



Is Now Part of



**ON Semiconductor®**

To learn more about ON Semiconductor, please visit our website at  
[www.onsemi.com](http://www.onsemi.com)

Please note: As part of the Fairchild Semiconductor integration, some of the Fairchild orderable part numbers will need to change in order to meet ON Semiconductor's system requirements. Since the ON Semiconductor product management systems do not have the ability to manage part nomenclature that utilizes an underscore (\_), the underscore (\_) in the Fairchild part numbers will be changed to a dash (-). This document may contain device numbers with an underscore (\_). Please check the ON Semiconductor website to verify the updated device numbers. The most current and up-to-date ordering information can be found at [www.onsemi.com](http://www.onsemi.com). Please email any questions regarding the system integration to [Fairchild\\_questions@onsemi.com](mailto:Fairchild_questions@onsemi.com).

ON Semiconductor and the ON Semiconductor logo are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.



ON Semiconductor®

April 2017

# FTCO3V455A1

## 3-Phase Inverter Automotive Power Module

### General Description

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

The module utilizes Fairchild'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

- 40V-150A 3-phase trench MOSFET inverter bridge
- 1% precision shunt current sensing
- Temperature sensing
- DBC substrate
- 100% lead free and RoHS compliant 2000/53/C directive.
- UL94V-0 compliant
- Isolation rating of 2500Vrms/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

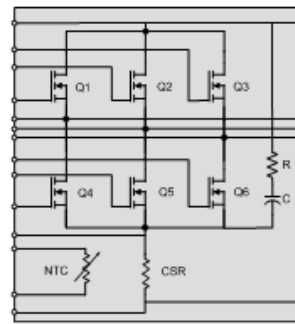


Figure 1.schematic

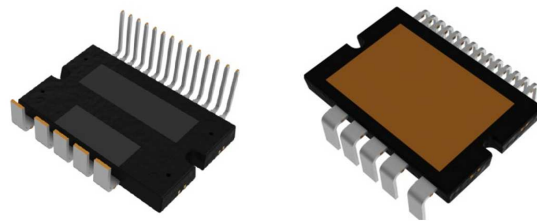


Figure 2. package

### Absolute Maximum Ratings (T<sub>J</sub> = 25°C, Unless Otherwise Specified)

Symbol	Parameter	Rating	Unit
V <sub>DS</sub> (Q1~Q6)	Drain to Source Voltage	40	V
V <sub>GS</sub> (Q1~Q6)	Gate to Source Voltage	±20	V
I <sub>D</sub> (Q1~Q6)	Drain Current Continuous(T <sub>C</sub> = 25°C, V <sub>GS</sub> = 10V)	150	A
E <sub>AS</sub> (Q1~Q6)	Single Pulse Avalanche Energy (*Note 1)	947	mJ
P <sub>D</sub>	Power dissipation	115	W
T <sub>J</sub>	Maximum Junction Temperature	175	°C
T <sub>STG</sub>	Storage Temperature	125	°C

### Pin Configuration

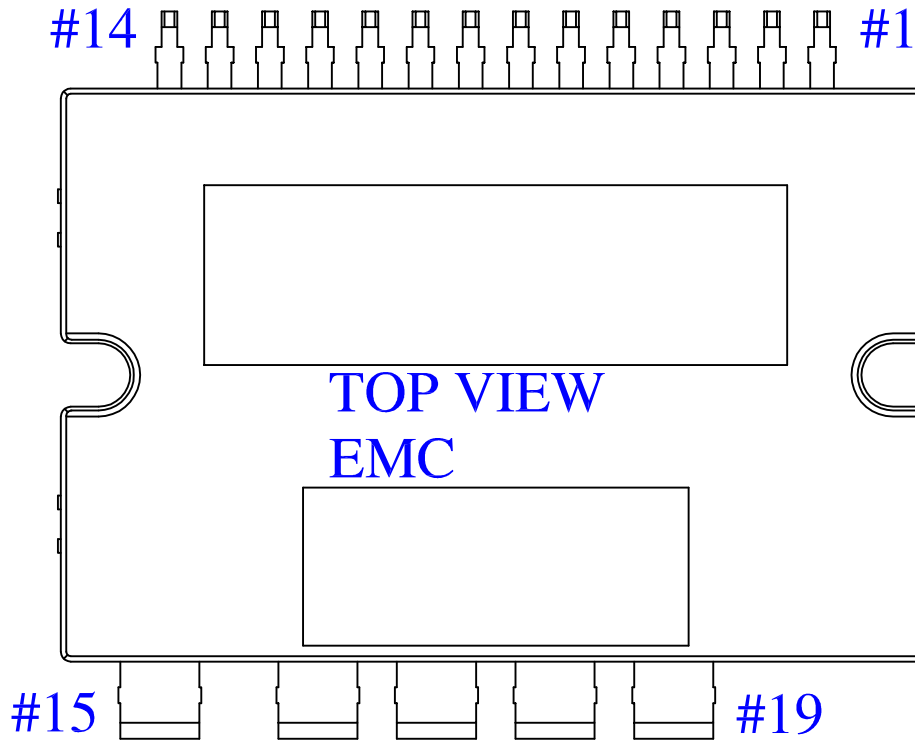


Figure 3.

### 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

Internal Equivalent Circuit

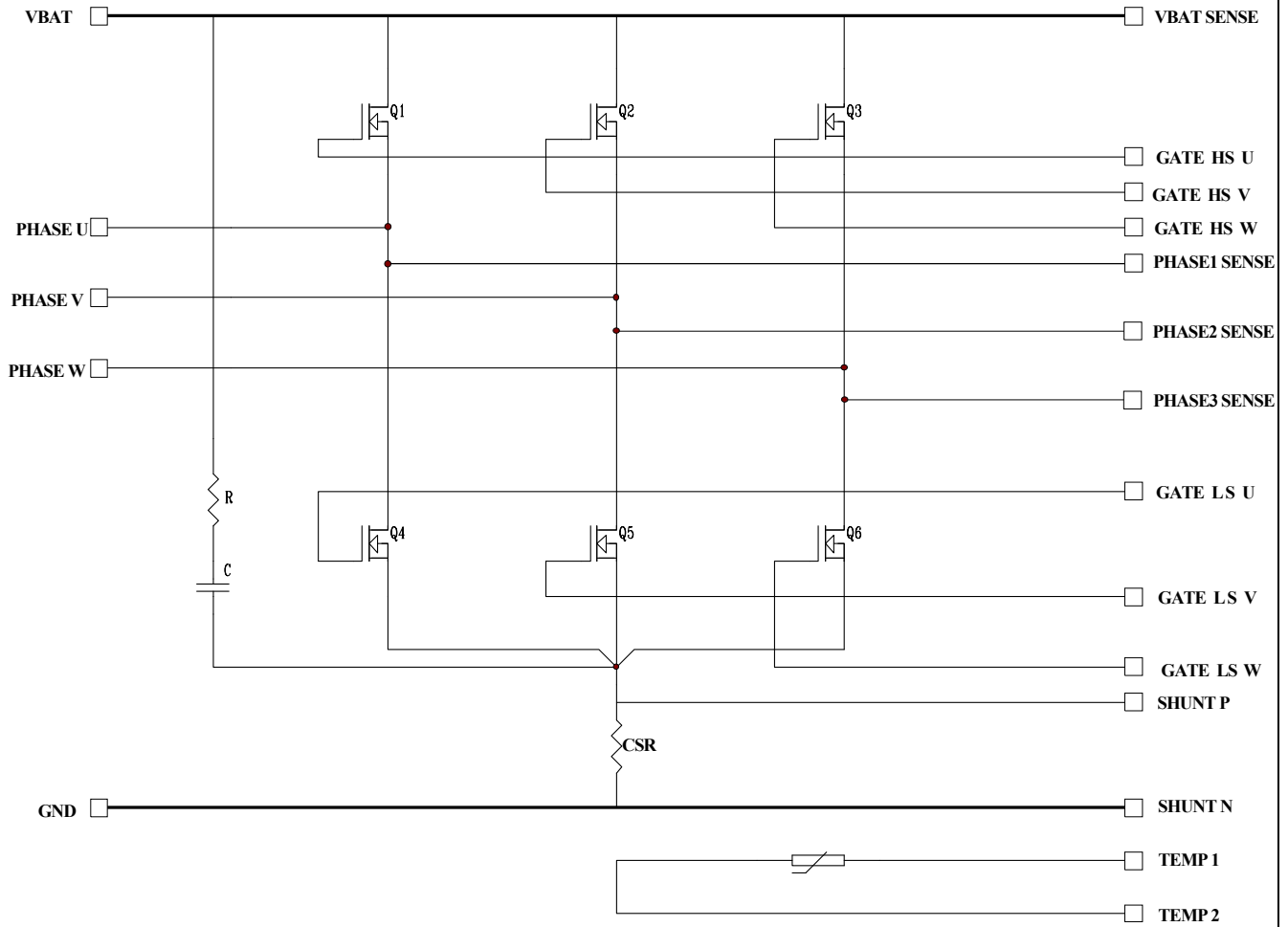


Figure 4.

## Flammability Information

All materials present in the power module meet UL flammability rating class 94V-0 or higher.

## Solder

Solder used is a lead free SnAgCu alloy.

## Compliance to RoHS

The Power Module is 100% lead free and RoHS compliant with the 2000/53/C directive.

**Absolute Maximum Ratings** ( $T_J = 25^\circ\text{C}$ , Unless Otherwise Specified)

Symbol	Parameter	Rating	Unit
$V_{DS}(Q1\sim Q6)$	Drain to Source Voltage	40	V
$V_{GS}(Q1\sim Q6)$	Gate to Source Voltage	$\pm 20$	V
$I_D(Q1\sim Q6)$	Drain Current Continuous ( $T_C = 25^\circ\text{C}$ , $V_{GS} = 10\text{V}$ )	150	A
$E_{AS}(Q1\sim Q6)$	Single Pulse Avalanche Energy (*Note 1)	947	mJ
$P_D$	Power dissipation	115	W
$T_J$	Maximum Junction Temperature	175	$^\circ\text{C}$
$T_{STG}$	Storage Temperature	125	$^\circ\text{C}$

**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	$^\circ\text{C}/\text{W}$
	Q2 Thermal Resistance J -C	-	0.8	1.1	$^\circ\text{C}/\text{W}$
	Q3 Thermal Resistance J -C	-	0.8	1.1	$^\circ\text{C}/\text{W}$
	Q4 Thermal Resistance J -C	-	0.8	1.1	$^\circ\text{C}/\text{W}$
	Q5 Thermal Resistance J -C	-	0.8	1.1	$^\circ\text{C}/\text{W}$
	Q6 Thermal Resistance J -C	-	0.8	1.1	$^\circ\text{C}/\text{W}$
$T_J$	Maximum Junction Temperature	-		175	$^\circ\text{C}$
$T_S$	Operating Sink Temperature	-40		120	$^\circ\text{C}$
$T_{STG}$	Storage Temperature	-40		125	$^\circ\text{C}$

**Notes:**

\* Note 1 - Starting  $T_J=25^\circ\text{C}$ ,  $V_{ds}=20\text{V}$ ,  $I_{as}=64\text{A}$ ,  $L=480\mu\text{H}$ .

\* Note 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.

**Electrical Characteristics** ( $T_J = 25^\circ\text{C}$ , Unless Otherwise Specified)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
$BV_{DSS}$	D-S Breakdown Voltage (Inverter MOSFETs)	$V_{GS}=0, I_D=250\mu\text{A}$	40	-	-	V
$V_{GS}$	Gate to Source Voltage (Inverter MOSFETs)	-	-20	-	20	V
$V_{TH}$	Threshold Voltage (Inverter MOSFETs)	$V_{GS}=V_{DS}, I_D=250\mu\text{A}, T_J=25^\circ\text{C}$	2.0	2.8	4.0	V
$V_{SD}$	MOSFET Body Diode Forward Voltage	$V_{GS}=0\text{V}, I_S=80\text{A}, T_J=25^\circ\text{C}$		0.8	1.28	V
$R_{DS(ON)Q1}$	Inverter High Side MOSFETs Q1 (See *Note3)	$V_{GS}=10\text{V}, I_D=80\text{A}, T_J=25^\circ\text{C}$	-	1.15	1.66	$\text{m}\Omega$
$R_{DS(ON)Q2}$	Inverter High Side MOSFETs Q2 (See *Note3)	$V_{GS}=10\text{V}, I_D=80\text{A}, T_J=25^\circ\text{C}$	-	1.22	1.73	$\text{m}\Omega$
$R_{DS(ON)Q3}$	Inverter High Side MOSFETs Q3 (See *Note3)	$V_{GS}=10\text{V}, I_D=80\text{A}, T_J=25^\circ\text{C}$	-	1.31	1.82	$\text{m}\Omega$
$R_{DS(ON)Q4}$	Inverter Low Side MOSFETs Q4 (See *Note3)	$V_{GS}=10\text{V}, I_D=80\text{A}, T_J=25^\circ\text{C}$	-	1.36	1.87	$\text{m}\Omega$
$R_{DS(ON)Q5}$	Inverter Low Side MOSFETs Q5 (See *Note3)	$V_{GS}=10\text{V}, I_D=80\text{A}, T_J=25^\circ\text{C}$	-	1.57	2.08	$\text{m}\Omega$
$R_{DS(ON)Q6}$	Inverter Low Side MOSFETs Q6 (See *Note3)	$V_{GS}=10\text{V}, I_D=80\text{A}, T_J=25^\circ\text{C}$	-	1.86	2.32	$\text{m}\Omega$
$I_{DSS}$	Inverter MOSFETs (UH,UL,VH,VL,WH,WL)	$V_{GS}=0\text{V}, V_{DS}=32\text{V}, T_J=25^\circ\text{C}$	-	-	1.0	$\mu\text{A}$
$I_{GSS}$	Inverter MOSFETs Gate to Source Leakage Current	$V_{GS}=\pm 20\text{V}$	-	-	$\pm 100$	nA
Total loop resistance VLINK(+) - V0 (-)		$V_{GS}=10\text{V}, I_D=80\text{A}, T_J=25^\circ\text{C}$	-	4.69	5.5	$\text{m}\Omega$

\* Note 3 - All Mosfets have same die size and Rdson. The different Rdson values listed in the datasheet are due to the different access points available inside the module for Rdson 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 Rdson values.

**Temperature Sense (NTC Thermistor)**

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

**Current Sense Resistor**

Symbol	Test Conditions	Test Time	Min	Typ	Max	Units
Resistance	Current Senset resistor current = 80A	T=0.5ms	0.46	-	0.53	$\text{m}\Omega$

**Typical Characteristics** (Generated using MOSFETs assembled in a TO263 package, for reference purposes only)

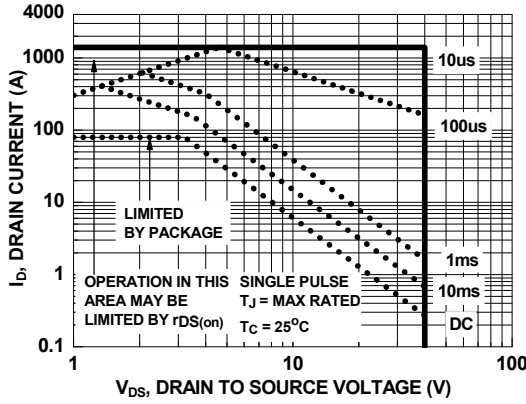
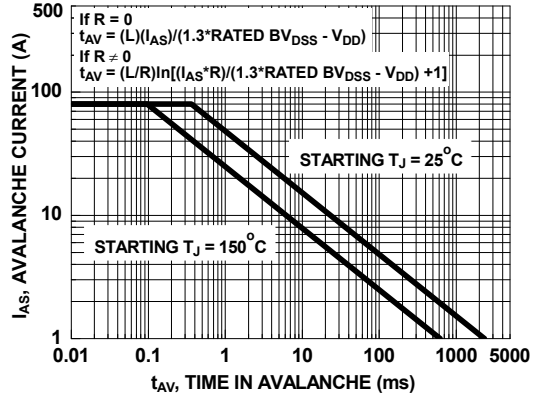


Figure 5. Forward Bias Safe Operating Area



NOTE: Refer to Fairchild Application Notes AN7514 and AN7515

Figure 6. Unclamped Inductive Switching Capability

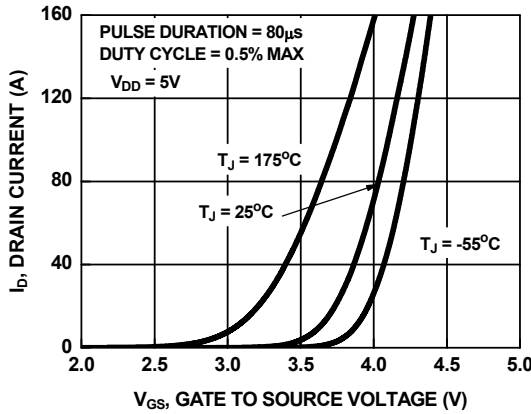


Figure 7. Transfer Characteristics

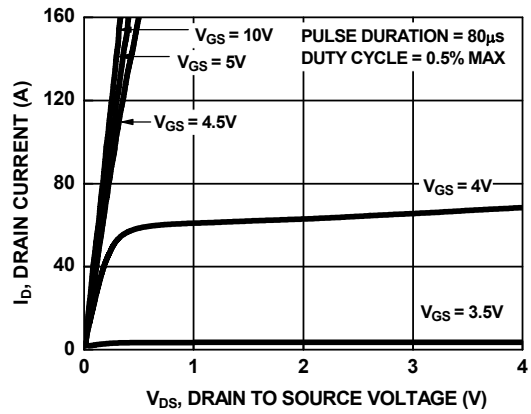


Figure 8. Saturation Characteristics

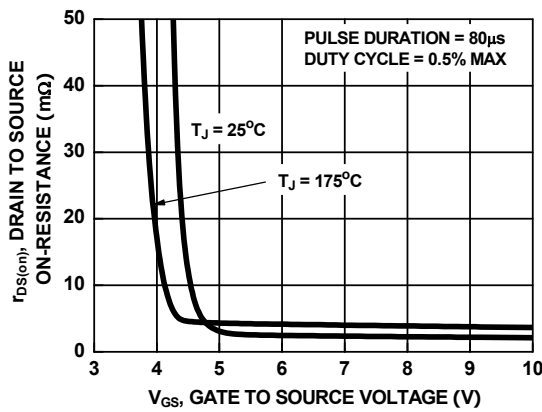


Figure 9. Drain to Source On-Resistance Variation vs Gate to Source Voltage

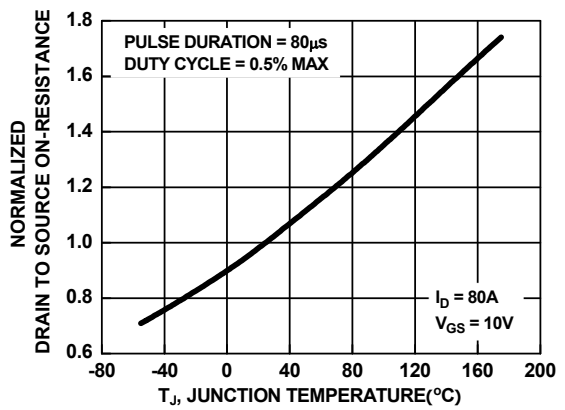


Figure 10. Normalized Drain to Source On-Resistance vs Junction Temperature



**Typical Characteristics** (Generated using MOSFETs assembled in a TO263 package, for reference purposes only)

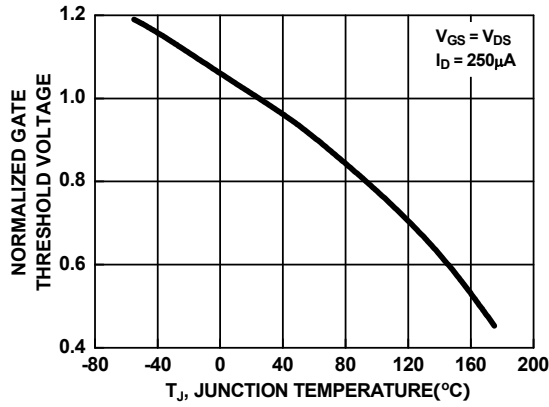


Figure 11. Normalized Gate Threshold Voltage vs Junction Temperature

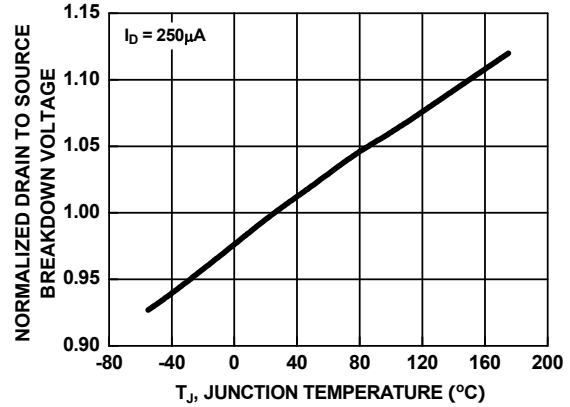


Figure 12. Normalized Drain to Source Breakdown Voltage vs Junction Temperature

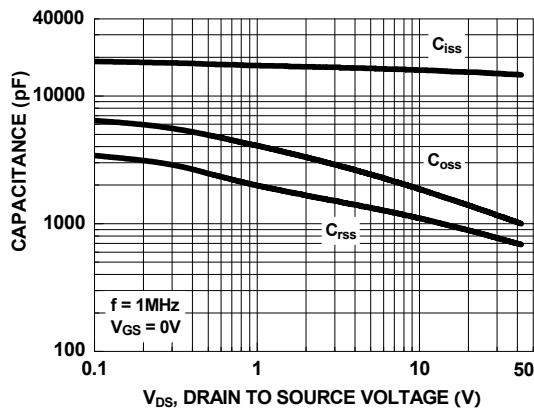


Figure 13. Capacitance vs Drain to Source Voltage

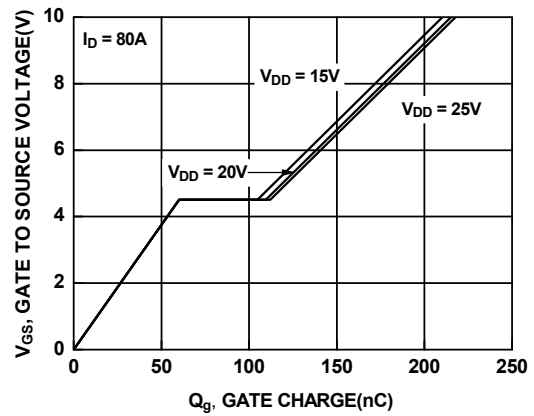
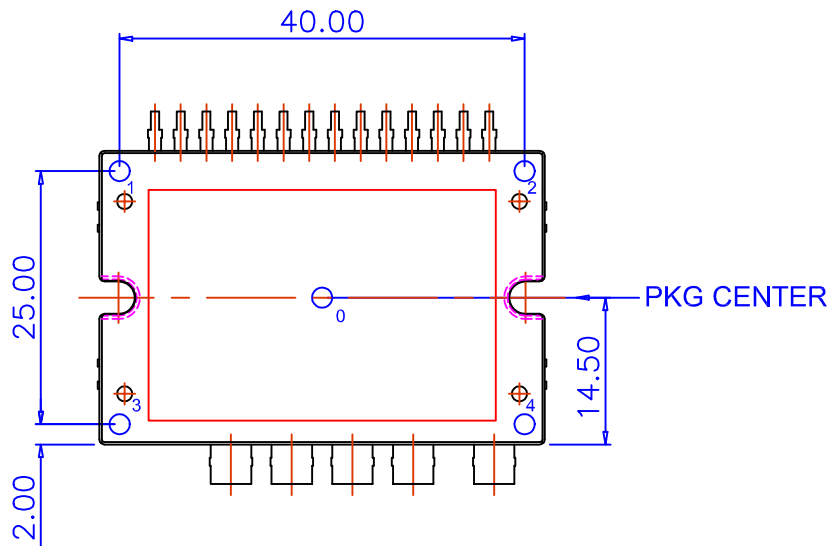


Figure 14. Gate Charge vs Gate to Source Voltage

### Mechanical Characteristics and Ratings

Parameter	Condition	Limits			Unit
		Min.	Typ.	Max.	
Device Flatness	Note Fig.15	0	-	+200	um
Mounting Torque	Mounting Screw: - M3, Recommended 0.7N.m	0.6	0.7	0.8	N.m
Weight		-	20	-	g



FLATNESS : MAX. 200um

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

**Fig. 15. Flatness Measurement Position**

### Package Marking and Ordering Information

Device Marking	MOSFET	Packing Type	Quantity
FTCO3V455A1	PCF33478	Tube	11

Detailed Package Outline Drawings

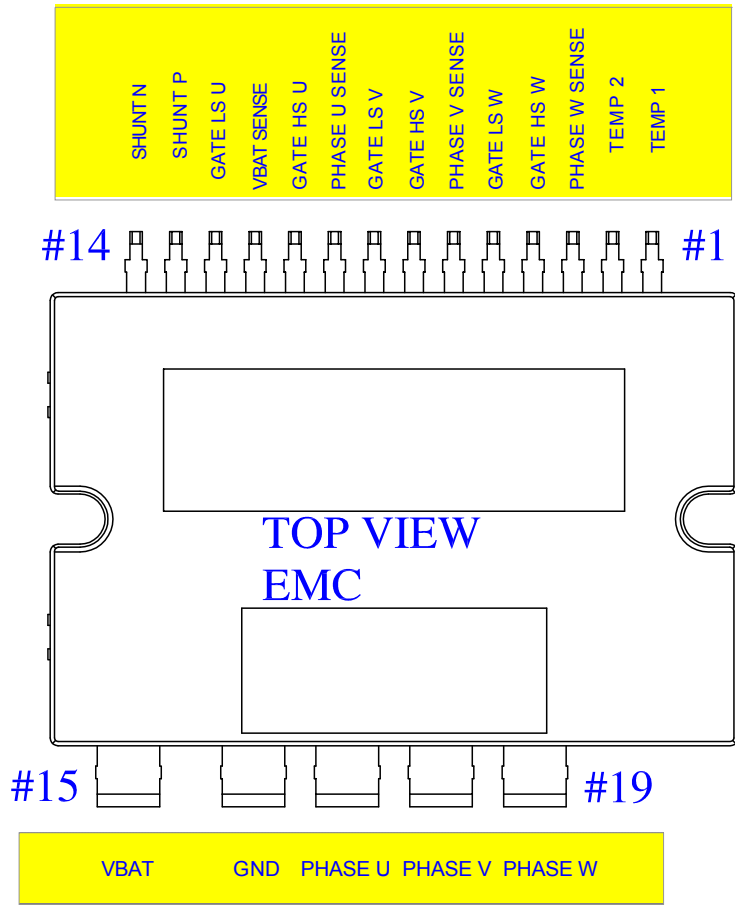


Figure 16.

Detailed Package Outline Drawings

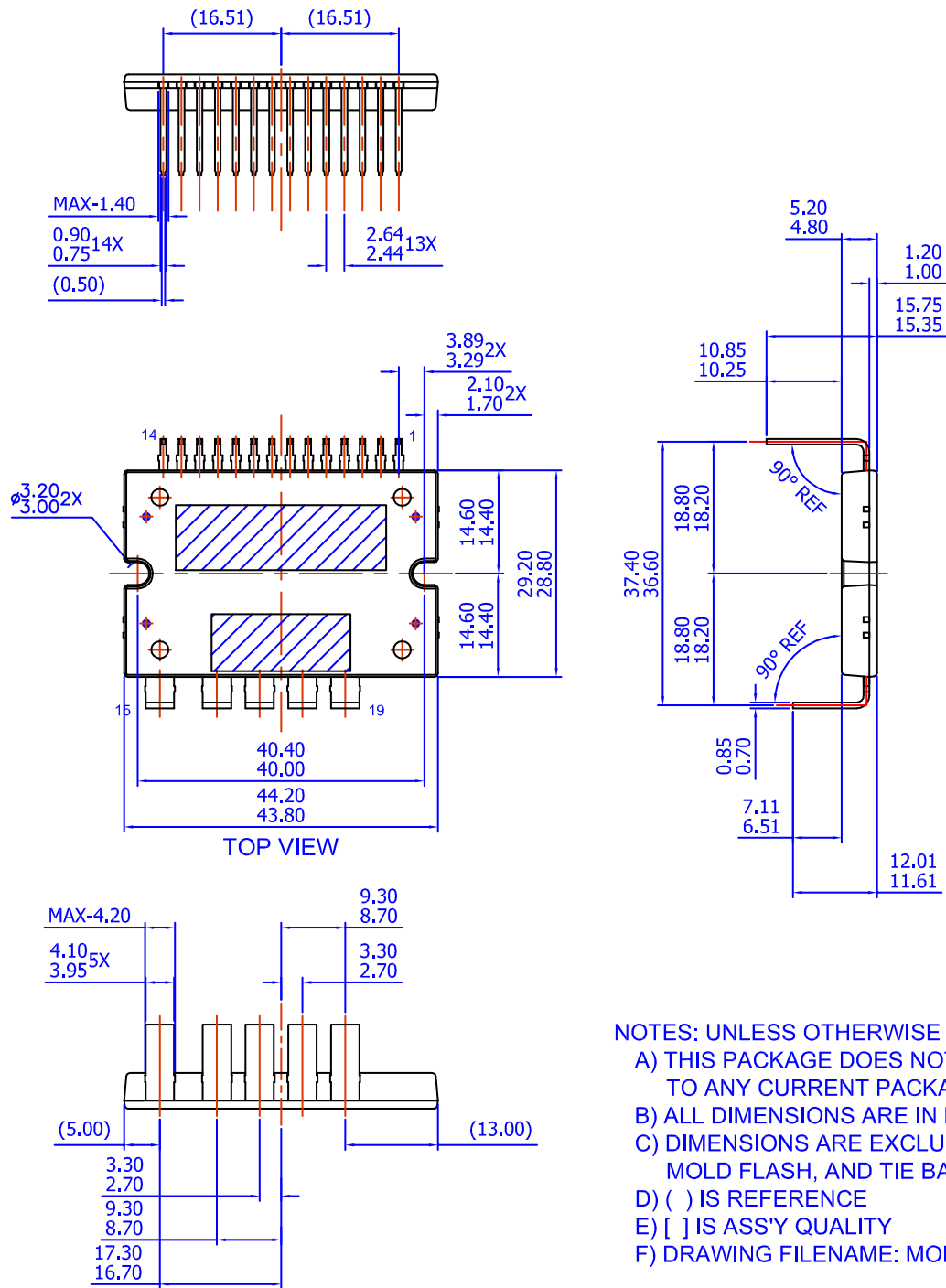


Figure 17.

ON Semiconductor and the ON Semiconductor logo are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

## PUBLICATION ORDERING INFORMATION

### LITERATURE FULFILLMENT:

Literature Distribution Center for ON Semiconductor  
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA  
Phone: 303-675-2175 or 800-344-3860 Toll Free USA/Canada  
Fax: 303-675-2176 or 800-344-3867 Toll Free USA/Canada  
Email: [orderlit@onsemi.com](mailto:orderlit@onsemi.com)

**N. American Technical Support:** 800-282-9855 Toll Free  
USA/Canada.

**Europe, Middle East and Africa Technical Support:**  
Phone: 421 33 790 2910

**Japan Customer Focus Center**  
Phone: 81-3-5817-1050

**ON Semiconductor Website:** [www.onsemi.com](http://www.onsemi.com)

**Order Literature:** <http://www.onsemi.com/orderlit>

For additional information, please contact your local  
Sales Representative

ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

## PUBLICATION ORDERING INFORMATION

### LITERATURE FULFILLMENT:

Literature Distribution Center for ON Semiconductor  
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA  
**Phone:** 303-675-2175 or 800-344-3860 Toll Free USA/Canada  
**Fax:** 303-675-2176 or 800-344-3867 Toll Free USA/Canada  
**Email:** [orderlit@onsemi.com](mailto:orderlit@onsemi.com)

**N. American Technical Support:** 800-282-9855 Toll Free  
USA/Canada  
**Europe, Middle East and Africa Technical Support:**  
Phone: 421 33 790 2910  
**Japan Customer Focus Center**  
Phone: 81-3-5817-1050

**ON Semiconductor Website:** [www.onsemi.com](http://www.onsemi.com)  
**Order Literature:** <http://www.onsemi.com/orderlit>  
For additional information, please contact your local  
Sales Representative