<IGBT Modules>

# 6.1th Gen. S1 SERIES NX TYPE /6th Gen. S SERIES NX TYPE / 5th Gen .NX SERIES APPLICATION NOTE

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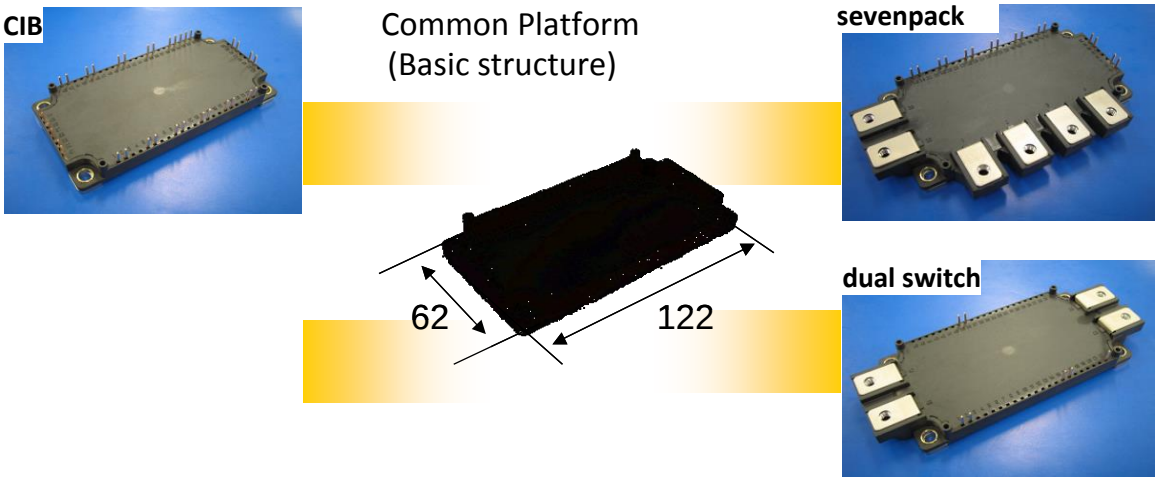
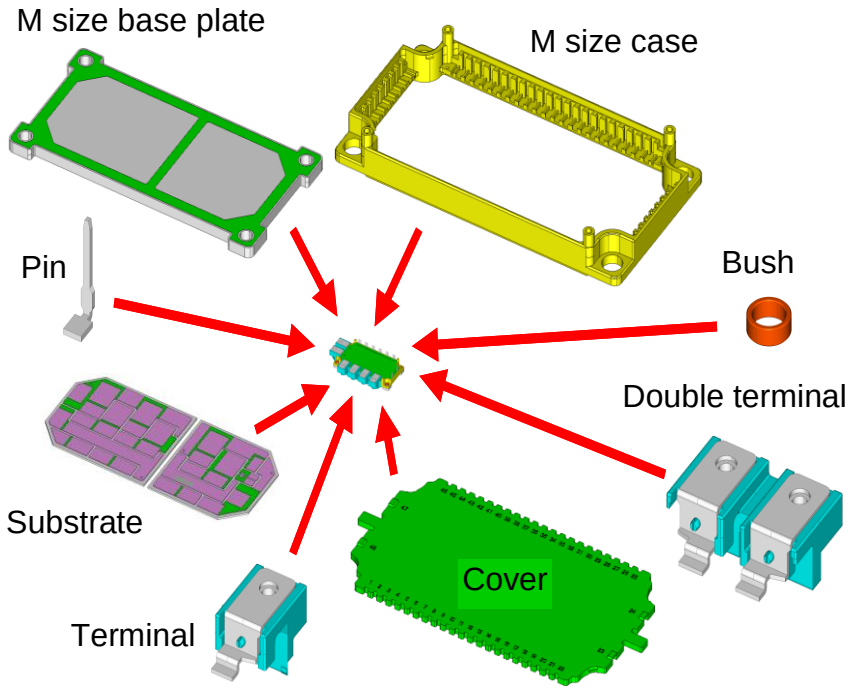
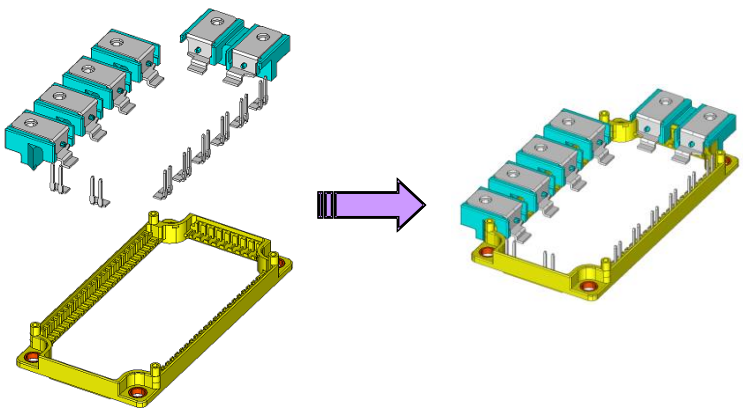
**1. Index**

**2. Features (except for 6.1th S1 series NX type)**



**3. Product line-up**

(a) IGBT Modules 6.1th Gen. S1 series NX type

| dual switch | sixpack | sevenpack |
|---|---|---|
| 1200 V | 1200 V | 1200 V |
| CM225DX-24S1 | CM100TX-24S1 | CM100RX-24S1 |
| CM300DX-24S1 | CM150TX-24S1 | CM150RX-24S1 |
| CM450DX-24S1 | | |
| CM600DX-24S1 | | |

(b) IGBT Modules 6th Gen. S series NX type

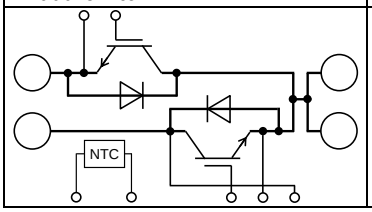
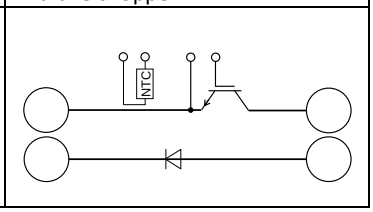
| dual switch | sixpack | sevenpack | CIB | brake chopper |
|---|---|---|---|---|
| 1200 V | 1200 V | 1200 V | 1200 V | 1200 V |
| CM150DX-24S | CM 75TX-24S | CM 75RX-24S | CM35MXA-24S | CM150EXS-24S |
| CM200DX-24S | CM100TX-24S | CM100RX-24S | CM50MXA-24S | CM200EXS-24S |
| CM300DX-24S | CM150TX-24S | CM150RX-24S | CM75MXA-24S | CM300EXS-24S |
| CM450DX-24S | | CM200RXL-24S | CM100MXA-24S | |
| CM600DXL-24S | | | | |
| CM1000DXL-24S | | | | |

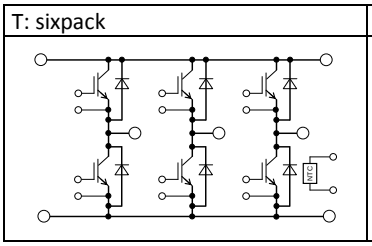
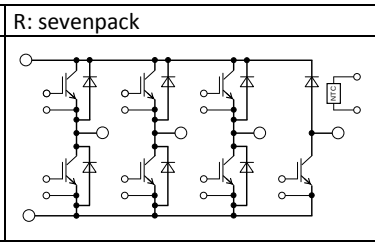
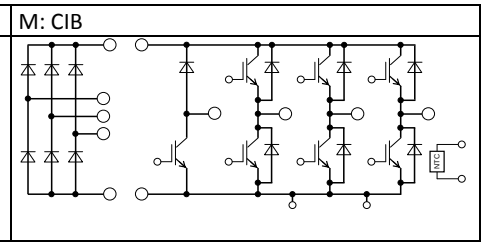
| dual switch | | sevenpack) | CIB | brake chopper |
|---|---|---|---|---|
| 1700 V | | 1700 V | 1700 V | 1700 V |
| CM150DX-34SA | CM450DXL-34SA | CM75RX-34SA | CM75MXA-34SA | CM200EXS-34SA |
| CM200DX-34SA | CM600DXL-34SA | CM150RXL-34SA | | |
| CM300DX-34SA | | | | |

(c) IGBT Modules 5th Gen. NX series

| dual switch | sevenpack | CIB |
|---|---|---|
| 600 V | 600 V | 600 V |
| CM300DX-12A | CM100RX-12A | CM75MX-12A |
| CM400DX-12A | CM150RX-12A | CM100MX-12A |
| | CM200RX-12A | |

Table A Connection Diagram: without mark on Label

| D: dual switch | E: brake chopper |
|---|---|
|  |  |

| T: sixpack | R: sevenpack | M: CIB |
|---|---|---|
|  |  |  |

## Product line-up

Peripheral Device (ISAHAYA ELECTRONICS CORPORATION SELECTION GUIDE for Power Electronics 2013)

・IGBT gate drive unit

VLA536-01R

VLA536-01R

・IGBT gate driver

VLA541-01R, VLA542-01R VLA546-01R

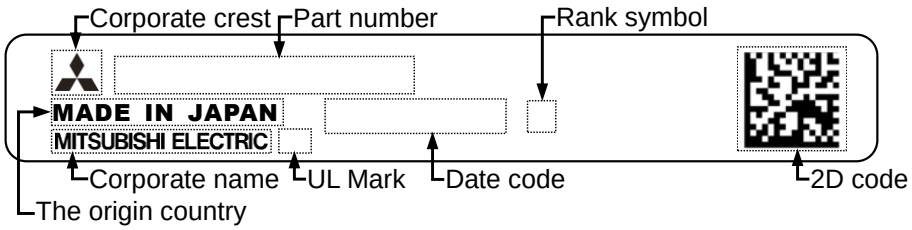
Please contact to the following company to inquire about these products.

ISAHAYA ELECTRONICS CORPORATION

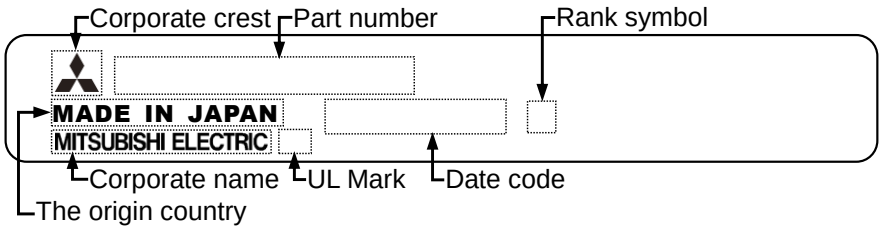
URL: http://www.idc-com.co.jp/

**4. Label marking**

(a) A marking example with 2D code and rank symbol




(b) A marking example with rank symbol for 5th Gen. IGBT modules



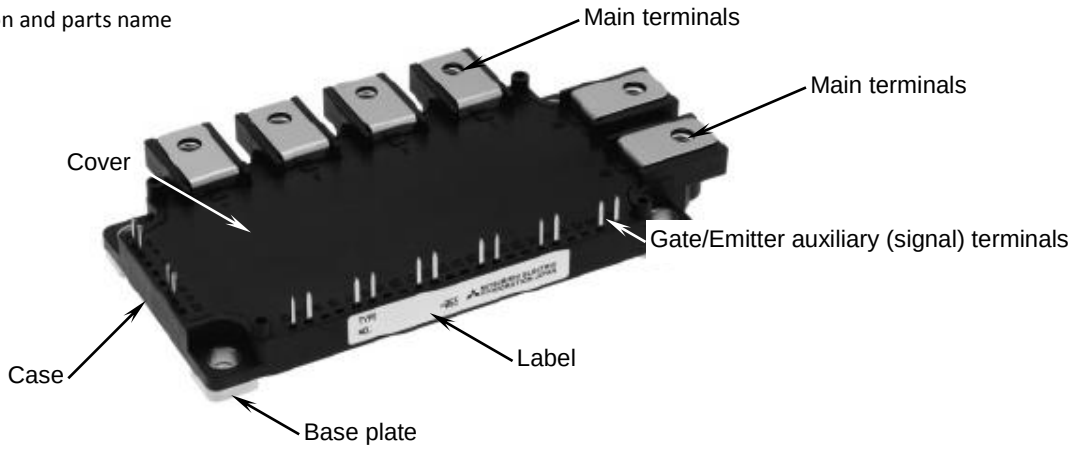

(c) Date code formation

N 1 2 H A 1 G D

- D — $V_{CEsat}$ rank symbol (for parallel use only)
- G — RoHS Directive compliance symbol
- 1 — Manufacturing management number
- A — Manufacturing month: 1 - 9; January - September
  O; October, N; November, D; December
- 1 — Manufacturing year: last digit of A.D.
- H — Factory code (UL Factory Identification)

Note: Some parametric are optional.

(d) Label position and parts name



**5. 2D code specifications**

2D code specifications

| Item | Specification |
|---|---|
| Symbology | Data Matrix (ECC200) |
| Data type | alphanumeric (ASCII) characters |
| Error correction ability | 20 - 35 % |
| Symbol size | 6.0 mm × 6.0 mm |
| Code size | 24 cell × 24 cell |
| Cell size | 0.25 mm |
| Data size | 32, 35 letters |

| Data item | Letter size |
|---|---|
| Part number | 20 |
| Space | 2 |
| Date code | 8 |
| Space | 2 |
| Total | 32 |

| Data item | Letter size |
|---|---|
| Part number | 20 |
| Space | 2 |
| Date code | 8 |
| Space | 1 |
| Rank sumbol | 3 |
| Space | 1 |
| Total | 35 |

Data contents example ("SP" means space , equivalent to ASCII code number 32)

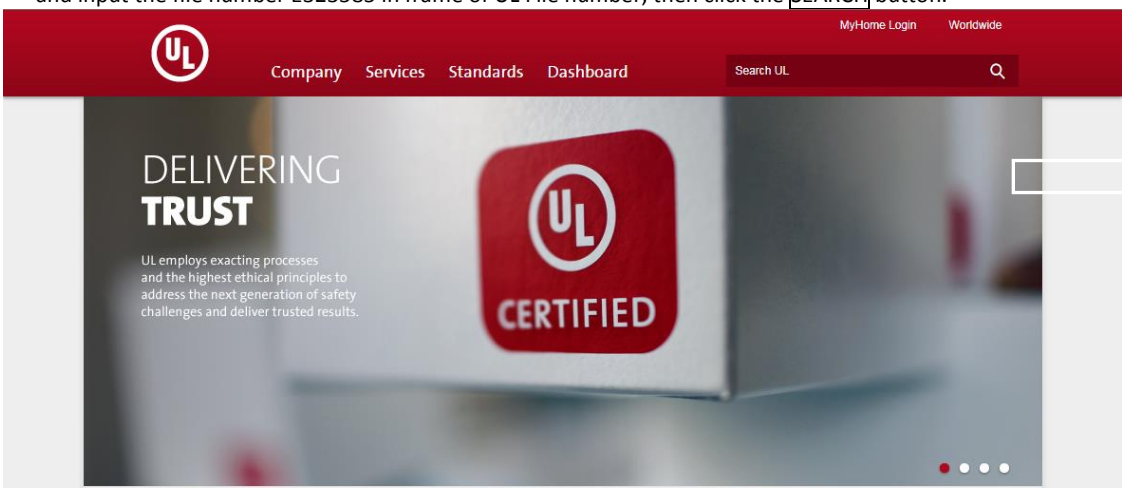
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | M | 4 | 5 | 0 | D | X | - | 2 | 4 | S | SP | SP | SP | SP | SP | SP | SP | SP | SP | SP | SP | N | 1 | 2 | H | A | 1 | G | SP | SP | SP |
| 20 | | | | | | | | | | | | | | | | | | | | 2 | | 8 | | | | | | | | 2 | |

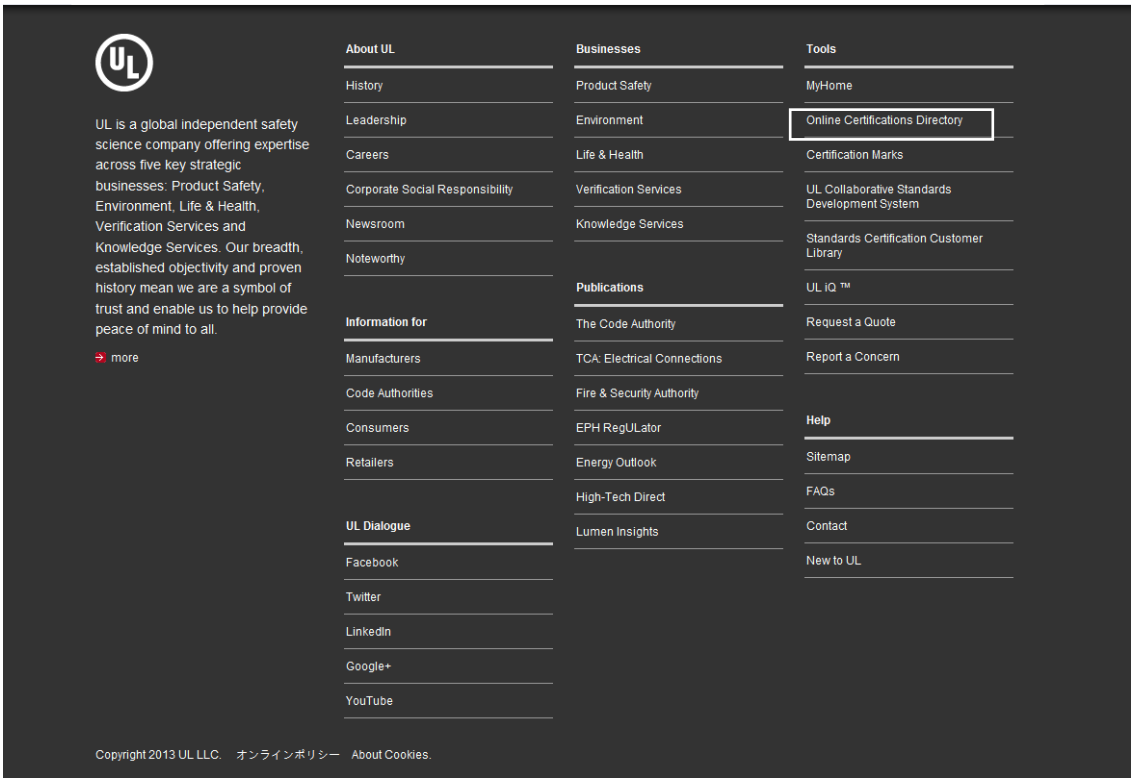
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | M | 4 | 5 | 0 | D | X | - | 2 | 4 | S | SP | SP | SP | SP | SP | SP | SP | SP | SP | SP | SP | N | 1 | 2 | H | A | 1 | G | SP | SP | D | SP | SP | SP |
| 20 | | | | | | | | | | | | | | | | | | | | 2 | | 8 | | | | | | | | 1 | 3 | | | 1 |

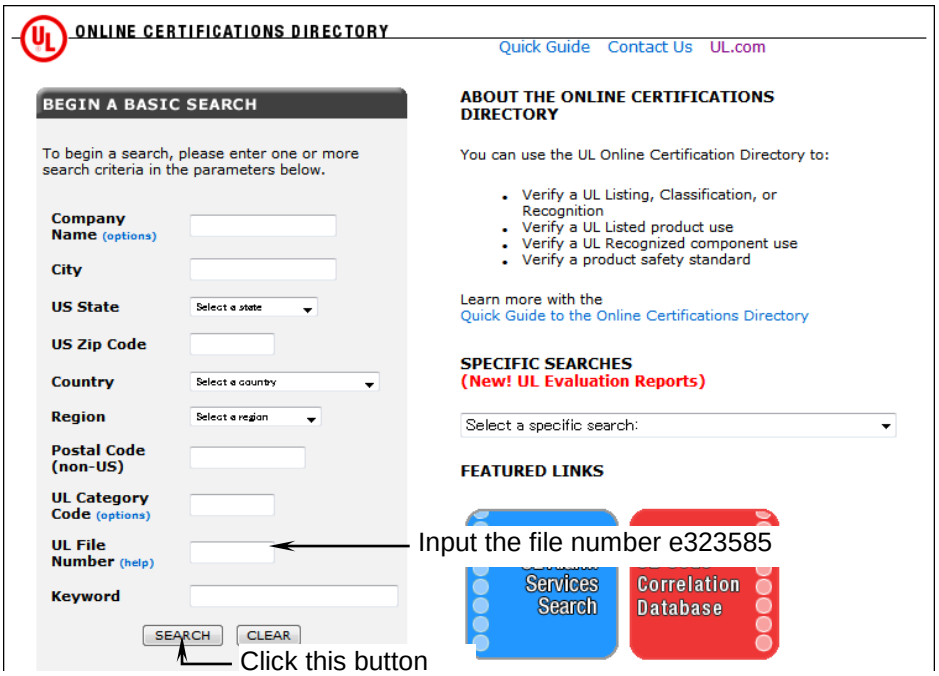
**6. Safety Standard (UL)**

Compliance with international standard UL1557 has already been certified (File No. E323585).
Please refer the certified modules to UL website.
We do not apply the certification, the authorization about other security standards (TUV, VDE, and CSA).
(And do not do a design in consideration of correspondence to the reinforcement insulation of the CE marking.)

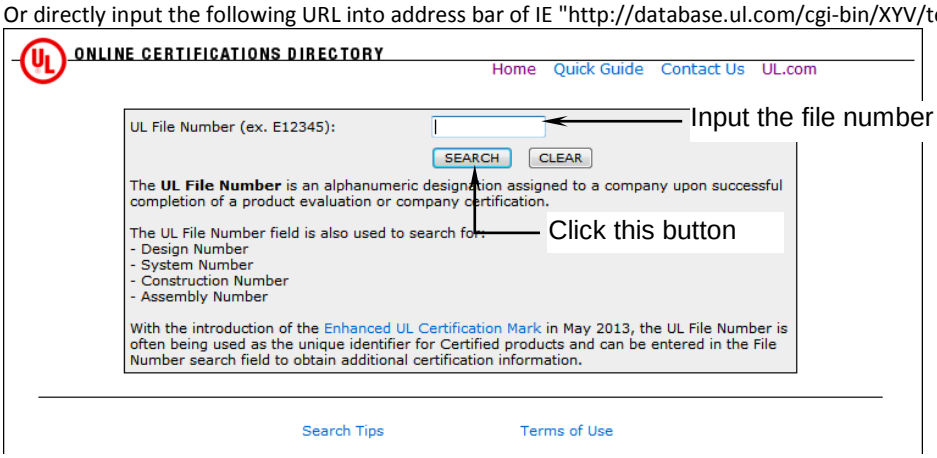
(a) Certified modules can be searched through the following website (2014/9/23), click the Online Certifications Directory, and input the file number E323585 in frame of UL File number, then click the SEARCH button.



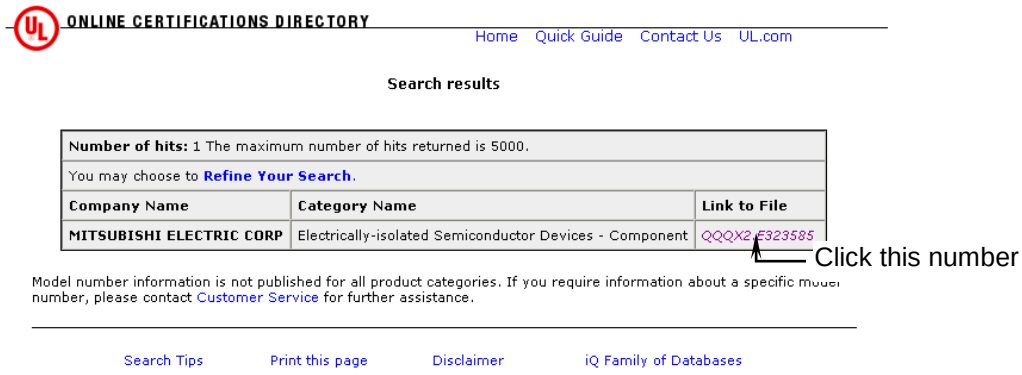






Or directly input the following URL into address bar of IE "http://database.ul.com/cgi-bin/XYV/template/LISEXT/1FRAME/gfilenbr.html"




(b) In the search results page as in the below figure, click *QQQX2.E323585* shown in cell of Link to File, then the certified module table will be displayed (refer to the next page).



(c) Certified Modules (Search results example)

ONLINE CERTIFICATIONS DIRECTORY

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**QQQX2.E323585**
**Electrically Isolated Semiconductor Devices - Component**

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**Electrically Isolated Semiconductor Devices - Component**

See General Information for Electrically Isolated Semiconductor Devices - Component

**MITSUBISHI ELECTRIC CORP** E323585
POWER DEVICE WORKS
1-1-1 IMAJUKUHIGASHI, NISHI-KU
FUKUOKA-SHI, FUKUOKA 819-0192 JAPAN

**Power switching semi-conductors**, TSB series, Models MG400V1US51, MIG50J4CSB1W, MIG50J7CSB1W, MIG50J6CSB1W, MIG75J7CSB1W, MIG75J6CSB1W, MIG100J7CSB1W, MIG100J6CSB1W, MIG150J7CSB1W, MIG150J6CSB1W, MIG150J7CSB2W, MIG50Q6CSB1X, MIG50Q7CSB1X, MIG75Q7CSB1X, MIG600J2CMB1W, MIG300Q2CMB1X, MIG400Q2CMB1X, MG400J2YS60A, MG600J2YS60A, MG400J2YS61A, MG200Q2YS60A, MG600J2YS61A, MG300Q2YS60A, MG400Q2YS60A, MG400Q2YS70A, MG150J7KS61, MIG300J2CSB1W, MIG400J2CSB1W, MIG200Q2CSB1X, MIG100Q6CMB1X, MIG150Q6CMB1X, MIG200J6CMB1W, MIG200J6CMB2W, MG800J2YS50A, MG600Q2YS60A, MG200J6ES61, MG25Q1BS11, MG50Q1BS11, MG75Q1BS11, MG25J1BS11, MG50J1BS11, MG75J1BS11, MG100J1BS11, MG150J1BS11, MG50Q2YS50, MG75Q1ZS50, MG100Q2YS51, MG200Q2YS50, MG200Q2YS65H, MG300Q1US51, MG400Q1US51, MG400Q1US65H, MG300Q2YS50, MG50J2YS91, MG300J1US51, MG300J2YS40, MG300J2YS50, MG75Q2YS40, MG150Q2YS40, MG200Q2YS40, MG300Q1US11, MG300Q1US41, MG400Q1US1, MG400Q1US11, MG400Q1US41, MG500Q1US1, MG500Q1US11, MG600Q1US51, MG25J2YS40, MG50J2YS40, MG50J2YS45, MG75J2YS40, MG100J2YS40, MG100Q2YS65H, MG150Q2YS65H, MG75J6ES50, MG50J2YS50, MG75J2YS50, MG100J2YS50, MG150J1ZS50, MG150J2YS40, MG150J2YS50, MG200J2YS40, MG200J2YS50, MG300Q2YS61, MG600Q1US61, MG25Q6ES43.

CM-U series, Models CM100DU-12H, CM100DU-24H, CM100E3U-12H, CM100E3U-24H, CM150DU-12H, CM150DU-24H, CM150E3U-12H, CM200DU-12H, CM200DU-24H, CM200E3U-12H, CM300DU-12H, CM400DU-12H, CM400DU-24H, CM50DU-24H, CM50E3U-24H, CM75DU-12H, CM75DU-24H, CM75E3U-12H, CM75E3U-24H, CM800DU-12H, CM100BU-12H, CM100TU-12H, CM300DU-24H, CM300E3U-24H, CM50BU-24H, CM50TU-24H, CM600DU-12H, CM600HU-24H, CM75BU1-24H, CM75BU-12H, CM75TU-12H, CM800HUS-12H, CM400HU-24H, CM600HU-12H, CM100TU-24H, CM150TU-12H, CM200TU-12H, CM75TU-24H, CM150E3U-24H, CM200E3U-24H, CM300E3U-12H, CM300EC2U-12H, CM300EC3U-12H, CM400E3U-12H.

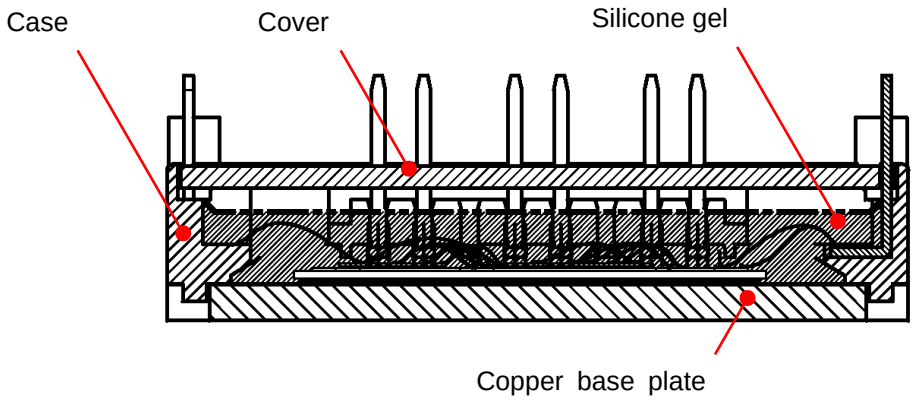
CM-F series, Models CM800E2UA-24F, CM800E3UA-24F, CM100TJ-12F, CM100TJ-24F, CM100TJA-24F, CM100TJA-24FA, CM150TJ-12F, CM150TJA-12F, CM50TJ-24F, CM50TJA-34KA, CM75TJ-24F, CM75TJA-24F, CM75TJA-24FA, CM450HA-5F, CM600HA-5F, CM600HN-5F, CM800DU-5F, CM100DU-12F, CM100DU-24F, CM100DUS-12F, CM100E3U-12F, CM100E3U-24F, CM150DU-12F, CM150DU-24F, CM150DU-24FA, CM150DUM-12F, CM150DUS-12F, CM150E3U-12F, CM200DU-12F, CM200DU-24F, CM300DU-12F, CM400DU-12F, CM400DU-24F, CM400DU-24FA, CM400DU-5F, CM50DU-24F, CM75DU-12F, CM75DU-24F, CM75DUM-12F, CM75E3U-24F, CM800E2U-24F, CM800E3U-24F, CM100TU-12F, CM150BUM6-12F, CM200DUR-24F, CM300DU-24F, CM300DU-24FA, CM50B3U-24F, CM50TU-24F, CM600DU-24F, CM600DU-24FA, CM600DU-5F, CM600HU-24F, CM75B3U-12F, CM75BUM6-12F, CM75TU-12F, CM400HU-24F, CM600HU-12F, CM100TU-24F, CM150TU-12F, CM200TU-12F, CM200TU-5F, CM350DU-5F, CM75TU-24F, CM150E3U-24F, CM200E3U-24F, CM300E2U-12F, CM400E2U-12F, CM400E4U-24F.

CM-NF series, Models CM300TJ-24NF, CM450TJ-24NF, CM1000E2UA-24A, CM1000E2UA-24D, CM1000E3UA-24A, CM1000E3UA-24D, CM400HA-24A, CM500HA-34A, CM600HA-24A, CM600HB-24A, CM150BL6-12NFH, CM100HA1-12NF, CM150HA1-12NF, CM50HA1-24NF, CM75HA1-12NF, CM100DC1-24NFM, CM150DC1-24NFM, CM200DC1-24NFM, CM300DC1-24NFM, CM100DU-24NFH, CM100DY-24A, CM100DY-24NF, CM100DY-34A, CM100E3Y-24NF, CM150DU-24NFH, CM150DY-12NF, CM150DY-12NFA, CM150DY-24A, CM150DY-24NF, CM150DY-34A, CM150E3Y2-24NF, CM150E3Y-24NF, CM200CU-12NFH, CM200DU-12NFH, CM200DU-24FA, CM200DU-24NFH, CM200DY-12NF, CM200DY-12NFA, CM200DY-24A, CM200DY-24NF, CM200DY-34A, CM200DY6-12NF, CM200E3Y-12NF, CM300DU-12NFH, CM300DU-24NFH, CM300DY1-24NF, CM300DY-12NF, CM300DY-12NFA, CM300DY-12NFB, CM300DY-24A, CM300DY-24NFH, CM400DU-12NFH, CM400DY-12NF, CM400DY-12NFA, CM400DY-12NFB, CM400E3Y-12NF, CM600DY2-12NFB, CM75DY-24NF, CM75DY-34A, CM600DU-24NF, CM600HU-24NF, CM600HUA-24NFH, CM75BU-24NFH, CM75BU-24NFM, CM900HU-24NF, CM400DY-34A, CM300DY-24NF, CM300DY-34A, CM400DU-24NFH, CM400DU-24NFJ, CM400DY-24A, CM400DY-24NF, CM600DU-12NFH, CM600DU-24NFH, CM600DY-12NF, CM600DY-12NFB, CM600DY-24A, CM600E3U-12NFH, CM100DC-24NFM, CM150DC-24NFM, CM150DC6-24NFM, CM200DC-24NFM, CM300DC-24NFM, CM400HC-24NFM, CM400HC6-24NFM, CM600HC-24NFM, CM150RL-24NF, CM150TL-24NF, CM200RL-12NF, CM200RL-24NF, CM200TL-12NF, CM200TL-24NF, CM100RL-12NF, CM100RL-24NF, CM100TL-12NF, CM100TL-24NF, CM100TL6-12NF, CM150RL-12NF, CM150RL-12NFB, CM150TL-12NF, CM150TL6-12NF, CM200RL-12NFB, CM50FL6-12NFH, CM50RL-24NF, CM50TL-24NF, CM75RL-12NF, CM75RL-24NF, CM75TL-12NF, CM75TL-24NF, CM75TL6-12NF, CM1000DU-34NF, CM1000DU-34NF, CM1000DUC-34NF, CM1000E3U-34NF, CM1400DU-24NF, CM1400DUC-24NF, CM1400E3U-24NF, CM900DU-24NF, CM900DUC-24NF, CM300E3Y6-24NFH, CM400E3Y6-24NFH, CM400C1Y-24S, CM450DY-24S, CM800DY-24S, CM1000DUC-34SA, CM1400DUC-24S, CM300DY-24S, CM600DY-24S, CM1800DY-34S, CM2500DY-24S, CM400E4Y-24A.

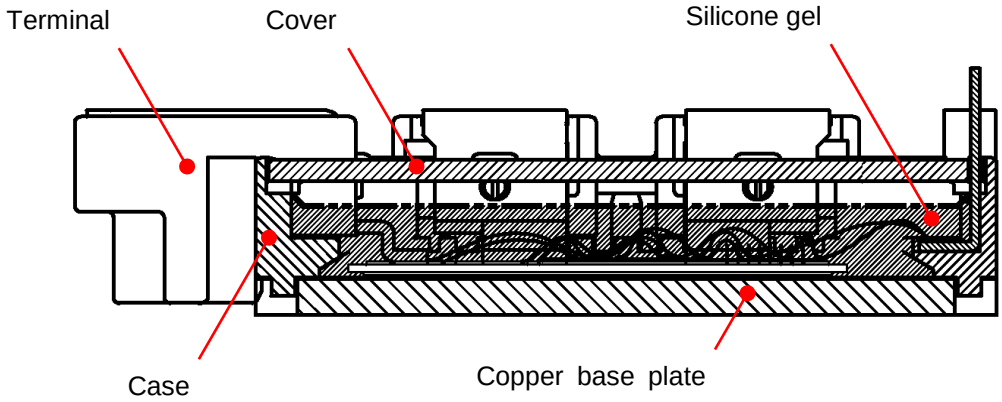
* There is a case of the omission of the update delay and the authorization article according to the convenience of the update of Homepage.
* When a corresponding article isn't found out, please contact us.
* At present, Mitsubishi Electric Corporation don't supply yellow card "E323585".

**7. Internal structure**

(a) Pin terminal types (ex. CIB type)




(b) Screw terminal type (ex. sevenpack type)




About the flammable

The PPS (Poly Phenylene Sulfide Resin) in IGBT module complies with standard of UL 94V-0, but the silicone gel is combustible and does not comply with 94V-0, but it has the dielectric breakdown strength of above 10 kV/mm after the hardening at the flash point temperature of 340 °C and at the ignition point temperature 450 °C.

Because there is not self extinguish-ability, too, in case of the fire, a fire must be extinguished using the dry chemicals, the carbon dioxide extinguishing agent and the bubble extinguishing agent and so on.

Because PPS has self extinguish-ability, if a burning source is cut off, there is not live danger.

There is not a fireproof standard of UL which corresponds to the other silicon chip, the copper base board and so on.

Others

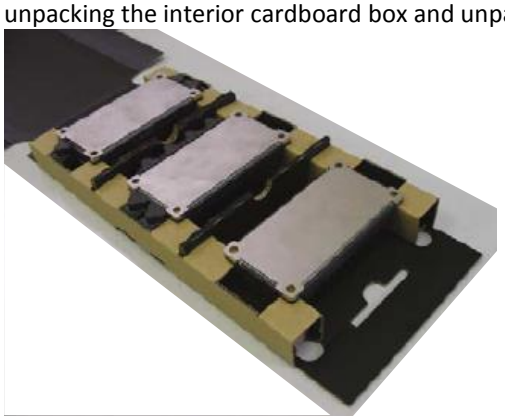
Insulation distances of Mitsubishi Electric's modules are in accordance with UL standards. In general, the electric strength to the same space distance falls due to the decrease of atmospheric pressure at high altitude.

Moreover, the amount of cosmic rays increases rapidly when the altitude goes up. It has been known that cosmic rays can raise the possibility of faults in semiconductors. There is no data concerning the probability.

**8. How to use Power Module properly and safely**

Unsuitable operation (such as electrical, mechanical stress and so on) may lead to damage of power modules.
Please pay attention to the following descriptions and use Mitsubishi Electric's IGBT modules according to the guidance.

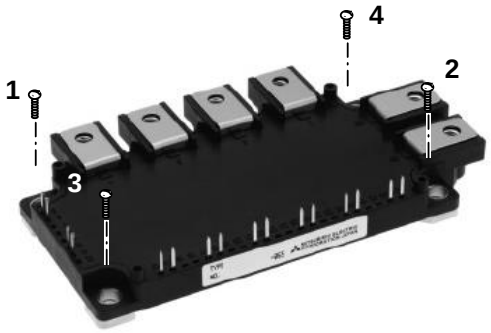
| ⚠ Cautions | |
|---|---|
| During Transit | • Keep shipping cartons right side up. If stress is applied by either placing a carton upside down or by leaning a box against something, terminals can be bent and/or resin packages can be damaged.<br>• Tossing or dropping of a carton may damage devices inside.<br>• If a device gets wet with water, malfunctioning and failure may result.<br>Special care should be taken during rain or snow to prevent the devices from getting wet. |
| Storage | • The temperature and humidity of the storage place should be 5 ~ 35 °C and 45 ~ 75 % respectively. The performance and reliability of devices may be jeopardized if devices are stored in an environment far above or below the range indicated above. |
| Prolonged Storage | • When storing devices more than one year, dehumidifying measures should be provided for the storage place. When using devices after a long period of storage, make sure to check the exterior of the devices is free from scratches, dirt, rust, and so on. |
| Operating Environment | • Devices should not be exposed to water, organic solvents, corrosive gases, explosive gases, fine particles, or corrosive agents, since any of those can lead to a serious accident. |
| Flame Resistance | • Although the epoxy resin and case materials are in conformity with UL94 V-0 standards, it should be noted that those are not non-flammable. |
| Electrostatic Discharge | • Following precautions should be taken for MOS-gated devices such as IGBT modules (CM*** series), to prevent electrostatic build up which could damage the devices.<br>(1) Precautions against the device rupture caused by static electrostatic electricity of human bodies and cartons and/or excessive voltage applied across the gate to emitter may damage and rupture devices.<br>The basis of anti-electro static build-up and quick dissipation of the charged electricity.<br>* Containers that are susceptible to static electricity should not be used for transit or for storage.<br>* Gate to emitter should be always shorted with a carbon cloth or the like until right before a module is used. Never touch the gate terminals with bare hands.<br>* Always ground the equipment and your body during installation (after removing a carbon cloth or the like. It is advisable to cover the workstation and its surrounding floor with conductive mats and ground them.<br>* It should be noted that the static electricity charged to a printed circuit board might damage devices if the gate to emitter of the circuit board is open.<br>* Use soldering irons with grounded tips which are low voltage (DC 12 V - 24 V) types for semiconductor. |

| ⚠ Cautions | |
|---|---|
| Anti-electrostatic Measures | (2) Precautions when the gate to emitter is open<br>* Voltage should not be applied across the collector to emitter when the gate to emitter is open.<br>* The gate to emitter should be shorted before removing a device from a unit.<br>(3) IGBT modules "NX" series<br>We use conductive cardboard box for interior packing box. The product abolishes the use of conductive sponge, which is used for the short circuit between the gate and emitter.<br>* This conductive cardboard box completely short-circuits between gate emitters like a conventional conductive sponge, and it is not an electrostatic measures parts clamping over voltage.<br>* During an installation process (after taking out a module from a packing box to the installation to an apparatus), please take enough static electricity measures such as the use of ground band on the worker and/or using static-eliminator.<br>* If storage with the containers excepts the interior cardboard box, take any electrostatic measures such as the use of a conductive container.<br>* The modules are not fixed in the interior cardboard box.<br>Please be careful about the handling enough not to drop a module at the time of takeoff and unpacking the interior cardboard box and unpacking the interior cardboard box.<br>  <br>* IGBT modules "NX" series<br>Representative part number: CM35MX-24A, CM100RX-12A, CM300DX-24A<br>Product appearance example:<br>  |
| Electrically-charged measure | • When applying the voltage to gate-emitter test for acceptance as saturated voltage test, after the test and before collecting the modules to the storage (conductivity) container or a packing box, let it discharge electricity by high resistance (extent of 10 kΩ) |
| Wiring method | • Do not add the over stress to the screw terminals or terminal structure when mounting modules. It might cause the damage to terminal structure or jointing part between case and terminals. (mainly in IGBT module "NX series ")<br>• Do not add the over stress to the pin terminals when use the printed circuit board for wiring. It might cause the bent (or snap) of pin terminals.<br>• Be careful about the size of the screw and the mounting process when fixing the printed circuit board to the module case part with a self-tapping screw. The case of the module may be damaged when using the wrong size screw and/or the wrong mounting process. |

## ⚠ Cautions

**Mounting**

- When mounting a module on a heat sink, a device could get damage if a sudden torque ("one side tightening ") is applied at only one mounting terminal, since stress is applied on a ceramic plate and silicon chips inside the module.
  Shown in Fig.1 is the recommended torquing order for mounting screws.




(a) Four-point mounting type
Temporary tightening 1–2–3–4, Final tightening 1–2–3–4

Fig.1 Recommended torquing order for mounting screws

<u>* Temporary tightening torque should be set at 20 ~ 30 % of maximum rating.</u>

- Also, care must be taken to achieve maximum contact (i.e. minimum contact thermal resistance) for the best heat dissipation.
  The flatness of heat sink ($e_s$) where a module is mounted should be as follows.
  Copper base plate; IGBT module "NX" series (S series NX type)" :
  -50 μm ~ +100 μm on a length of 100 mm
  Also, the surface finish should be as follows.
  Less than 10 μm of roughness on a length of 100 mm
  Please apply good thermal conductivity grease (termed hereinafter called grease) for heat radiation to the contact surface of the module and heat sink evenly as follows.
  +50 μm ~ +100 μm
  Grease on the contact surface prevents the corrosion of the contact surface.
  However, use the kind of grease that has a stable characteristic over the whole operating temperature range and does not change its properties for several years.
  A torque wrench shall be used in tightening mounting screws and tighten screws to the specified torque. Excessive torquing may result in damage or degradation of a device.

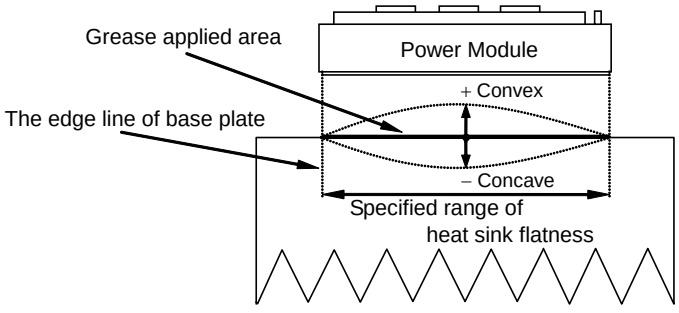



Fig.2 Flatness of heat sink

(For the non-plating base plate of entire surface)
Because there are already the adoption results in IPM and the long-term market use results, we think there are no problems in reliability about the non-plating base plate of entire surface adoption in the NX series.
The surface oxidation layer of the base plate does not have influence on thermal resistance specification.
In addition, we do not regard the pattern to occur on the base plate surface by the oxidation as a problem in the appearance either.
This is a similar point of view about the nickel plating base plate.

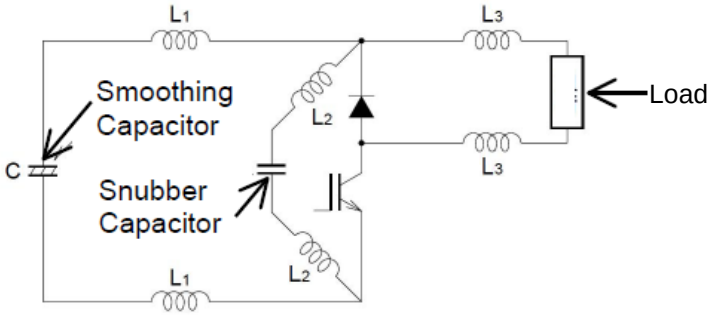
## 9. Installation of Power Module

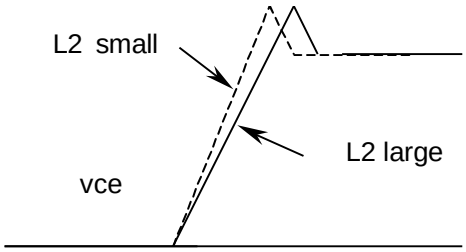
### 9.1 Installing Capacitor

During switching, voltage is induced in power circuit stray inductance by the high di/dt of the main current when the stray inductance is too large. This voltage can appear on the IGBT module and cause damage. In order to avoid this problem, guidelines that should be followed in designing the circuit layout are:

① Locate the smoothing capacitor as close as possible to the IGBT module
② Use bypass capacitor (ceramic capacitor or film capacitor) near the IGBT module to bypass high frequency current
③ Adopt low impedance electrolytic capacitor as smoothing capacitor
④ Use snubber circuit to absorb surge voltage
⑤ Decrease switching speed in order to lower di/dt.

② and ⑤ are the most effective to reduce surge voltage. The stray inductance of snubber circuit generally is not considered to avoid complicating the circuit. In addition, combination of ②, ④, ⑤ is needed since there is a limit to shorten the length of wiring. The bypass capacitor of approach ② should be replaced with snubber circuit (RC, RCD) when oscillation.




L1: Stray inductance between the smoothing (electrolytic) capacitor and the IGBT module.
L2: Stray inductance between the bypass (or snubber) capacitor and the IGBT module.
L3: Stray inductance between the load and the power circuit's output stage.

### 9.2 Mounting instructions

When mounting IGBT modules on a heat sink, uneven mounting can cause the module ceramic isolation destroy.

To achieve the best thermal radiation effect, the larger the contact area is, the smaller the thermal resistance is. Heat sink should have a surface finish in range of Rz6 - Rz12, warpage within 100 µm ( for 24A series products, heat sink should have a surface roughness within 10 µm, warpage within 20 µm corresponding to 100 mm length).

Uniform coating of grease between the module and heat sink can prevent corrosion of contact parts. Select a compound, which has stable characteristics over the whole operating temperature range and does not change its properties over the life of the equipment. (See Table1 for suggested type).

Use a uniform coating of thermal interface compound.
The thickness of grease should be in the range +50 µm-+100 µm according to the surface finish.

Mounting screws should be tightened by using a torque wrench until the prescribed torque. As mentioned before, over torque terminal or mounting screws may result in damage of IGBT modules. When an electric screwdriver is used, grease with low viscosity is recommended and extra grease shall be extruded before final tightening screws.

* For the recommended torque order for mounting screws, refer to "Mounting" in the section of "How to Use Power Module Properly and Safely."

Note) Maximum torque specifications are provided in device data sheets. The type and quantity of grease having an effect on the thermal resistance are determined by consideration of both grease and heat sink. Typical value given in datasheet is measured by using grease manufactured by Shin-Etsu Chemical Co., Ltd. {Thermal conductivity grease of λ=0.9 W/(m・K)}.

Note: Formerly the mounting screws were prepared for users as accessories with module.
But for some reasons, this service was stopped since NF series products.
The mounting screws for《NF Series or the former》modules can be referred to Table 1.

Table 1

| Size | Type | Manufacturer | (2012/08/22 to present) |
|---|---|---|---|
| M5×12 | Cross recessed hexagon head bolts with captive washer | FC-TEC CO.,LTD. | http://www.fctec.co.jp/ |
| M6×12 | Cross recess nuts and Hexagon head bolts | | |

M5-M6 hexagon head bolt: JIS B 1187

Note: When using the screw except the attached screw, be careful of the screw length. If use the screw which is longer than necessary, the bursting screw head reaches gel and aluminum wire in the module and causes the device destruction in the resin of the terminal area. Use a screw with the length which is the optimal for the top to refer to the thickness and the following size of the terminal for the connection.

Table 2 Terminal screwing hole depth and thickness (Unit in mm tolerance: ±0.3 mm)

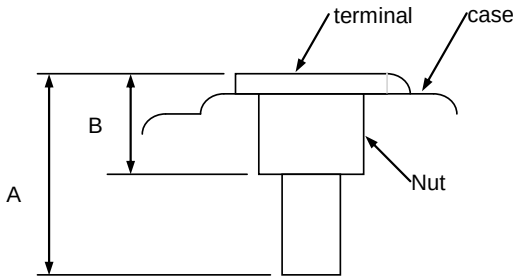
| Screw size | | $V_{CES}$ (V) | Part number | A | B | thickness |
|---|---|---|---|---|---|---|
| Main Terminal | M5 | 600 | CM100RX-12A, CM150RX-12A, CM200RX-12A | 12.5 | 6.5 | 1.0 |
| | | 1200 | CM75RX-24S, CM100RX-24S, CM150RX-24S | | | |
| | | | CM200RXL-24S<br>CM100RX-24S1, CM150RX-24S1 | 13.4 | 5.9 | 1.0 |
| | | | CM150EXS-24S, CM200EXS-24S, CM300EXS-24S | 13.1 | 5.6 | 1.0 |
| | | 1700 | CM200EXS-34SA | | | |
| | | | CM75RX-34SA, CM150RXL-34SA | 13.4 | 5.9 | 1.0 |
| Main Terminal | M6 | 600 | CM300DX-12A, CM400DX-12A | 13.5 | 6.5 | 1.0 |
| | | 1200 | CM150DX-24S, CM200DX-24S,<br>CM300DX-24S, CM450DX-24S | | | |
| | | | CM600DXL-24S, CM1000DXL-24S | 13 | 6.5 | 1.0 |
| | | | CM225DX-24S1, CM300DX-24S1<br>CM450DX-24S1, CM600DX-24S1 | 14 | 7.0 | 1.0 |
| | | 1700 | CM150DX-34SA, CM200DX-34SA, CM300DX-34SA,<br>CM450DXL-34SA, CM600DXL-34SA | | | |

∴ Not including the float of the terminal in size A and B.

The minimum valid depth for the main terminal

The formula to calculate the minimum valid depth is as the following.

The main terminal A - tolerance=12.5-0.3=12.2 mm



**9.3 Additional Instructions**

9.3.1. Mounting the printed circuit board (PCB) on the standoffs

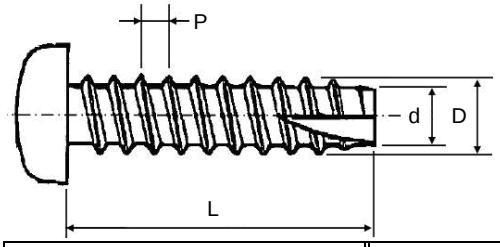
Use the following screws when mounting the printed circuit board (PCB) on the standoffs.
The length of the screw depends on the PCB thickness (t1.6-t2.0).

9.3.1.1 6.1th Gen. S1 and 6th Gen. S series NX type (except CM225/300/450/600DX-24S1 and CM150/200/300DX-34SA)

"ϕ2.6×10 or ϕ2.6×12 B1 tapping screw"

9.3.1.2 5th Gen. NX series

"ϕ2.3×10 or ϕ2.3×12 B1 tapping screw"




| Item | 6.1th | 6th | 5th | Tolerance |
|---|---|---|---|---|
| d [mm] | 2 | 2 | 1.7 | +0 -0.1 |
| D [mm] | 2.6 | 2.6 | 2.3 | +0 -0.1 |
| P [mm] | 0.91 | 0.91 | 0.79 | - |
| L [mm] | 10 or 12 | 10 or 12 | 8 or 10 | +0 -0.8 |
| Max. tightening torque [N・m] | 0.5 | 0.5 | 0.25 | - |
| tightening method | By hand work | By hand work | By hand work | - |
| The mounting / dismounting permission times | once | once | once | - |

9.3.1.3 CM225/300/450/600DX-24S1, CM150/200/300DX-34SA

| Type | Size | Manufacturer | Tightening torque (N•m) | Tightening method |
|---|---|---|---|---|
| (1) PT® | K25×8 | EJOT | 0.55 ± 0.055 | by handwork (equivalent to 30 r/min ~ 600 r/min (by mechanical screw driver) by mechanical screw driver) |
| (2) PT® | K25×10 | | 0.75 ± 0.075 | |
| (3) DELTA PT® | 25×8 | | 0.55 ± 0.055 | |
| (4) DELTA PT® | 25×10 | | 0.75 ± 0.075 | |
| (5) B1 tapping screw | ϕ2.6×10 | - | 0.75 ± 0.075 | |
| | ϕ2.6×12 | | | |

*. Generally the listed company name and the brand name are the trademarks or registered trademarks of the respective companies.

9.3.2. Pin terminals

9.3.2.1 Pin terminal specifications (6.1th and 6th Gen.)

| Item | Specification | |
|---|---|---|
| Materials | Copper (Cu) | |
| Plating materials | Tin (Sn) | |
| | Nickel (Ni) grounding plating | |
| Plating thickness | Sn | 4 - 10 μm |
| | Ni | 1 - 6 μm |

9.3.2.2 Pin terminal specifications (5th Gen.)

| Item | Specification |
|---|---|
| Materials | Copper (Cu) |
| Plating materials | Nickel (Ni) |
| Plating thickness | 2 - 6 μm |

9.3.2.3 Soldering conditions

a. Dip soldering

| Item | Condition |
|---|---|
| Solder temperature | 260 °C ± 5 °C |
| Immersion time | 10 s ± 1 s |

b. Soldering iron

| Item | Condition |
|---|---|
| Tip temperature | 360 °C ± 10 °C |
| Heat time | 5 s ± 1 s |

**9.4 Coating method of thermal conductive grease**

The coating method of thermal conductive grease is introduced in this section. The thermal conductive grease is called as grease in the following.

① Preparations: power module, grease, screen, squeegee, electronic mass meter and gloves
② Relationship between the coating amount and thickness is,

$$\text{Thickness of grease} = \frac{\text{amount of grease}\,[g]}{\text{base area of module}[cm^2] \times \text{density of grease}\,[g/cm^3]}$$

The recommended thickness of grease is 50 - 100 μm

The amount of grease can be obtained as the following example.

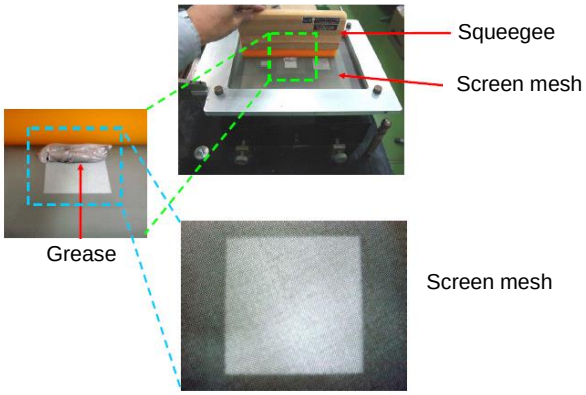
For example: For case with size of 121×62 (refer to the figure of page 14), the amount of Shin-Etsu Chemical Co.,Ltd. grease G-747 can be calculated through the equation below.

$$50 - 100\ \mu m = \frac{\text{amount of grease}\ [g]}{75.02[cm^2] \times 2.65[g/cm^3]}$$

∴The amount needed is≒1.0 - 2.0 [g]

③ Measure the mass of module
④ Measure the grease with the same amount as calculated
⑤ Coating the module base uniformly by using squeegee

There are the using screen mesh printing methods in others. Example photo is shown as following.




Finally it is fulfilled to uniformly cover thermal grease on the module base with specified thickness.

Table 1 Thermal conductive grease (example)

| Manufacturer | Type | Note |
|---|---|---|
| Shin-Etsu Chemical Co., Ltd. | G-747, G-776, etc. | for insulated type module |
| | G-751 | for non-insulated type module |

For more information of characteristics and caution of use, please contact to each manufacturers.

ALCAN UNIVERSAL JOINTING-COMPOUND is grease for the aluminum conductor connection.
The purpose of grease is an electric contact resistance decline by the contact-ability improvement and the corrosion control of the aluminum surface.
It seems that there is long-range use experience but because we are not the one of the purpose to improve a heat conduction at the contacted part, the contact thermal resistance reductional effect cannot look forward to it too much.
When employing these, because information enough for thermal management becomes necessary, please contact to each manufacture.

**9.5 Explanation of Thermal resistance**



The notice

* With the thickness of the heat sink to use, the thermal resistance $R_{th(f-a)}$ of the heat sink sometimes changes.
  The smaller the size of is in the heat sink is the thinner the thickness of it becomes, the larger the thermal resistance becomes under the same metal material.
* It the amount of coating of grease, contact thermal resistance $R_{th(c-s)}$ sometimes changes.
* Because the use of a naturally-air-cooled or forced-air-cooled heat sink is assumed for the general industrial power modules, when using a water-cooled heat sink, thermal resistance $R_{th(j-c)}$ and/or contact thermal resistance $R_{th(j-c)}$ sometimes change. Significantly from the values of specification due to the difference of the heat transfer characteristics.
* Because the packages of the: general industrial power modules are not hermetically sealed structure, it is possible for liquid to infiltrate easily inside the module.
* Because we design the general industrial power modules on the assumption that the package materials and the semiconductor chips do not have long-range contact with anything except the silicone gel to be used, after pulling the modules in the silicone oil and so on, the characteristics and the reliability is not guaranteed.

**9.6 An example of thermocouple mounting method**

An example of mounting a thermocouple on the base plate of the modules just under a semiconductor chip is given as follows.

Fig.1-1 shows an example of a trench processed from the end of the center of the chip on the base plate.
After check of the center of the chip, a trench of 1.5- 2 mm in width and 1 mm in depth should be processed by a milling machine.
The trench should be processed 2 mm longer than the distance between the end of the base plate and the center of the chip to improve the work efficiency to swage a head of thermocouple. As taking care not to damage of the thermocouple and a heat sink, some burr should be removed from the processed surface of the base plate.

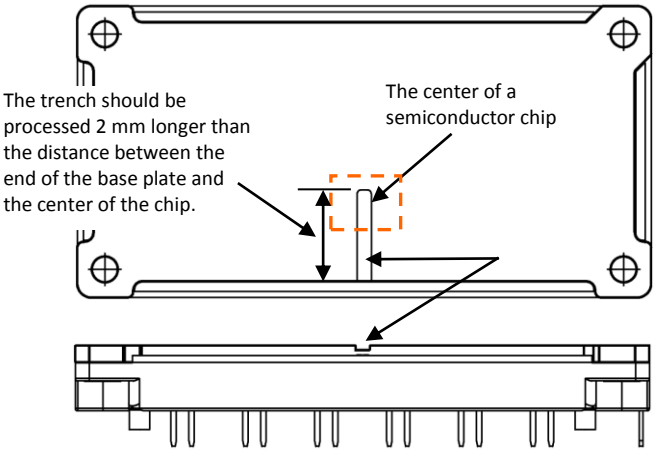



Fig.1-1 An example of a trench processed on the base plate (bottom and side view)

A hole of 0.8 mm in diameter and 1 mm in depth should be processed by a drilling machine.
Fig.1-2 shows an example of a hole drilling on the base plate.

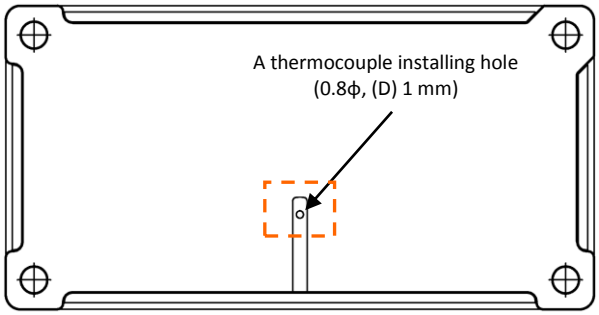
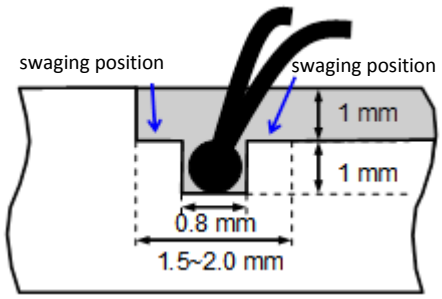
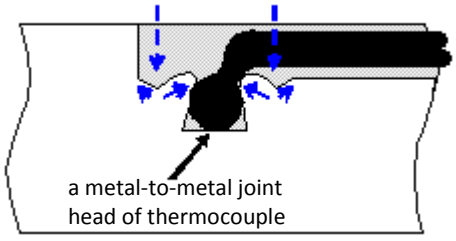



Fig.1-2 An example of a hole drilled on the base plate (bottom view)

Install the thermocouple in the hole and fix the base plate with the metal-to-metal joint head contacted and swage both side edges of the hole by a center punch. Refer to Fig.1-3.
Before the above work, the metal-to-metal joint head should be cut around 1 mm long if it is longer than 1 mm.
Then trail the thermocouple through the trench and fill it with a filler to prevent protrusion and cut-off when the base plate is mounted to a heat sink.
After the base plate is coated with thermal conductive grease, it is mounted to a heat sink and the thermocouple is connected with a temperature measuring instrument (eq. multimeter or data logger)
If a indicated value of the instrument is not stable, it is necessary to confirm again whether the head of thermocouple is contacted with the base plate properly or whether the thermocouple is cut off.




before swaging a thermocouple




after swaging a thermocouple

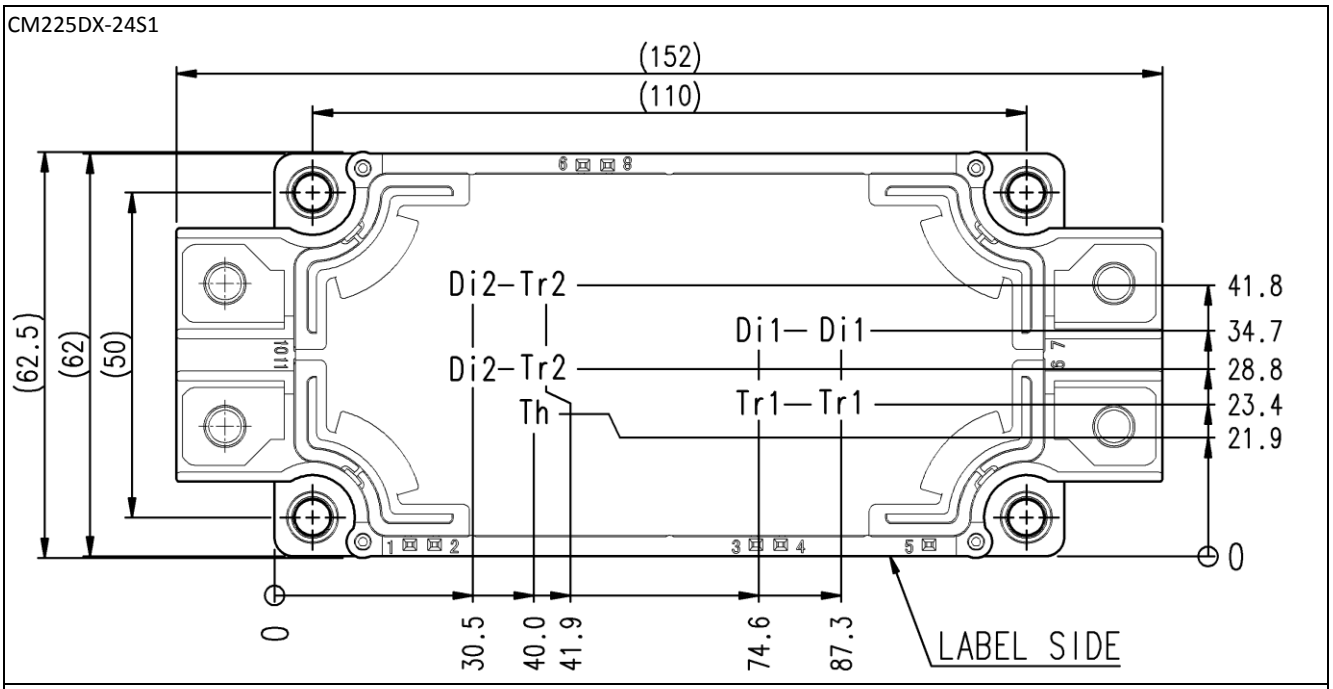
Fig.1-3 An example of swaging a thermocouple

Fig.1 An example of thermocouple mounting method

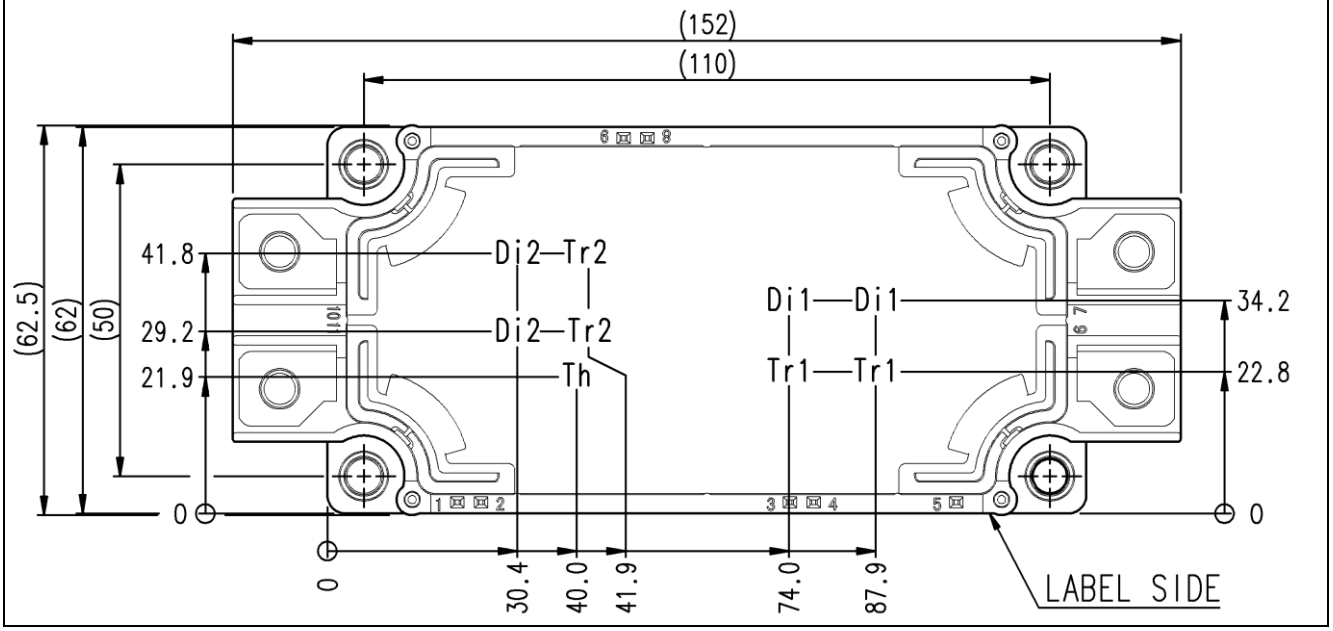
**9.7 Chip locations 6.1th Gen.**

Chip locations – 1200 V class dual switch (Dimension: mm)

CM225DX-24S1



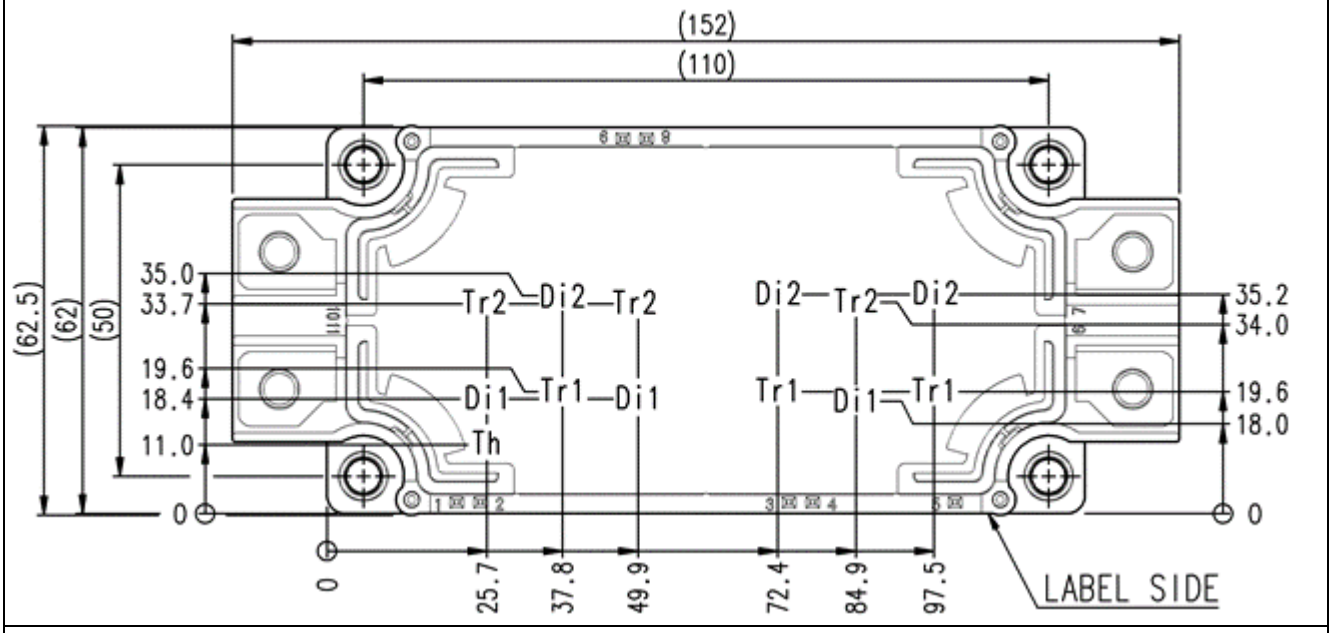

CM300DX-24S1



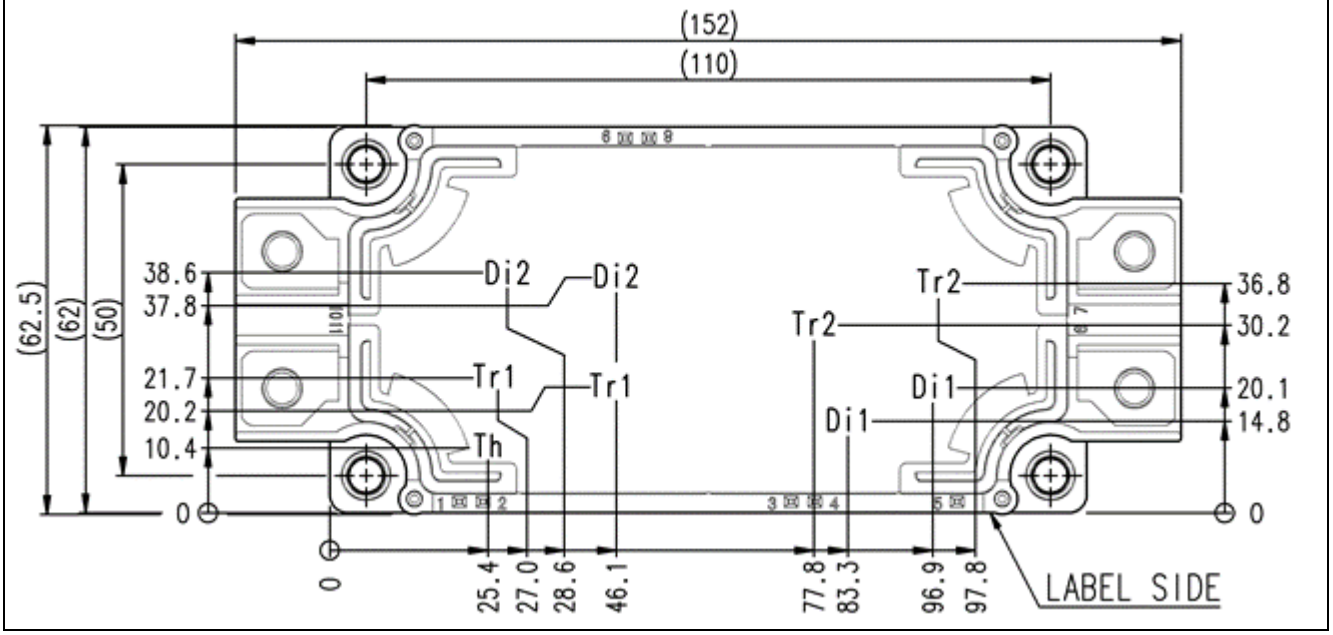
## Chip locations

Chip locations – 1200 V class dual switch (Dimension: mm)

CM450DX-24S1



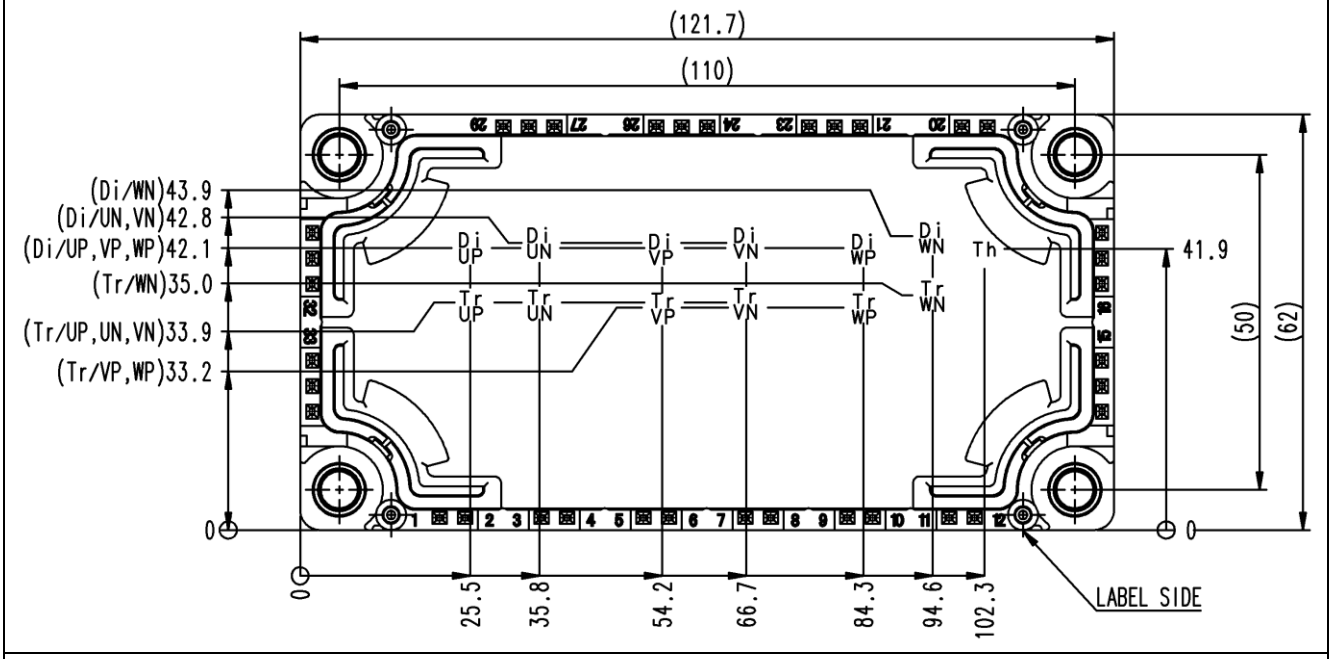

CM600DX-24S1



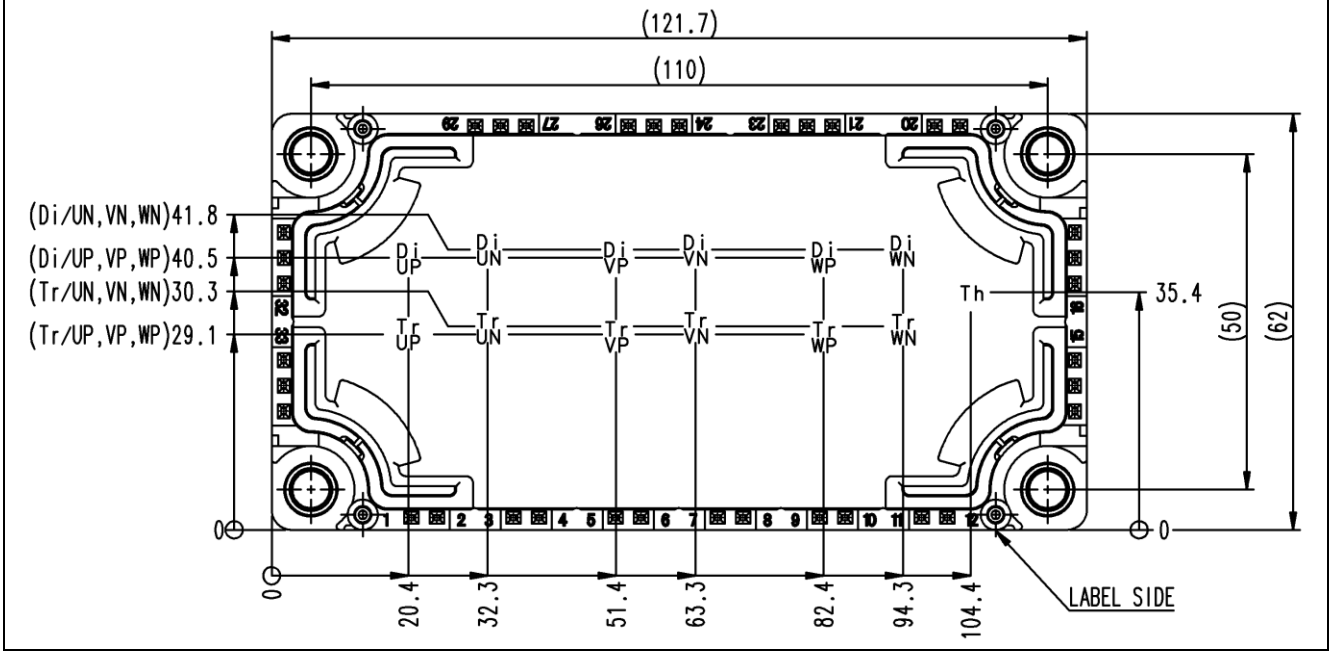
## Chip locations

Chip locations – 1200 V class sixpack (Dimension: mm)

CM100TX-24S1



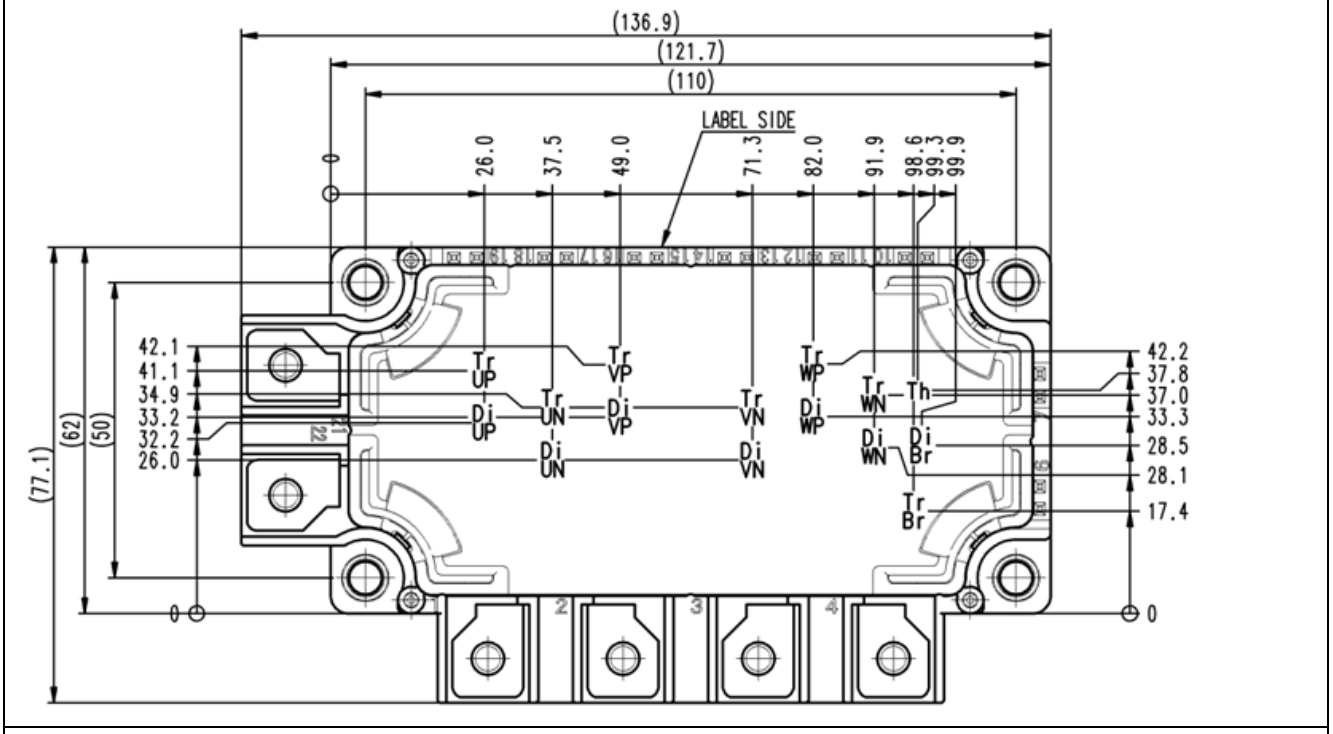

CM150TX-24S1



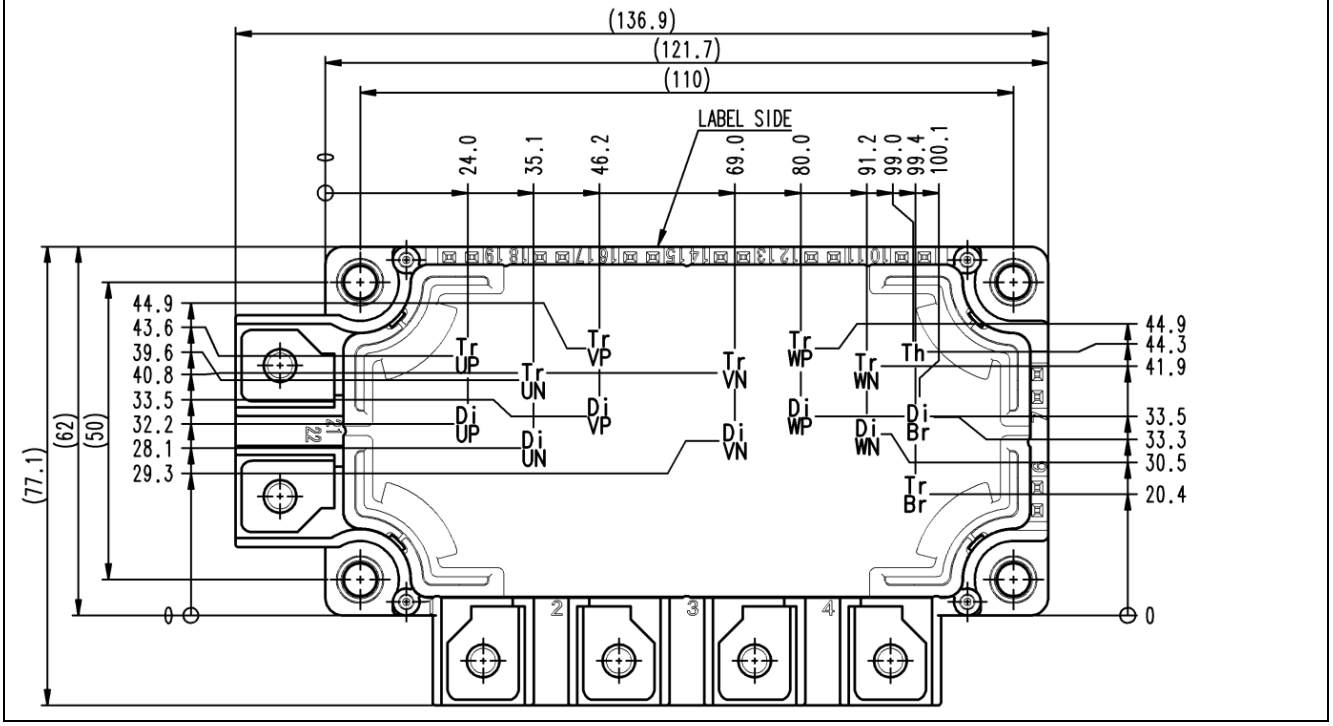
## Chip locations

Chip locations – 1200 V class sevenpack (Dimension: mm)

CM100RX-24S1



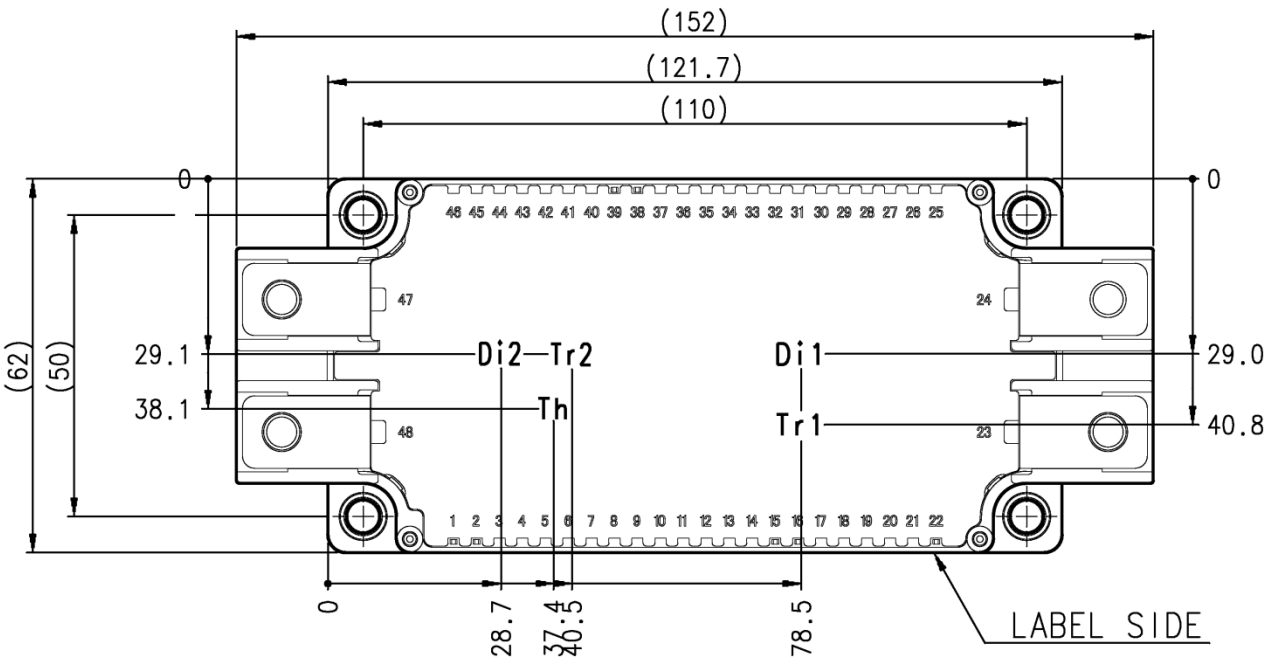

CM150RX-24S1



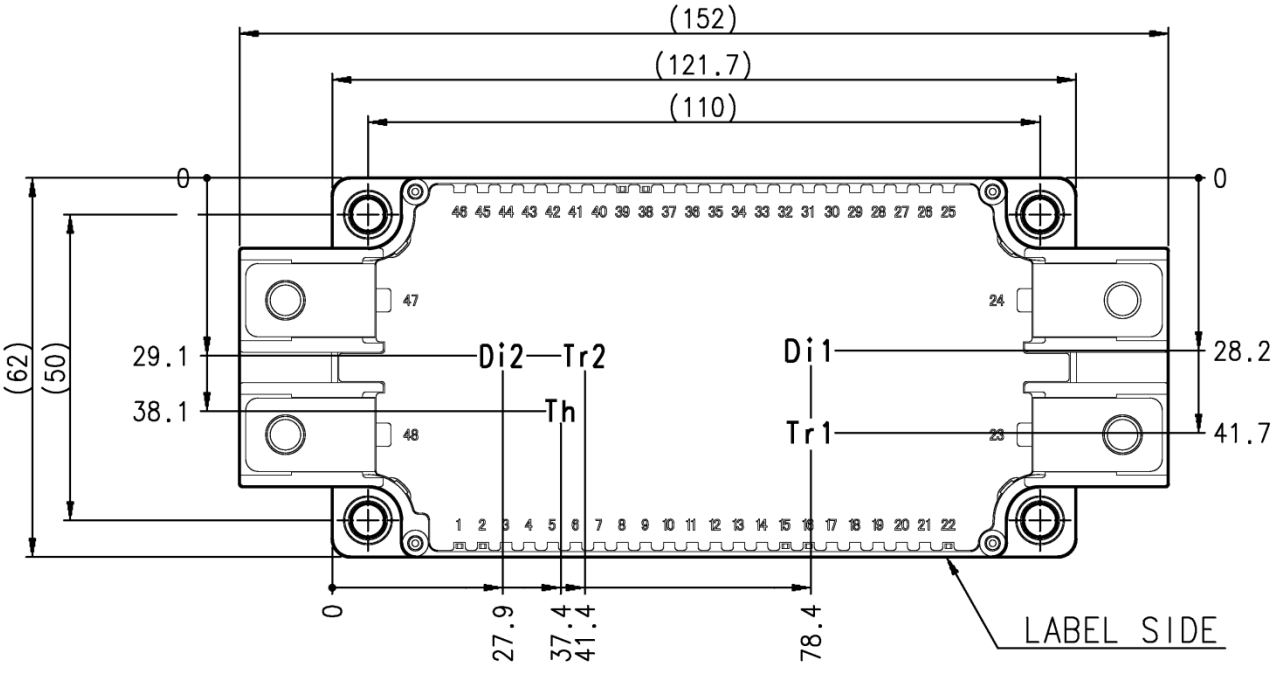
**9.8 Chip locations 6th Gen.**

Chip locations – 1200 V class dual switch (Dimension: mm)

CM150DX-24S



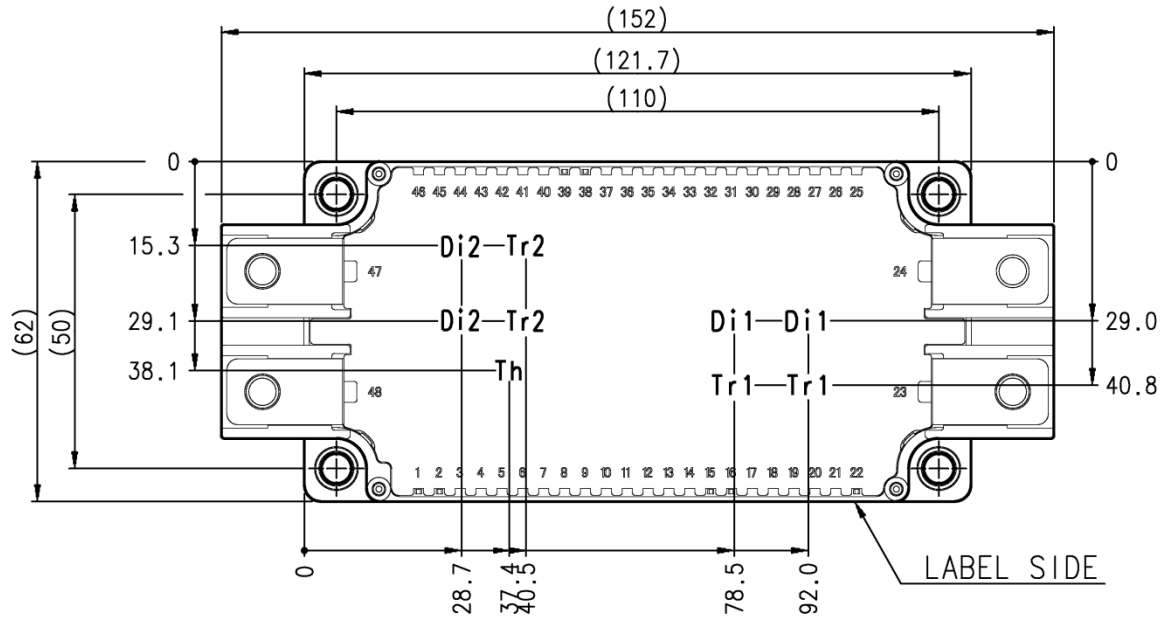

CM200DX-24S



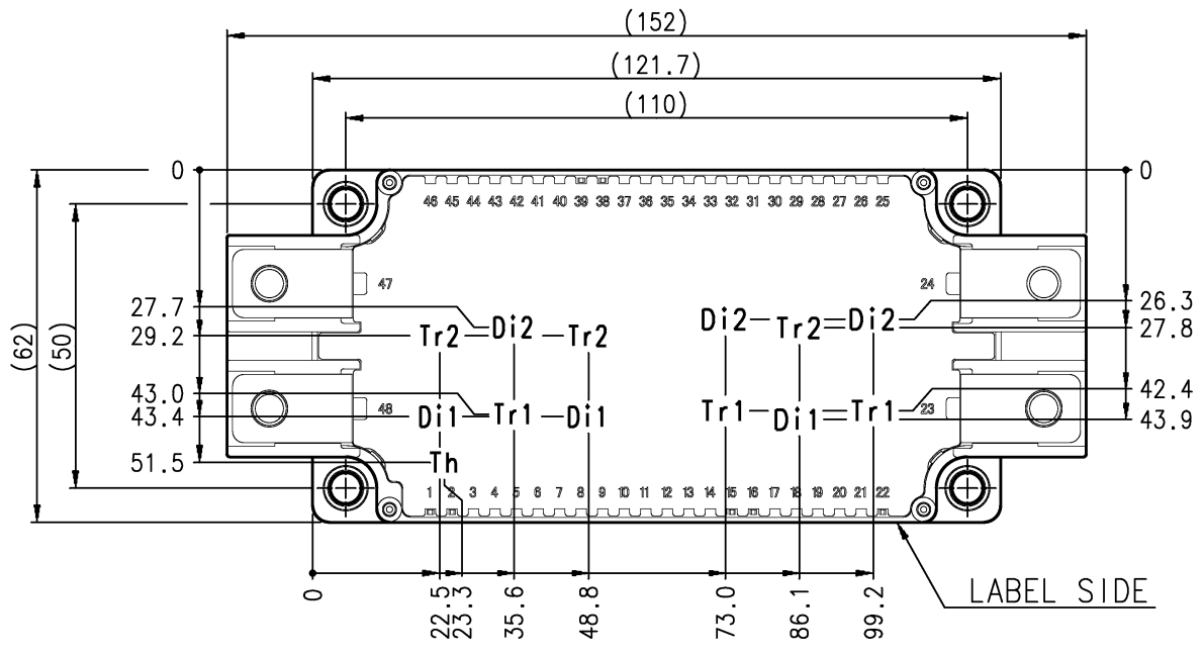
## Chip locations

Chip locations – 1200 V class dual switch (Dimension: mm)

CM300DX-24S



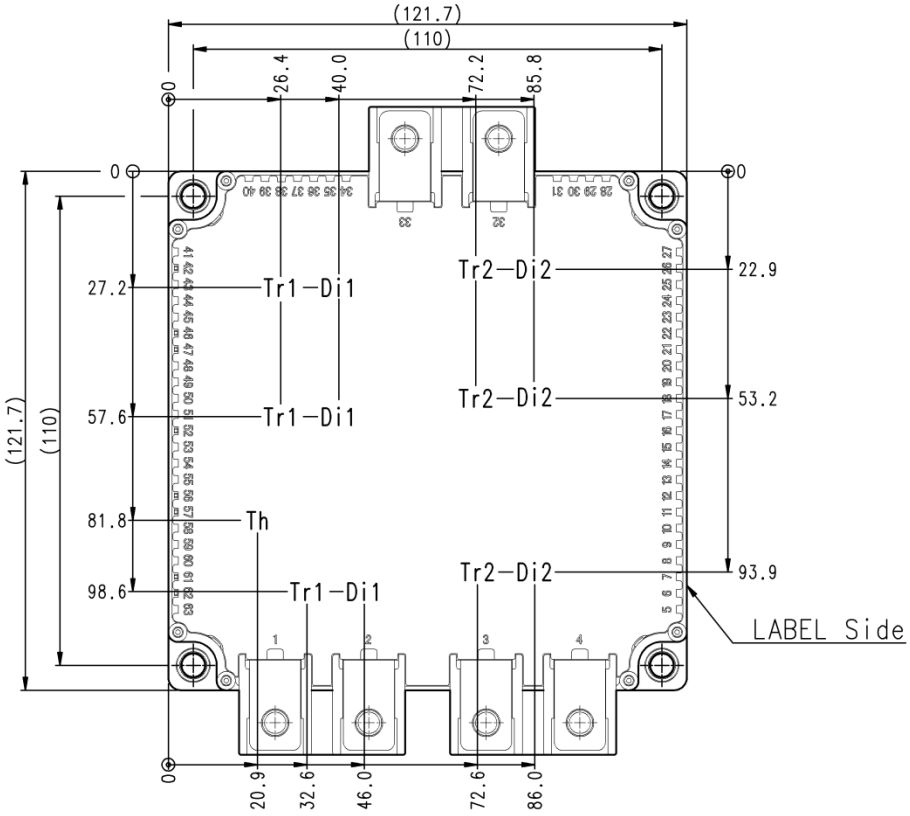

CM450DX-24S



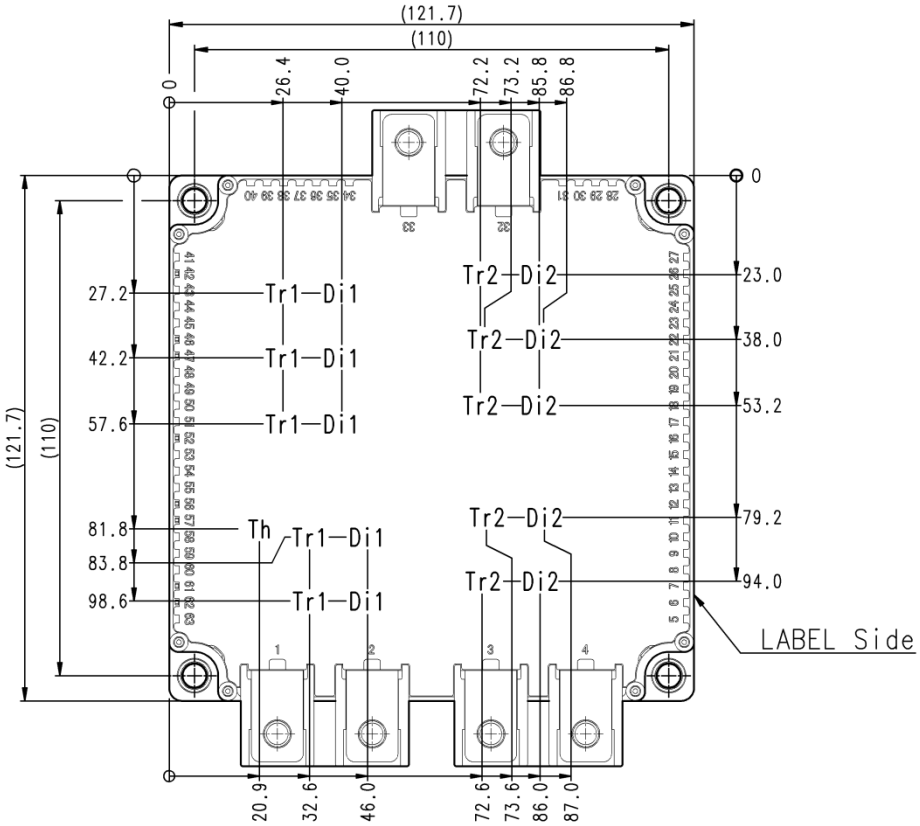
## Chip locations

Chip locations – 1200 V class dual switch (Dimension: mm)

CM600DXL-24S



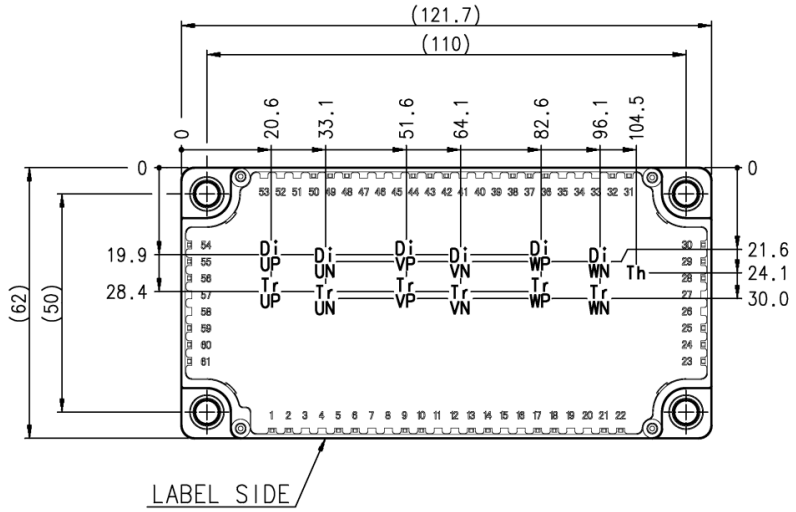

CM1000DXL-24S



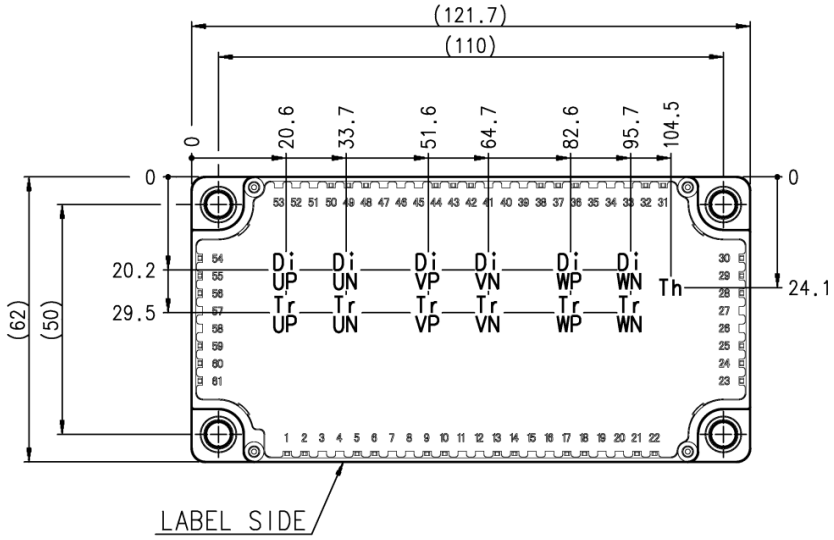
## Chip locations

Chip locations – 1200 V class sixpack (Dimension: mm)

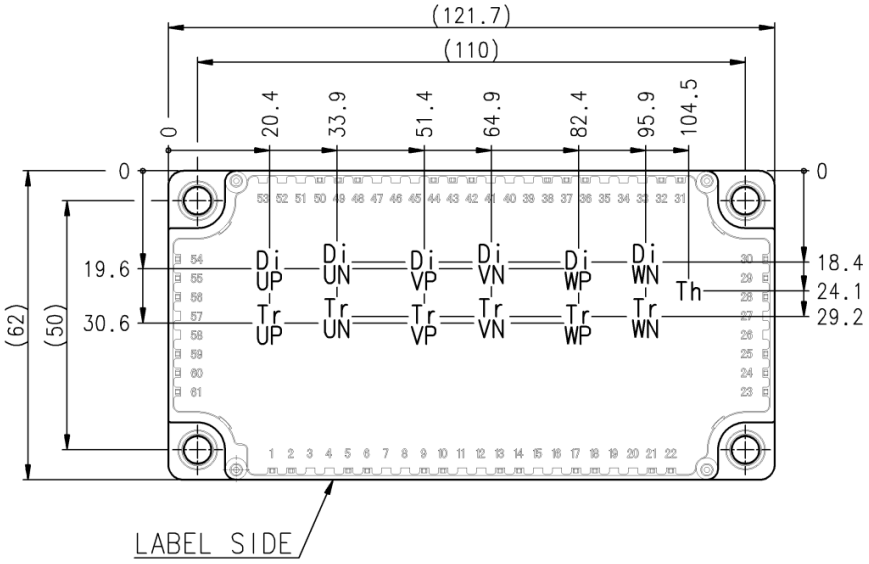
CM75TX-24S




CM100TX-24S



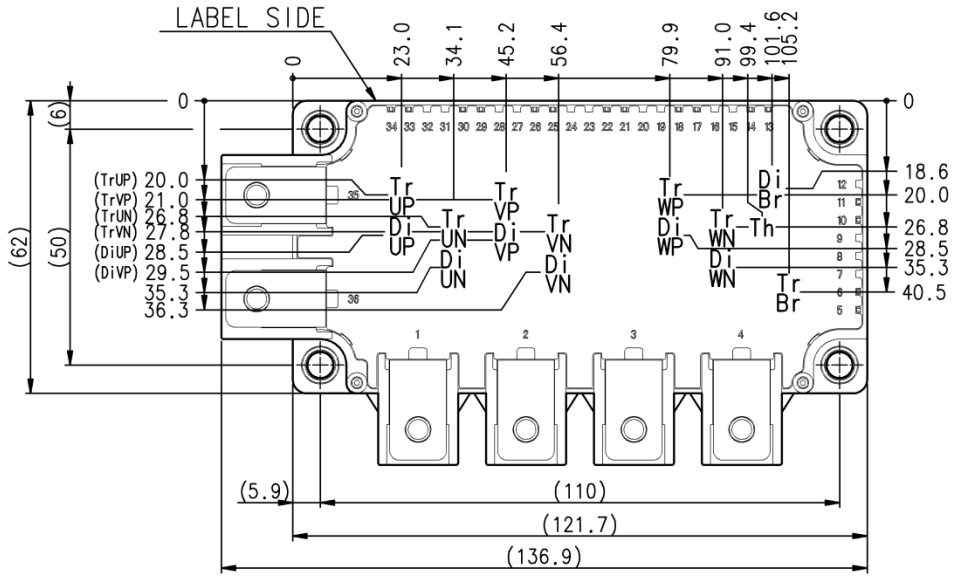

CM150TX-24S



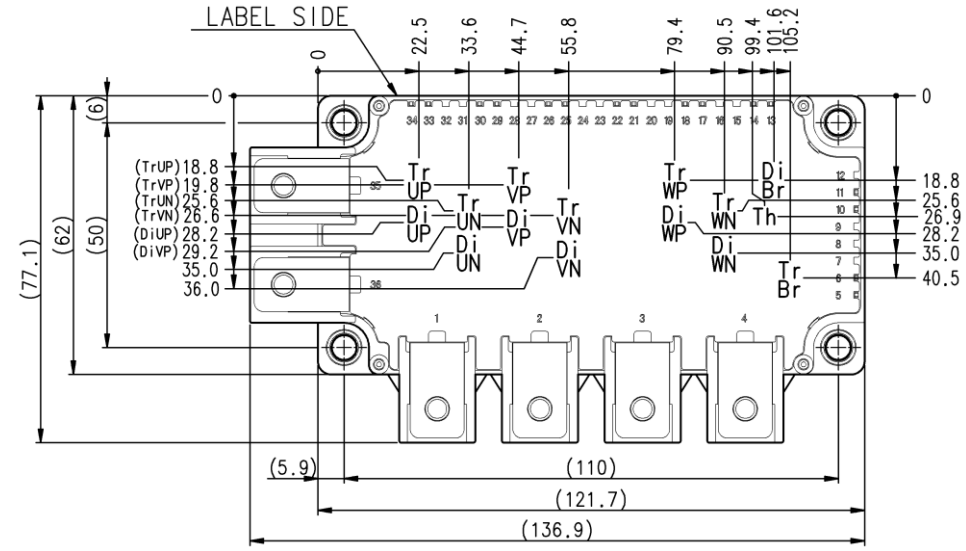
## Chip locations

Chip locations – 1200 V class sevenpack (Dimension: mm)

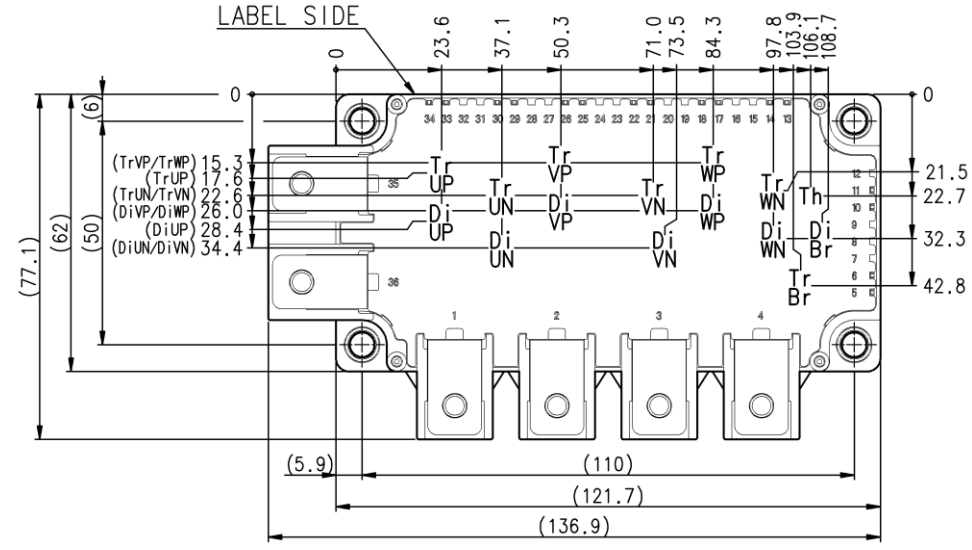
CM75RX-24S




CM100RX-24S



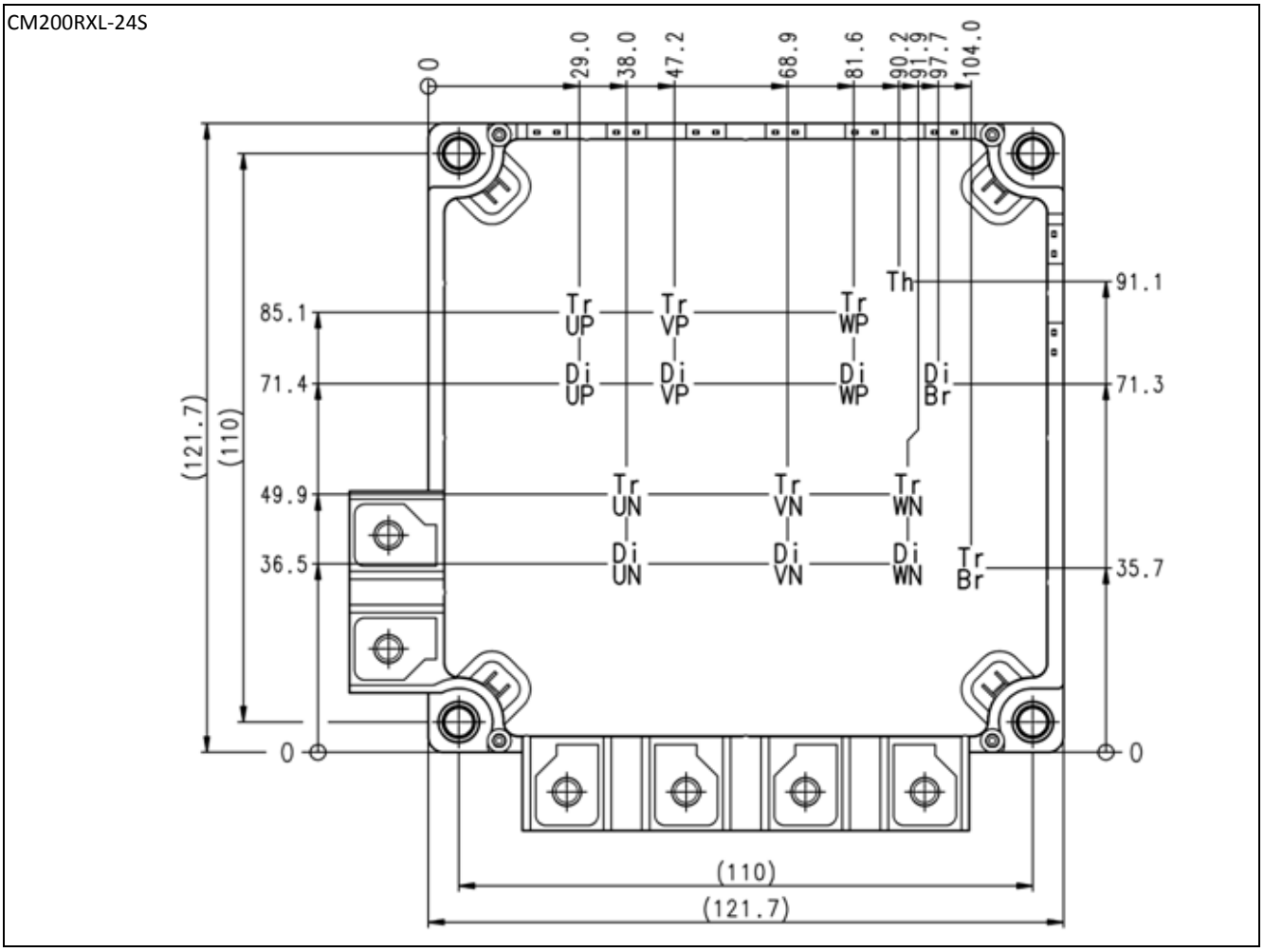

CM150RX-24S



## Chip locations

Chip locations – 1200 V class sevenpack (Dimension: mm)

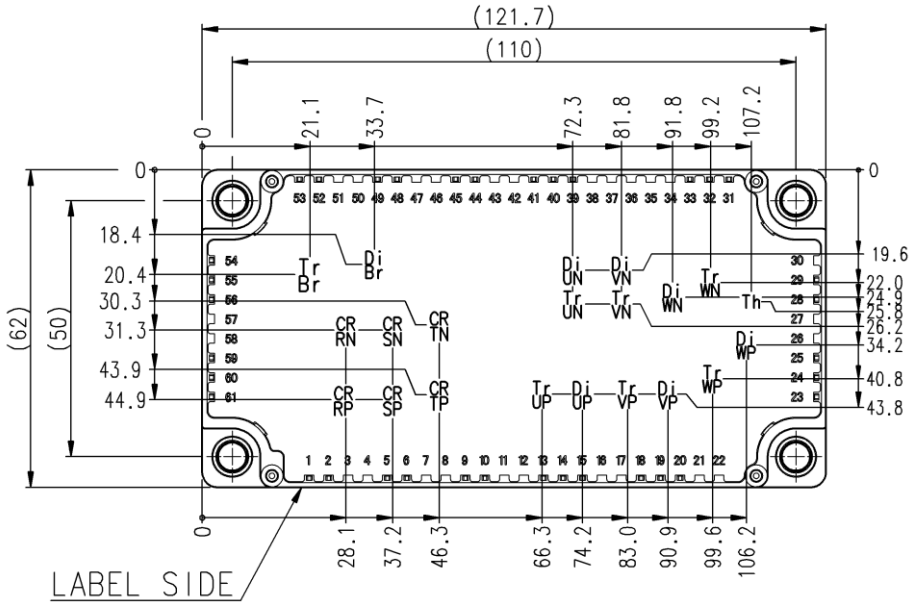
CM200RXL-24S



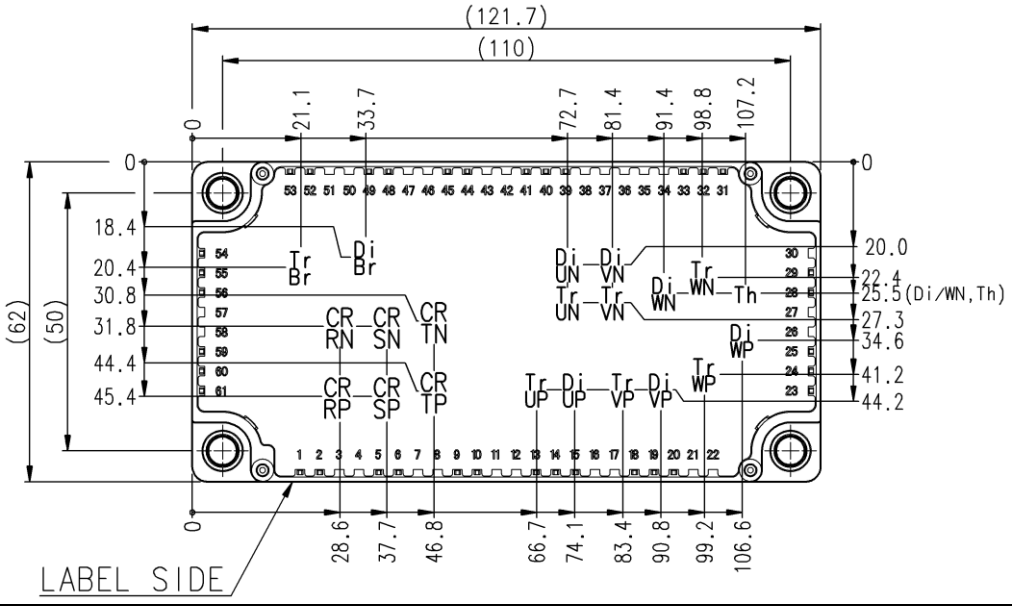
## Chip locations

Chip locations – 1200 V class CIB (Dimension: mm)

CM35MXA-24S



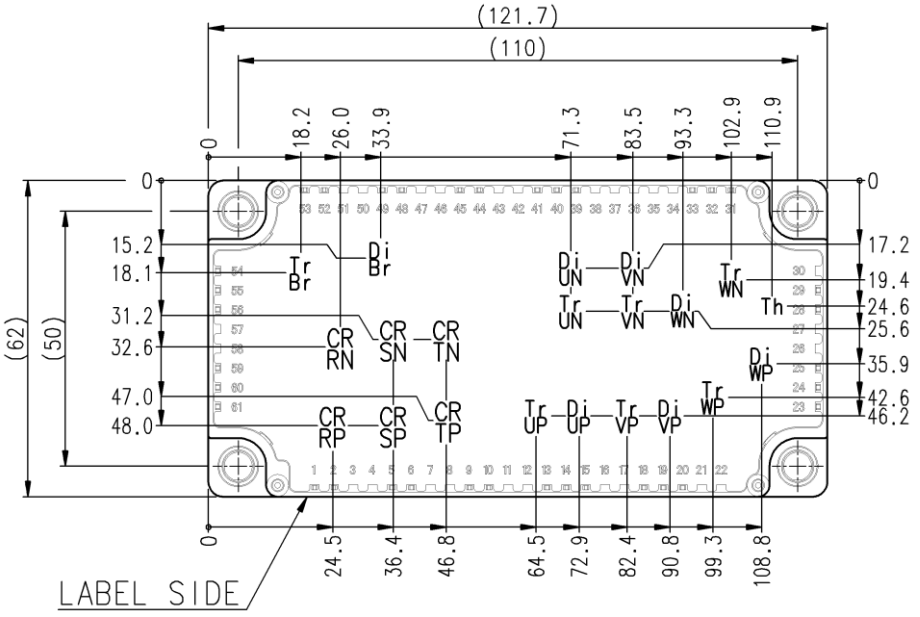

CM50MXA-24S



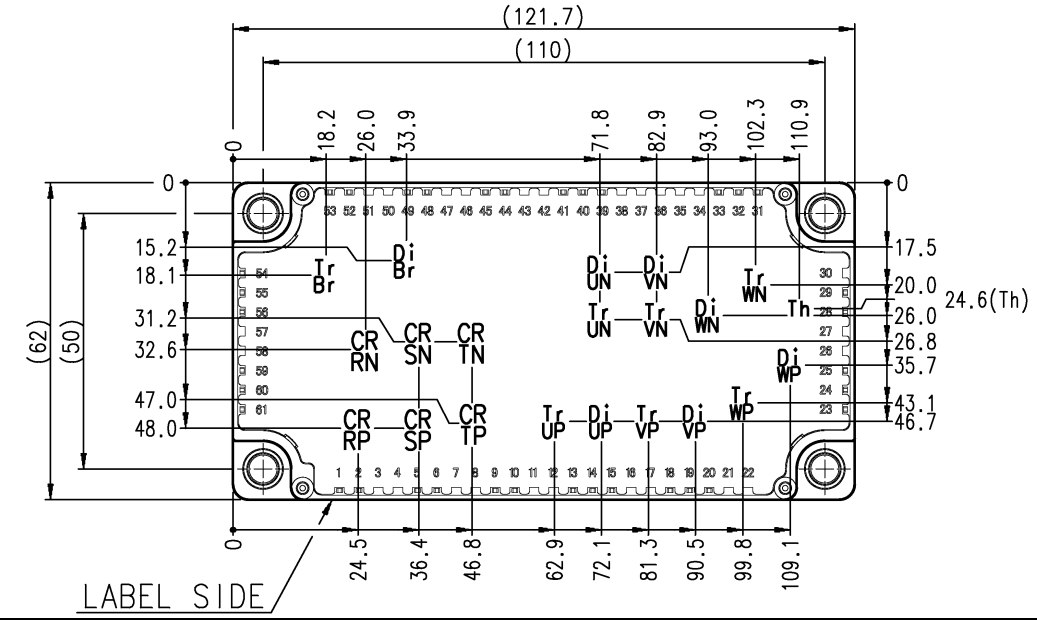
## Chip locations

Chip locations – 1200 V class CIB (Dimension: mm)

CM75MXA-24S



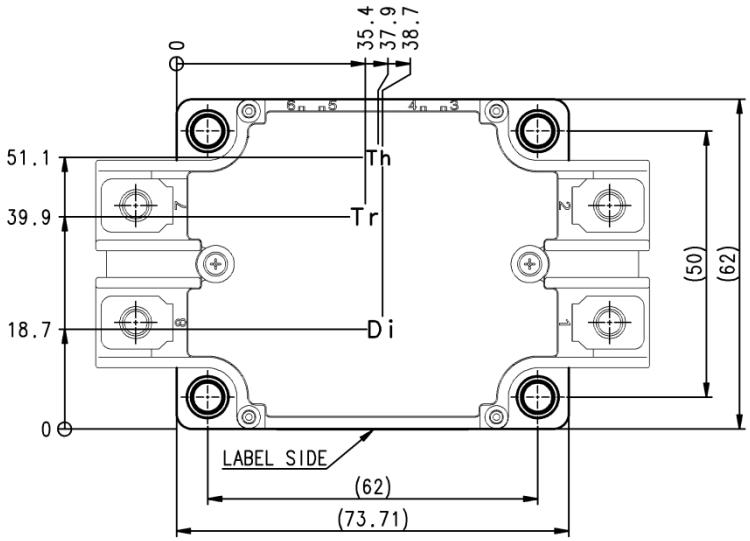

CM100MXA-24S



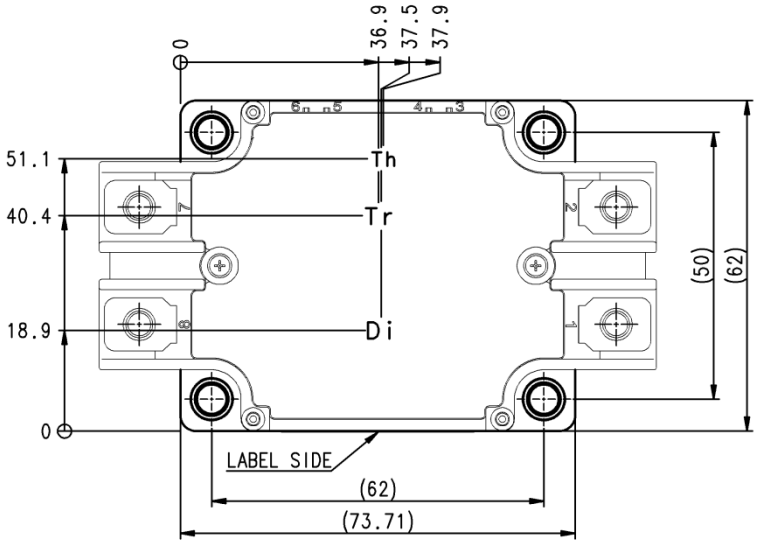
## Chip locations

Chip locations – 1200 V class brake chopper (Dimension: mm)

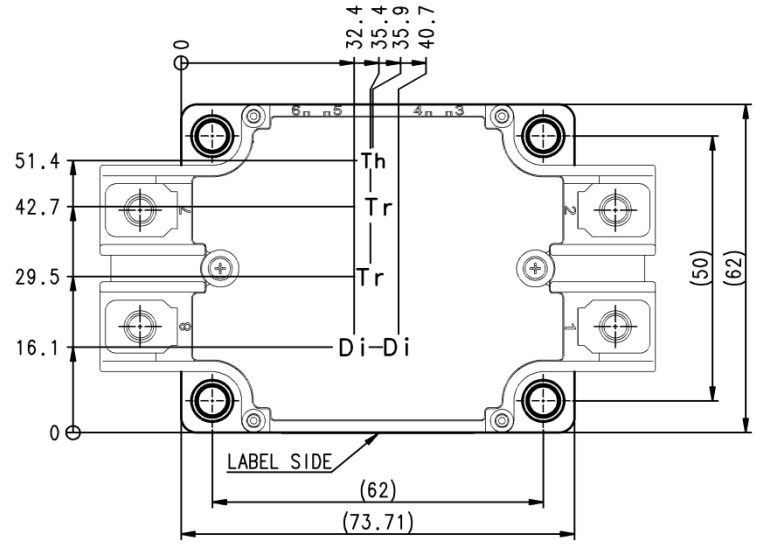
CM150EXS-24S




CM200EXS-24S



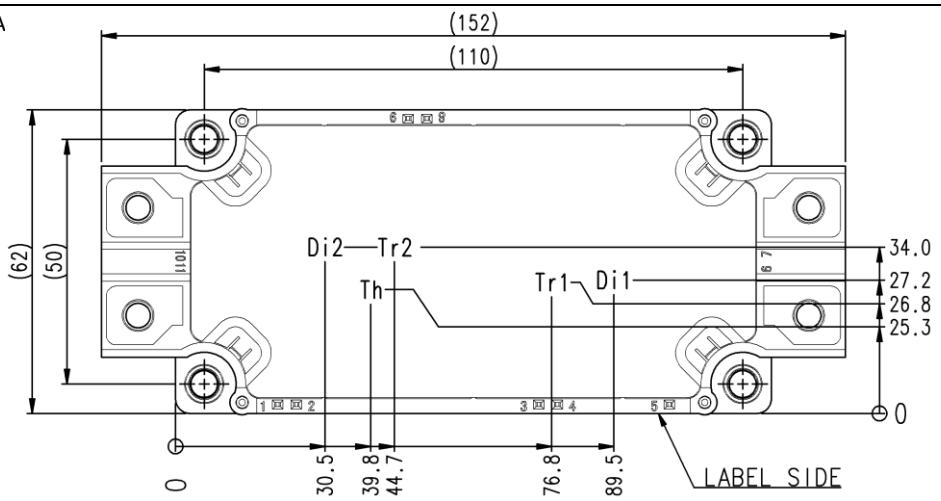

CM300EXS-24S



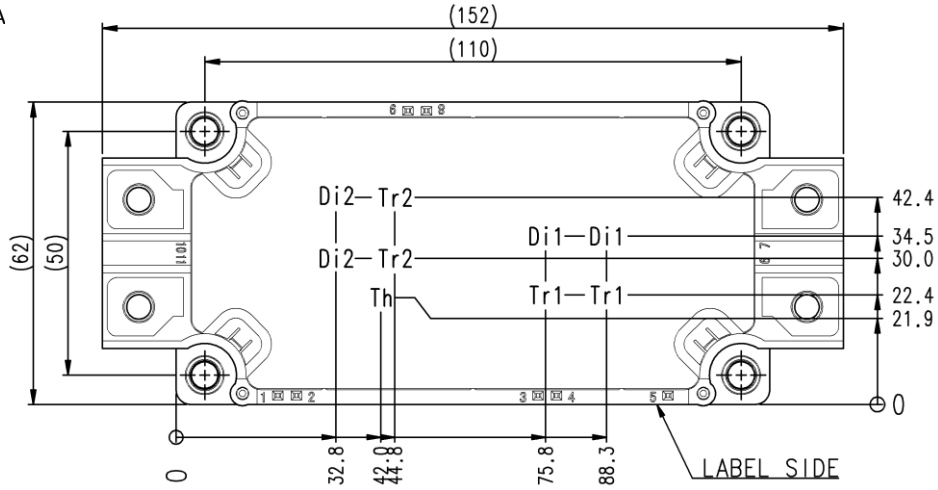
## Chip locations

Chip locations – 1700 V class dual switch (Dimension: mm)

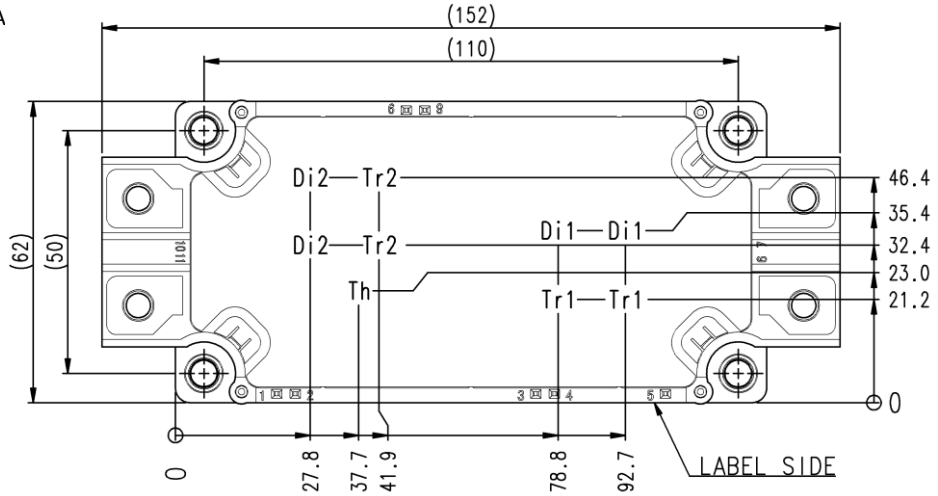
CM150DX-34SA




CM200DX-34SA



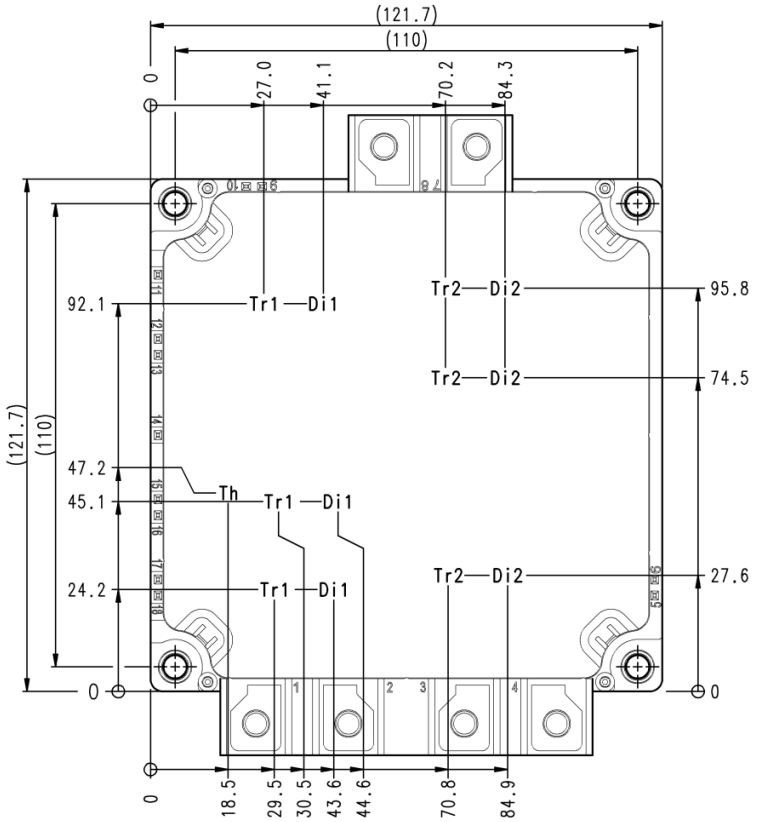

CM300DX-34SA



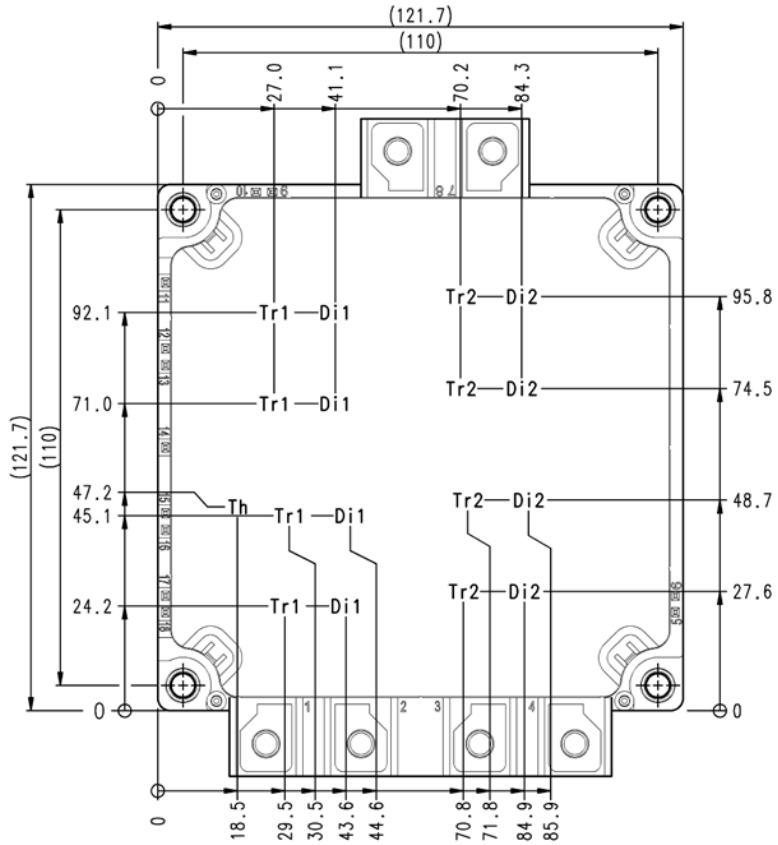
## Chip locations

Chip locations – 1700 V class dual switch (Dimension: mm)

CM450DXL-34SA



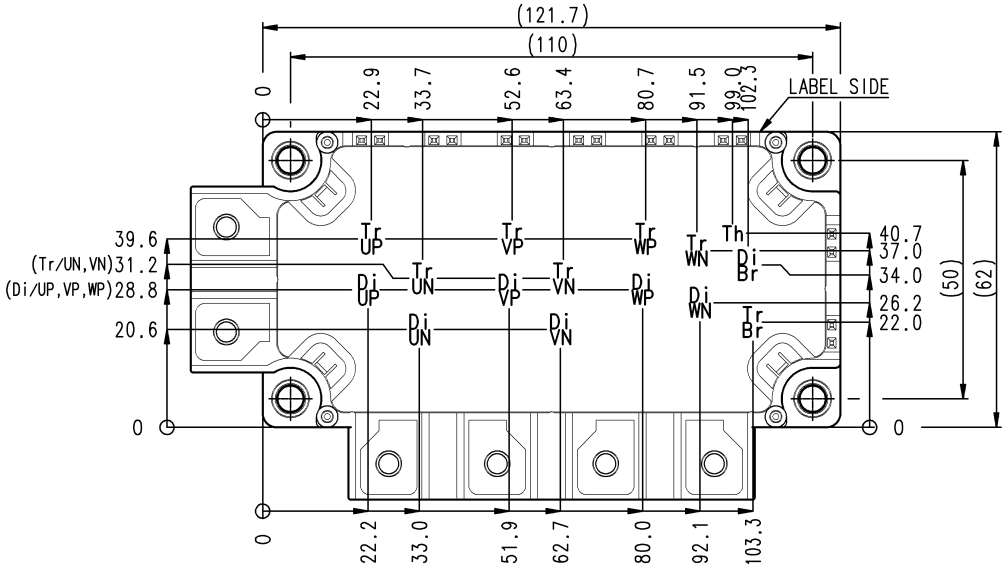

CM600DXL-34SA



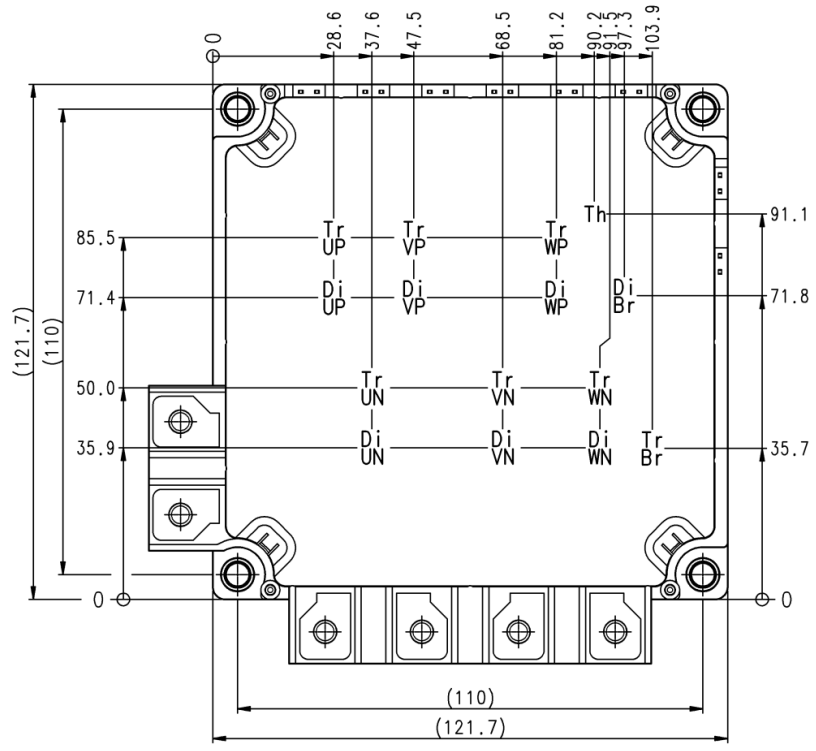
## Chip locations

Chip locations – 1700 V class sevenpack (Dimension: mm)

CM75RX-34SA



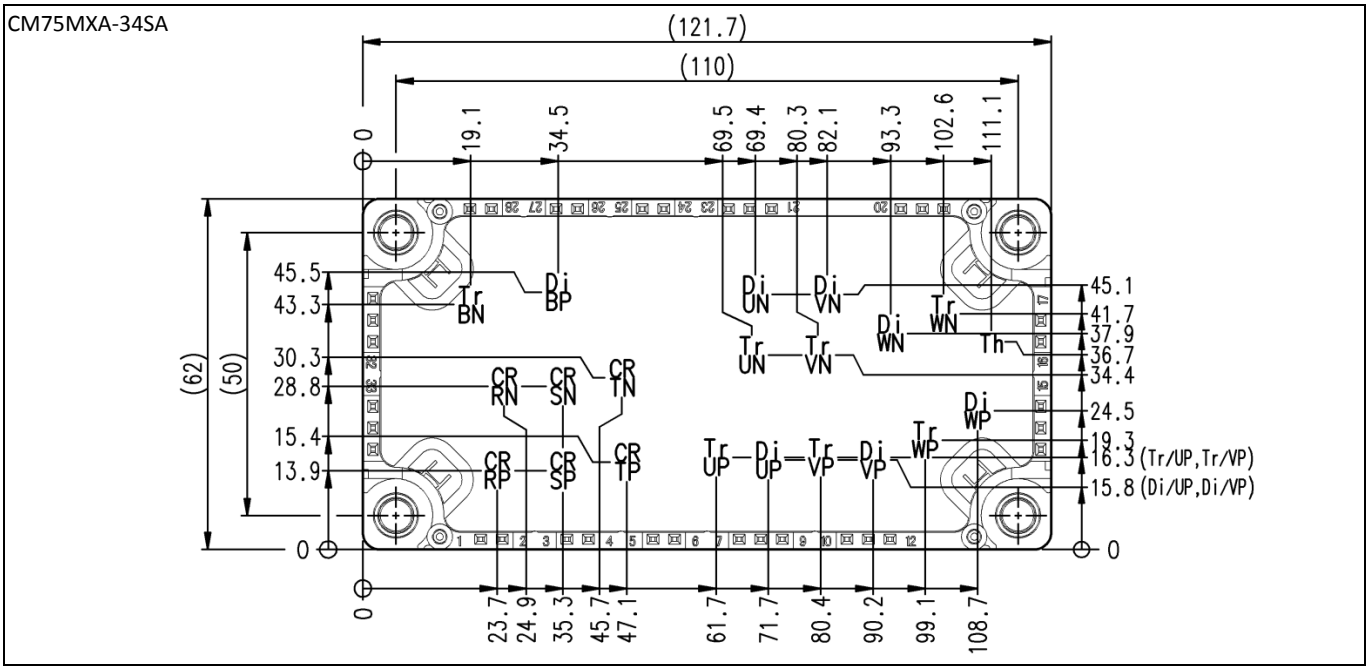

CM150RXL-34SA



## Chip locations

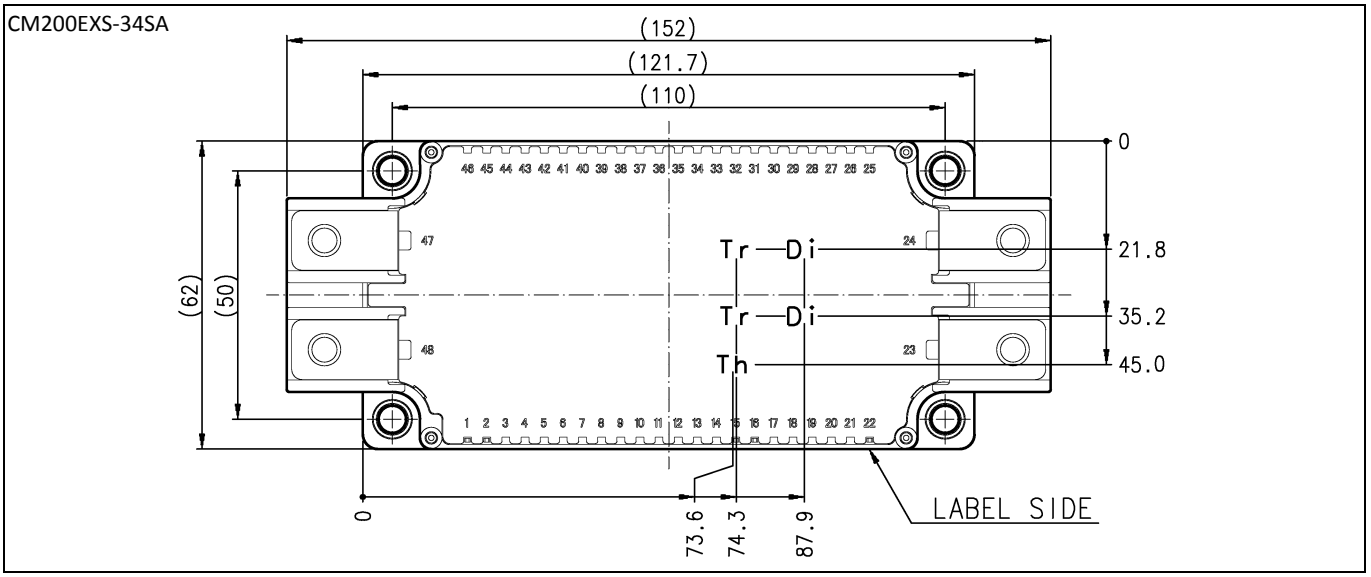
Chip location – 1700 V class CIB (Dimension: mm)

CM75MXA-34SA




Chip location – 1700 V class brake chopper (Dimension: mm)

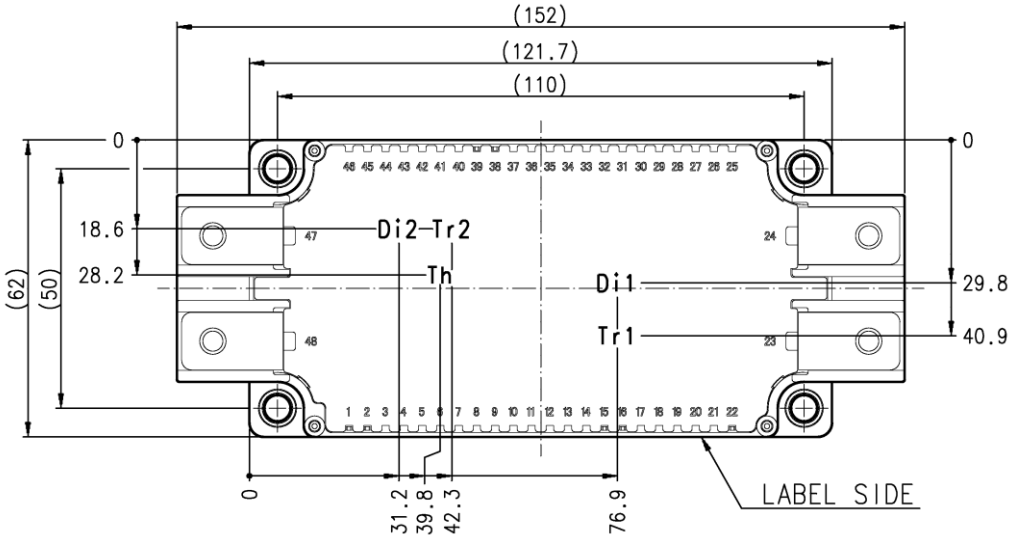
CM200EXS-34SA



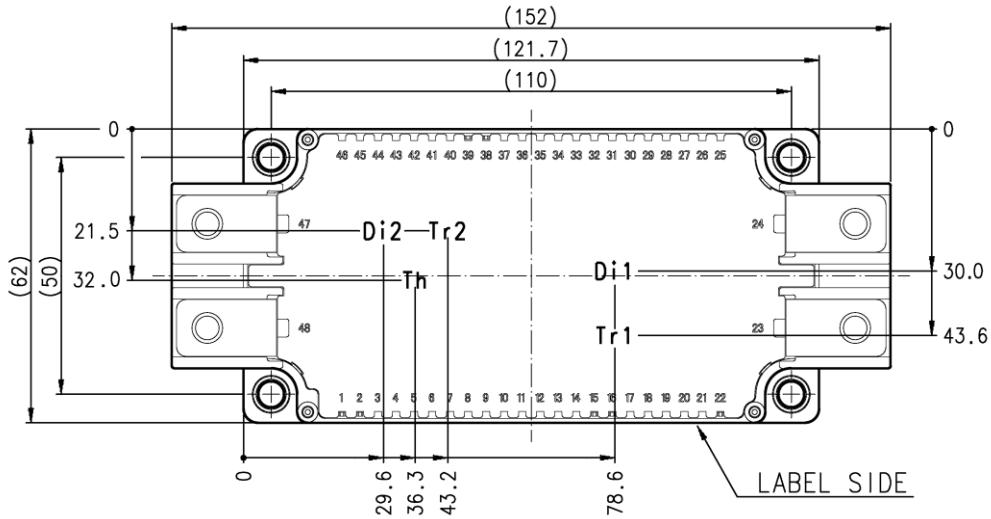
**9.9 Chip locations 5th Gen.**

Chip locations – 600 V class dual switches (Dimension: mm)

CM300DX-12A



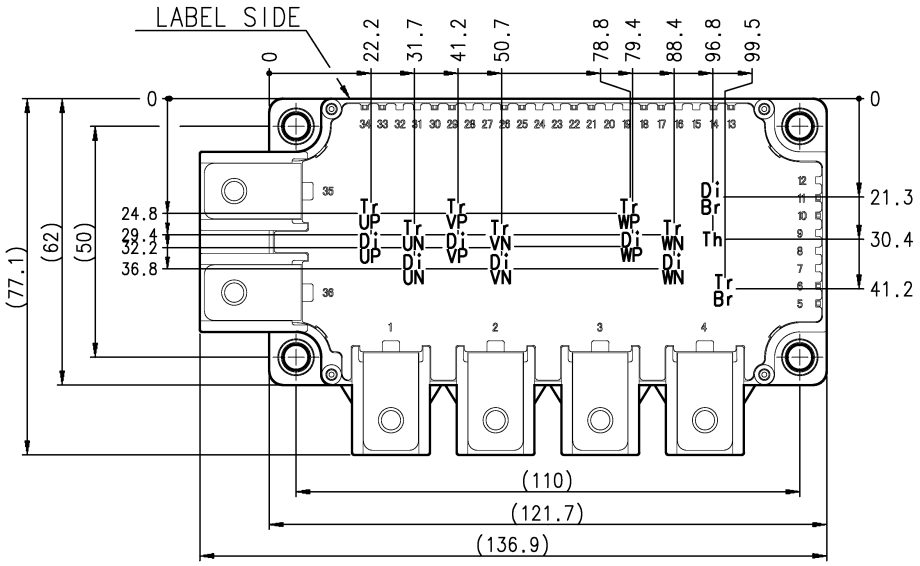

CM400DX-12A



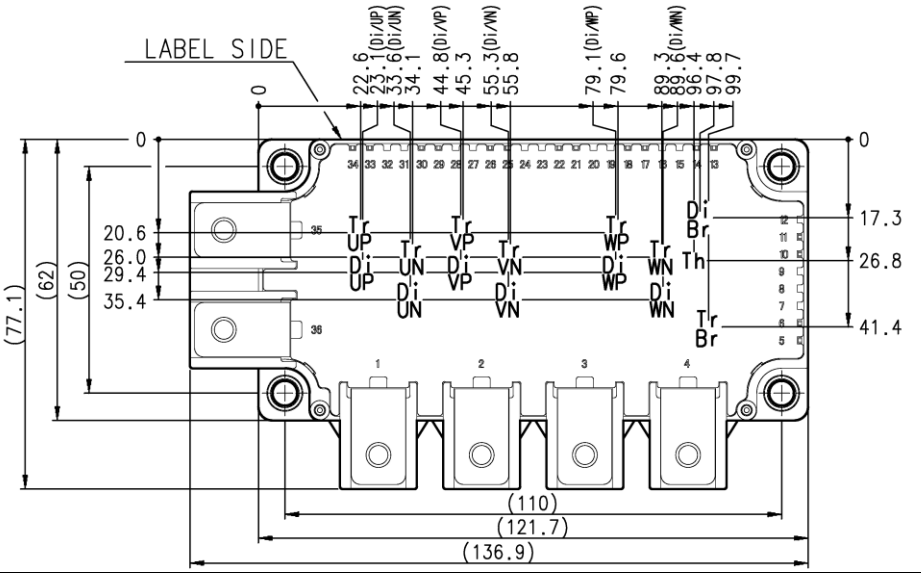
## Chip locations

Chip locations – 600 V class sevenpack (Dimension: mm)

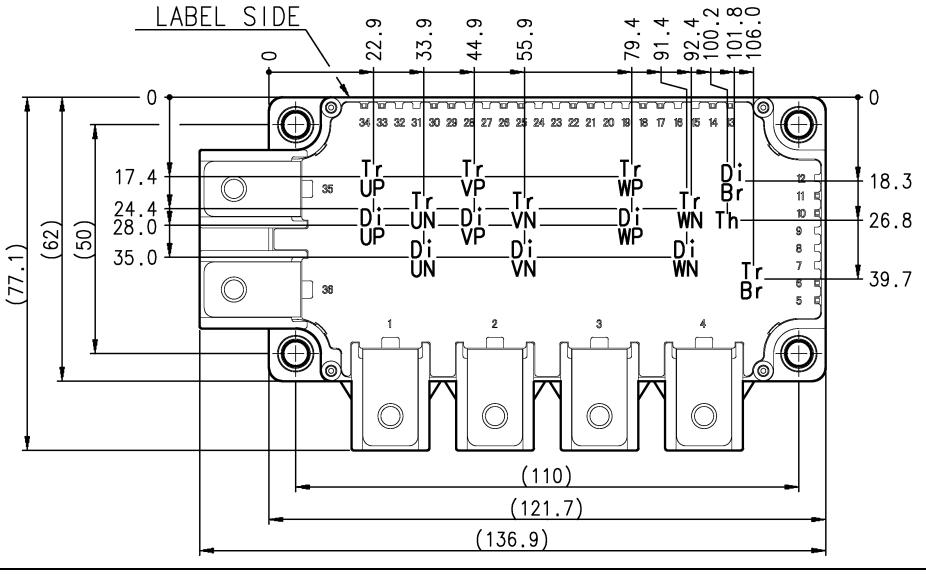
CM100RX-12A




CM150RX-12A



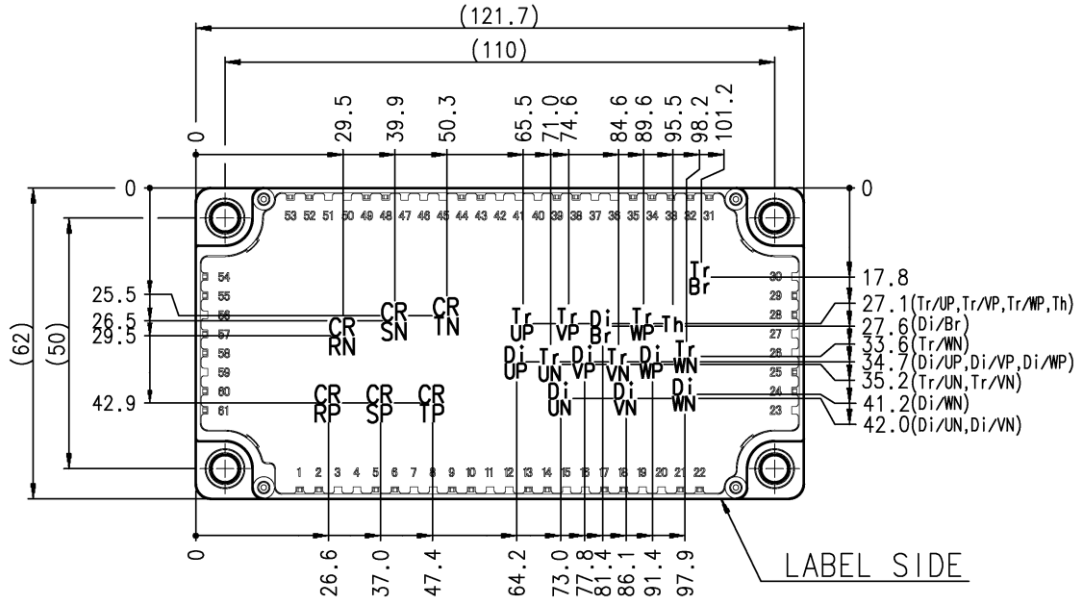

CM200RX-12A



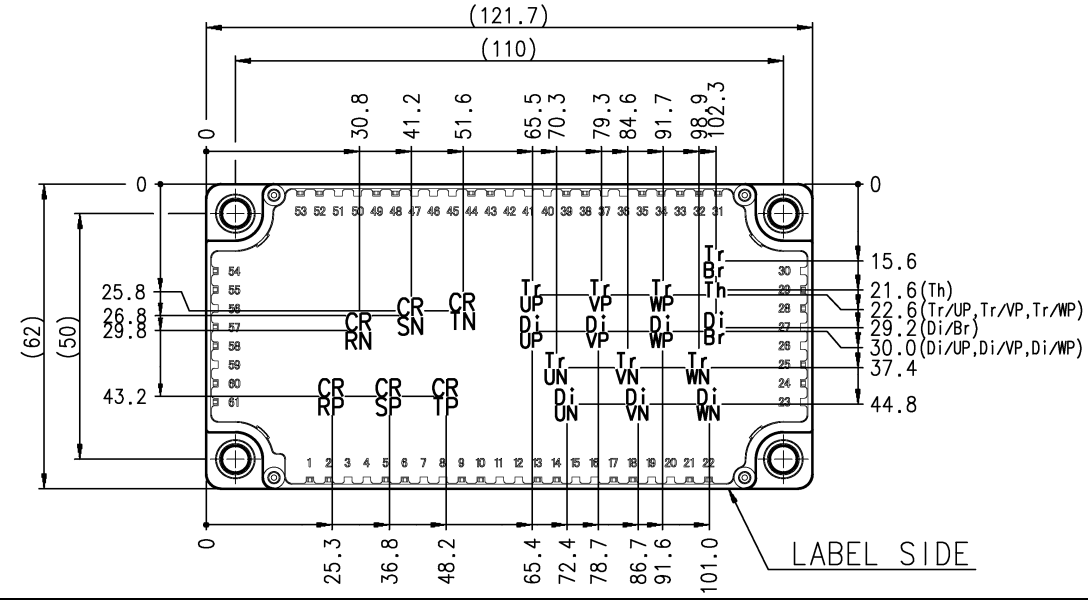
## Chip locations

Chip locations – 600 V class CIB (Dimension: mm)

CM75MX-12A




CM100MX-12A



**10. Switching energy**

When it performs instruction load half (full) bridge movement at a high temperature that switching energy becomes maximum and wiring inductance is small enough.

We show typical examples of switching energy under the conditions described below in Fig.3-11.

$V_{CC}$=600 V(6.1th Gen.),$V_{GE}$=±15V, ———: $T_j$=150 °C, - - - - -: $T_j$=125 °C

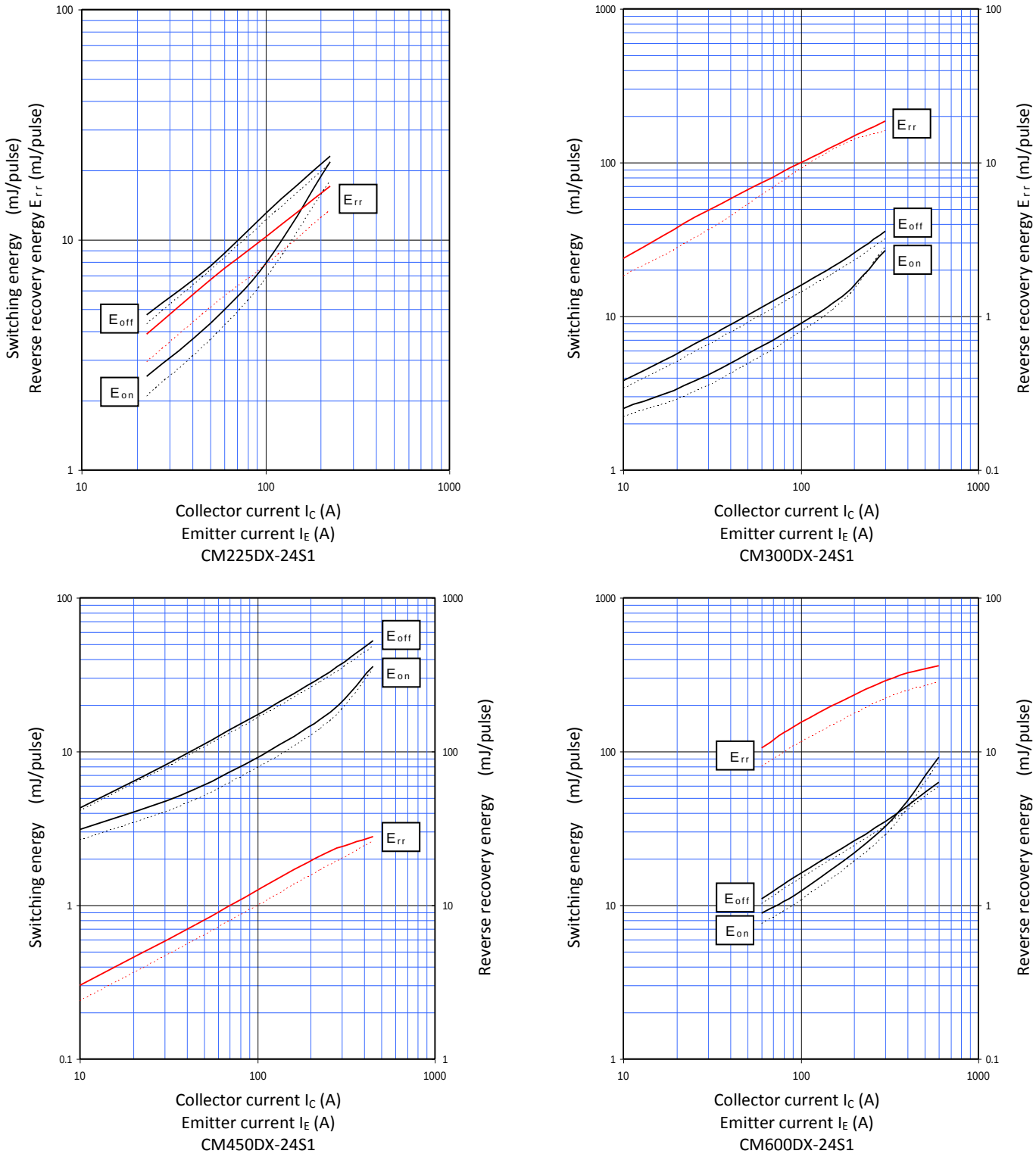
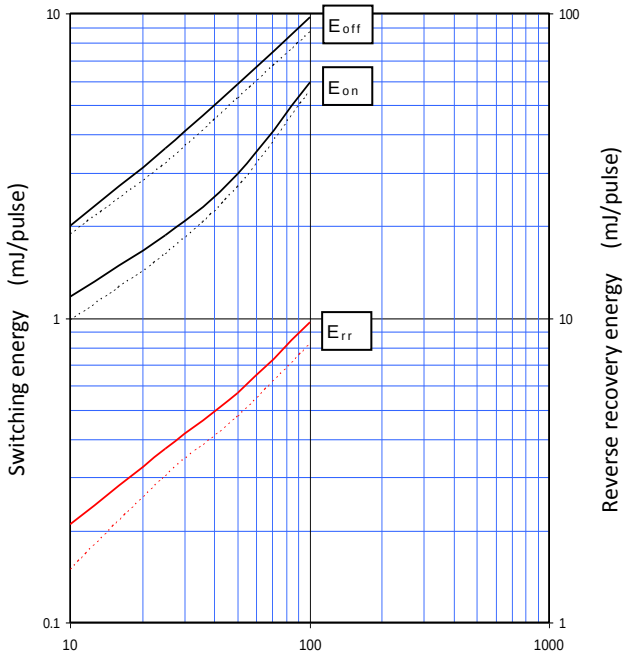
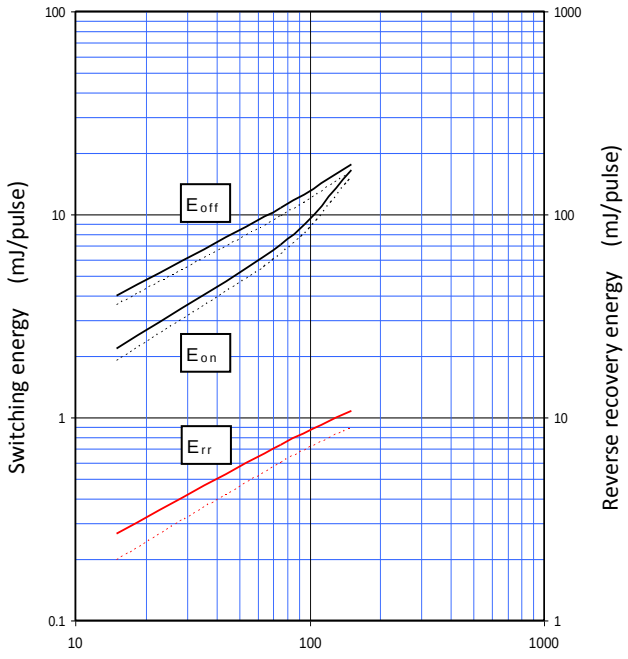



Fig.3-1 Half-bridge Inductive load switching energy of 6th Gen. dual switch

$V_{CC}$=600 V(6.1th Gen.),$V_{GE}$=±15V, ———: $T_j$=150 °C, - - - - -: $T_j$=125 °C

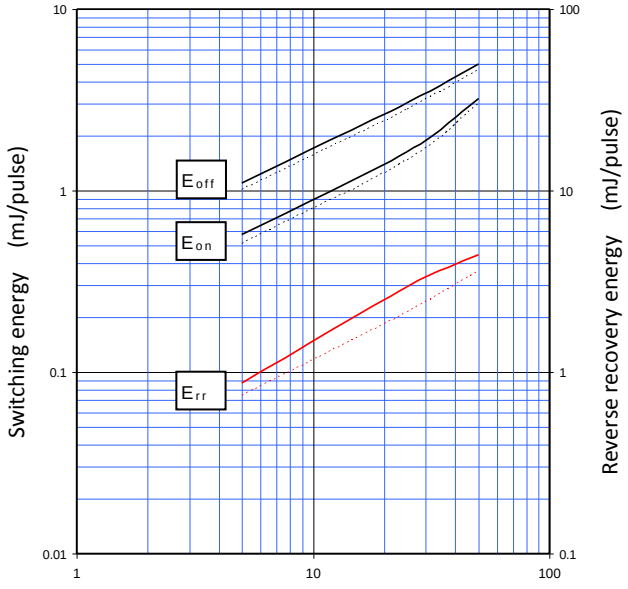



Collector current $I_C$ (A)
Emitter current $I_E$ (A)
CM100TX/RX-24S1 Inverter part

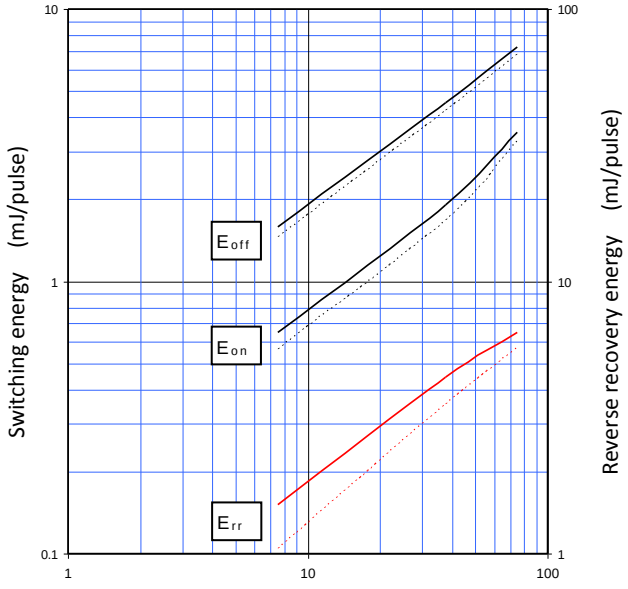



Collector current $I_C$ (A)
Emitter current $I_E$ (A)
CM150TX/RX-24S1 Inverter part

Fig.3-2 Half-bridge Inductive load switching energy of 6.1th Gen. sixpack / sevenpack




Collector current $I_C$ (A)
Emitter current $I_E$ (A)
CM100RX-24S1 Brake part




Collector current $I_C$ (A)
Emitter current $I_E$ (A)
CM150RX-24S1 Brake part

Fig.3-3 Half-bridge Inductive load switching energy of 6.1th Gen. sevenpack

Fig.3. Half-bridge Inductive load switching energy of 6.1th Gen.

Conditions: $T_j$=150 °C, $V_{CC}$=600 V (6th Gen.), $V_{GE}$=±15 V, $R_G$: Table 4

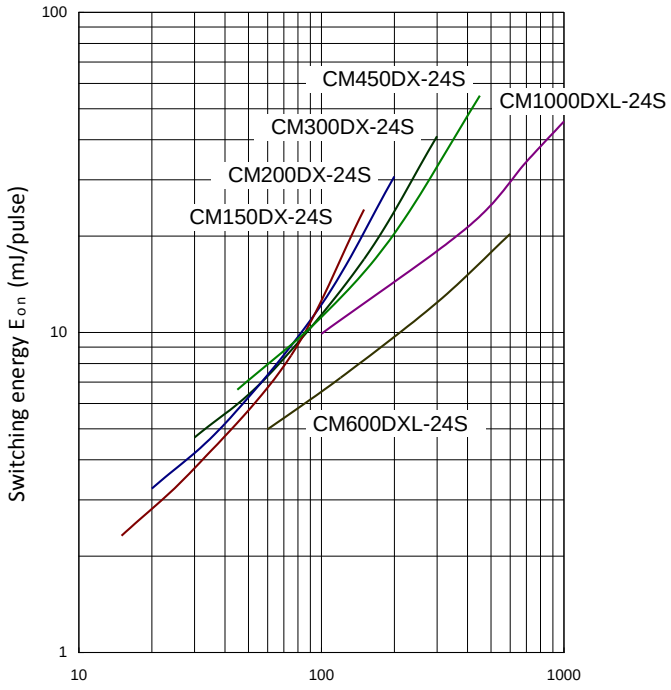



Fig.4-1 IGBT Turn-on switching energy

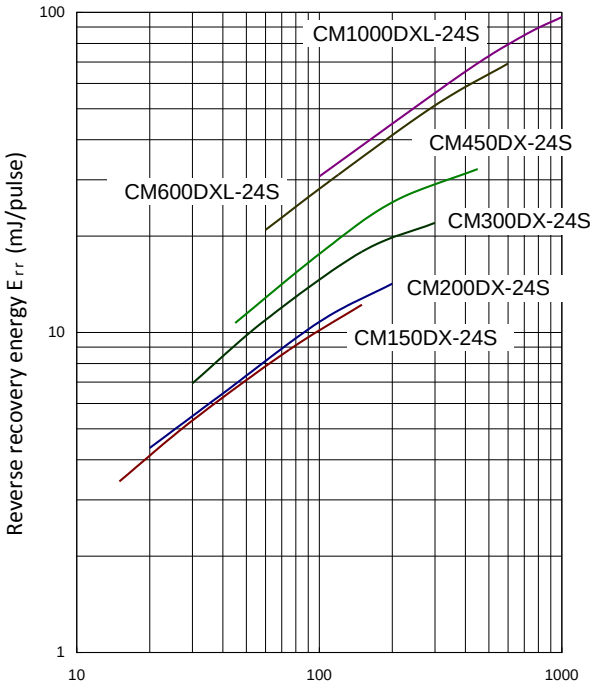



Fig.4-3 Diode Reverse recovery energy

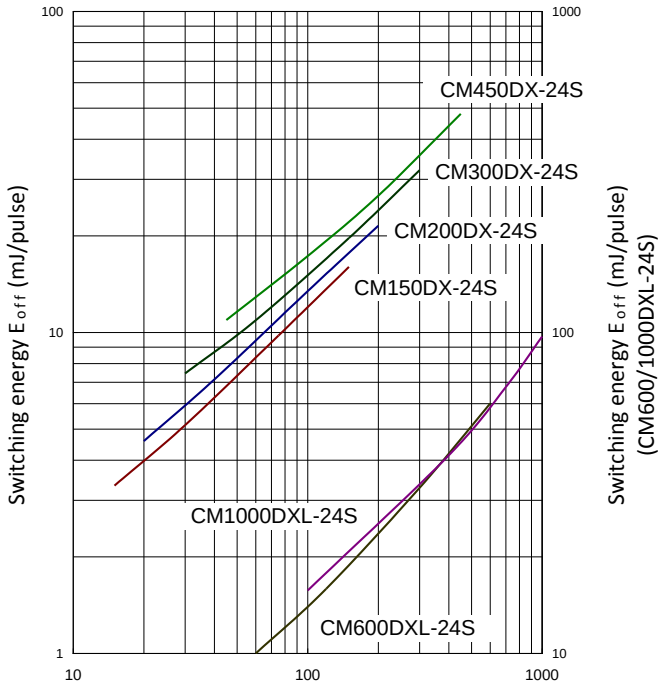



Fig.4-2 IGBT Turn-off switching energy

Fig.4 Half-bridge Inductive load switching energy of 6th Gen. dual switch

## Switching energy

Conditions: $T_j$=150 °C, $V_{CC}$=600 V (6th Gen.), $V_{GE}$=±15 V, $R_G$: Table 4

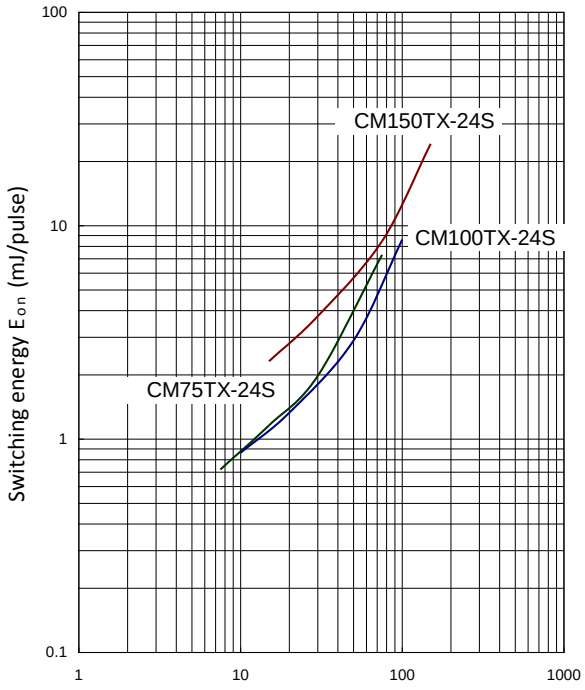



Fig.5-1 IGBT Turn-on switching energy

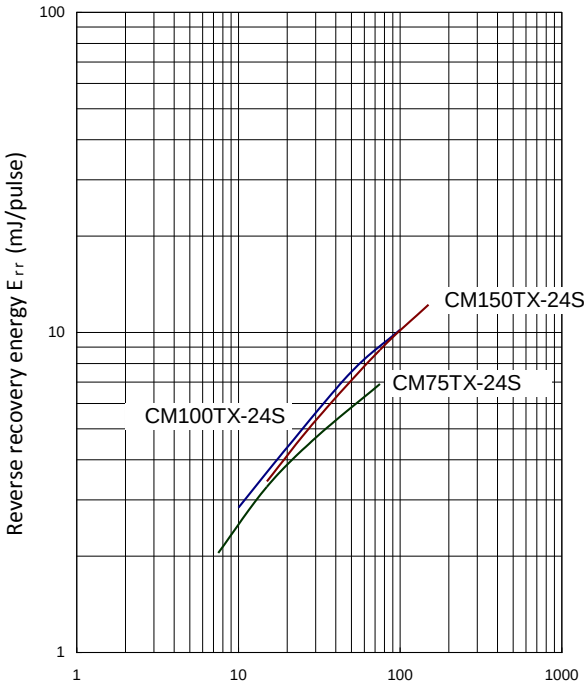



Fig.5-3 Diode Reverse recovery energy

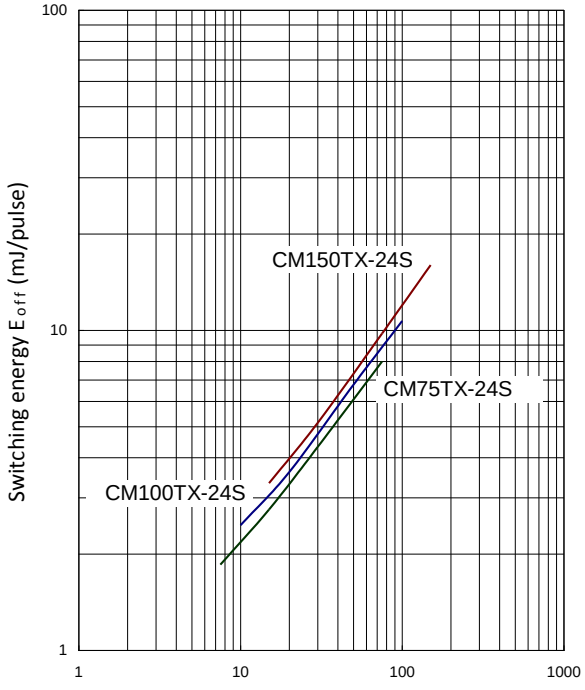



Fig.5-2 IGBT Turn-off switching energy

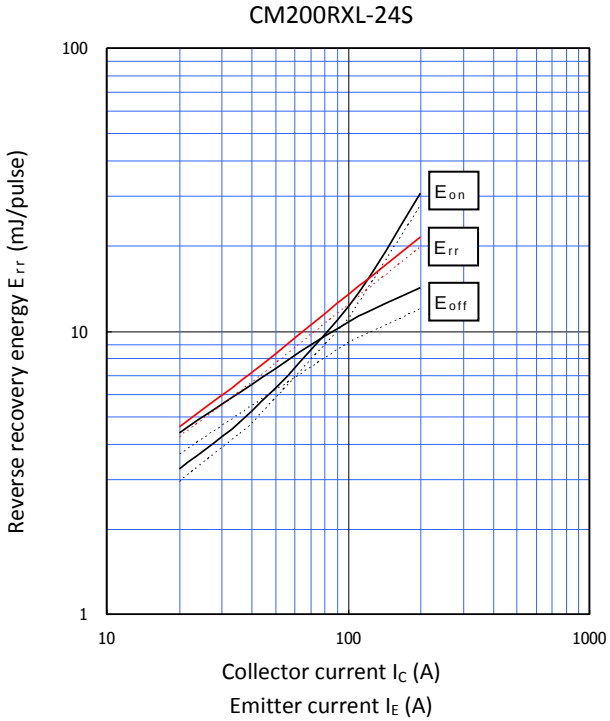



Fig.5 Half-bridge Inductive load switching energy of 6th Gen. sixpack / sevenpack

## Switching energy

Conditions: $T_j$=150 °C, $V_{CC}$=600 V (6th Gen.), $V_{GE}$=±15 V, $R_G$: Table 4

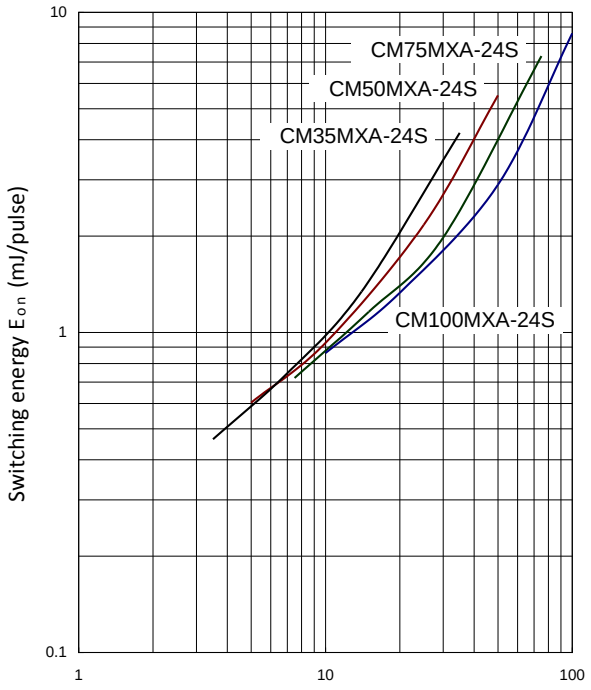



Fig.6-1 IGBT Turn-on switching energy

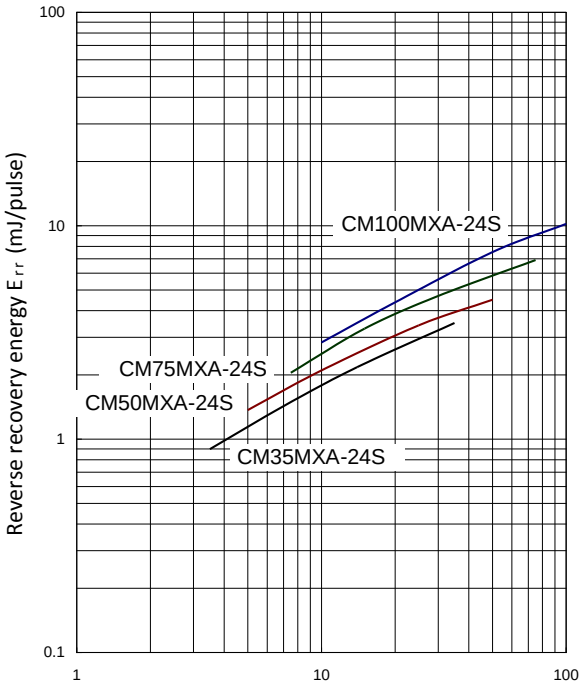



Fig.6-3 Diode Reverse recovery energy

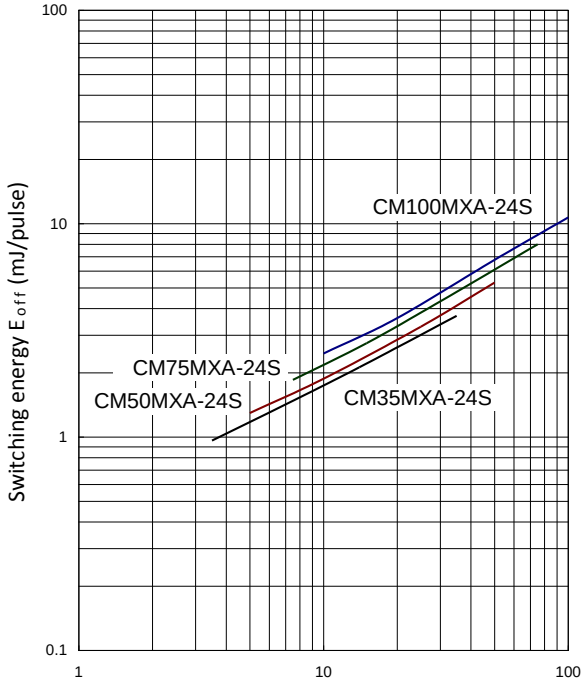



Fig.6-2 IGBT Turn-off switching energy

CM35MXA-24S Inverter part:
CM35/50MXA-24S Brake part
CM50MXA-24S Inverter part:
CM75/100MXA-24S, CM75/100RX-24S
Brake part
CM100MXA-24S Inverter part:
CM200TXL-24S Brake part

Fig.6 Half-bridge Inductive load switching energy of 6th Gen. CIB

Conditions: $T_j$=150 °C, $V_{CC}$=600 V (6th Gen.), $V_{GE}$=±15 V, $R_G$: Table 4

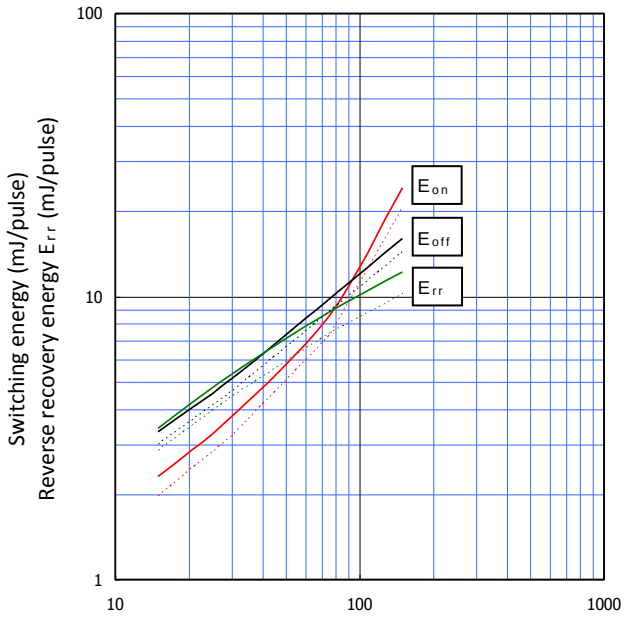



Fig.7-1 CM150EXS-24S

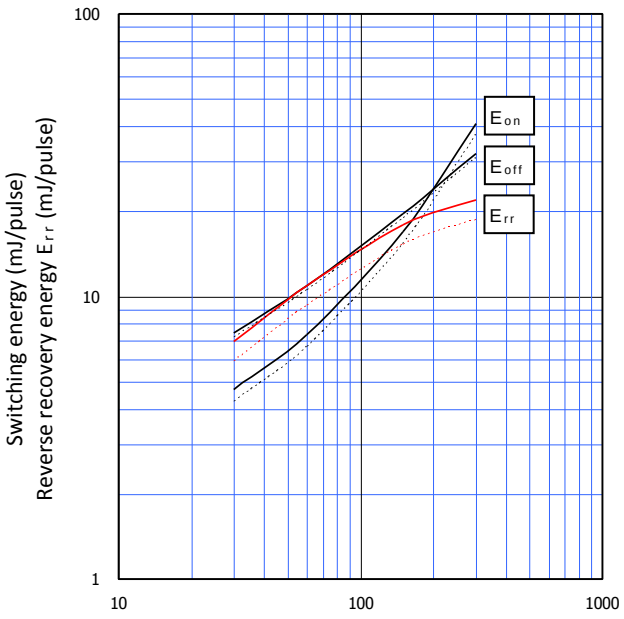



Fig.7-3 CM300EXS-24S

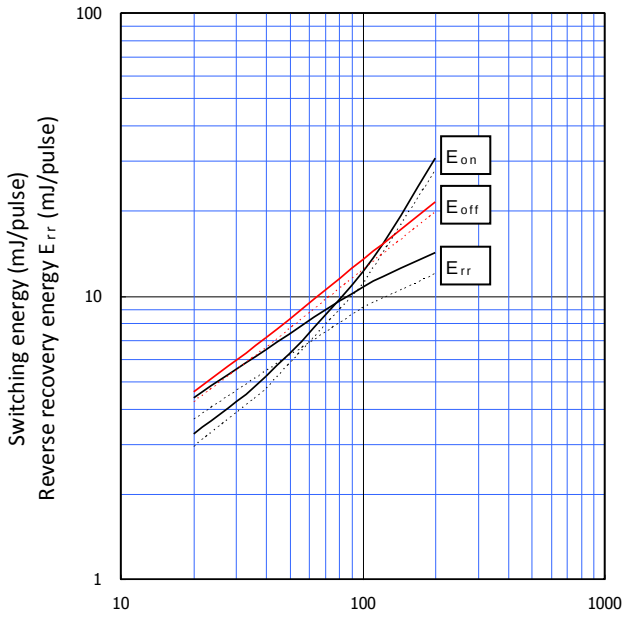



Fig.7-2 CM200EXS-24S

Fig.7 Half-bridge Inductive load switching energy of 6th Gen. brake chopper

## Switching energy

$T_j$=150 °C, $V_{CC}$=1000 V(6th Gen. 1700 V), $V_{GE}$=±15V, $R_G$: Table 4

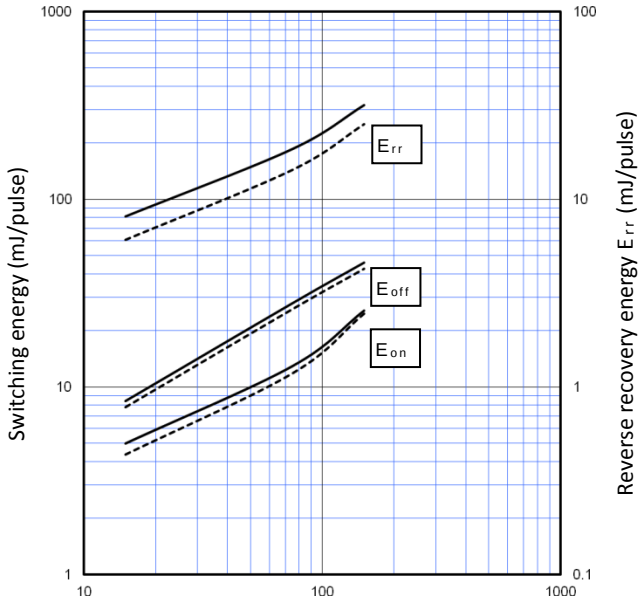



Fig.8-1 CM150DX-34SA/CM150RXL-34SA(Inv part)

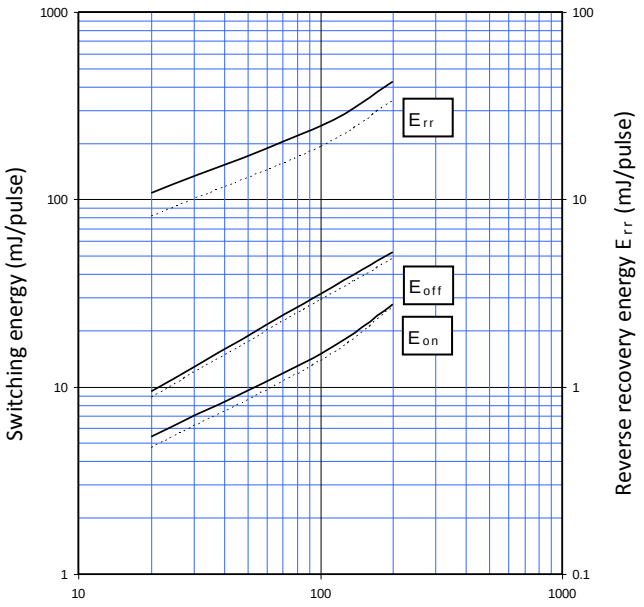



Fig.8-3 CM200DX-34SA/CM200EXS-34SA

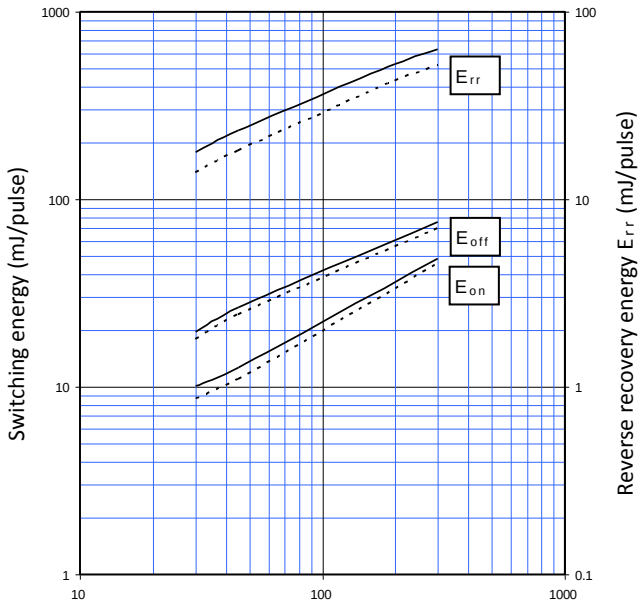



Fig.8-2 CM300DX-34SA

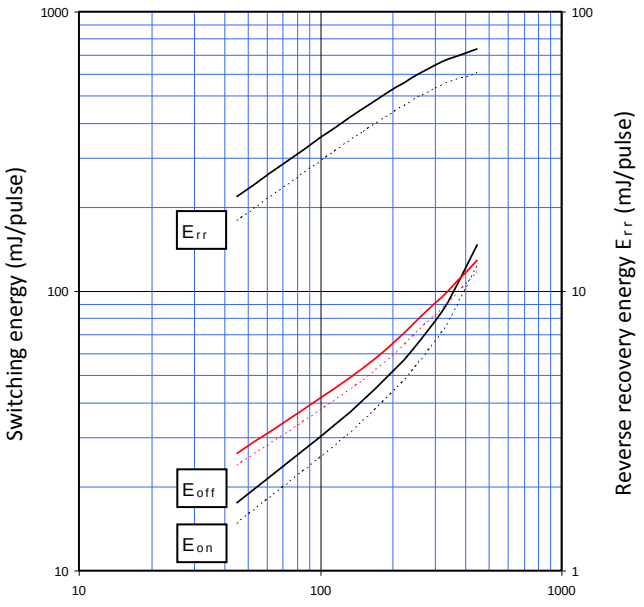



Fig.8-4 CM450DXL-34SA

Fig.8 Half-bridge Inductive load switching energy of 6th Gen. 1700 V

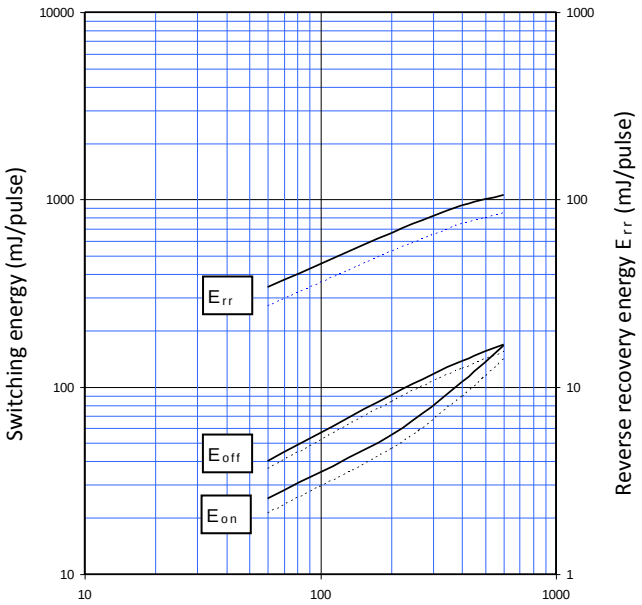



Fig.8-5 CM600DXL-34SA

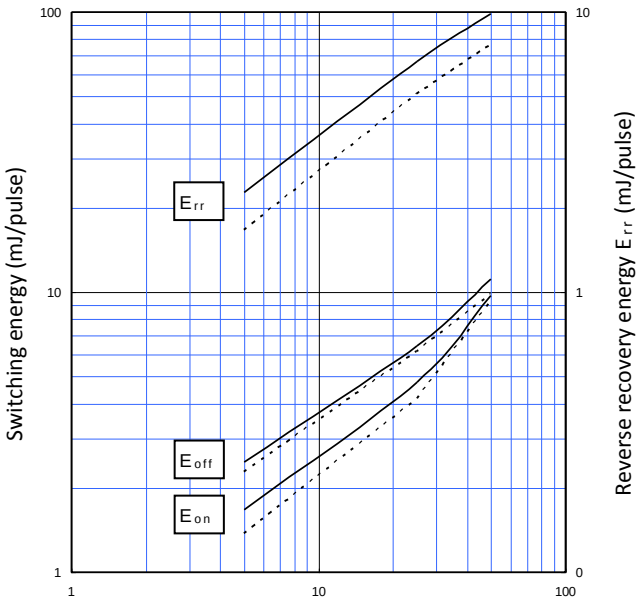



Fig.8-7 CM75RX-34SA/CM75MXA-34SA(Brake part)

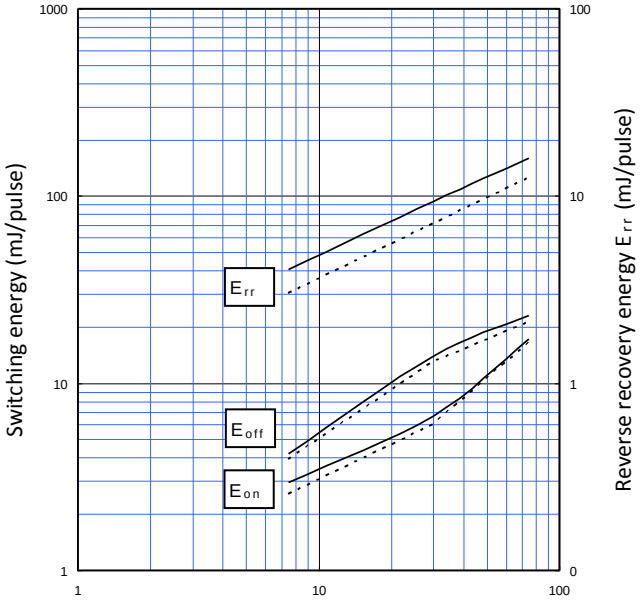



Fig.8-6 CM75RX-34SA/CM75MXA-34SA(Inv part)/
CM150RXL-34SA(Brake part)

Fig.8 Half-bridge Inductive load switching energy of 6th Gen. 1700 V

## Switching energy

Conditions: $T_j$=125 °C, $V_{CC}$=300 V (5th Gen. 600 V class) / 600 V (5th Gen. 1200 V class), $V_{GE}$=±15 V, $R_G$: Table 4

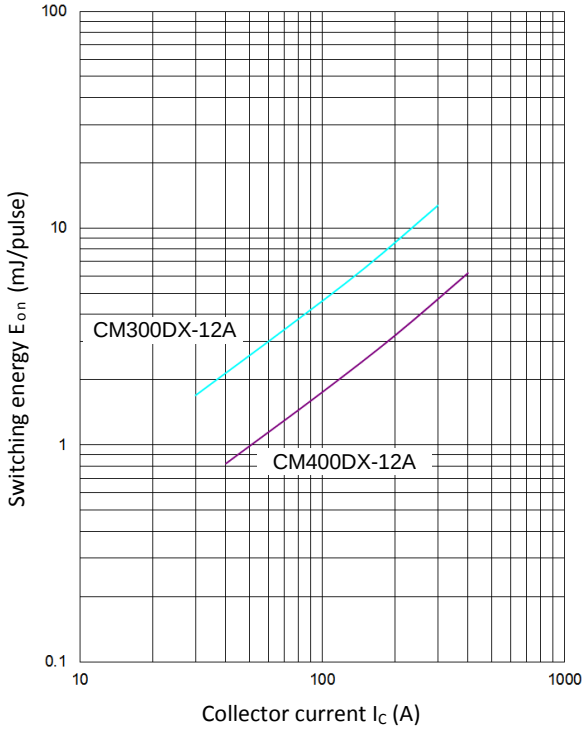



Fig.9-1 IGBT Turn-on switching energy

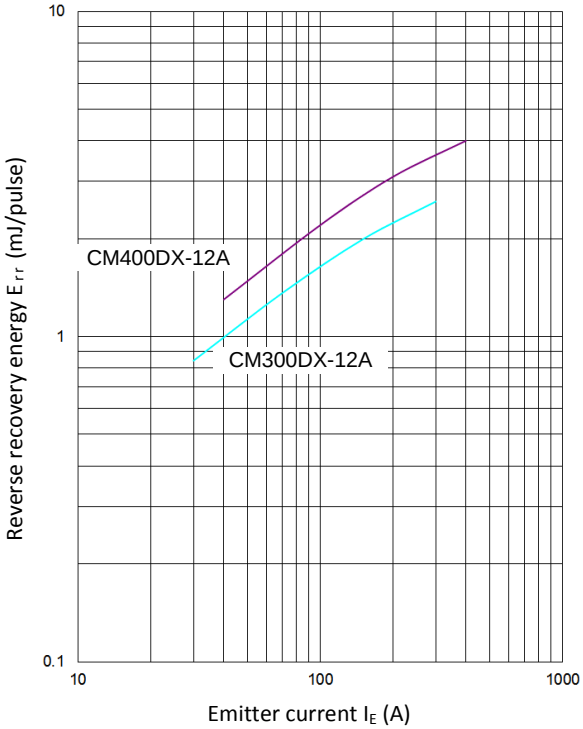



Fig.9-3 Diode Reverse recovery energy

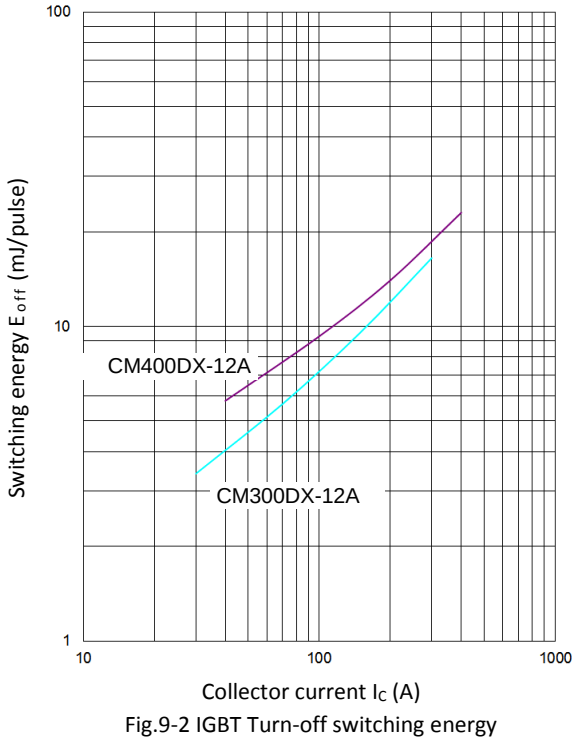



Fig.9-2 IGBT Turn-off switching energy

Fig.9 Half-bridge Inductive load switching energy of 5th Gen. 600 V class single / dual switch

## Switching energy

Conditions: $T_j$=125 °C, $V_{CC}$=300 V (5th Gen. 600 V class) / 600 V (5th Gen. 1200 V class), $V_{GE}$=±15 V, $R_G$: Table 4

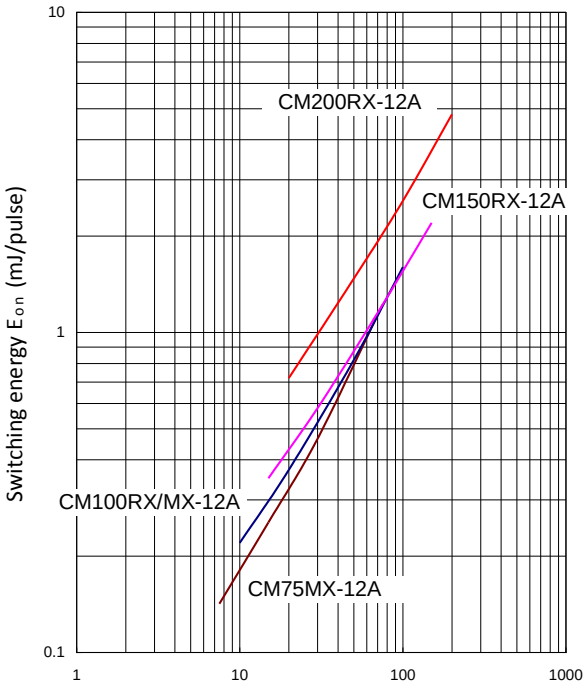



Fig.10-1 IGBT Turn-on switching energy

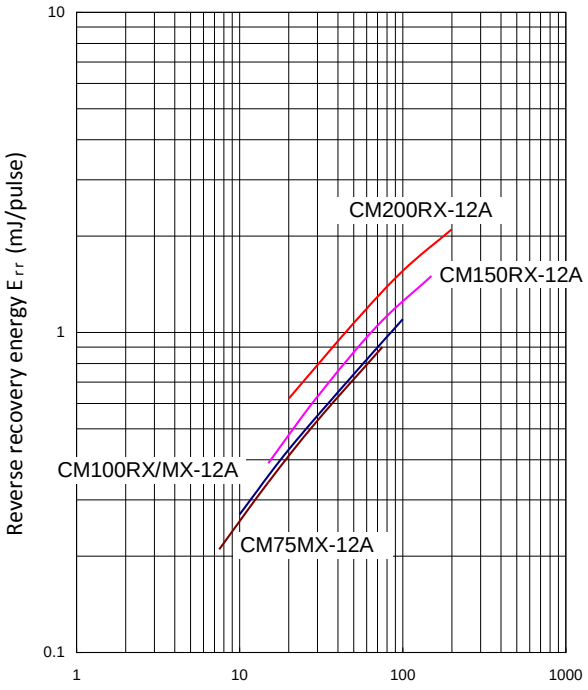



Fig.10-3 Diode Reverse recovery energy

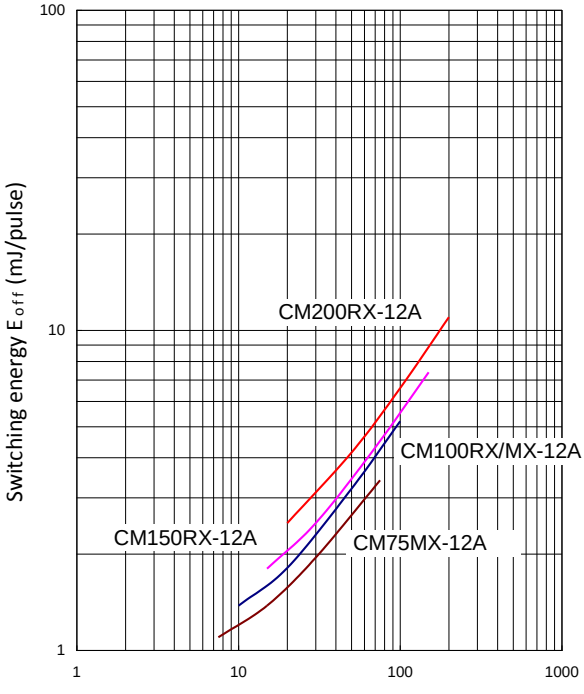



Fig.10-2 IGBT Turn-off switching energy

Fig.10 Half-bridge Inductive load switching energy of 5th Gen. 600 V class sevenpack / CIB

Table 4 Recommended Gate Resistance and $R_G$ value used for switching energy measurement (Typ.)

| Module | $R_G$ (Ω) | Typ. (Ω) | Module | $R_G$ (Ω) | Typ. (Ω) |
|---|---|---|---|---|---|
| CM100TX-24S1 | 6.2-62 | 6.2 | CM225DX-24S1 | 1.5-15 | 1.5 |
| CM150TX-24S1 | 0-30 | 0 | CM300DX-24S1 | 0-15 | 0 |
| CM100RX-24S1 | 6.2-62 | 6.2 | CM450DX-24S1 | 0-10 | 0 |
| CM150RX-24S1 | 0-30 | 0 | CM600DX-24S1 | 0-6.8 | 0 |

| Module | $R_G$ (Ω) | Typ. (Ω) | Module | $R_G$ (Ω) | Typ. (Ω) | Module | $R_G$ (Ω) | Typ. (Ω) |
|---|---|---|---|---|---|---|---|---|
| CM75TX-24S | 8.2-82 | 8.2 | CM35MXA-24S | 18-180 | 18 | CM150DX-24S | 0-30 | 0 |
| CM100TX-24S | 6.2-62 | 6.2 | CM50MXA-24S | 13-130 | 13 | CM200DX-24S | 0-22 | 0 |
| CM150TX-24S | 0-30 | 0 | CM75MXA-24S | 8.2-82 | 8.2 | CM300DX-24S | 0-15 | 0 |
| CM75RX-24S | 8.2-82 | 8.2 | CM100MXA-24S | 6.2-62 | 6.2 | CM450DX-24S | 0-10 | 0 |
| CM100RX-24S | 6.2-62 | 6.2 | | | | CM600DXL-24S | 0-6.8 | 0 |
| CM150RX-24S | 0-30 | 0 | | | | CM1000DXL-24S | 0-5.1 | 0 |

| Module | $R_G$ (Ω) | Typ. (Ω) | Module | $R_G$ (Ω) | Typ. (Ω) | Module | $R_G$ (Ω) | Typ. (Ω) |
|---|---|---|---|---|---|---|---|---|
| CM150DX-34SA | 0-50 | 0 | CM450DXL-34SA | 0-18 | 0 | CM75RX-34SA | 10-100 | 10 |
| CM200DX-34SA | 0-38 | 0 | CM600DXL-34SA | 0-13 | 0 | CM150RXL-34SA | 0-50 | 0 |
| CM300DX-34SA | 1.2-27 | 1.2 | CM200EXS-34SA | 0-38 | 0 | CM75MXA-34SA | 10-100 | 10 |

*: In case of type CM**RX and CM**MXA, Typ. represents inverter part only

| Module | $R_G$ (Ω) | Typ. (Ω) | Module | $R_G$ (Ω) | Typ. (Ω) |
|---|---|---|---|---|---|
| CM75MX-12A | 8.0-83 | 8.2 | CM300DX-12A | 2.0-21 | 5.1 |
| CM100MX-12A | 6.0-62 | 6.2 | CM400DX-12A | 1.6-16 | 3.0 |
| CM100RX-12A | 6.0-62 | 6.2 | | | |
| CM150RX-12A | 4.1-41 | 4.3 | | | |
| CM200RX-12A | 3.0-31 | 5.6 | | | |

*: In case of type CM**RX, CM**MX and CM**MXA, Typ. represents inverter part only

Table 5 Internal gate resistance

| Part number | $r_g$ (Ω) | Part number | $r_g$ (Ω) | Part number | $r_g$ (Ω) |
|---|---|---|---|---|---|
| CM150RX-24S1 | 13 | CM225DX-24S1 | 3.2 | CM450DX-24S1 | 4.3 |
| CM150TX-24S1 | 13 | CM300DX-24S1 | 6.5 | CM600DX-24S1 | 5.0 |

*: In case of type CM**RX, CM**MX and CM**MXA, Typ. represents inverter part only

| Part number | $r_g$ (Ω) | Part number | $r_g$ (Ω) | Part number | $r_g$ (Ω) | Part number | $r_g$ (Ω) |
|---|---|---|---|---|---|---|---|
| CM150RX-24S | 13 | CM300DX-24S | 6.5 | CM150DX-34SA | 3.4 | CM450DXL-34SA | 3.2 |
| CM150TX-24S | 13 | CM450DX-24S | 4.3 | CM200DX-34SA | 2.5 | CM600DXL-34SA | 2.4 |
| CM150DX-24S | 13 | CM600DXL-24S | 3.3 | CM300DX-34SA | 1.7 | CM150RXL-34SA | 3.4 |
| CM200DX-24S | 9.8 | CM1000DXL-24S | 2.0 | | | CM200EXS-34SA | 2.5 |

*: In case of type CM**RX, CM**MX and CM**MXA, Typ. represents inverter part only

The internal gate resistance of the 5th Gen. NX series uses semiconductor chip resistors.
* The semiconductor resistor has max. 200 % of temperature coefficient of 125 °C for 25 °C and ±30 % of resistance variation.

**11. Test circuit and waveforms**

Half-bridge switching test circuit and waveforms

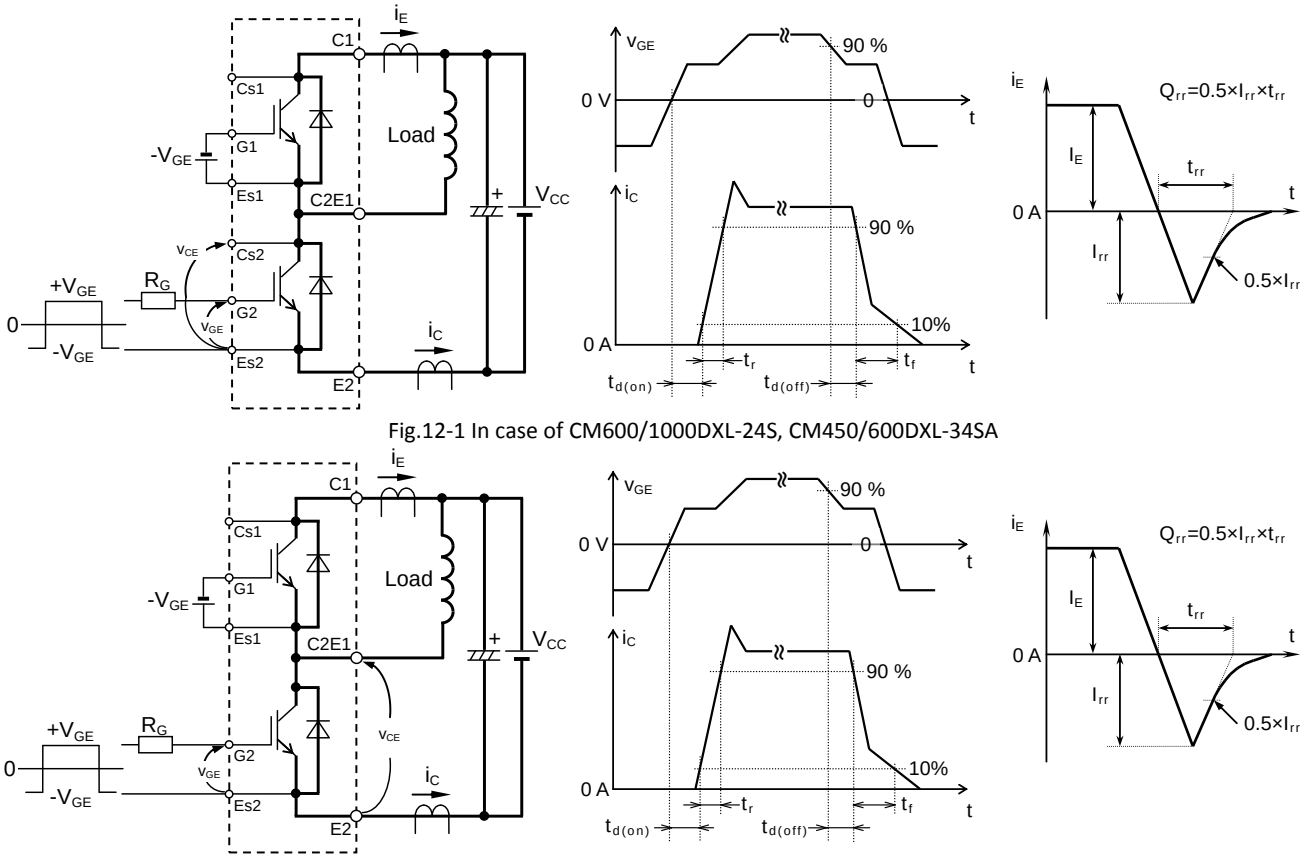
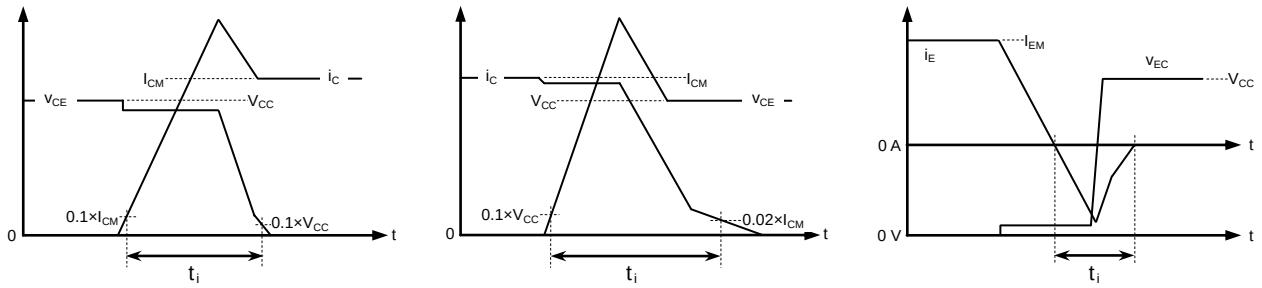



Fig.12-1 In case of CM600/1000DXL-24S, CM450/600DXL-34SA




Fig.12-2 In case of CM***DX

Fig.12 Half-bridge switching test circuit and waveforms




IGBT Turn-on switching energy | IGBT Turn-off switching energy | Diode Reverse recovery energy

Fig.13 IGBT turn-on/turn-off switching energy and Diode reverse recovery test wave forms.
(Integral time instruction drawing)

100% of parameter to fix each 10% and 2% doesn't include the current which is caused by Diode reverse recovery or the stray capacitance of load and a surge voltage and a voltage drop which is caused by the stray inductance.

100% of $V_{CE}$ is $V_{CC}$.

An influence over the switching loss by the corrugated change, which is caused by these, is reflected in the switching loss just as it is.

Also, for the reactive-power, we included it in the integration value because it is impossible to separate.

Strictly, 0% of the $I_C$ is not $I_C$=0 A and it is Ices. 0% of $V_{CE}$ is not $V_{CE}$=0 V and it is $V_{CEsat}$.

When it isn't possible to sufficiently remove the vibration, which is caused by the wiring inductance, a range is fixed based on the line, which estimated the center line of the vibration.

But, when the same estimation above is difficult, we sometimes suppose that the range is fixed based on the time which the waveform reaches the criterion first.

**12. Loss calculation**

Simulation software designed for the power loss calculation with Mitsubishi Electric power modules under customers specific application conditions (2-level and 3-level inverter circuit) and for junction temperature rises as a consequence of power loss.

You need to register yourself to our web site and download the data in order to access the loss simulator.

http://www.mitsubishielectric.com/semiconductors/simulator/index.html

**13. Parallel specifications**

The following sub-sections outline the basic requirements and considerations for parallel operation of single or dual switch IGBT modules with ratings of 200 A or more.

With proper attention to circuit design and device selection several modules can be reliably operated in parallel.

- We deliver .the classified modules which are in the same saturation rank according to the paralleled number of modules on the orders received.
- The saturation voltage rank symbol (C, D, E etc.) is marked on the module label.

Table 6 the saturation voltage rank symbol for parallel applications ($I_C$=rated current, $V_{GE}$=15 V, $T_j$=25 °C)

| CM200~450DX-24S1 (chip) | | CM600DX-24S1 (chip) | |
|---|---|---|---|
| Rank symbol | $V_{CEsat}$ (V) | Rank symbol | $V_{CEsat}$ (V) |
| A | 1.49 - 1.67 | A | 1.61 - 1.72 |
| B | 1.58 - 1.81 | B | 1.66 - 1.84 |
| C | 1.67 - 1.95 | C | 1.73 - 1.97 |
| D | 1.81 - 2.15 | D | 1.85 - 2.19 |
| - | - | E | 1.98 - 2.30 |

This table is settled from the view point of keeping current imbalance within ±15% at its $T_j$=150 °C.

| 24S (chip) | |
|---|---|
| Rank symbol | $V_{CEsat}$ (V) |
| A | 1.49 - 1.67 |
| B | 1.58 - 1.81 |
| C | 1.67 - 1.95 |
| D | 1.81 - 2.15 |

This table is settled from the view point of keeping current imbalance within ±15% at its $T_j$=150 °C.

| 12A | |
|---|---|
| Rank symbol | $V_{CEsat}$ (V) |
| B | 1.44 - 1.59 |
| C | 1.55 - 1.72 |
| D | 1.68 - 1.87 |
| E | 1.83 - 2.04 |

This table is settled from the view point of keeping current imbalance within ±10% (12A) at its $T_j$=125 °C.

Notes

1. Modules of same rank should be applied only for each paralleled connection, and it permits to use the different rank modules to the different phase outputs or axis in the one equipment.
2. This rank specification is useful for the static balance at DC current point, and this is not effective for dynamic balance at switching transition.
   As the switching balance is mainly dominated by wiring inductance in the equipment,
   take care of the symmetric circuit design and layout about this wiring for parallel operation with these modules.

3 Target imbalances

When modules of the same saturation voltage rank are paralleled, the static current imbalance will be minimized so that the following imbalance rate can be applied: 10% for 600 V class, 15% for 1200 V class.

The imbalance rate is defined when more than two modules are paralleled. The collector current easily concentrates on one element with the parallel number increasing. Therefore, derating is important for parallel operation.

When more than two modules are paralleled the derating factor can be calculated using the following formula:

(1-((n-1)× (1-x)/ (1+x)+1)/n)×100%, where ±x×100% is the imbalance rate described above.

For example, in case of four IGBT modules of 600V class connected in parallel, the current derating factor is

(1-((4-1)×(1-0.1)/(1+0.1)+1)/4)×100%=13.6%

so the allowable current with 4 parallel 300 A modules is

300×(1-0.136)×4=1036 A

| Parallel No. n | derating factors (%) | |
|---|---|---|
| | 600 V class | 1200 V class |
| 2 | 10.0 | 15.0 |
| 3 | 12.1 | 17.4 |
| 4 | 13.6 | 19.6 |

**14. Safe operating area (SOA)**

6.1th Gen. S series NX type

**Turn-off switching SOA (Reverse Bias SOA)**

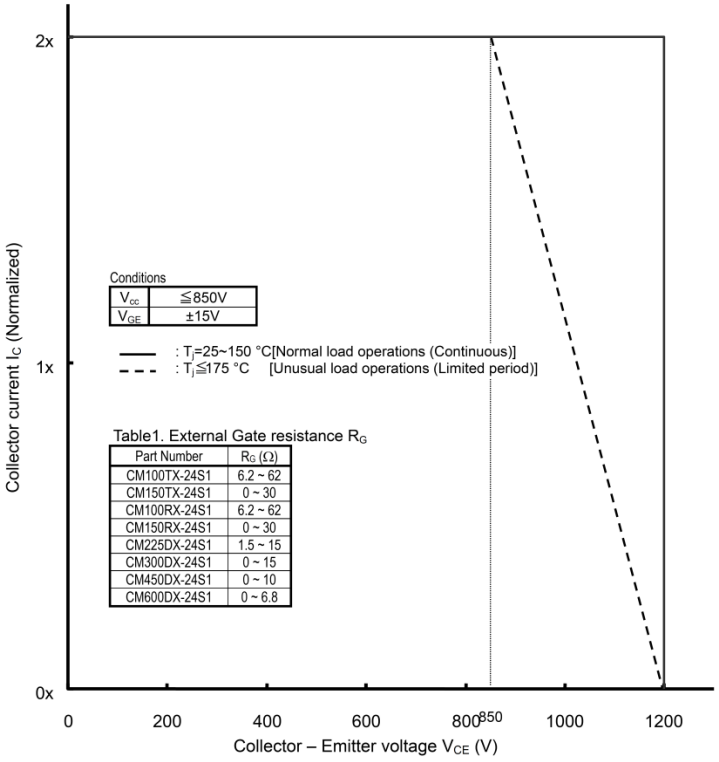
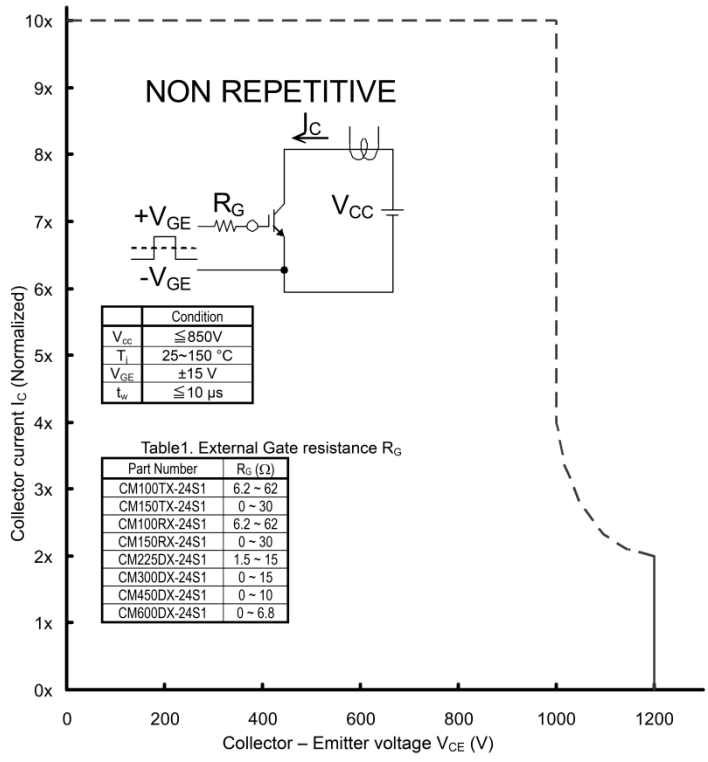



Table1. External Gate resistance $R_G$

| Part Number | $R_G$ (Ω) |
|---|---|
| CM100TX-24S1 | 6.2 ~ 62 |
| CM150TX-24S1 | 0 ~ 30 |
| CM100RX-24S1 | 6.2 ~ 62 |
| CM150RX-24S1 | 0 ~ 30 |
| CM225DX-24S1 | 1.5 ~ 15 |
| CM300DX-24S1 | 0 ~ 15 |
| CM450DX-24S1 | 0 ~ 10 |
| CM600DX-24S1 | 0 ~ 6.8 |

**Short-circuit SOA**




| | Condition |
|---|---|
| $V_{cc}$ | ≦850V |
| $T_j$ | 25~150 °C |
| $V_{GE}$ | ±15 V |
| $t_w$ | ≦10 μs |

Table1. External Gate resistance $R_G$

| Part Number | $R_G$ (Ω) |
|---|---|
| CM100TX-24S1 | 6.2 ~ 62 |
| CM150TX-24S1 | 0 ~ 30 |
| CM100RX-24S1 | 6.2 ~ 62 |
| CM150RX-24S1 | 0 ~ 30 |
| CM225DX-24S1 | 1.5 ~ 15 |
| CM300DX-24S1 | 0 ~ 15 |
| CM450DX-24S1 | 0 ~ 10 |
| CM600DX-24S1 | 0 ~ 6.8 |

Note; For suppressing $V_{CE}$ at short-circuit turn-off below this SCSOA curve We recommend to use a soft turn-off technique for -di/dt (off) decreasing control.
SOA is 99% guarantee by extremal probability

## Safe operating area (SOA)

6th Gen. S series NX type 1200 V

**Turn-off switching SOA (Reverse Bias SOA)**

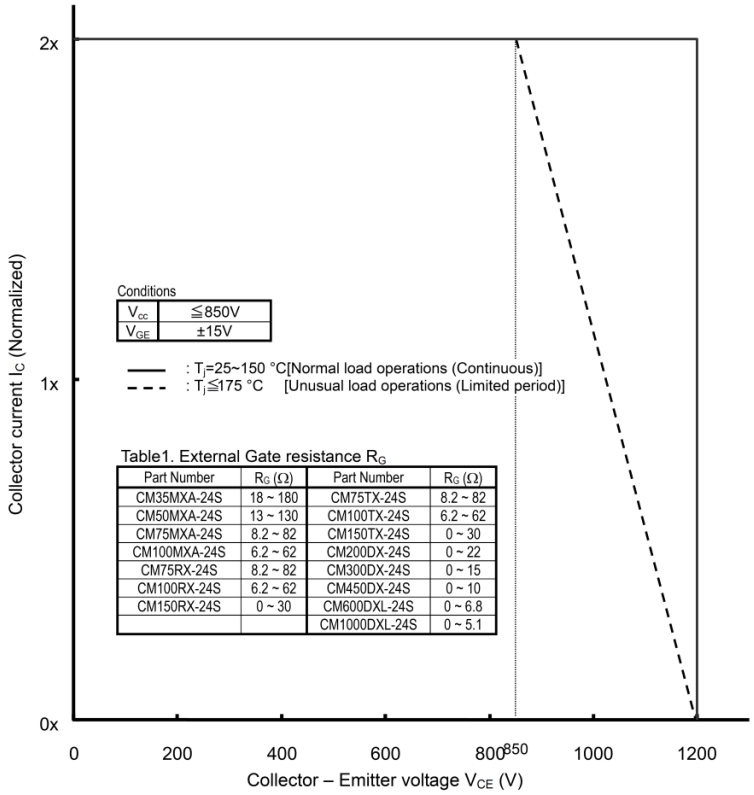



Table1. External Gate resistance $R_G$

| Part Number | $R_G$ (Ω) | Part Number | $R_G$ (Ω) |
|---|---|---|---|
| CM35MXA-24S | 18 ~ 180 | CM75TX-24S | 8.2 ~ 82 |
| CM50MXA-24S | 13 ~ 130 | CM100TX-24S | 6.2 ~ 62 |
| CM75MXA-24S | 8.2 ~ 82 | CM150TX-24S | 0 ~ 30 |
| CM100MXA-24S | 6.2 ~ 62 | CM200DX-24S | 0 ~ 22 |
| CM75RX-24S | 8.2 ~ 82 | CM300DX-24S | 0 ~ 15 |
| CM100RX-24S | 6.2 ~ 62 | CM450DX-24S | 0 ~ 10 |
| CM150RX-24S | 0 ~ 30 | CM600DXL-24S | 0 ~ 6.8 |
| | | CM1000DXL-24S | 0 ~ 5.1 |

**Short-circuit SOA**

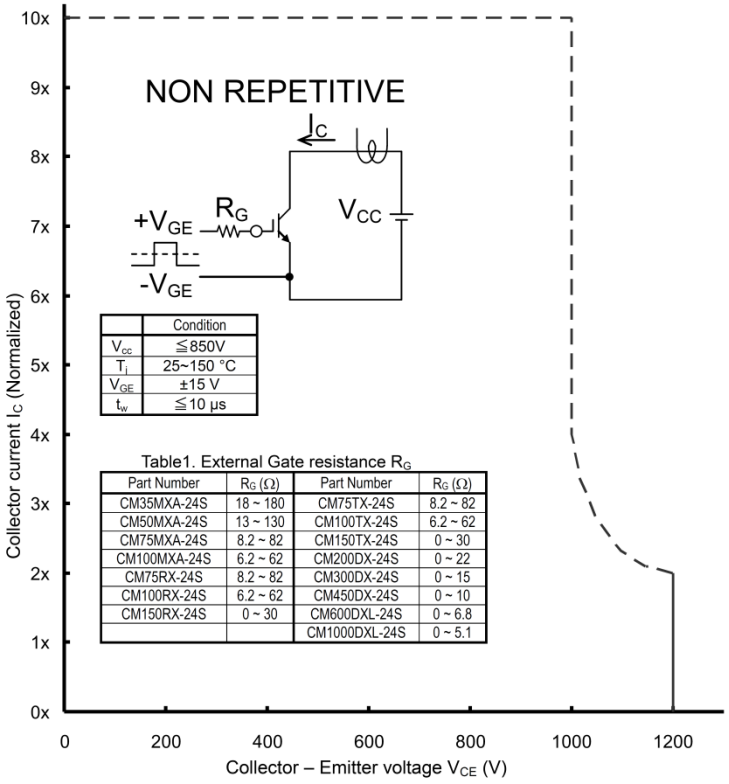



Table1. External Gate resistance $R_G$

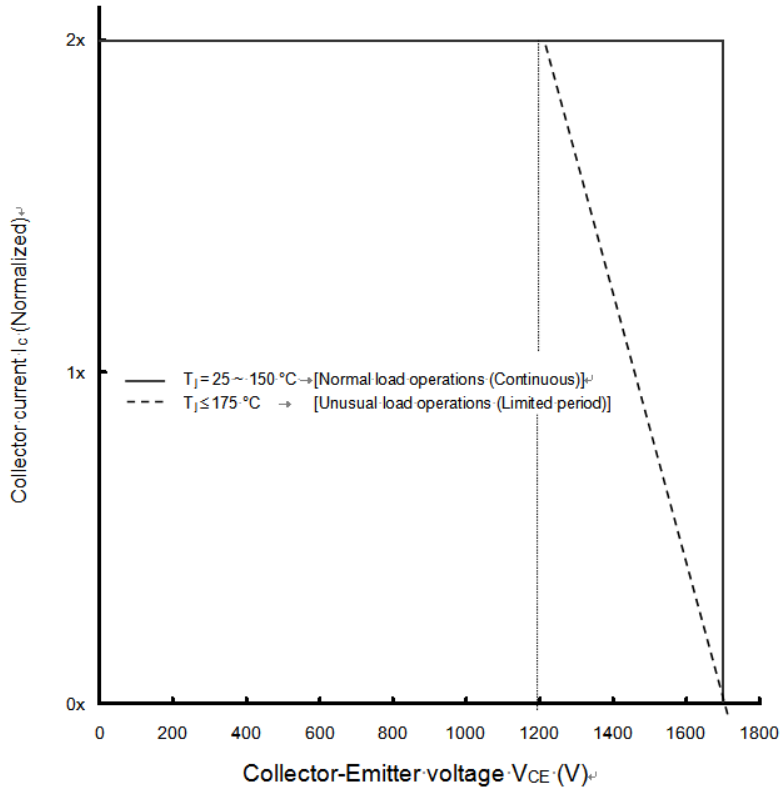
| Part Number | $R_G$ (Ω) | Part Number | $R_G$ (Ω) |
|---|---|---|---|
| CM35MXA-24S | 18 ~ 180 | CM75TX-24S | 8.2 ~ 82 |
| CM50MXA-24S | 13 ~ 130 | CM100TX-24S | 6.2 ~ 62 |
| CM75MXA-24S | 8.2 ~ 82 | CM150TX-24S | 0 ~ 30 |
| CM100MXA-24S | 6.2 ~ 62 | CM200DX-24S | 0 ~ 22 |
| CM75RX-24S | 8.2 ~ 82 | CM300DX-24S | 0 ~ 15 |
| CM100RX-24S | 6.2 ~ 62 | CM450DX-24S | 0 ~ 10 |
| CM150RX-24S | 0 ~ 30 | CM600DXL-24S | 0 ~ 6.8 |
| | | CM1000DXL-24S | 0 ~ 5.1 |

Note; For suppressing $V_{CE}$ at short-circuit turn-off below this SCSOA curve We recommend to use a soft turn-off technique for -di/dt (off) decreasing control.
SOA is 99% guarantee by extremal probability

## Safe operating area (SOA)

6th Gen. S series NX type 1700 V

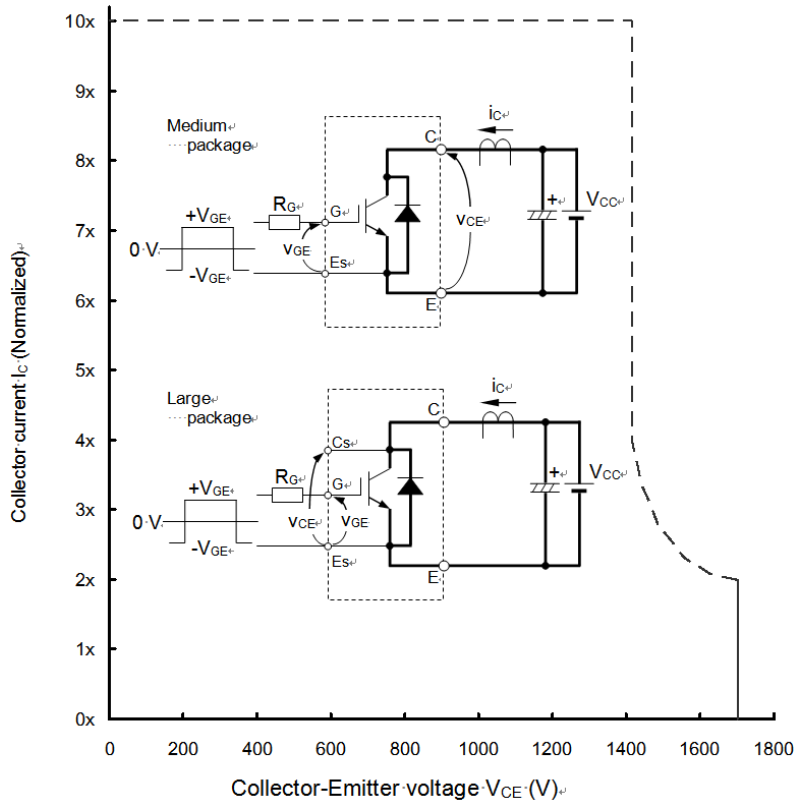
### Turn-off switching SOA (Reverse Bias SOA)




$V_{CC} \leq 1200$ V, $V_{GE} = \pm 15$ V
( ): $R_G$ value for Brake part,
*: Large package

| Part No. | RG (Ω) | Part No. | RG (Ω) |
|---|---|---|---|
| CM75MXA-34SA | 10 ~ 100 | CM150DX-34SA | 0~50 |
| CM75MXA-34SA | (13~130) | CM200DX-34SA | 0~38 |
| CM75RX-34SA | 10 ~ 100 | CM300DX-34SA | 1.3~21 |
| CM75RX-34SA | (13~130) | CM450DXL-34SA* | 0~18 |
| CM150RXL-34SA* | 0~50 | CM600DXL-34SA* | 0~13 |
| CM150RXL-34SA* | (10~100) | | |

### Short-circuit SOA



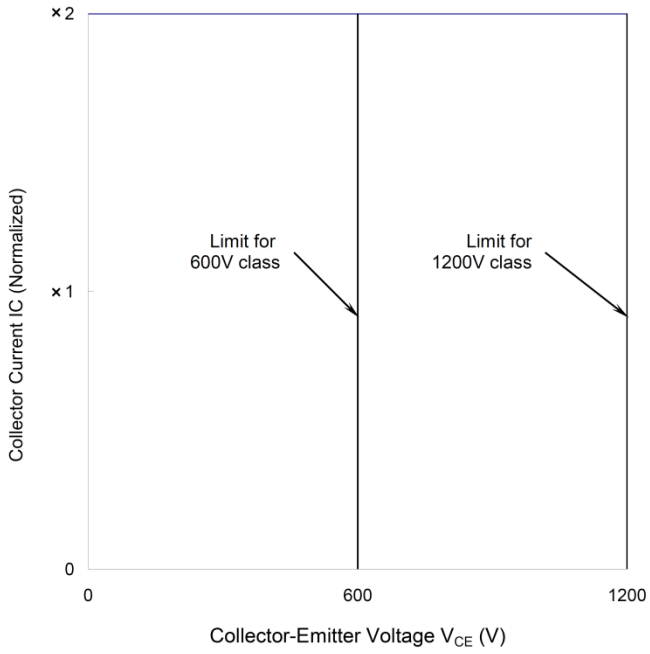

$V_{CC} \leq 1200$ V, $V_{GE} = \pm 15$ V, $T_j$: 25~150 °C,
$t_W \leq 10$ µs, Non-Repetitive
*: Large package

| Part No. | RG (Ω) | Part No. | RG (Ω) |
|---|---|---|---|
| CM75MXA-34SA | 10 ~ 100 | CM150DX-34SA | 0~50 |
| CM75MXA-34SA | (13~130) | CM200DX-34SA | 0~38 |
| CM75RX-34SA | 10 ~ 100 | CM300DX-34SA | 1.3~21 |
| CM75RX-34SA | (13~130) | CM450DXL-34SA* | 0~18 |
| CM150RXL-34SA* | 0~50 | CM600DXL-34SA* | 0~13 |
| CM150RXL-34SA* | (10~100) | | |

Note; For suppressing $V_{CE}$ at Short Circuit turn-off below this SC-SOA curve we recommend to use a soft turn-off technique for -di/dt(off) decreasing control.

5th Gen. NX series

**Turn-off switching SOA (Reverse Bias SOA)**

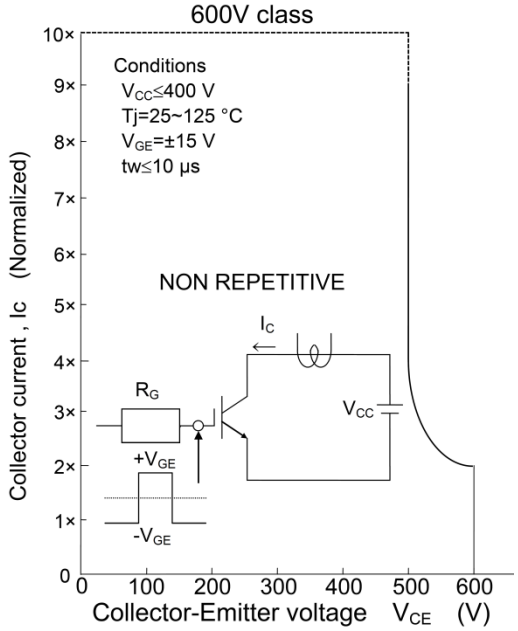



Conditions :
$V_{CC}$≤400V, Tj=25 ~ 125°C, $V_{GE}$=±15V

Gate resistance ($R_G$) value list

| Part Number | $R_G$ (Ω) |
|---|---|
| CM75MX-12A | 8.0 ~ 83 |
| CM100MX-12A | 6.0 ~ 62 |
| CM100RX-12A | 6.0 ~ 62 |
| CM150RX-12A | 4.1 ~ 41 |
| CM200RX-12A | 3.0 ~ 31 |
| CM300DX-12A | 2.0 ~ 21 |
| CM400DX-12A | 1.5 ~ 16 |

**Short-circuit SOA**




Gate resistance ($R_G$) value list

| Part Number | $R_G$ (Ω) |
|---|---|
| CM75MX-12A | 8.0 ~ 83 |
| CM100MX-12A | 6.0 ~ 62 |
| CM100RX-12A | 6.0 ~ 62 |
| CM150RX-12A | 4.1 ~ 41 |
| CM200RX-12A | 3.0 ~ 31 |
| CM300DX-12A | 2.0 ~ 21 |
| CM400DX-12A | 1.5 ~ 16 |

Note; For suppressing $V_{CE}$ at Short Circuit turn-off below this SCSOA curve, we recommend to use a soft turn-off technique for –di/dt(off) decreasing control. SOA is 99% guarantee by extremal probability.

## Keep safety first in your circuit designs!

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