COMPACT IPM SERIES EVB

STK5x4U3xx Series, NFAxxx60xxx Series Evaluation Board User's Manual

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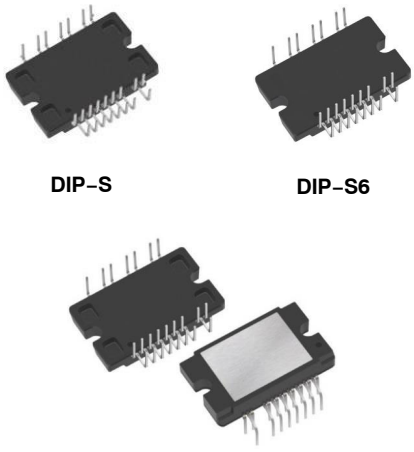
EVAL BOARD USER'S MANUAL



Introduction

This user's guide is intended to provide practical guidelines for the *STK5x4U3xx* series and *NFAxxx60xxx* series. From now on, these series are called the compact IPM series. It should be used in conjunction with the datasheet and application note

Product Description

The compact IPM series is Intelligent Power Module (IPM) for 3−phase motor drives which contain the main power circuitry and the supporting control circuitry.

The Compact IPMs are a fully−integrated inverter power stage consisting of a high−voltage driver, six IGBTs for three−phase inverter, six fast recovery diodes, three bootstrap diodes and a thermistor, suitable for driving permanent magnet synchronous (PMSM) motors, brushless−DC (BLDC) motors and AC asynchronous motors. The IGBTs are configured in a 3−phase bridge with separate emitter connections for the lower legs for maximum flexibility in the choice of control algorithm.

Features

- Three−phase 3 A ~ 15 A/600 V IGBT Module with Integrated Drivers
- Compact IPM 29.6 mm x 18.2 mm, Dual In−line Package
- Cross−conduction Protection
- Adjustable Over−current Protection Level
- Integrated Boot−strap Diodes and Resistors
- Enable Pin
- Thermistor

Typical Application

- Industrial Pumps, Fans and Automation
- Home Appliances

Table 1. LINE−UP

	STK5C4U332J−E	STK5Q4U352J−E	STK5C4U362J−E NFAQ1060L33T (Note 1)	NFAQ1560R43T (Note 1)
Package	DIP−S (Note 2)	DIP−S3 (Note 3)	DIP−S3/6 (Note 3)	DIP−S6 (Note 3)
Voltage (V_{CEMAX})	600 V			
Current, I_C	3 A	8 A	10 A	15 A
Peak Current, I_{CMAX}	6 A	16 A	20 A	30 A
Isolation Voltage	2000 V			

1. Under development.
2. DIP−S package is full package and has cavity hole.
3. DIP−S3/6 are DBC version, DIP−S3 has cavity hole, DIP−S6 is no cavity hole.

EVALUATION BOARD DESCRIPTION

Schematic

Figure 1 shows a circuity of the evaluation board of Compact IPM. The evaluation board consists of interface circuit, bootstrap capacitors, snubber capacitor, short−circuit protection circuit, fault out circuit and one shunt resistor.

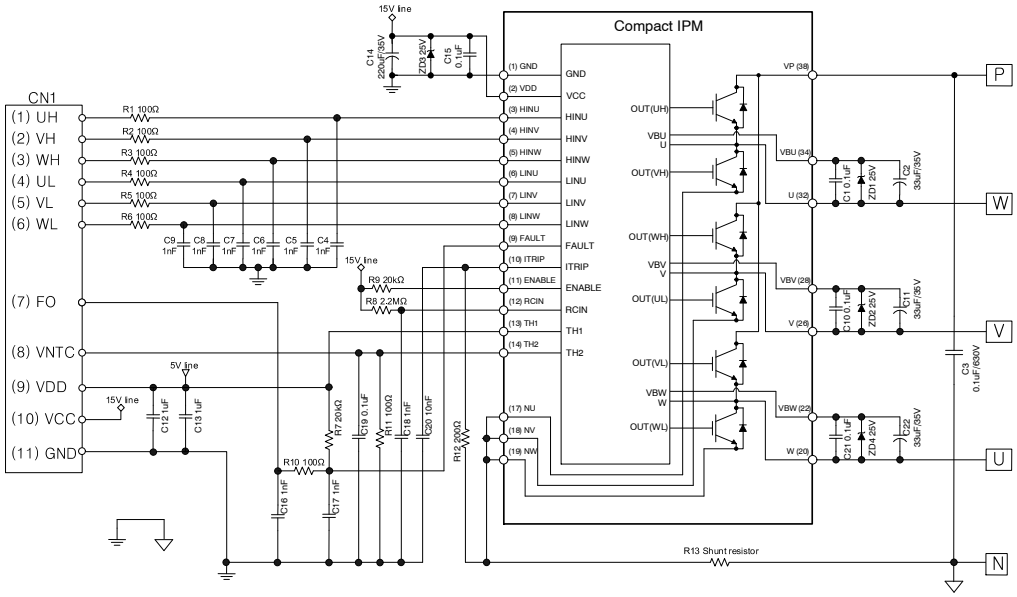


Figure 1. Evaluation Board Circuits

Figure 2 shows the evaluation board of the Compact IPM.

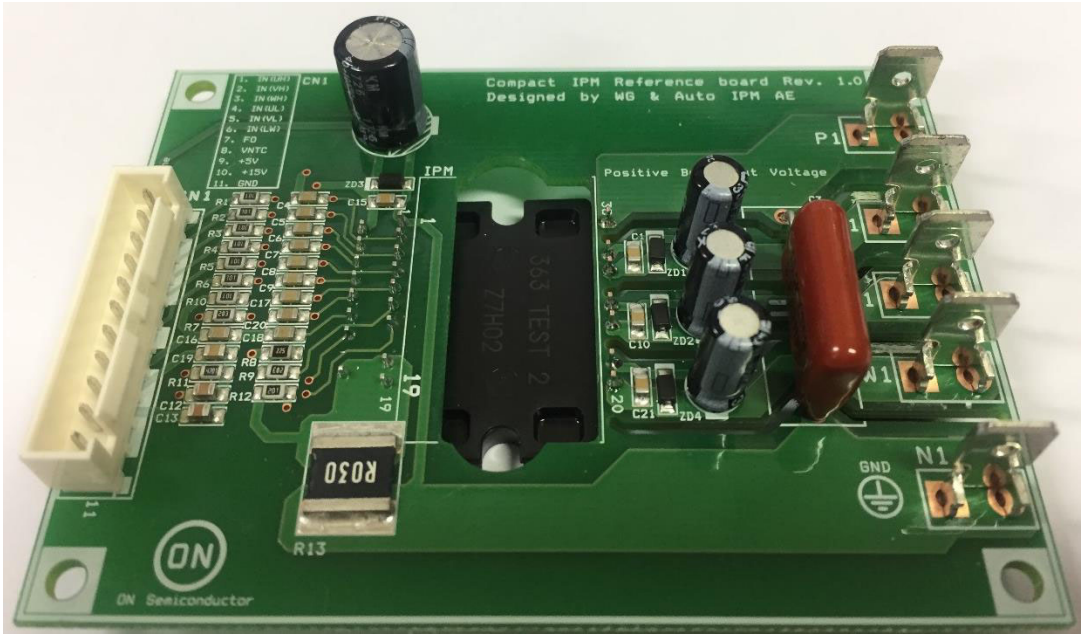


Figure 2. Evaluation Board for the Compact IPM

PCB Map

Figure 3 shows the PCB layout of compact IPM.

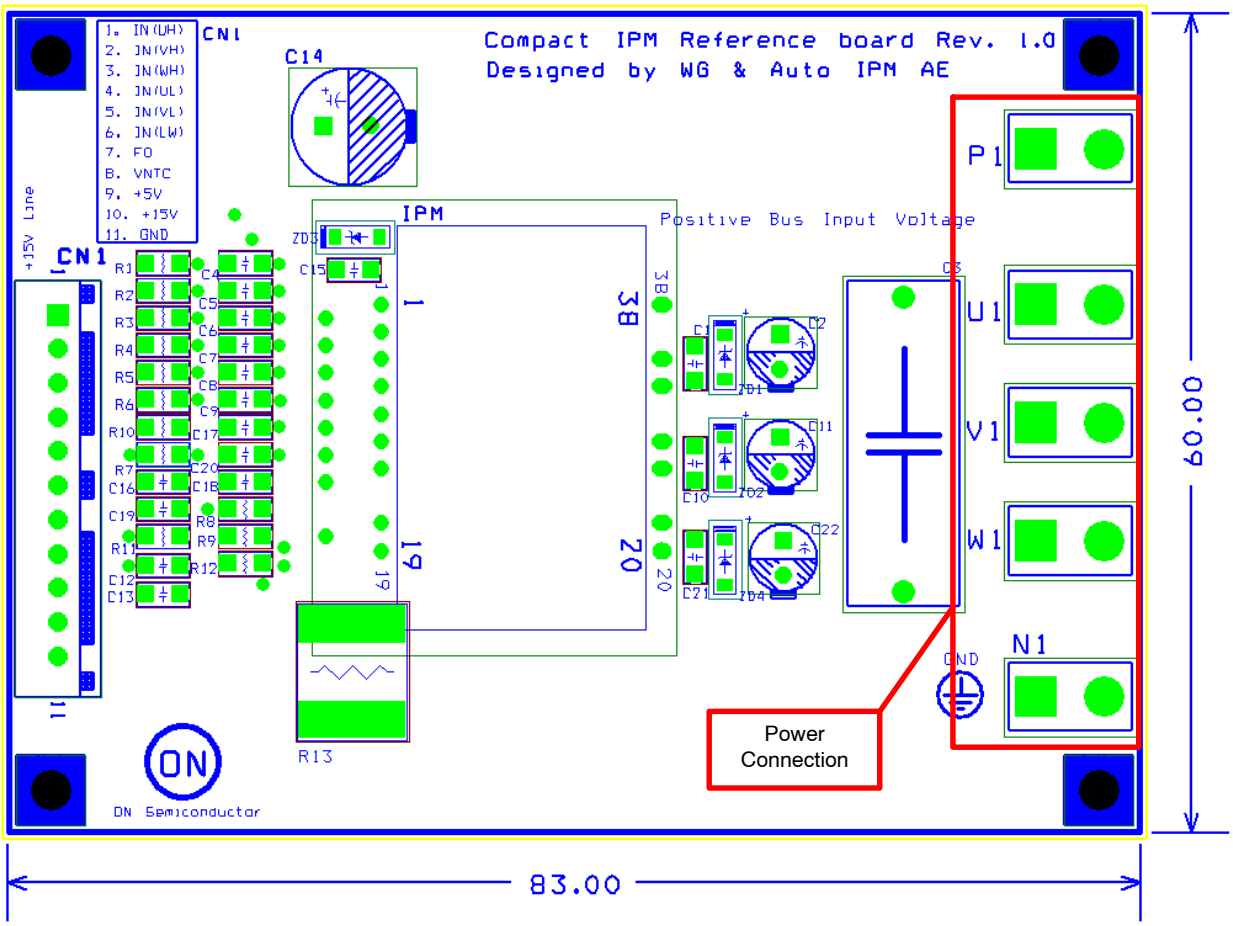


Figure 3. PCB Layout of the Compact IPM

Circuit Layout Design Guidance

1. PCB size is 83.0 mm x 60.0 mm
2. To avoid malfunction, the wiring of each input should be as short as possible. (Less than 2−3 cm)
3. To prevent protection function errors, the “R12” and “C20” wiring should be as short as possible
4. All the de−coupling capacitors and filter capacitors should be placed very close to IPM
5. The short−circuit protection time constant R12*C20 should be set in the range of 1.5~2.0 μsec
6. The isolation distance of DC−P, U, V, W−phase, DC−N/GND block should be over 2.54 mm (100 mil) for 300 V~500 V P−N voltage
7. Power−GND and signal−GND should be connected with each other through only one 1.5~2 mm width pattern
8. To prevent surge destruction, the wiring between the filter capacitor and the P & Ground pins should be as short as possible. The use of a high frequency non−inductive capacitor (Snubber, C3) between the P & Ground pins is recommended. In addition to reducing local voltage spikes, the placement and quality of this capacitor will have a direct impact on both conducted and radiated EMI.

This evaluation board is simply, customer have to connect just signal interface, VPN voltage and Motor connection (U/V/W). For future detail information, refer to the datasheet and application note.

Pin Description

Table 2. PIN DESCRIPTION

Connection	Pin	Description
Signal Interface (CN1)	1	High−Side Input Signal from MCU (Phase U)
	2	High−Side Input Signal from MCU (Phase V)
	3	High−Side Input Signal from MCU (Phase W)
	4	Low−Side Input Signal from MCU (Phase U)
	5	Low−Side Input Signal from MCU (Phase V)
	6	Low−Side Input Signal from MCU (Phase W)
	7	Fault−Out Signal to MCU
	8	T_C Monitoring to MCU
	9	IPM Bias Supply +5 V Terminal
	10	IPM Bias Supply +15 V Terminal
	11	IPM Bias Supply GND Terminal
Power Connection	P	Positive DC Link Input Connection
	N	Negative DC Link Input Connection
	U	Motor Input Connection (Phase U)
	V	Motor Input Connection (Phase V)
	W	Motor Input Connection (Phase W)

Printed Circuit Board

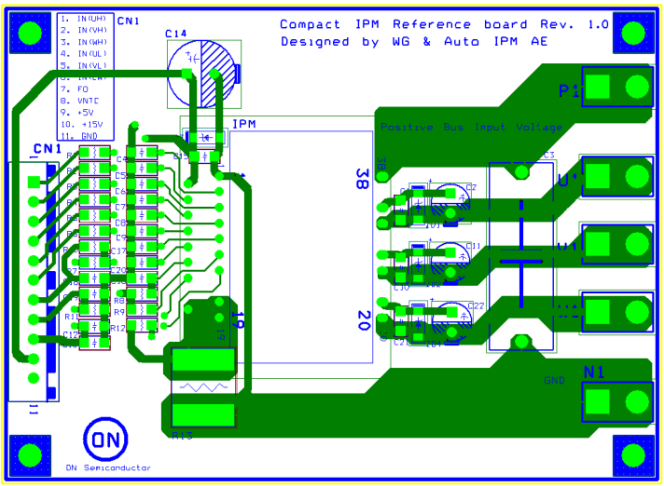


Figure 4. Top Side View

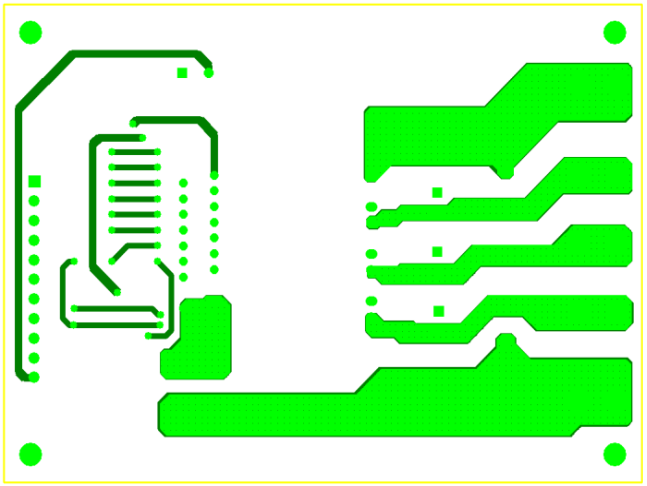


Figure 5. Bottom Side View

BILL of Materials

Table 3. BILL OF MATERIALS

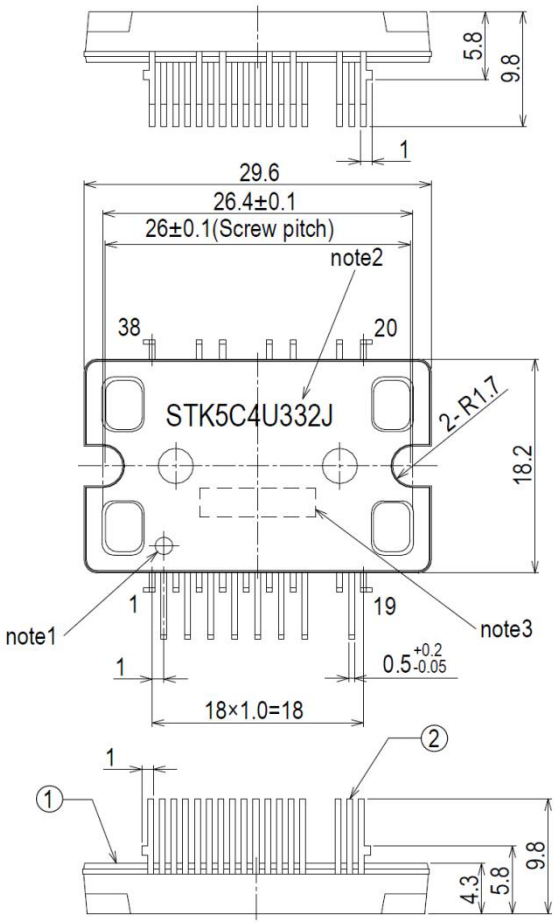
Part No.	Type Name	Definition	pcs	Definition
R1	MCR10EZPJ101	100 Ω, 1/8W, 5%	1	ROHM
R2	MCR10EZPJ101	100 Ω, 1/8W, 5%	1	ROHM
R3	MCR10EZPJ101	100 Ω, 1/8W, 5%	1	ROHM
R4	MCR10EZPJ101	100 Ω, 1/8W, 5%	1	ROHM
R5	MCR10EZPJ101	100 Ω, 1/8W, 5%	1	ROHM
R6	MCR10EZPJ101	100 Ω, 1/8W, 5%	1	ROHM
R7	MCR10EZPJ203	20 kΩ, 1/8W, 5%	1	ROHM
R8	MCR10EZPJ225	2.2 MΩ, 1/8W, 5%	1	ROHM
R9	MCR10EZPJ203	20 kΩ, 1/8W, 5%	1	ROHM
R10	MCR10EZPJ101	100 Ω, 1/8W, 5%	1	ROHM
R11	MCR10EZPJ472	4.7 kΩ, 1/8W, 5%	1	ROHM
R12	MCR10EZPJ201	200 Ω, 1/8W, 5%	1	ROHM
R13	MPR 5RS XXX	0.10/0.04/0.03/0.02 Ω, 5 W (Non−Inductive Resistor)	1	RARA ELEC.
C1	CL21B104KB	100 nF, 50 V	1	SAMSUNG ELEC.
C2	KXL 33 μF, 35 V	33 μF, 35 V	1	SAMYOUNG
C3	PCMP483D6U104	0.1 μF, 630 V	1	PILKOR
C4	CL21B102 KB	1 nF, 50 V	1	SAMSUNG ELEC.
C5	CL21B102 KB	1 nF, 50 V	1	SAMSUNG ELEC.
C6	CL21B102 KB	1 nF, 50 V	1	SAMSUNG ELEC.
C7	CL21B102 KB	1 nF, 50 V	1	SAMSUNG ELEC.
C8	CL21B102 KB	1 nF, 50 V	1	SAMSUNG ELEC.
C9	CL21B102 KB	1 nF, 50 V	1	SAMSUNG ELEC.
C10	CL21B104 KB	100 nF, 50 V	1	SAMSUNG ELEC.
C11	KXL 33 μF, 35 V	33 μF, 35 V	1	SAMYOUNG
C12	CL21B102 KB	1 μF, 50 V	1	SAMSUNG ELEC.
C13	CL21B102 KB	1 μF, 50 V	1	SAMSUNG ELEC.
C14	KXL 220 μF, 35 V	220 μF, 35 V	1	SAMYOUNG
C15	CL21B104 KB	100 nF, 50 V	1	SAMSUNG ELEC.
C16	CL21B102 KB	1 nF, 50 V	1	SAMSUNG ELEC.
C17	CL21B102 KB	1 nF, 50 V	1	SAMSUNG ELEC.
C18	CL21B102 KB	1 nF, 50 V	1	SAMSUNG ELEC.
C19	CL21B104 KB	100 nF, 50 V	1	SAMSUNG ELEC.
C20	CL21B103 KB	10 nF, 50 V	1	SAMSUNG ELEC.
C21	CL21B104 KB	100 nF, 50 V	1	SAMSUNG ELEC.
C22	KXL 33 μF, 35 V	33 μF, 35 V	1	SAMYOUNG
ZD1	MMSZ5252B	24 V, 0.5 W	1	ON Semiconductor
ZD2	MMSZ5252B	24 V, 0.5 W	1	ON Semiconductor
ZD3	MMSZ5252B	24 V, 0.5 W	1	ON Semiconductor
ZD4	MMSZ5252B	24 V, 0.5 W	1	ON Semiconductor
CN1	SMW250−11	11pin Connector	1	YEONHO
U1, V1, W1, P1, N1	GP881191−2	Tab Terminal	1	KET
IPM1	Compact IPM	Motion−SPM™ in a small−DIP	1	ON Semiconductor

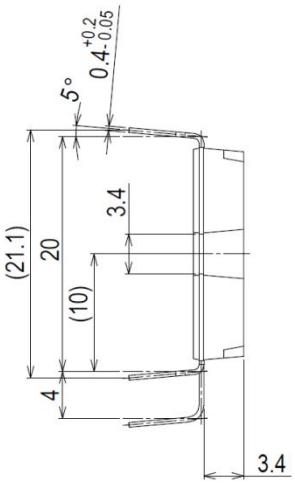
PACKAGE OUTLINE

There are three kind of package type for compact IPM. The package of DIP-S shown in Figure 6, DIP-S3 shown in Figure 7 and DIP-S6 shown in Figure 8.

Package Outline and Dimension

STK5C4U332J−E (DIP−S)



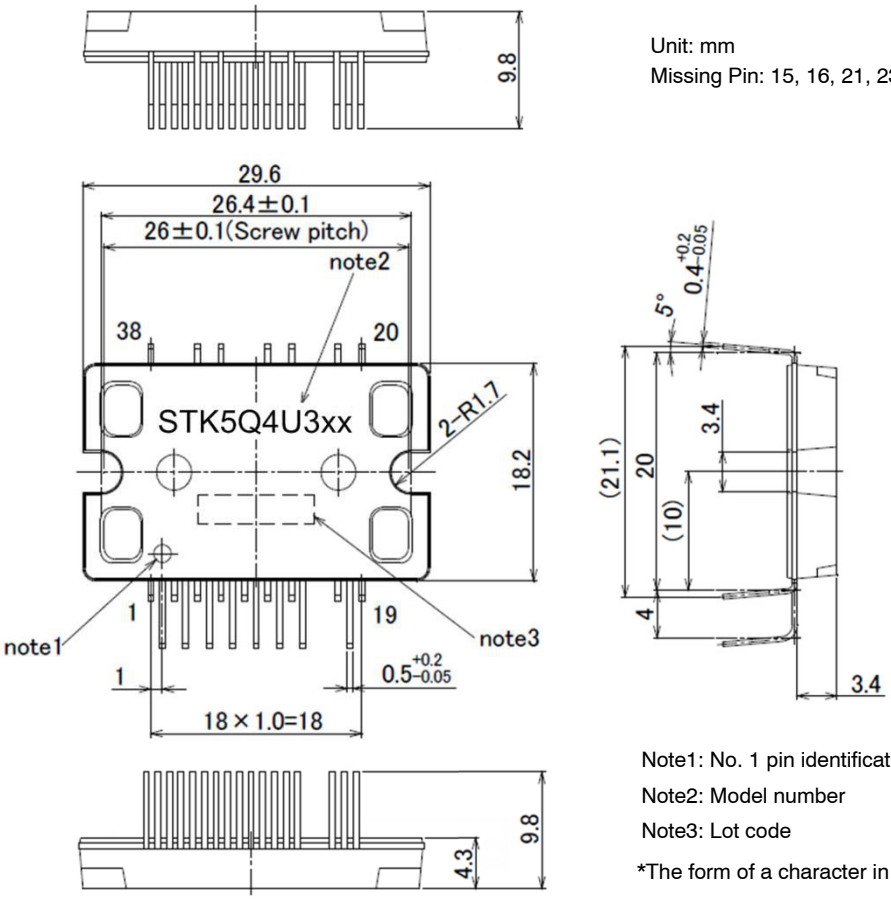


Unit: mm
Missing Pin: 15, 16, 21, 23, 24, 25, 27, 29, 30, 31, 33, 35, 36, 37

Note1: No. 1 pin identification mark
Note2: Model number
Note3: Lot code
*The form of a character in this drawing differs from that of IPM.

Figure 6. DIP−S Package Outline

STK5Q4U3xx series (DIP−S3)



Unit: mm

Missing Pin: 15, 16, 21, 23, 24, 25, 27, 29, 30, 31, 33, 35, 36, 37

Note1: No. 1 pin identification mark

Note2: Model number

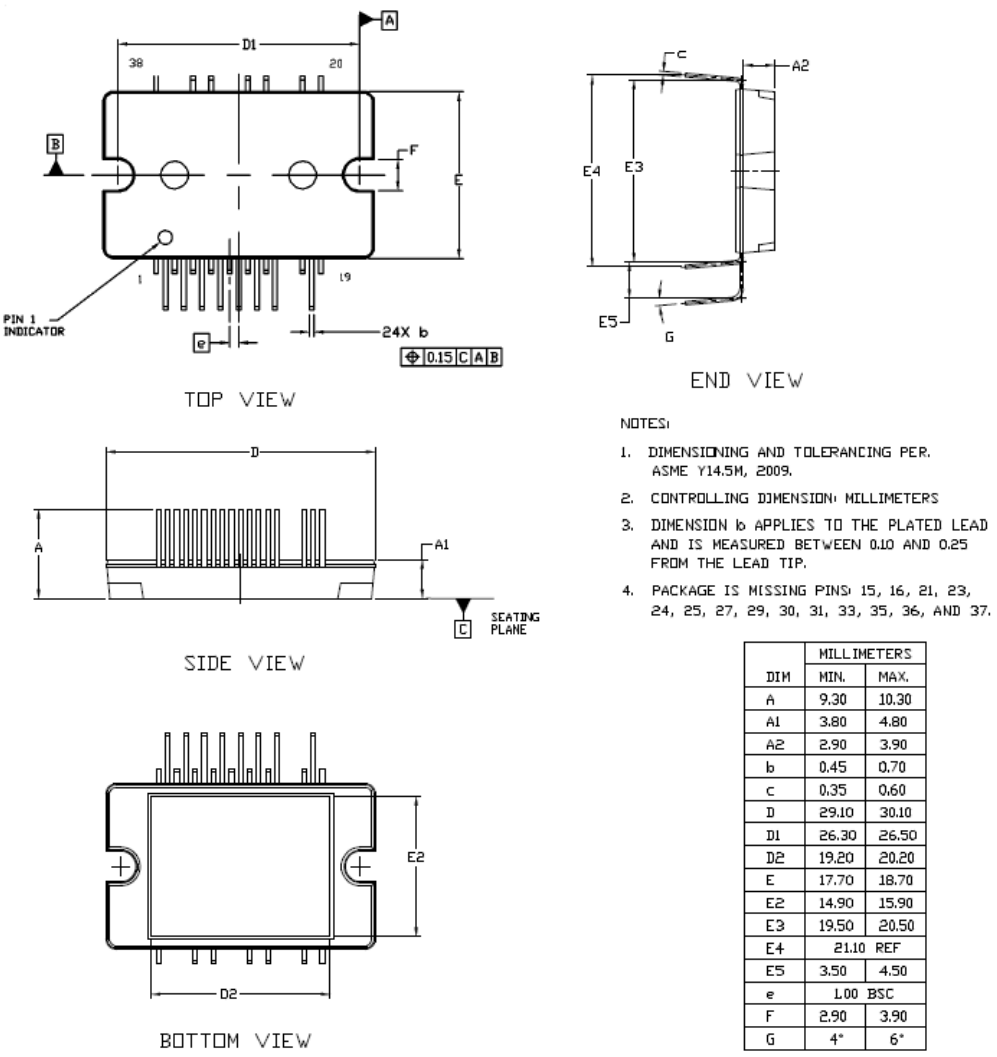
Note3: Lot code

*The form of a character in this drawing differs from that of IPM.

Figure 7. DIP−S3 Package Outline

NFAQxx60xxx series (DIP−S6)

unit : mm



NOTES:

1. DIMENSIONING AND TOLERANCING PER. ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION b APPLIES TO THE PLATED LEAD AND IS MEASURED BETWEEN 0.10 AND 0.25 FROM THE LEAD TIP.
4. PACKAGE IS MISSING PINS: 15, 16, 21, 23, 24, 25, 27, 29, 30, 31, 33, 35, 36, AND 37.

	MILLIMETERS	
DIM	MIN.	MAX.
A	9.30	10.30
A1	3.80	4.80
A2	2.90	3.90
b	0.45	0.70
c	0.35	0.60
D	29.10	30.10
D1	26.30	26.50
D2	19.20	20.20
E	17.70	18.70
E2	14.90	15.90
E3	19.50	20.50
E4	21.10 REF	
E5	3.50	4.50
e	1.00 BSC	
F	2.90	3.90
G	4°	6°

Figure 8. DIP−S6 Package Outline

Recommended Land Pattern

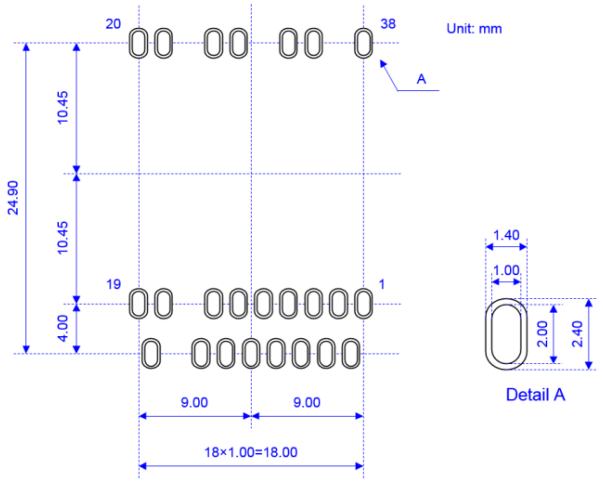


Figure 9. Recommended Land Pattern

HEAT SINK MOUNTING

Heat Sink Mounting and Torque

If a heat sink is used, insufficiently secure or inappropriate mounting can lead to a failure of the heat sink to dissipate heat adequately. This can lead to an inability of the device to provide its inherent performance, a serious reduction in reliability, or even destruction, burst and burn of the device due to overheating.

The following general points should be observed when mounting IPM on a heat sink:

1. Verify the following points related to the heat sink:
   - There must be no burrs on aluminum or copper heat sinks
   - Screw holes must be countersunk
   - There must be no unevenness in the heat sink surface that contacts IPM
   - There must be no contamination on the heat sink surface that contacts IPM
2. Highly thermal conductive silicone grease needs to be applied to the whole back (substrate side) uniformly, and mount IPM on a heat sink. Upon re−mounting apply silicone grease (50um to 100um) again uniformly
3. For an intimate contact between the IPM and the heat sink, the mounting screws should be tightened gradually and sequentially while a left/right balance in pressure is maintained. Either a bind head screw or a truss head screw is recommended. Please do not use tapping screw. We recommend using a flat washer in order to prevent slack. The standard heat sink mounting condition of Compact IPM series is as follows

Table 4. MOUNTING CONDITION

Item	Recommended Condition
Pitch	26.0±0.1 mm (Please refer to package outline diagram)
Screw	Diameter: M3 Bind machine screw, Truss machine screw, Pan machine screw
Washer	Plane washer, Don't use spring washer The size is D: 7.0 mm, d: 3.2 mm and t: 0.5 mm
Heat sink	Material: Copper or Aluminum Warpage (the surface that contacts IPM) : −50 ~ 50 μm Screw holes must be countersunk No contamination on the heat sink surface that contacts IPM
Torque	DIP−S/DIP−S3/DIP−S6 Final tightening : 0.4 ~ 0.6 Nm Temporary tightening : 50 ~ 60% of final tightening
Grease	Silicone grease Thickness : 50 ~ 100 μm Uniformly apply silicon grease to whole back (Figure 12)

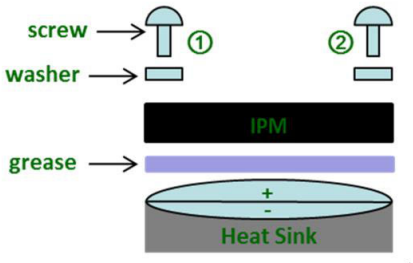


Figure 10. Mount IPM on a Heat Sink

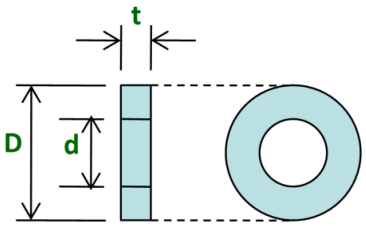


Figure 11. Size of Washer

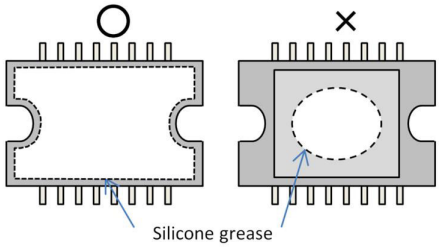


Figure 12. About Uniformly Application

Steps to mount an IPM on a heat sink

1st: Temporarily tighten maintaining a left/right balance.

2nd : Finally tighten maintaining a left/right balance.

Mounting and PCB considerations

In designs in which the printed circuit board and the heat sink are mounted to the chassis independently, use a mechanical design which avoids a gap between IPM and the heat sink, or which avoids stress to the lead frame of IPM by an assembly that slipping IPM is forcibly fixed to the heat sink with a screw.

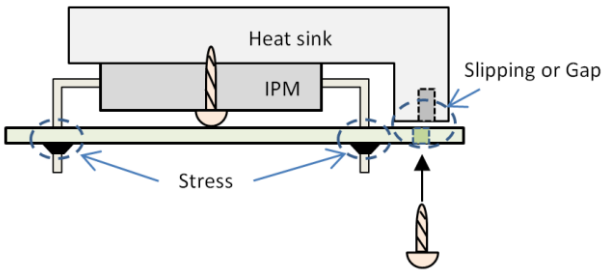


Figure 13. Fix to Heat Sink

Maintain a separation distance of at least 1.5 mm between the IPM case and the printed circuit board. In particular, avoid mounting techniques in which the IPM substrate or case directly contacts the printed circuit board.

Do not mount IPM with a tilted orientation. This can result in stress being applied to the lead frame and IPM substrate could short out tracks on the printed circuit board. Always mount the IPM vertically. If stress is given by compulsory correction of a lead frame after the mounting, a lead frame may drop out. Be careful of this point.

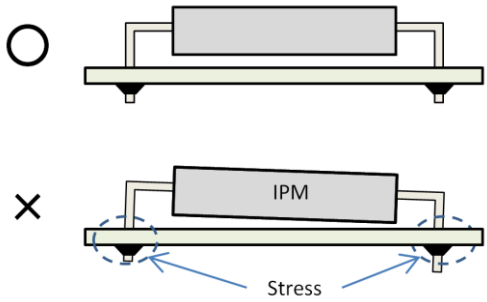


Figure 14. Mounting Position on PCB

Since the use of sockets to mount IPM can result in poor contact with IPM leads, we strongly recommend making direct connections to PCB.

IPMs are flame retardant. However, under certain conditions, it may burn, and poisonous gas may be generated or it may explode. Therefore, the mounting structure of the IPM should also be flame retardant.

Mounting on a Printed Circuit Board

1. Align the lead frame with the holes in the printed circuit board and do not use excessive force when inserting the pins into the printed circuit board. To avoid bending the lead frames, do not try to force pins into the printed circuit board unreasonably
2. Do not insert IPM into printed circuit board with an incorrect orientation, i.e. be sure to prevent reverse insertion. IPM may be destroyed, exploded, burned or suffer a reduction in their operating lifetime by this mistake
3. Do not bend the lead frame

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