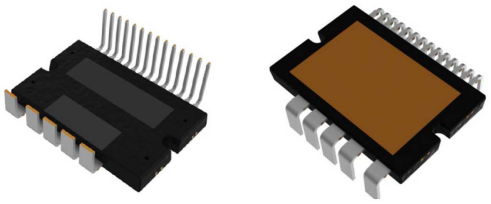
3-Phase Inverter Automotive Power Module

FTCO3V455A1



APMCB−A19
CASE MODCG

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

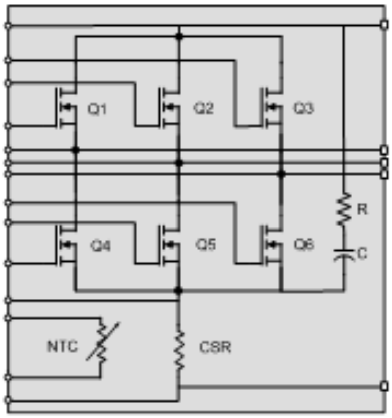
Flammability Information

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

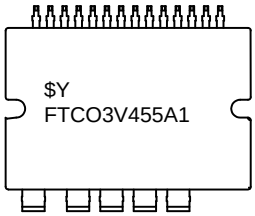
Solder

- Solder Used is a Lead Free SnAgCu Alloy

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.

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
Rthjc 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.

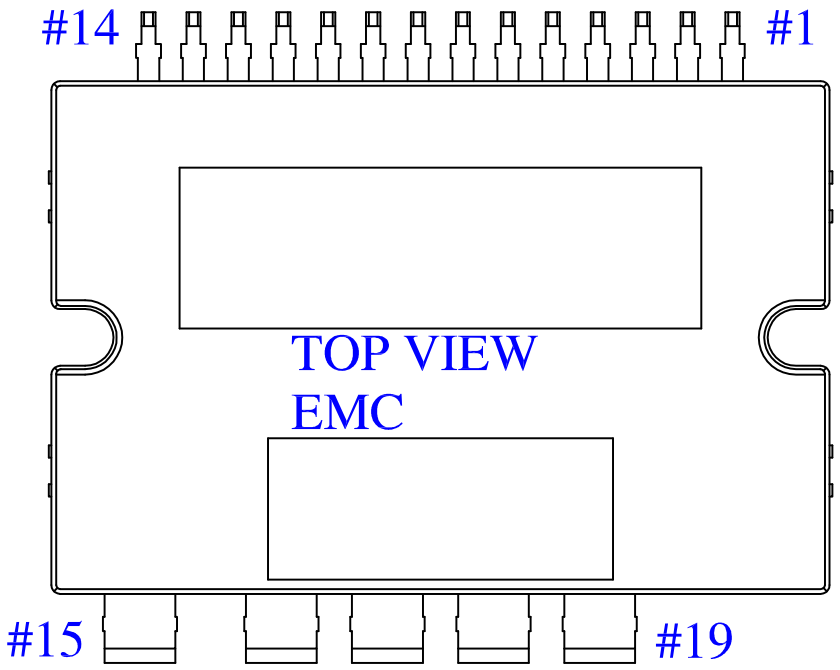


Figure 1. Pin Configuration

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

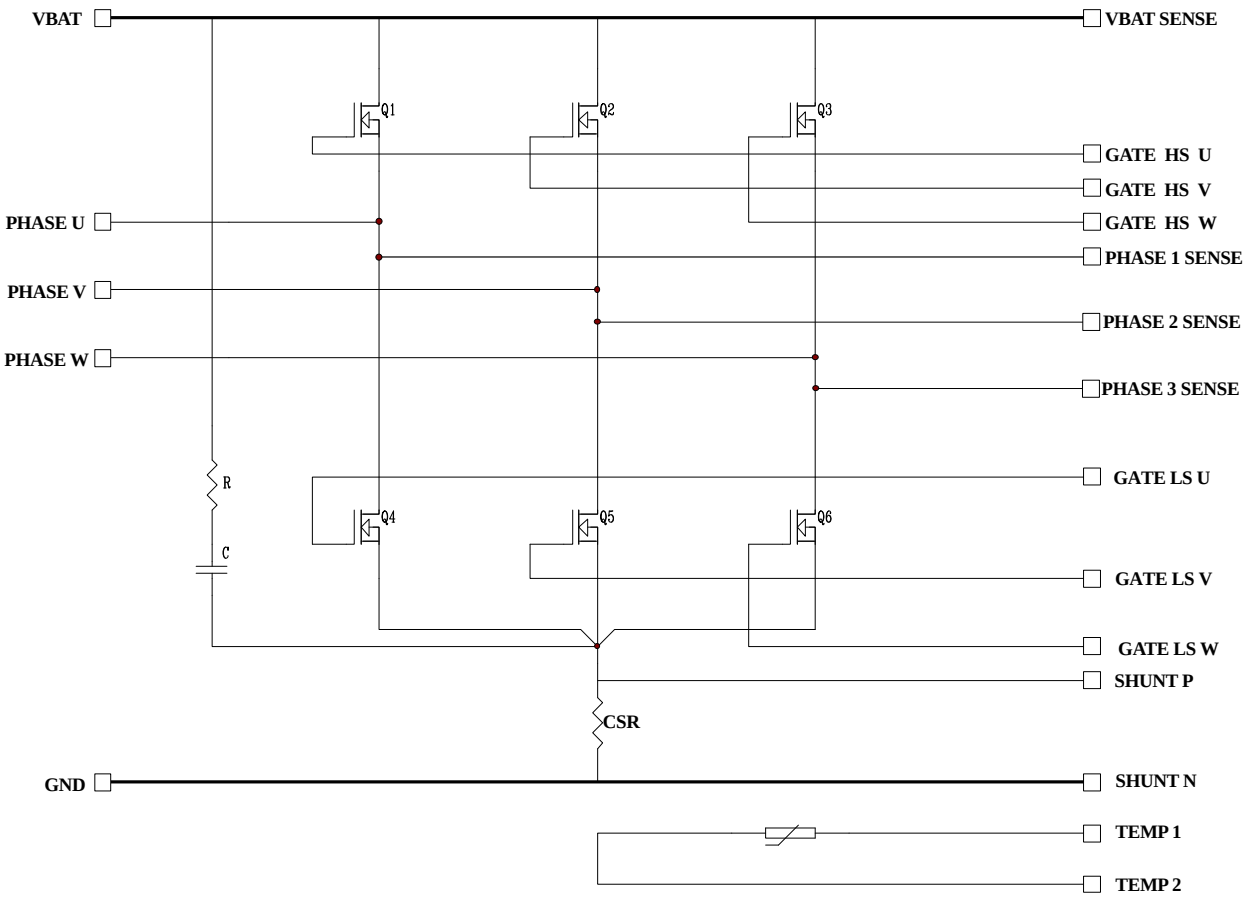


Figure 2. Internal Equivalent Circuit

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.)

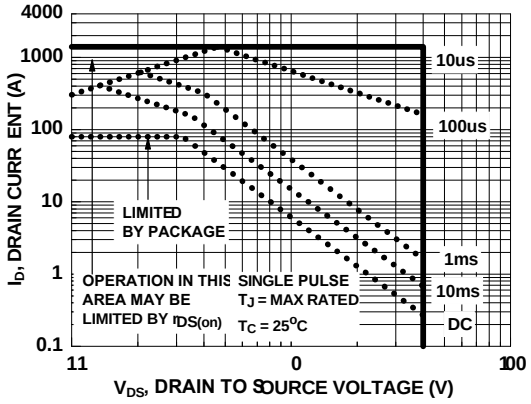
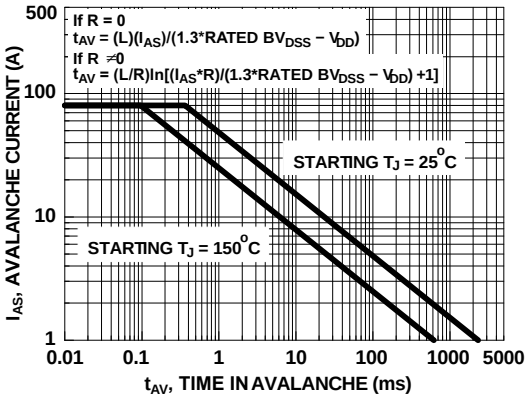


Figure 3. Forward Bias Safe Operating Area



NOTE: Refer to Application Notes AN7514 and AN7515

Figure 4. Unclamped Inductive Switching Capability

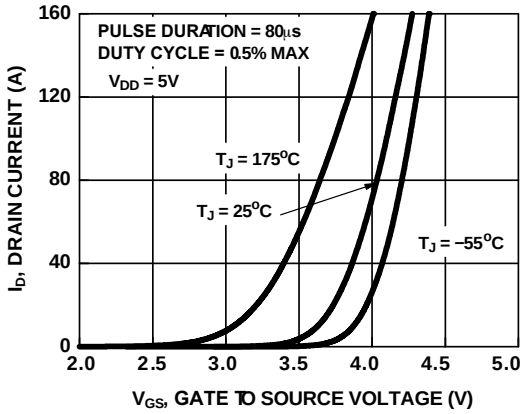


Figure 5. Transfer Characteristics

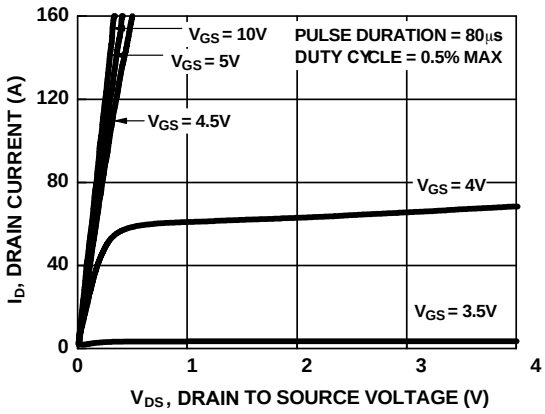


Figure 6. Saturation Characteristics

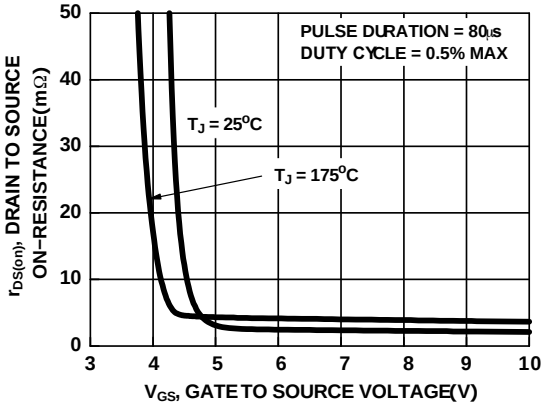


Figure 7. Drain to Source On−Resistance Variation vs Gate to Source Voltage

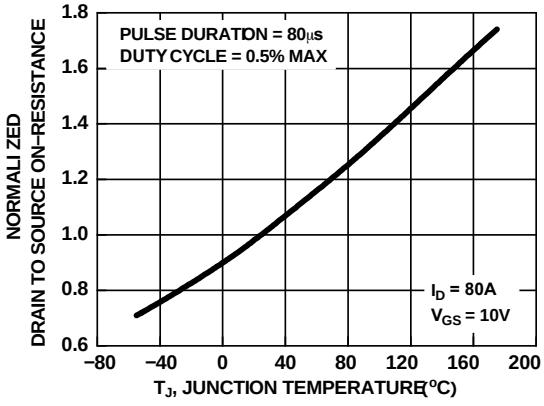


Figure 8. Normalized Drain to Source On Resistance vs Junction Temperature

TYPICAL CHARACTERISTICS

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

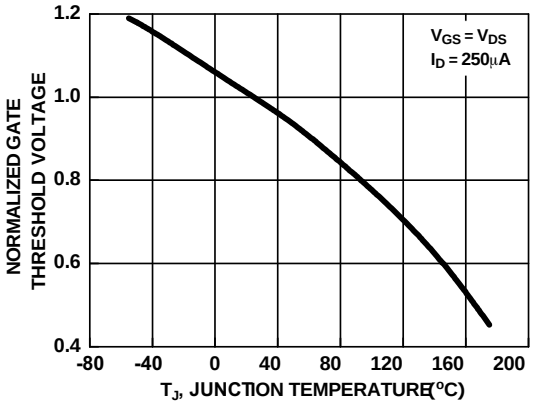


Figure 9. Normalized Gate Threshold Voltage vs Junction Temperature

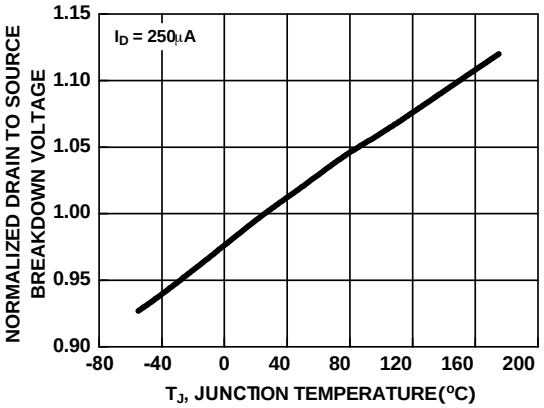


Figure 10. Normalized Drain to Source Breakdown Voltage vs Junction Temperature

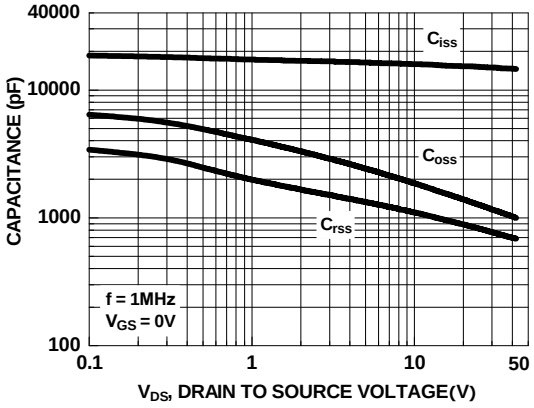


Figure 11. Capacitance vs Drain to Source Voltage

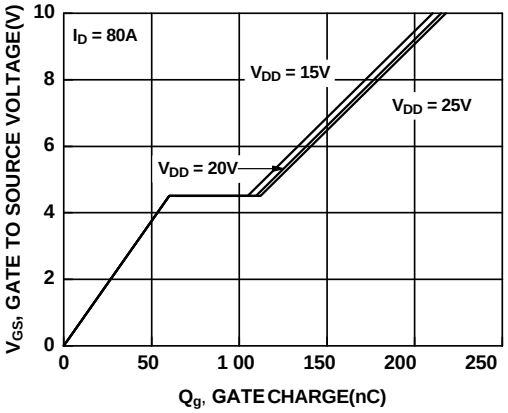


Figure 12. Gate Charge vs Gate to Source Voltage

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

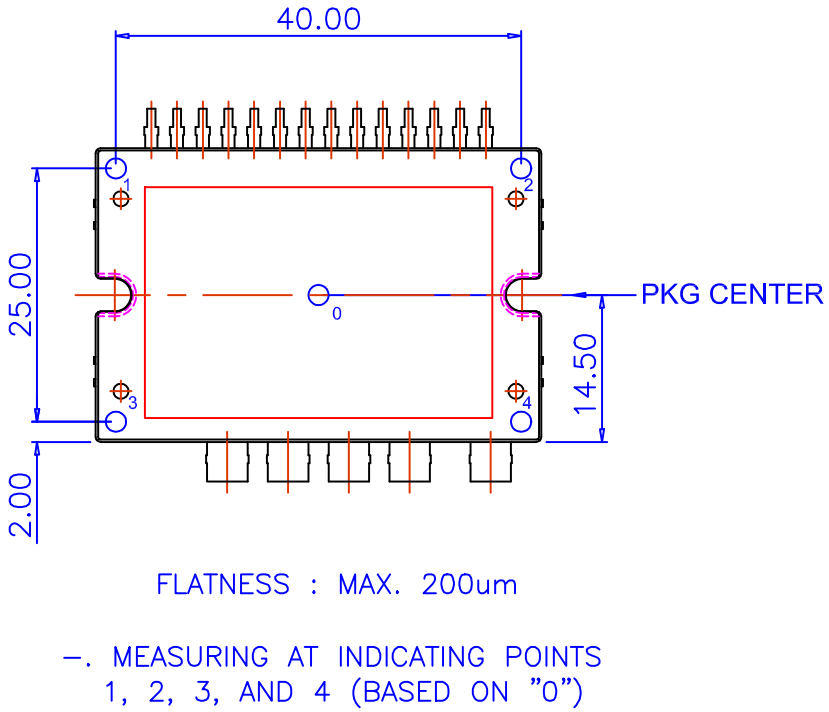


Figure 13. Flatness Measurement Position

ORDERING INFORMATION

Device Marking	MOSFET	Packing Type	Quantity
FTCO3V455A1	PCF33478	Tube	11

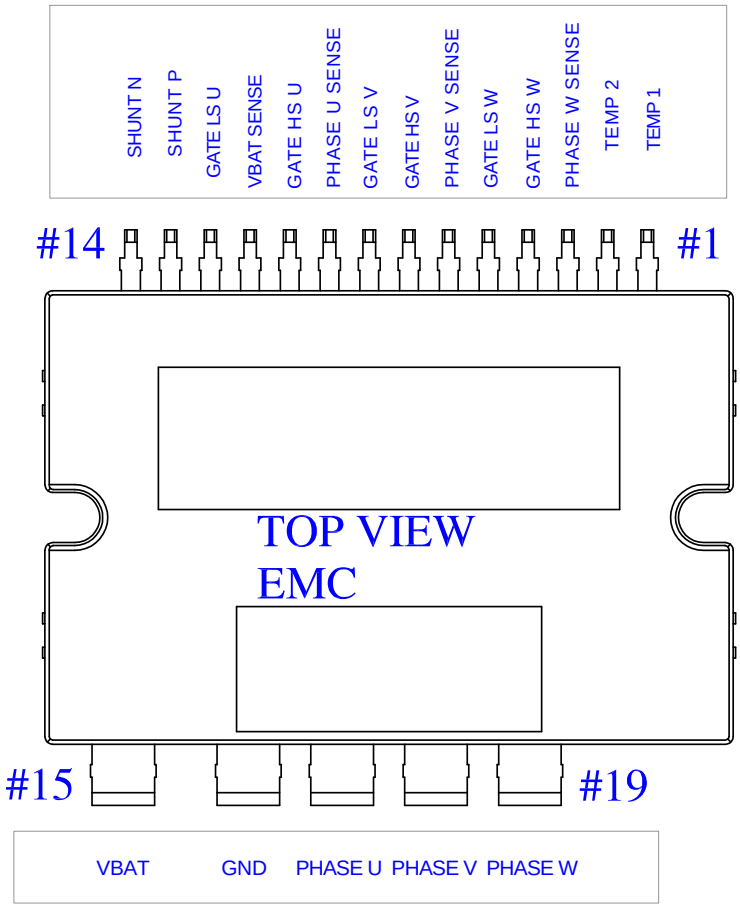
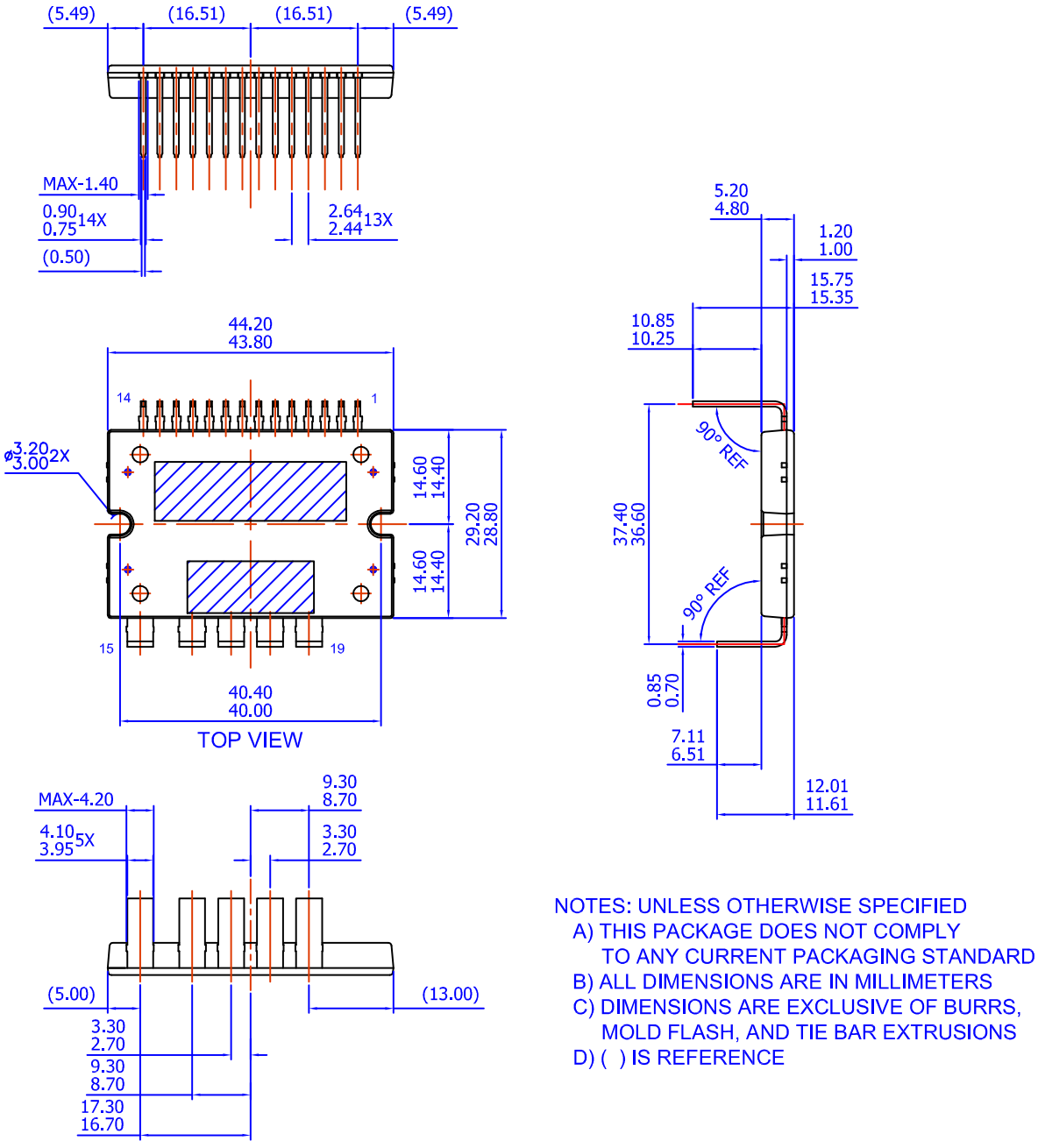

SHUNT N
SHUNT P
GATE LS U
VBAT SENSE
GATE HS U
PHASE U SENSE
GATE LS V
GATE HS V
PHASE V SENSE
GATE LS W
GATE HS W
PHASE W SENSE
TEMP 2
TEMP 1
#14
#1
TOP VIEW
EMC
#15
#19
VBAT
GND
PHASE U
PHASE V
PHASE W

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
C) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS
D) ( ) IS REFERENCE

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DESCRIPTION:	**APMCB–A19 / 19LD, APM, PDD STD DBC, DIP TYPE**		**PAGE 1 OF 1**

PUBLICATION ORDERING INFORMATION

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For additional information, please contact your local Sales Representative

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