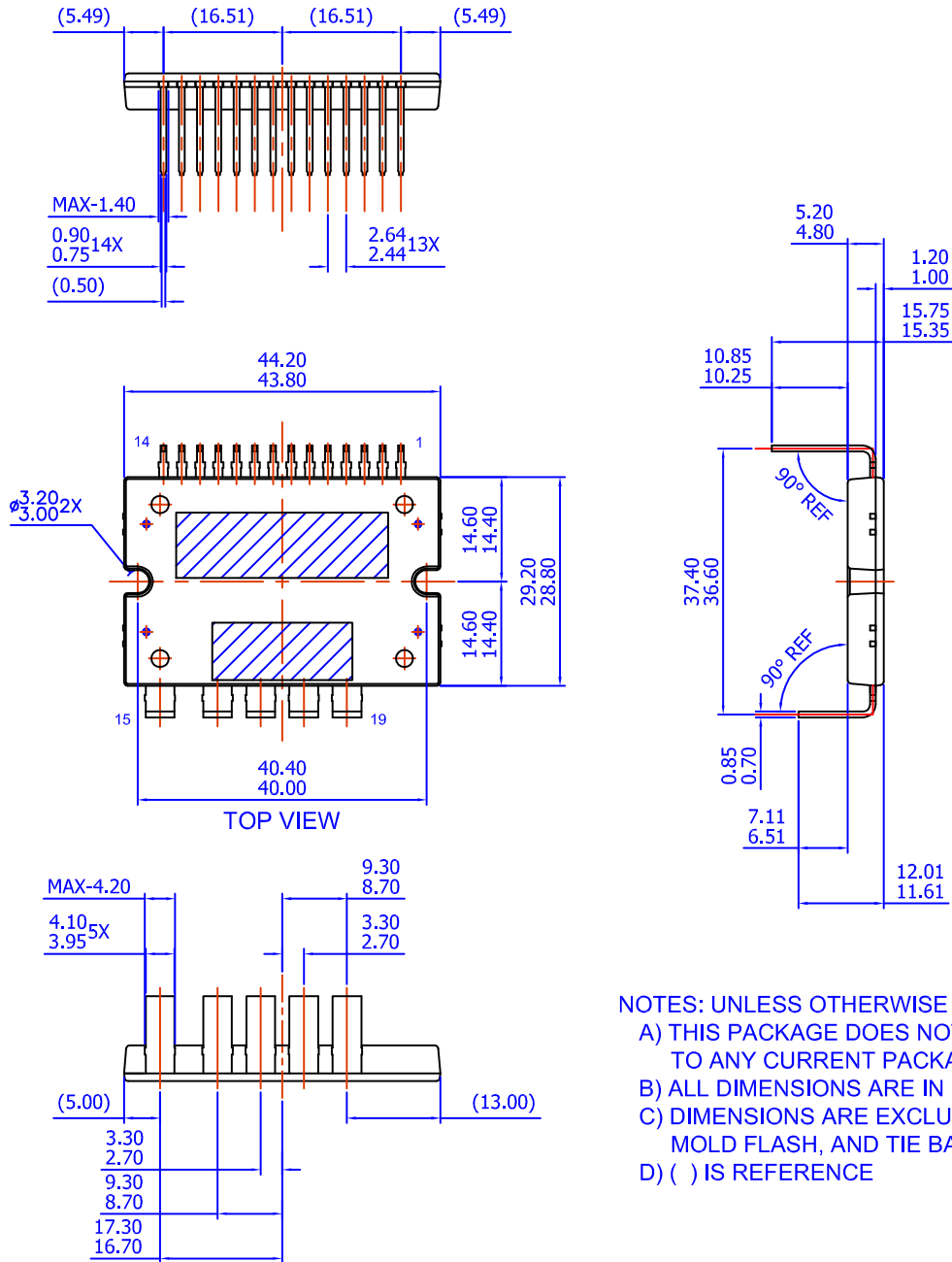


Figure 14.

APMCB-A19 / 19LD, APM, PDD STD DBC, DIP TYPE
CASE MODCG
ISSUE O

DATE 31 DEC 2016



NOTES: UNLESS OTHERWISE SPECIFIED
 A) THIS PACKAGE DOES NOT COMPLY TO ANY CURRENT PACKAGING STANDARD
 B) ALL DIMENSIONS ARE IN MILLIMETERS
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