FTCS120PS4PC

Electric Power Steering Power Module

650 V, 4 A

Features

- Fully Integrated EPS Gear Unit
- Rack Parallel Brushless AC Motor
- Remote ECU Option
- Direct Rack Drive by Low Friction
- Synchronous Belt and RCB Mechanism
- Rack Assist Force 13000 N
- Peak Output Power 600 Watts at the Rack
- Peak Battery Current 85 Amps @ 13.5 Volts
- Extended Packaging Flexibility

Applications

- Electric Power Steering Power Module

Benefits

- Reduced Vehicle Fuel Consumption and CO_2 Emission
- Free Programmable Assit Characteristics
- End of Line Calibration
- Simplified Vehicle Assembly
- Simplified Supply Chain Logistics

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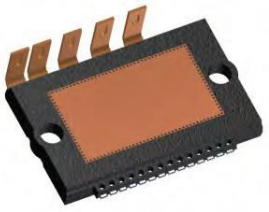
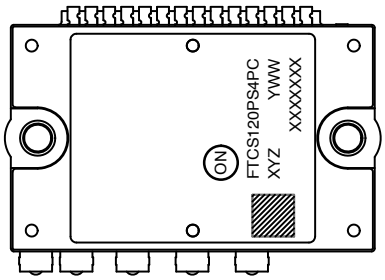
Top View

Bottom View



APM19−BA
CASE MODBU

MARKING DIAGRAM



ON	= ON Semiconductor Logo
	= Assembly Plant Code
	= Numeric Date Code
	= Lot Code
FTCS120PS4PC	= Specific Device Code

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 8 of this data sheet.

Pin Configuration

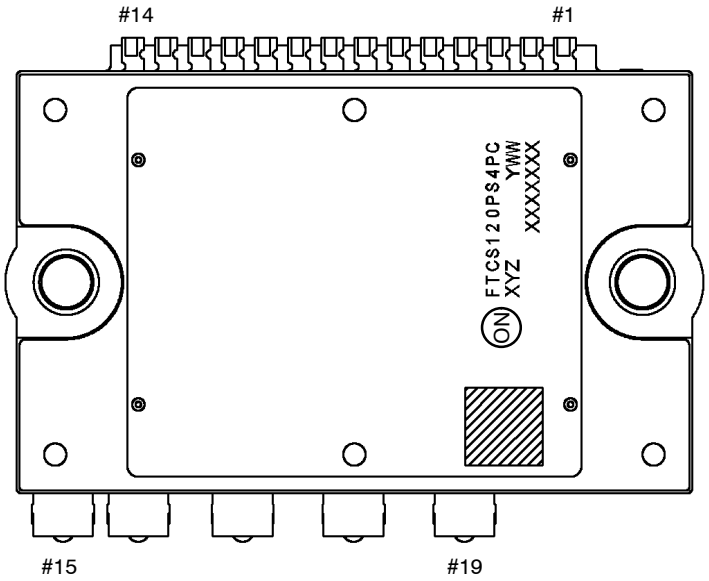


Figure 1.

PIN DESCRIPTION

Pin Number	Pin Name	Pin Descriptions
1	PHASE3 SENSE	Source of Q3 & Drain of Q6
2	MOSFET G3	Gate of Q3 MOSFET
3	MOSFET G6	Gate of Q6 MOSFET
4	PHASE2 SENSE	Source of Q2 & Drain of Q5
5	MOSFET G2	Gate of Q2 MOSFET
6	MOSFET G5	Gate of Q5 MOSFET
7	PHASE1 SENSE	Source of Q1 & Drain of Q4
8	MOSFET G1	Gate of Q1 MOSFET
9	MOSFET G4	Gate of Q4 MOSFET
10	V+5	NTC Thermistor Terminal
11	VLINK-SENSE	Drain of Q1, Q2 and Q3
12	I-BRIDGE-P	Source of Q4,Q5 & Q6 / Shunt+
13	FET TEMP SENSE	NTC Thermistor Terminal
14	I-BRIDGE-N	Negative Shunt terminal(Shunt-)
15	V0	Negative Battery terminal
16	VLINK	Positive Battery terminal
17	Phase1	Motor Phase #1 terminal
18	Phase2	Motor Phase #2 terminal
19	Phase3	Motor Phase #3 terminal

Internal Equivalent Circuit

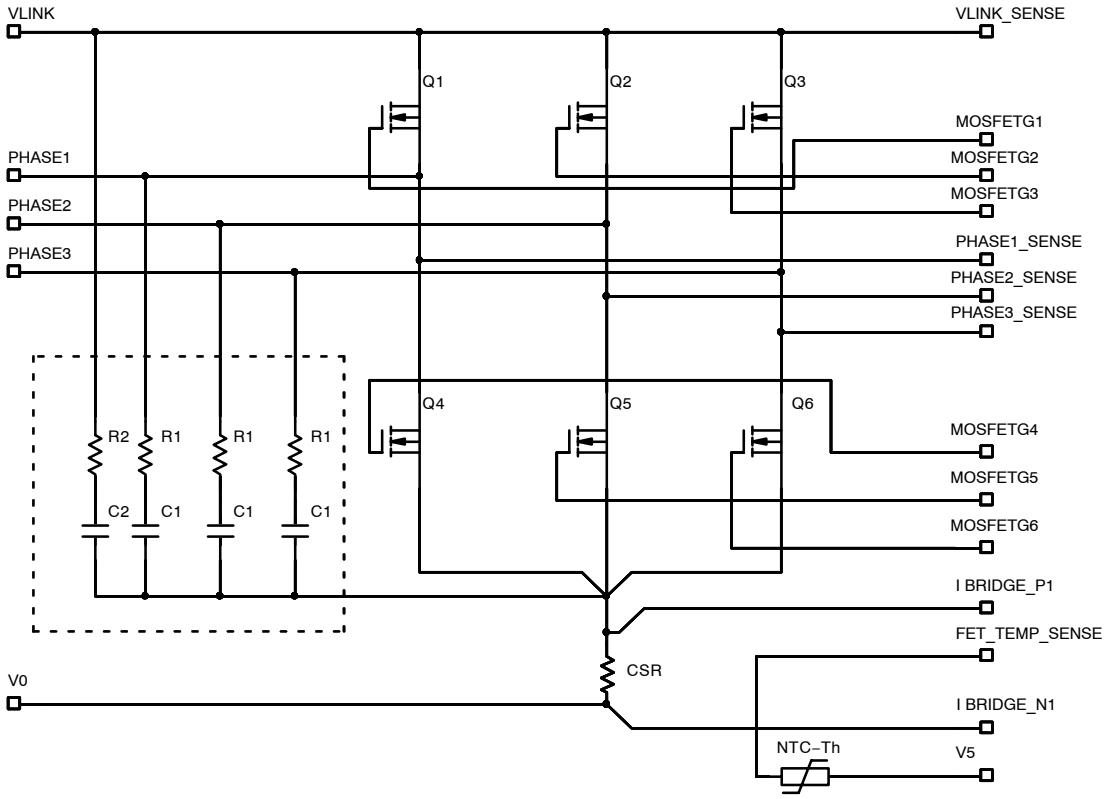


Figure 2.

COMPONENTS FOR THE FTCS120PS4PC

	Component						Size	Thickness	Maker
1	MOSFET	PCF33478	Typ. 1.2 mΩ Max 1.45 mΩ	Wafer	Bare Chip	Qty: 6	5,080 × 3,683 m	200 μm	FCS
2	Current Sense Resistor	BVB−Z−R0005−1.0	0.5 mΩ (1%)	Tape & Reel	Passive	Qty: 1	10,000 × 6,600 μm	3,000 μm	Isabellen huette
3	NTC Thermistor	NCP18XM472J0SRB	4.7 kΩ (5%)		Passive	Qty: 1	1,600 × 800 μm	800 μm	Murata
4	Resistor 1	MMA02040C3308FB300	MMA0204 3.3 Ω (1%) 50 ppm/°C		Passive	Qty: 3	3,600 × 1,400 μm		Vishay
5	Resistor 2	MMA02040C7507JB300	MMA0204 750 Ω (5%) 50 ppm/°C		Passive	Qty: 1	3,600 × 1,400 μm		Vishay
6	Capacitor 1	C0603C103K5RACAUTO / B37931K5103K60	10 nF (10%) 50 V X7R		Passive	Qty: 3	1,600 × 800 μm	1,100 μm	KEMET / EPCOS
7	Capacitor 2	C0805Y103K1RACAUTO / B3794X1103K060	10 nF (10%) 100 V X7R Safe Mode MLSC		Passive	Qty: 1	2,000 × 1,200 μm	800 μm	KEMET / EPCOS
−Bare Die Chip: 6, Passive Components: 10						Tot16			

DBC Substrate

- Alumina thickness is 0.5 mm
- Copper thickness is 0.4 mm on both sides
- DBC substrate is NOT Nickel plated

Leadframe

Leadframe with Al clad and locking feature on the signal pads plus 1 side Ag plating on the power terminals.

Flammability Information

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

Compliance to RoHS and GADSL directives (May 10, 2007)

The module is made with KTMC5400SL epoxy mold compound.
RoHS is often referred to as the lead−free directive, but it restricts the use of the following 6 substatances:

1. Lead
2. Mercury
3. Cadmium
4. Hexavalent chromium (Chromium VI or Cr6+)
5. Polybrominated biphenyls (PBB)
6. Polybrominated diphenyls ether (PBDE)

PBB and PBDE are flame retardants used in some plastics.

The maximum concentrations are 0.1% or 1000 ppm (except for Cadmium, which is limited to 0.01% or 100 ppm) by weight of homogeneous material.

The power module does not contain any substance prohibited by the RoHS directive.

GADSL (Global Automotive Declarable Substance List) compliance:
The power module does not contain any substance prohibited by the GADSL directive with either epoxy mold compound.
The following substances present in the KTMC5400SL are classified as “Declarable” (This does not mean that the substance is prohibited from being used in vehicles parts nor is to be de−selected from use. It simply means that has to be declared if it exceeds certain limits).

- Antimonytrioxide
- Phenol
- Epichlorohydrin
- Formaldehyde

Solder

Solder used is a lead free SnAgCu alloy. The power module is 100% lead free.

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

Symbol	Parameter	Rating	Unit
V_{DS}(Q1~Q6)	Dranin to Source Voltage	40	V
V_{GS}(Q1~Q6)	Gate to Source Voltage	±20	V
I_D(Q1~Q6)	Dranin Current Continuous(T_C < 120°C, V_{GS} = 10 V)	80	A
E_{AS}(Q1~Q6)	Single Pulse Avalanche Energy	947	mJ
P_D	Power Dissipation	300	W
T_J	Maximum Junction Temperature	175	°C
TSTG	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_{THJS} Thermal Resistance Junction to sink, Single Inverter FET, PKG center (Note 1)	Q1 Thermal Resistance J−S	–	1.21	1.55	°C/W
	Q2 Thermal Resistance J−S	–	1.18	1.62	°C/W
	Q3 Thermal Resistance J−S	–	1.32	1.80	°C/W
	Q4 Thermal Resistance J−S	–	1.02	1.38	°C/W
	Q5 Thermal Resistance J−S	–	1.08	1.49	°C/W
	Q6 Thermal Resistance J−S	–	1.26	1.68	°C/W
T_J	Maximum Junction Temperature	–		175	°C
T_C	Operating Case Temperature	−40		120	°C
TSTG	Storage Temperature	−40		125	°C

1. These values are based on Thermal simulations and PV level measurements.
These values assume a single MOSFET is on, therefore excluding cross conduction. Also the test condition is “Package Center” (compared to “Chip Center”). This means that the DT is measured between the T_J of each MOSFET and the Heatsink temperature immediately under the thermal media in the center of the package (compared to the heatsink temperature immediately under the thermal media in correspondence of the center of the relative chip). These values assume a bondline lower than 40 μm and thermal conductivity of 1.8 Wm/K. They can be achieved with a thermal media that provides good adhesion, low viscosity(< 60000 mPa/s) and high thermal conductivity (> 1.6 Wm/K). ON Semiconductor recommends SE4486, a RTV thermal conductive adhesive by Dow Corning.

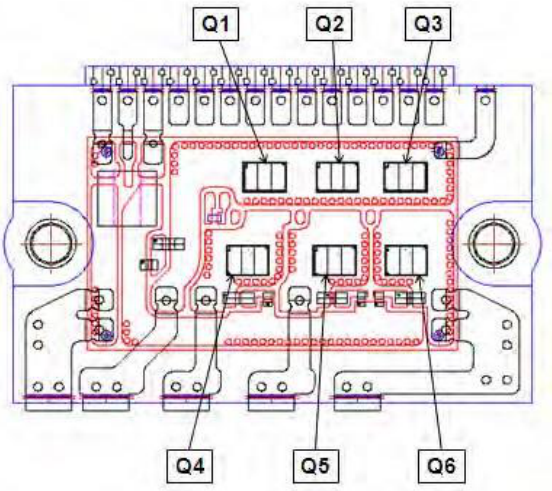


Figure 3.

ELECTRICAL CHARACTERISTICS (T_J = 25°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 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 2)	V_{GS} = 10 V, I_D = 80 A, T_J = 25°C	–	1.10	1.68	mΩ
$R_{DS(ON)Q2}$	Inverter High Side MOSFETs Q2 (See Note 2)	V_{GS} = 10 V, I_D = 80 A, T_J = 25°C	–	1.15	1.75	mΩ
$R_{DS(ON)Q3}$	Inverter High Side MOSFETs Q3 (See Note 2)	V_{GS} = 10 V, I_D = 80 A, T_J = 25°C	–	1.20	1.82	mΩ
$R_{DS(ON)Q4}$	Inverter Low Side MOSFETs Q4 (See Note 2)	V_{GS} = 10 V, I_D = 80 A, T_J = 25°C	–	1.8	2.31	mΩ
$R_{DS(ON)Q5}$	Inverter Low Side MOSFETs Q5 (See Note 2)	V_{GS} = 10 V, I_D = 80 A, T_J = 25°C	–	1.9	2.51	mΩ
$R_{DS(ON)Q6}$	Inverter Low Side MOSFETs Q6 (See Note 2)	V_{GS} = 10 V, I_D = 80 A, T_J = 25°C	–	2.0	2.58	mΩ
I_{DSS}	Inverter MOSFETs (UH, UL, VH, VL, WH, WL)	V_{GS} = 0 V, V_{DS} = 32 V, T_J = 25°C	–	–	1	μA
I_{GSS}	Inverter MOSFETs Gate to Source Leakaage Current	V_{GS} = ±20 V	–	–	±100	nA
Total loop resistance VLINK(+) → Phase → V0(−)		V_{GS} = 10 V, I_D = 80 A, T_J = 25°C	–	5.0	6.2	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.

2. Low side MOSFETs do not have source sense wirebonds, I_Bridge_P is used for source sensing, thus resulting in higher R_{DSON} values.

TEMPERATURE SENSE (NTC THERMISTOR)

Symbol	Test Condition	Test Time	Min	Typ	Max	Units
Voltage	Current = 1 mA, Temperature = 25°C	T = 0.5 ms	4.1	–	7.1	V

CURRENT SENSE RESISTOR

Symbol	Test Condition	Test Time	Min	Typ	Max	Units
Resistance	Current Senset resistor current = 80 A (Note 3)	T = 0.5 ms	0.47	–	0.53	mΩ

3. Limits are according the accurancy required by customer.

MECHANICAL CHARACTERISTICS AND RATINGS

Item	Condition		Limits			Unit
			Min.	Typ.	Max.	
Mounting Torque	Mounting Screw: TBD (Note 4, 5)	Recommended 15 Kg/cm	10	15	20	Kg/cm
		Recommended 1.5 N/m	1.0	1.5	2.0	N/m
DBC Flatness		Note Fig. 4	0	50	200	μm
Weight			–	46	–	g

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

4. Do not make over torque or mounting screws. Much mounting torque may cause ceramic cracks and bolts and Al heat−fin destruction.
5. Avoid one side tightening stress. Fig. 5 shows the recommended torque order for mounting screws. Uneven mounting can cause the SPM ceramic substrate to be damaged.

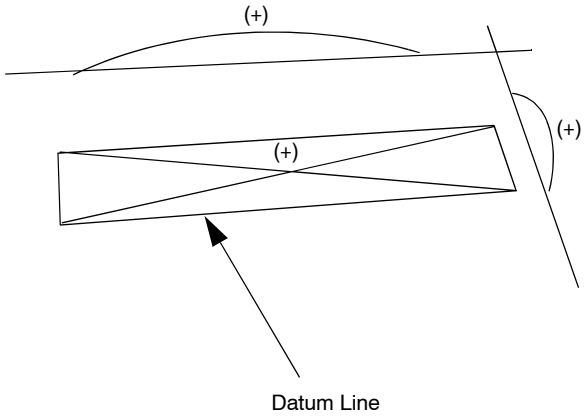


Figure 4. Flatness Measurement Position of The DBC Substrate

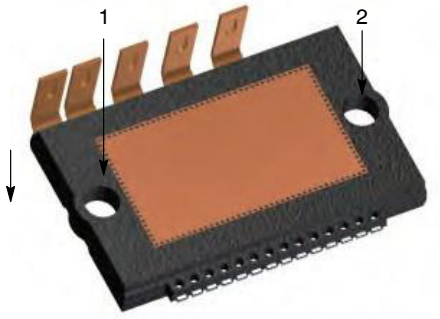


Figure 5. Mounting Screws Torque Order

PACKAGE MARKING AND ORDERING INFORMATION

Device Marking	Device	Package	Packing Type	Tube Size(mm)	Quantity/Tube
FTCS120PS4PC	PCF33478	APM19−BA	Tube	524 x 53 x 28	7

Detailed Package Outline Drawings

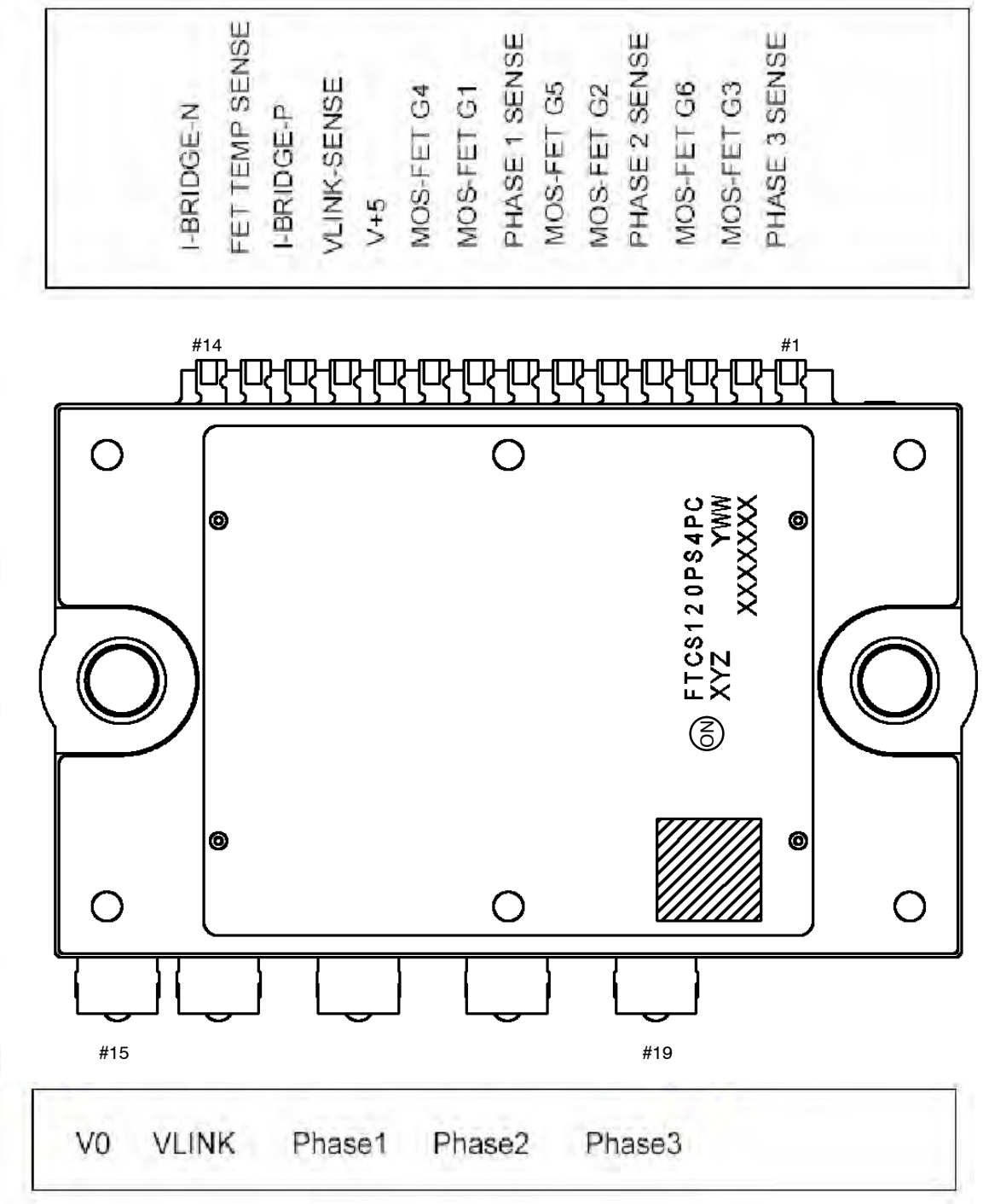
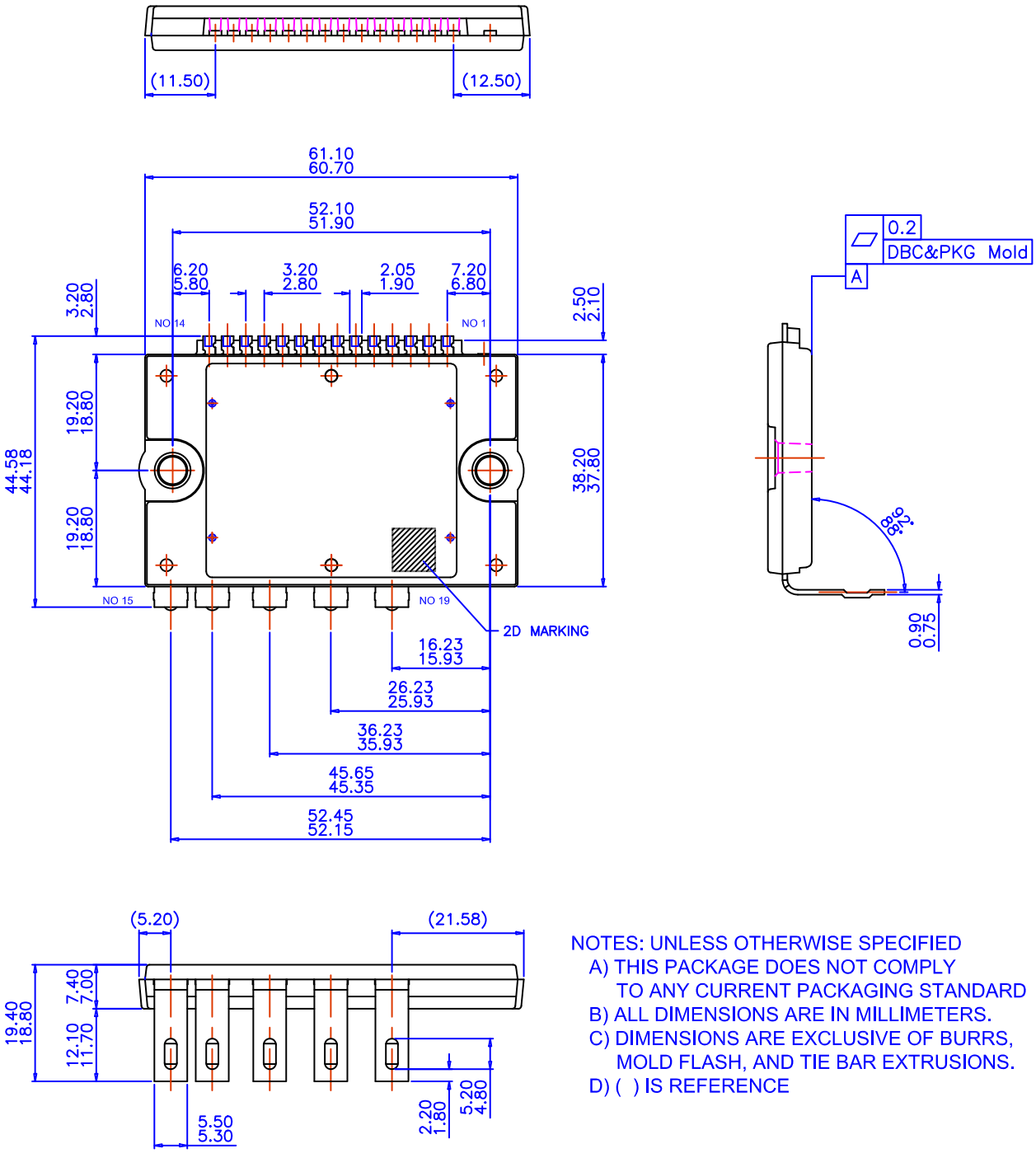


Figure 6. APM19−BA

PACKAGE DIMENSIONS

19LD PDD STD DBC DIP TYPE
CASE MODBU
ISSUE O



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

PUBLICATION ORDERING INFORMATION

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