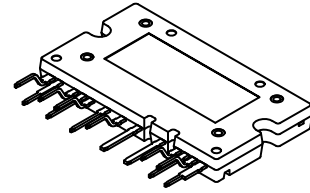


# ASPM16 Series for Exciter Motor Application Automotive 650 V 75 A Smart Power Module

## NFVF97565L1ZT1



ASPMCA-A16  
 CASE MODGH

### General Description

NFVF97565L1ZT1 is an advanced automotive smart power module providing a fully-featured, high-performance full bridge inverter output stage for Exciter Motor Application.

### Features

- 650 V – 75 A Full Bridge Inverter
- 13 pin Automotive Smart Power Module
- AQC324 Qualified and PPAP Capable
- Low-Loss, Short-Circuit Rated IGBTs
- Very Low Thermal Resistance using AlN DBC Substrate
- Thermistor
- UL Certified No. E209204 (UL1557)
- Single In Line Package
- Isolation Rating: 2500 V<sub>rms</sub> / 1 min
- Comparative Tracking Index (CTI) = 600
- Pb-Free and RoHS Compliant

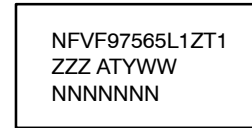
### Applications

- Exciter Motor Application

### Integrated Power Functions

- 650 V – 75 A IGBT Full Bridge Inverter for DC / AC Power Conversion (Please Refer to Figure 2)

### MARKING DIAGRAM



NFVF97565L1ZT1 = Specific Device Code  
 ZZZ = Lot ID  
 AT = Assembly & Test Location  
 Y = Year  
 W = Work Week  
 NNN = Serial Number

### ORDERING INFORMATION

See detailed ordering and shipping information on page 6 of this data sheet.

# NFVF97565L1ZT1

## Pin Configuration

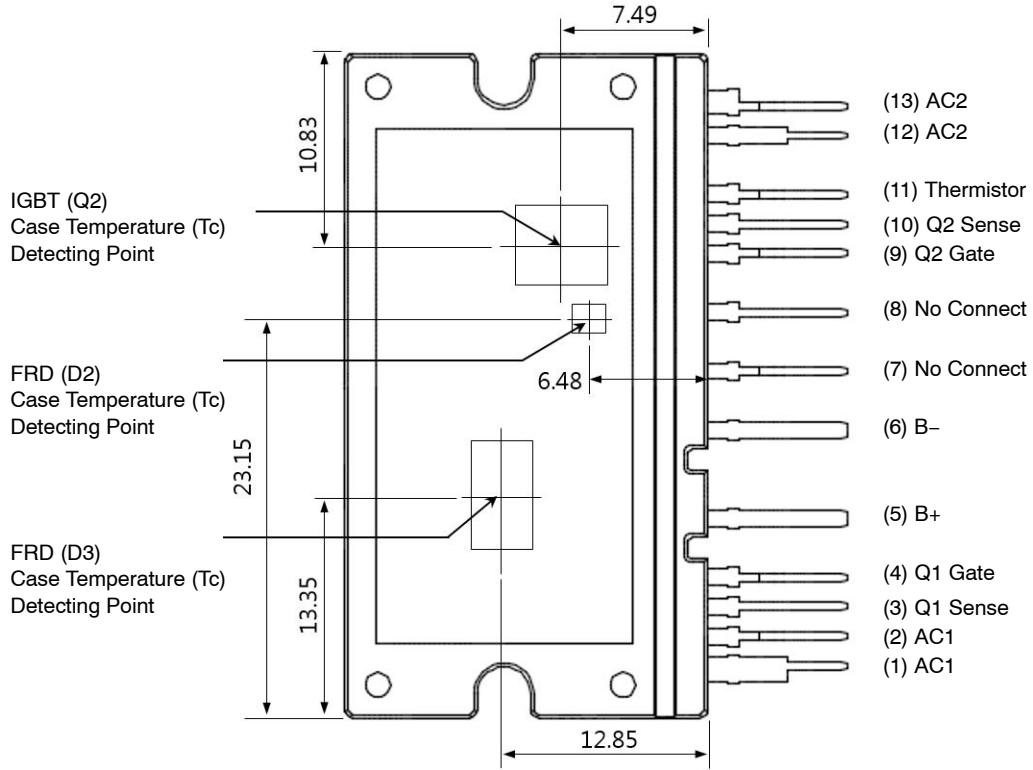


Figure 1. Bottom View

## PIN DESCRIPTIONS

Pin No.	Pin Name	Pin Description
1	AC1	AC1
2	AC1	AC1
3	Q <sub>1</sub> Sense	Sense of Q <sub>1</sub> IGBT
4	Q <sub>1</sub> Gate	Gate of Q <sub>1</sub> IGBT
5	B+	Positive Battery Input
6	B-	Negative Battery Input
7	No Connect	
8	No Connect	
9	Q <sub>2</sub> Gate	Gate of Q <sub>2</sub> IGBT
10	Q <sub>2</sub> Sense	Sense of Q <sub>2</sub> IGBT
11	Thermistor	Thermistor
12	AC2	AC2
13	AC2	AC2

# NFVF97565L1ZT1

## Internal Equivalent Circuit and Input/Output Pins

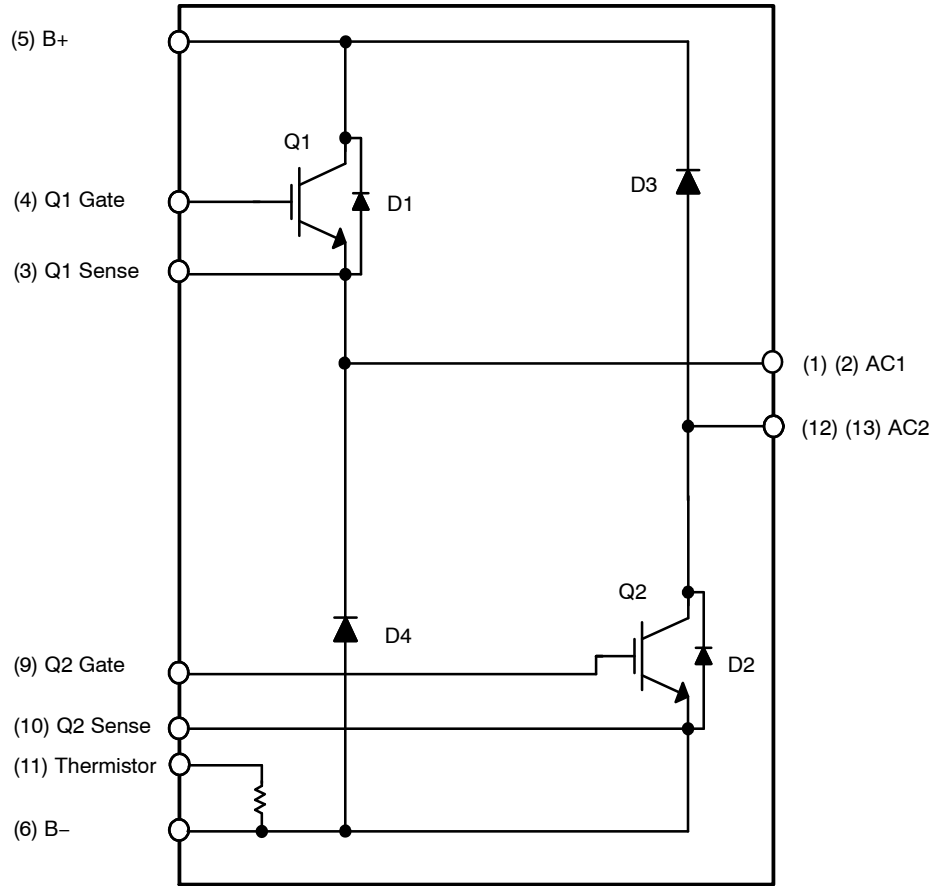


Figure 2. Internal Block Diagram

# NFVF97565L1ZT1

## ABSOLUTE MAXIMUM RATINGS ( $T_C = 25^\circ\text{C}$ , Unless Otherwise Specified)

Symbol	Parameter	Conditions	Rating	Unit
<b>IGBT AND FRD PART</b>				
$V_{CES}$	IGBT Collector – Emitter Voltage		650	V
$I_C$	Each IGBT Collector Current	$T_C = 25^\circ\text{C}$ , $T_J \leq 175^\circ\text{C}$ (Note 1)	150	A
	Each IGBT Collector Current	$T_C = 100^\circ\text{C}$ , $T_J \leq 175^\circ\text{C}$ (Note 1)	75	A
$I_{CM}$	Each IGBT Pulsed Collector Current	$T_J \leq 175^\circ\text{C}$ , Under 1 ms Pulse Width (Note 2)	225	A
$V_{RRM}$	FRD Repetitive Reverse Voltage		650	V
$I_F$ (D3, D4)	Each FRD Forward Current	$T_C = 25^\circ\text{C}$ , $T_J \leq 175^\circ\text{C}$ (Note 1)	150	A
	Each FRD Forward Current	$T_C = 100^\circ\text{C}$ , $T_J \leq 175^\circ\text{C}$ (Note 1)	75	A
$I_{FM}$ (D3, D4)	Each FRD Pulsed Forward Current	$T_J \leq 175^\circ\text{C}$ , Under 1ms Pulse Width (Note 2)	225	A
$I_F$ (D1, D2)	Each FRD Forward Current	$T_C = 25^\circ\text{C}$ , $T_J \leq 175^\circ\text{C}$ (Note 1)	30	A
	Each FRD Forward Current	$T_C = 100^\circ\text{C}$ , $T_J \leq 175^\circ\text{C}$ (Note 1)	15	A
$I_{FM}$ (D1, D2)	Each FRD Pulsed Forward Current	$T_J \leq 175^\circ\text{C}$ , Under 1ms Pulse Width (Note 2)	45	A
$I^2t$	$I^2t$ for FRD (D3, D4) Current square time	Value Corresponding to 1 cycle of half wave 60 Hz, surge on-state current, $T_J = 85^\circ\text{C}$ (Note 1)	200	$\text{A}^2\text{s}$
	$I^2t$ for FRD (D1, D2) Current square time		30	$\text{A}^2\text{s}$
$V_{GE}$	Transient Gate–Emitter Voltage		$\pm 20$	V
$P_C$	IGBT Power Dissipation	$T_C = 25^\circ\text{C}$ per One Chip (Note 3)	483	W
$P_K$	FRD (D3, D4) Part Power Dissipation	$T_C = 25^\circ\text{C}$ per One Chip (Note 3)	375	W
	FRD (D1, D2) Part Power Dissipation	$T_C = 25^\circ\text{C}$ per One Chip (Note 3)	74.6	W
$T_J$	Operating Junction Temperature		-40~175	$^\circ\text{C}$

## TOTAL SYSTEM

$T_{SC}$	Short Circuit Withstand Time	$V_{GE} = 15\text{ V}$ , $V_{CE} \leq 450\text{ V}$ , $T_J \leq 175^\circ\text{C}$	6	$\mu\text{s}$
$T_{STG}$	Storage Temperature		-40~150	$^\circ\text{C}$
$T_C$	Module Case Operation Temperature	(Note 4)	-40~150	$^\circ\text{C}$
$V_{ISO}$	Isolation Voltage	60 Hz, Sinusoidal, AC 1 minute, Connection Pins to Heat Sink Plate	2500	$V_{rms}$

## THERMAL RESISTANCE

Symbol	Parameter	Conditions	Min.	Typ.	Max	Unit
$R_{th(j-c)Q}$	Junction to Case Thermal Resistance (Note 3)	IGBT part	-	-	0.31	$^\circ\text{C}/\text{W}$
$R_{th(j-c)F}$		FWD (D3, D4) Part	-	-	0.40	$^\circ\text{C}/\text{W}$
$R_{th(j-c)F}$		FWD (D1, D2) Part	-	-	2.01	$^\circ\text{C}/\text{W}$
$L_\sigma$	Package Stray Inductance	B+ to B- (Note 5)		20		nH

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.

### NOTES:

- These values had been made an acquisition by the calculation considered to design factor, and Pulse width and period are limited due to junction temperature.
- Repetitive rating : Pulse width limited by max junction temperature.
- For the measurement point of case temperature ( $T_C$ ), please refer to Figure 1 and Figure 2 of chip location, and case temperature and heat sink temperature are defined on the each surface of base plate and heat sink just under the chips. DBC discoloration and Picker Circle Printing allowed, please refer to application note AN-9190 (Impact of DBC Oxidation on SPM Module Performance).
- $T_C$  is depend on the real operation condition.
- Stray inductance measured per IEC 60747-15.

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## ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
<b>IGBT AND FRD PART</b> ( $T_J = 25^\circ\text{C}$ as specified)						
$\Delta BV_{CES} / \Delta T_J$	Temperature Coefficient of Break-down Voltage	$V_{GE} = 0\text{ V}, I_C = 1\text{ mA}$	-	0.6	-	$\text{V}/^\circ\text{C}$
$V_{CE(SAT)}$ (Q1, Q2)	Collector-Emitter Saturation Voltage	$V_{GE} = 15\text{ V}, I_C = 75\text{ A}, T_J = 25^\circ\text{C}$	1.30	1.55	1.95	V
		$V_{GE} = 15\text{ V}, I_C = 75\text{ A}, T_J = 175^\circ\text{C}$	1.50	1.70	2.25	V
$V_F$ (D3, D4)	FRD Forward Voltage	$I_F = 50\text{ A}, T_J = 25^\circ\text{C}$	-	2.10	2.70	V
		$I_F = 50\text{ A}, T_J = 175^\circ\text{C}$	-	1.90	-	V
$V_F$ (D1, D2)	FRD Forward Voltage	$I_F = 15\text{ A}, T_J = 25^\circ\text{C}$	-	1.80	2.40	V
		$I_F = 15\text{ A}, T_J = 175^\circ\text{C}$	-	1.70	-	V
$V_{GE(TH)}$	Gate-Emitter Threshold Voltage	$V_{GE} = V_{CE}, I_C = 75\text{ mA}, T_J = 25^\circ\text{C}$	4.2	5.25	7.5	V
$Q_g$	Total Gate Charge	$V_{CE} = 400\text{ V}, V_{GE} = 15\text{ V}, I_C = 75\text{ A}$	-	500	-	nC
$Q_{ge}$	Gate to Emitter Charge		-	30	-	nC
$Q_{gc}$	Gate to Collector Charge		-	250	-	nC
$C_{ies}$	Input Capacitance		$V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V}, f_{sw} = 1\text{ MHz}$	-	6350	-
$C_{oes}$	Output Capacitance		-	230	-	pF
$C_{res}$	Reverse Capacitance		-	105	-	pF
$R_g$	Internal IGBT Gate Resistor	$T_J = 25^\circ\text{C}$	-	1.2	10	$\Omega$
$I_{GES}$	Gate-Emitter Leakage Current	$V_{CE} = 0\text{ V}, V_{GE} = 20\text{ V}, T_J = 25^\circ\text{C}$	-	-	1000	nA
IGBT	$t_{d(on)}$	IGBT Switching Times and Losses $V_{CE} = 400\text{ V}, V_{GE} = 15\text{ V}, I_C = 75\text{ A}, T_J = 25^\circ\text{C}, R_g = 8\ \Omega$ Inductive Load See Figure 13	-	130	-	ns
	$t_r$		-	70	-	ns
	$E_{ON}$		-	2.5	-	mJ
	$t_{d(OFF)}$		-	500	-	ns
	$t_f$		-	70	-	ns
	$E_{OFF}$		-	3.8	-	mJ
IGBT	$t_{d(on)}$	IGBT Switching Times and Losses $V_{CE} = 400\text{ V}, V_{GE} = 15\text{ V}, I_C = 75\text{ A}, T_J = 175^\circ\text{C}, R_g = 8\ \Omega$ Inductive Load See Figure 13	-	150	-	ns
	$t_r$		-	74	-	$\mu\text{s}$
	$E_{ON}$		-	3.7	-	mJ
	$t_{d(OFF)}$		-	575	-	ns
	$t_f$		-	74	-	ns
	$E_{OFF}$		-	3.9	-	mJ
FRD	$t_{rr}$	FRD Switching Times and Losses (D3, D4) $V_{AK} = 400\text{ V}, R_g = 8\ \Omega, I_A = 75\text{ A}, T_J = 25^\circ\text{C}$	-	50	-	ns
	$Q_{rr}$		-	200	-	nC
	$I_{RRM}$		-	8	-	A
	$E_{rr}$		-	150	-	$\mu\text{J}$
FRD	$t_{rr}$	FRD Switching Times and Losses (D3, D4) $V_{AK} = 400\text{ V}, R_g = 8\ \Omega, I_A = 75\text{ A}, T_J = 175^\circ\text{C}$	-	60	-	ns
	$Q_{rr}$		-	240	-	nC
	$I_{RRM}$		-	9.6	-	A
	$E_{rr}$		-	180	-	$\mu\text{J}$
$I_{CES}$	Collector-Emitter Leakage Current	$T_J = 25^\circ\text{C}, V_{CE} = V_{CES}$	-	-	250	$\mu\text{A}$
$I_R$	Anode-Cathode Leakage Current	$T_J = 25^\circ\text{C}, V_{AK} = V_{CES}$	-	-	250	$\mu\text{A}$

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.

# NFVF97565L1ZT1

## PACKAGE MARKING AND ORDERING INFORMATION

Device Marking	Device	Package	Packing Type	Quantity
NFVF97565L1ZT1	NFVF97565L1ZT1	ASPM16-CAA	Tube	12

TYPICAL PERFORMANCE CHARACTERISTICS

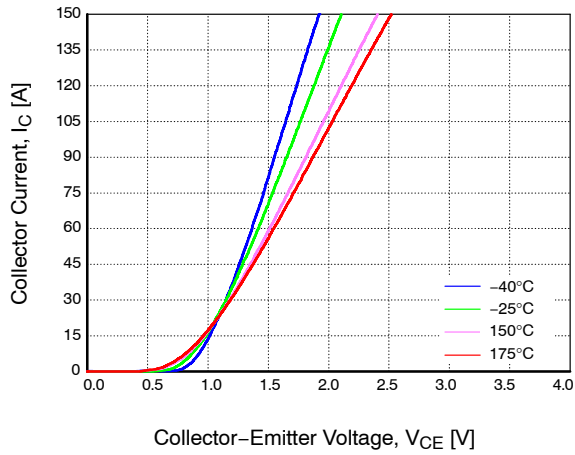


Figure 3. Typical Output Characteristics [Q1 and Q2 IGBT]

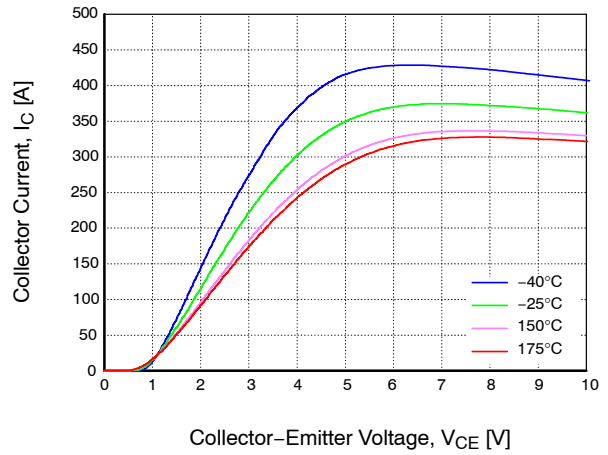


Figure 4. Typical Output Saturation Characteristics [Q1 and Q2 IGBT]

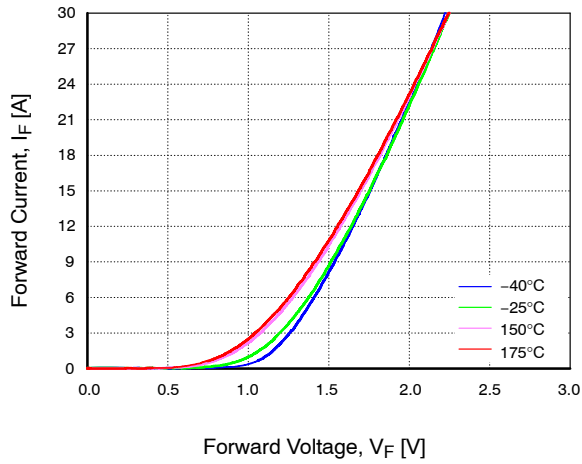


Figure 5. Typical 15 A Diode Forward Voltage

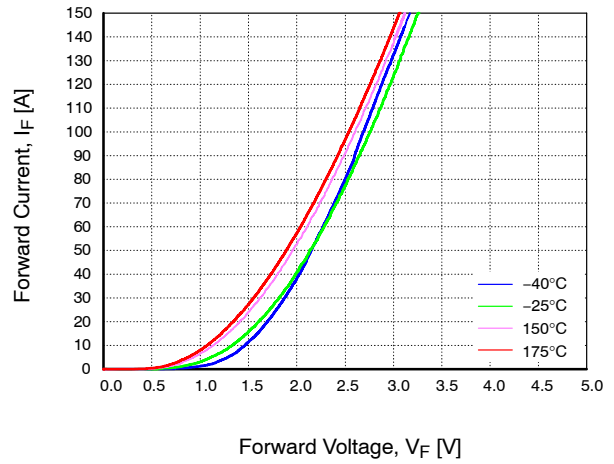


Figure 6. Typical 50 A Diode Forward Voltage

# NFVF97565L1ZT1

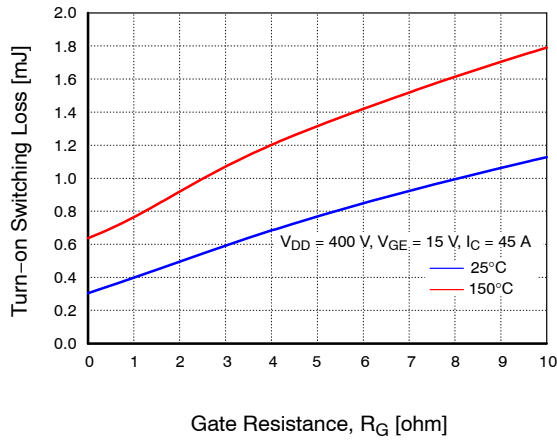


Figure 7. Turn-on Loss vs. Gate Resistance

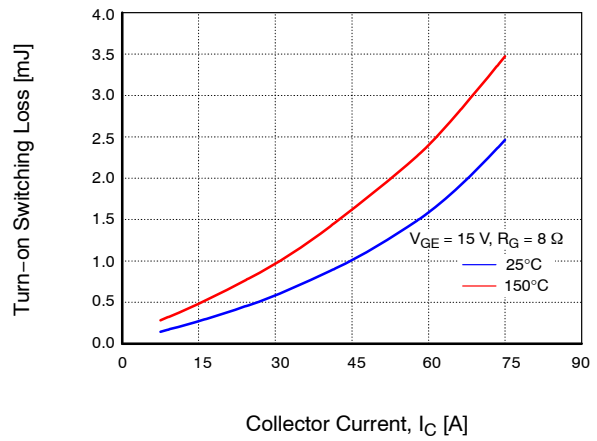


Figure 8. Turn-on Loss vs. Collector Current

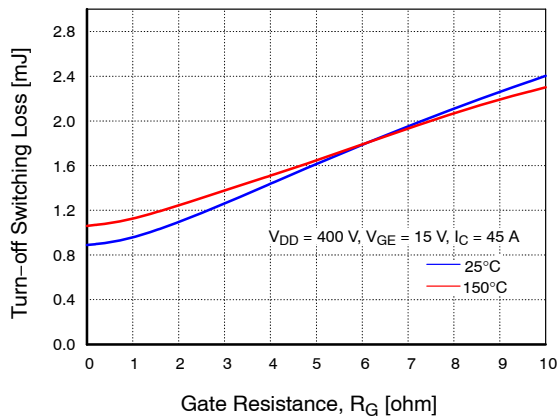


Figure 9. Turn-off Loss vs. Gate Resistance

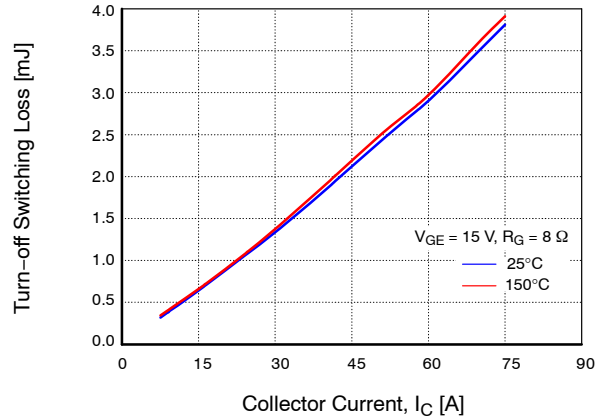


Figure 10. Turn-off Loss vs. Collector Current

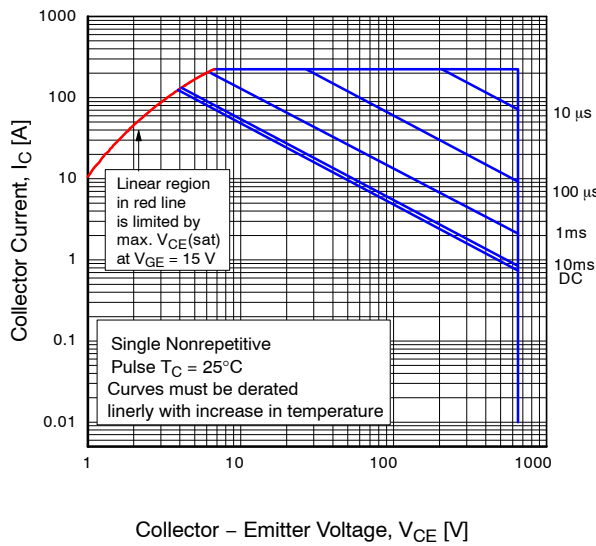


Figure 11. FBSOA Characteristics

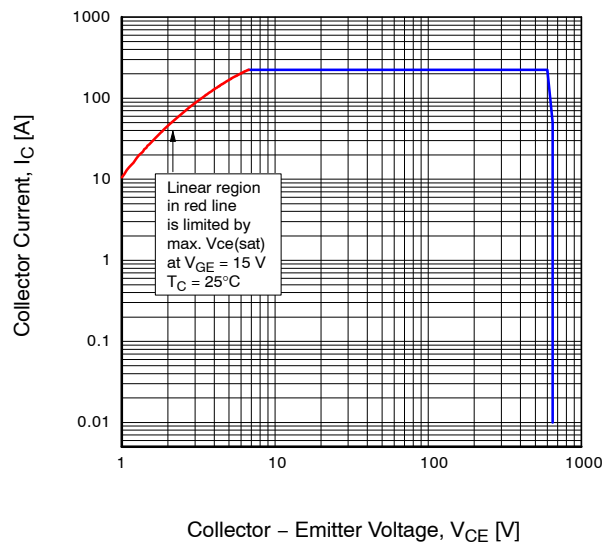


Figure 12. RBSOA Characteristics



# NFVF97565L1ZT1

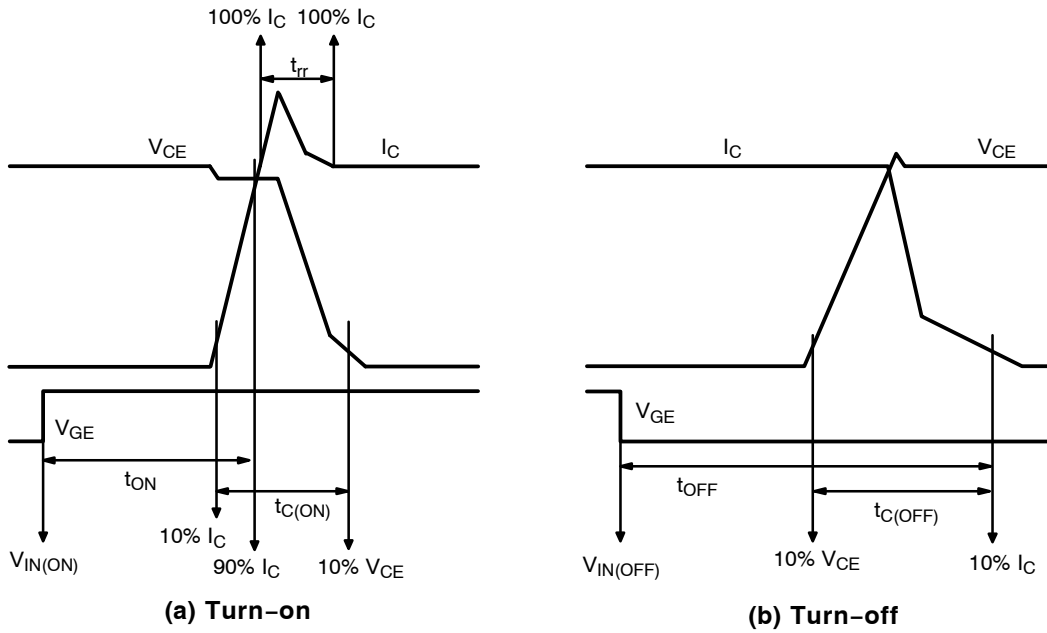


Figure 13. Switching Time Definition

## NTC THERMISTOR

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
R <sub>TH</sub>	Resistance of Thermistor	@T <sub>TH</sub> = 25°C	-	47	-	kΩ
		@T <sub>TH</sub> = 100°C	-	2.9	-	kΩ

6. T<sub>TH</sub> is the temperature of thermistor itself. To know temperature (T<sub>C</sub>), please make the experiment considering your application.

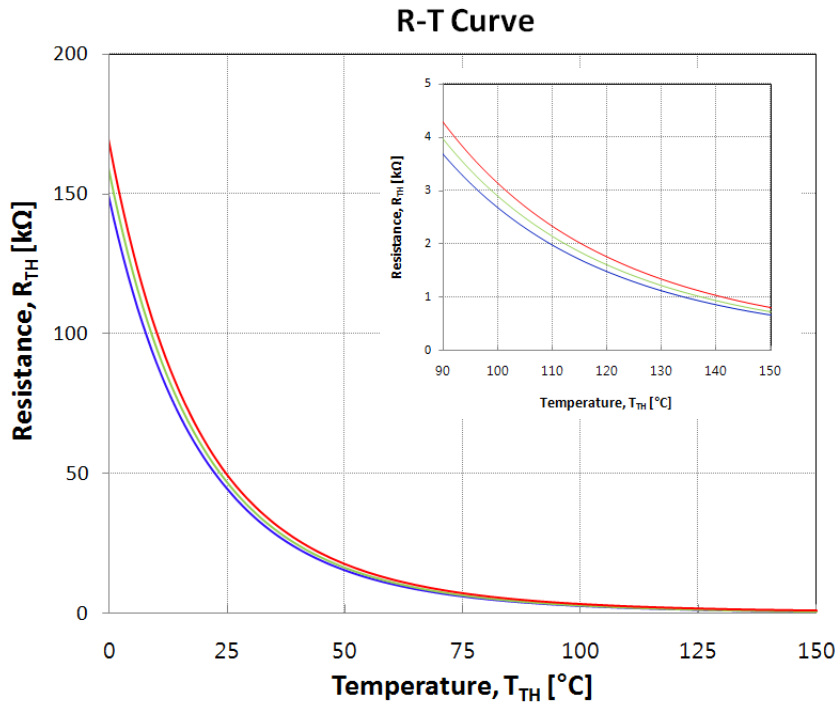


Figure 14. R-T Curve of The Built-in Thermistor

# NFVF97565L1ZT1

## MECHANICAL CHARACTERISTICS AND RATINGS

Parameter	Conditions	Limits			Unit
		Min.	Typ.	Max.	
Device Flatness	See Figure 15	0	-	150	$\mu\text{m}$
Weight		-	10	-	g

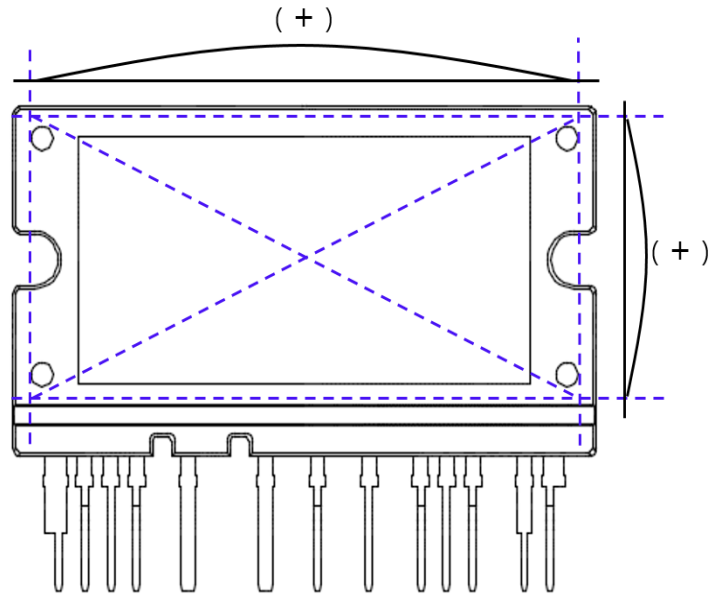


Figure 15. Flatness Measurement Position

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

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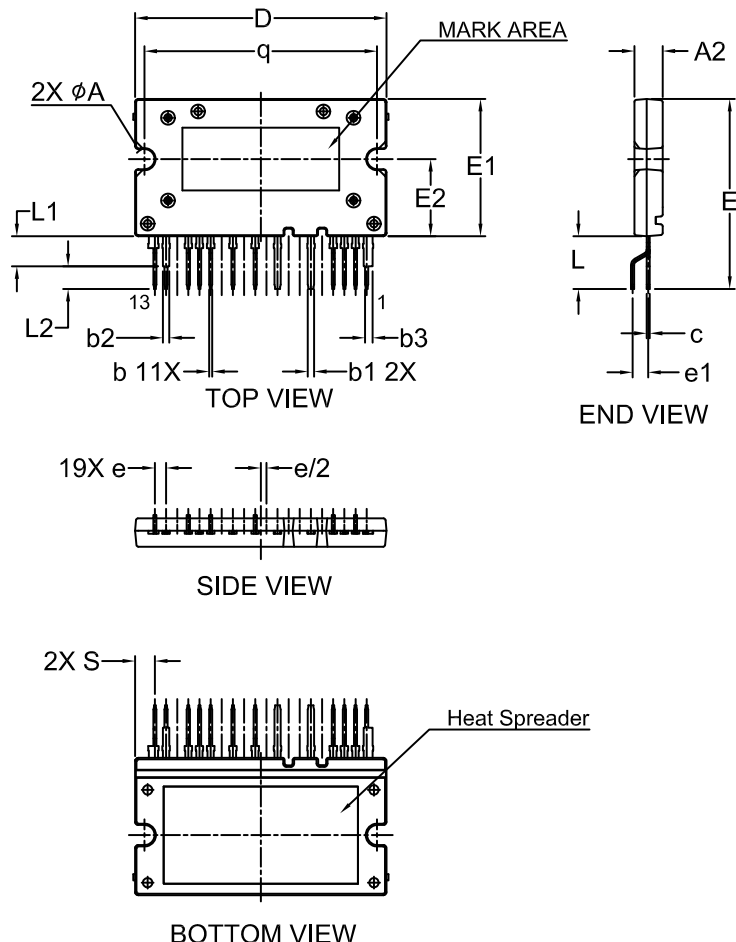
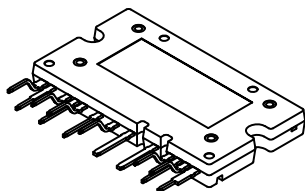


### ASPMCA-A16 / 13LD, AUTOMOTIVE MODULE

#### CASE MODGH

#### ISSUE B

DATE 03 NOV 2020

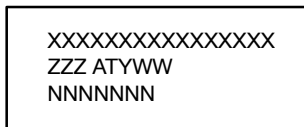


#### NOTES:

1. DIMENSIONING AND TOLERANCING PER. ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR EXTRUSIONS.

DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A2	4.30	4.50	4.70
b	0.45	0.50	0.60
b1	0.95	1.00	1.10
b2	0.95	1.00	1.10
b3	1.15	1.20	1.30
c	0.45	0.50	0.60
D	39.90	40.10	40.30
E	29.80	30.30	30.80
E1	21.70	21.90	22.10
E2	12.10	12.30	12.50
e	1.478	1.778	2.078
e1	2.20	2.50	2.80
L	8.10	8.40	8.70
L1	4.80 REF		
L2	3.30	3.60	3.90
q	36.85	37.10	37.35
S	3.159 REF		
φA	2.95	3.20	3.45

#### GENERIC MARKING DIAGRAM\*



XXXX = Specific Device Code  
 ZZZ = Lot ID  
 AT = Assembly & Test Location  
 Y = Year  
 W = Work Week  
 NNN = Serial Number

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "μ", may or may not be present. Some products may not follow the Generic Marking.

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