
Fuji IGBT Module V Series 600V Family

Technical Notes

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- Fuji IGBT Module V Series 600V Family -

RBSOA and SCSOA

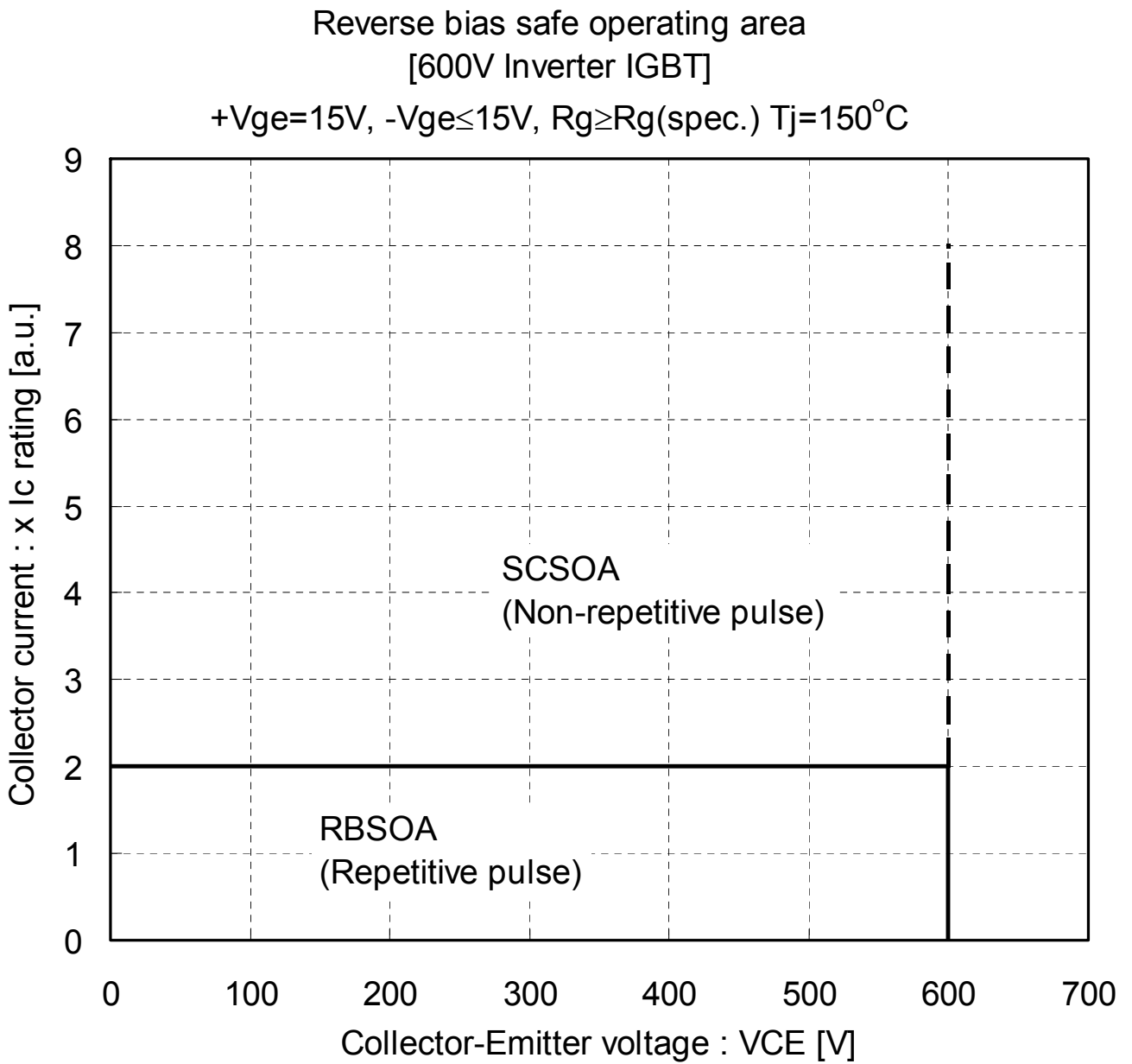


Fig. RBSOA and SCSOA

Technical data: MT5F24331

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High current output characteristics

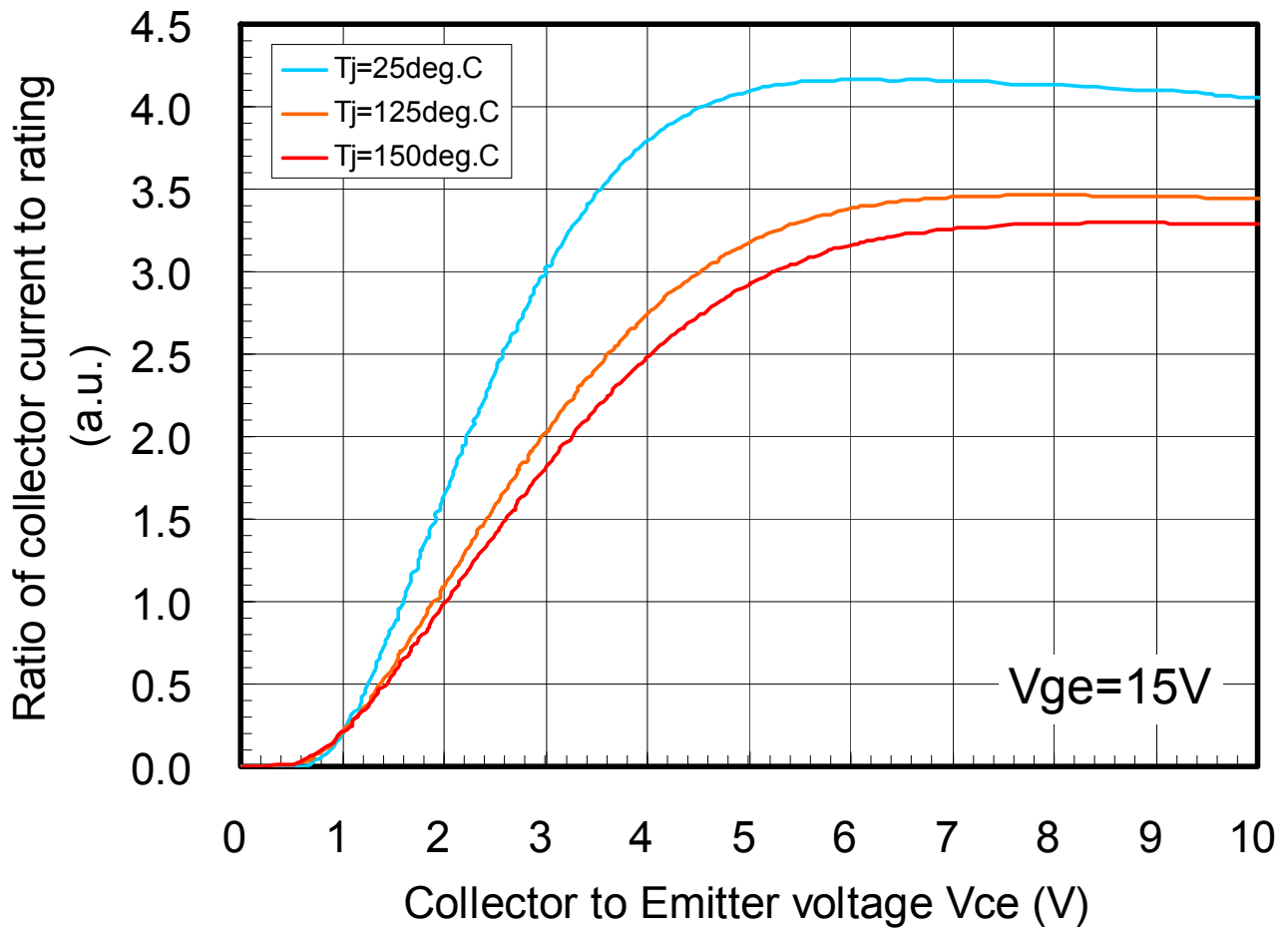
V series 600V product family

Conditions: $T_j=25^\circ\text{C}$, 125°C and 150°C

$V_{ge}=15\text{V}$

Note:

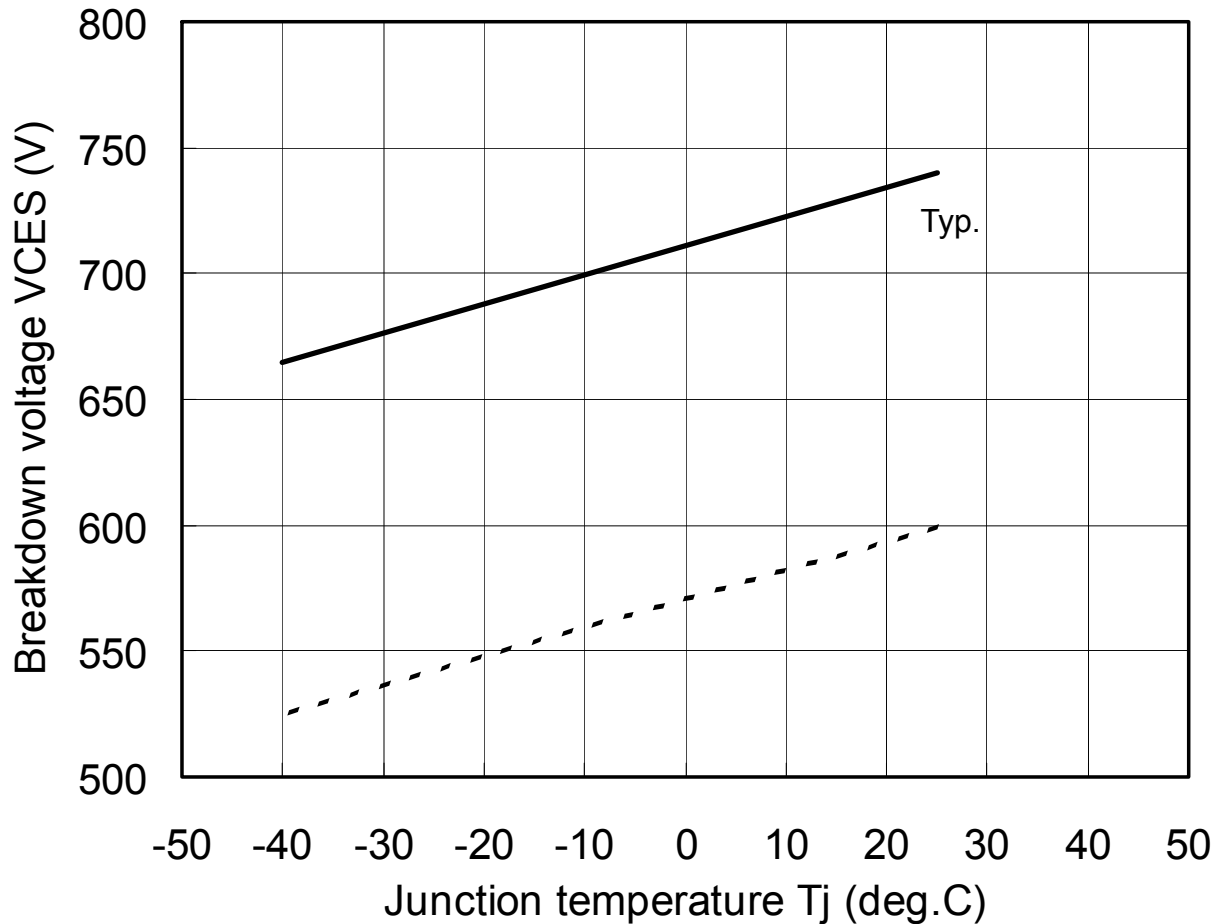
This data shows the typical waveforms of chip characteristics. The effect of the internal resistance of the module is not included



Technical data: MT5F24332

- Fuji IGBT Module V Series 600V Family -

Junction breakdown voltage V_{CES} and junction temperature T_j



Junction Temperature Dependence of Junction Breakdown Voltage

(same as 1200V)

Generally in semiconductor devices, when the temperature becomes lower, the lattice vibration within the silicon crystal decreases and the collision of carriers is suppressed. Therefore, impact ionization ratio increases and so the breakdown voltage of the semiconductor device becomes lower. Therefore, when you use the module at low temperature, take the breakdown voltage drop into account in design.

Technical data: MT5F24333

- Fuji IGBT Module V Series 600V Family -

Dynamic avalanche voltage V_{av} and T_j characteristics

Typename: 2MBI450VN-060-50

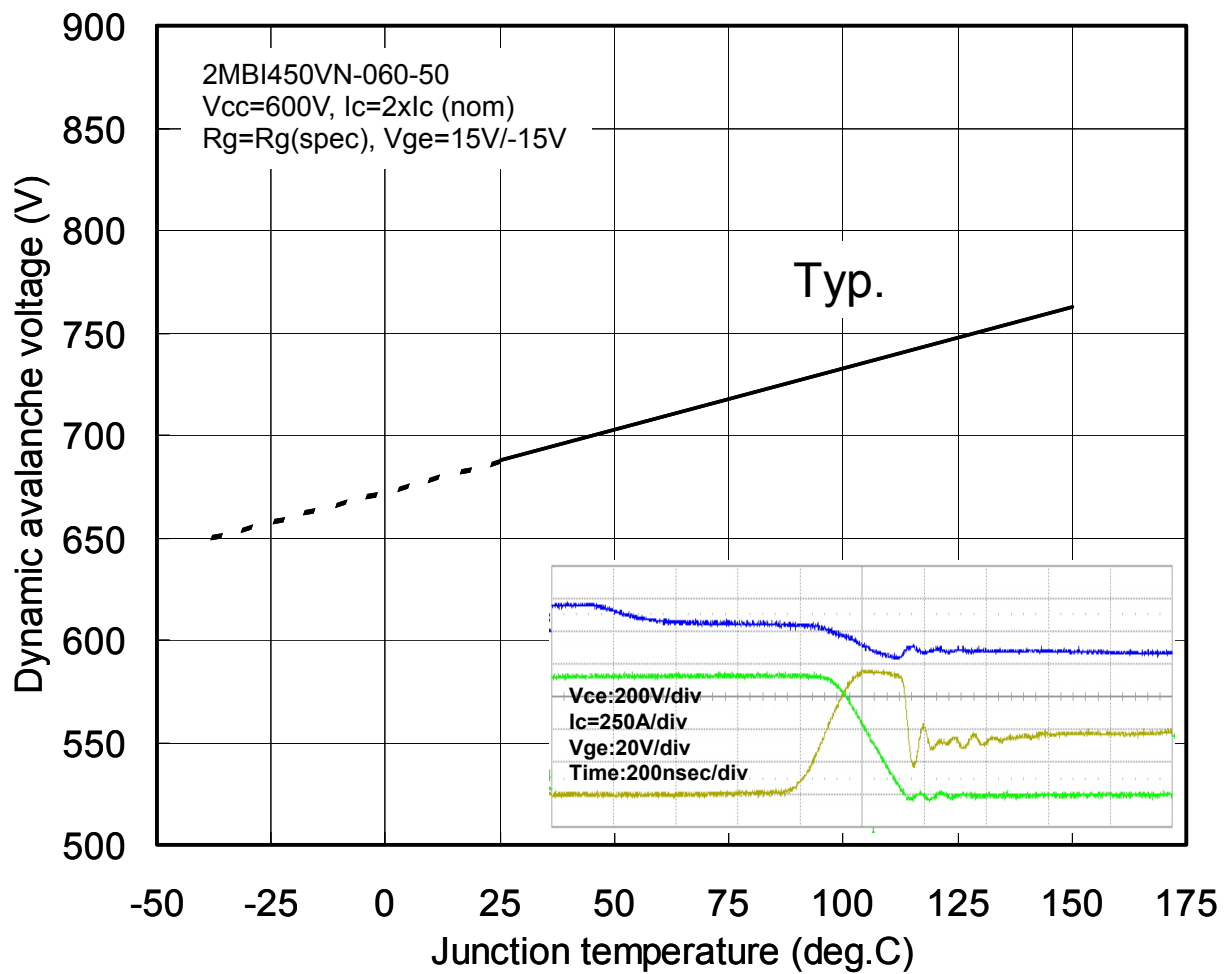


Fig. Dynamic Avalanche Voltage (V_{av}) as function of T_j

Technical data: MT5F24334

- Fuji IGBT Module V Series 600V Family -

Short-circuit capacity

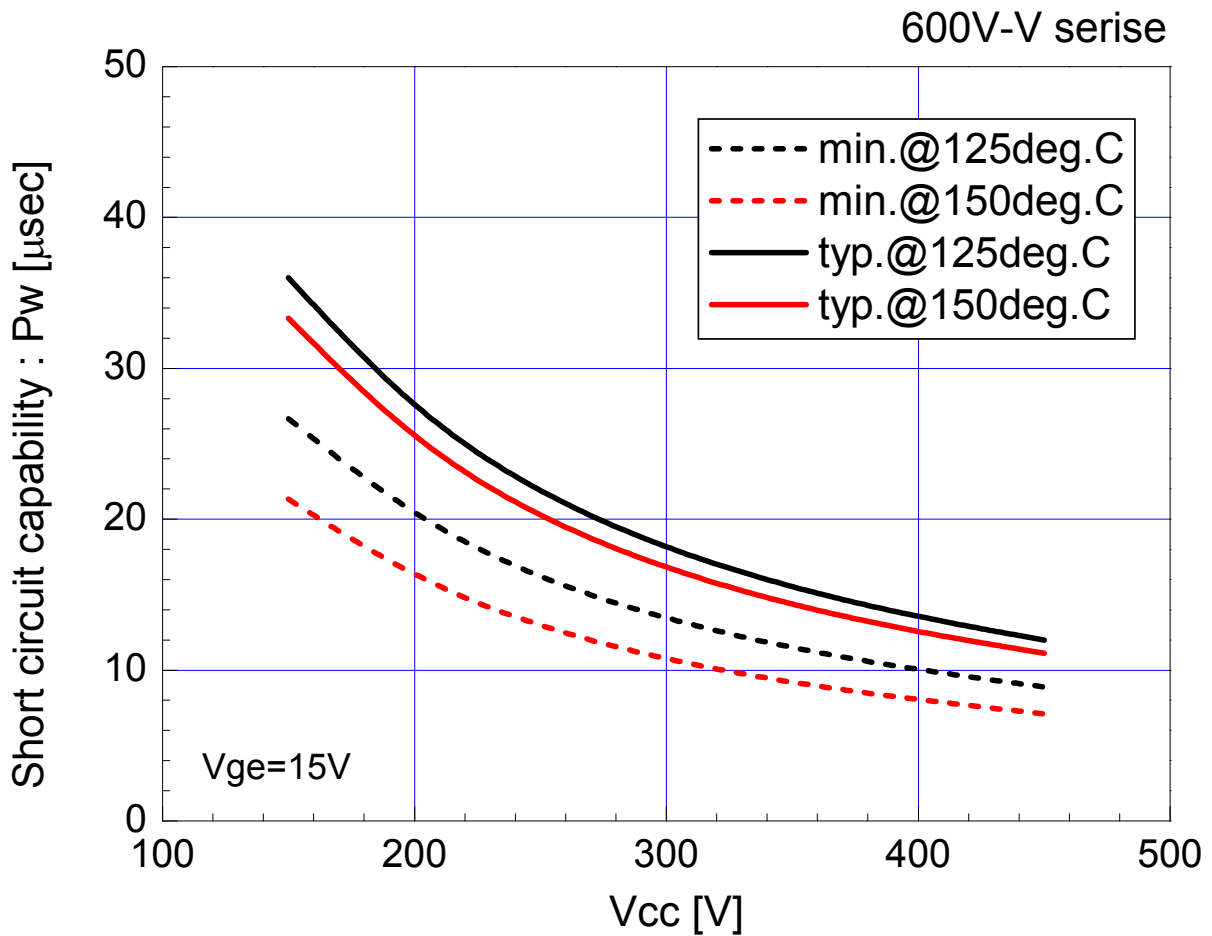


Fig. Relation between applied voltage and short-circuit capacity (600V Family)

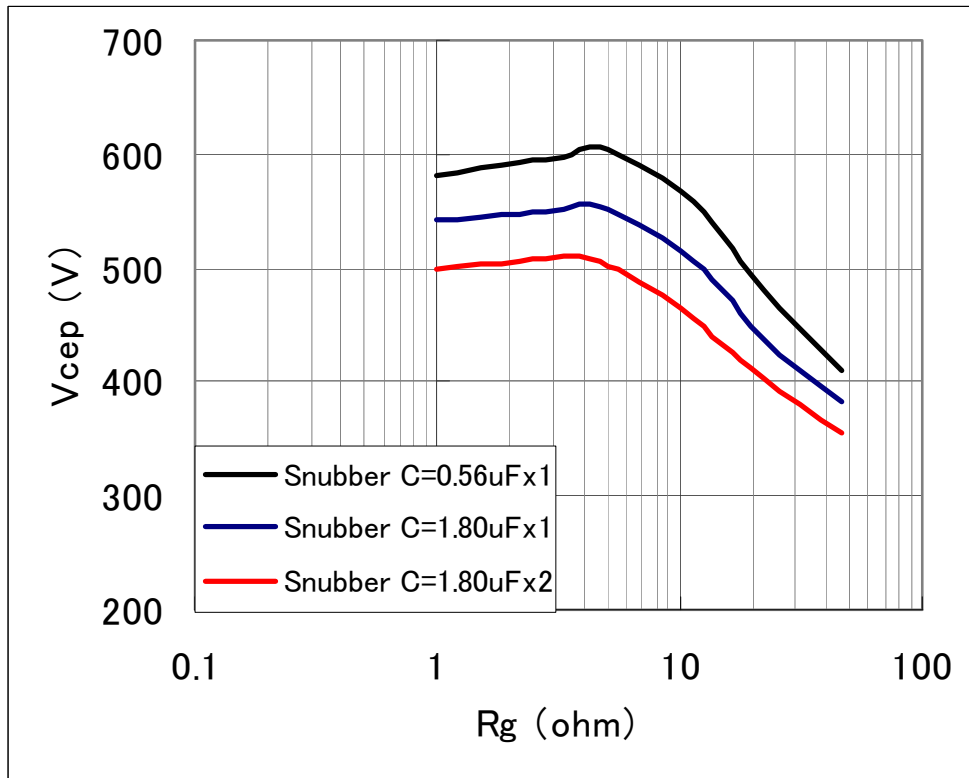
Technical data: MT5F24337

— Fuji IGBT Module V Series 600V Family —

Gate resistance dependence of surge voltage

Type name : 2MBI400VB-060-50

Conditions : $V_{dc}=300V$, $I_c=400A$, $V_{ge}=\pm 15V$, $T_j=25deg.C$, $R_g=vari.$



Gate Resistance Dependence of Turn-off Surge Voltage

The surge voltage, especially at IGBT turn off, depends on the gate resistance. As shown in the figure above figure shows, the surge voltage is able to control with the gate resistance but the curve shave peaks depending on the junction temperature. The primary reason of such behavior is the interaction of two silicon physics in IGBT chip; 1) the carriers stored in the drift region and 2) Current through MOS channel¹⁾.

Reference :

- 1) Y. Onozawa et al., "Investigation of carrier streaming effect for the low spike fast IGBT turn-off", Proc. ISPSD, pp173-176, 2006.

Technical data : MT5F26526

Evaluation Board for IGBT Module

1. Introduction

The Evaluation Board FA5650N_7MBR100VP060 was developed to support customers during their first steps designing applications with the High voltage driver IC FA5650N and IGBT module. This Board realizes driving 3-phase motor by easy wiring because built-in Rectifier Diode Bridge, Inverter circuit and IGBT gate drive circuit.

3. IGBT module type which can be tested

- 7MBR50VP060-50
- 7MBR75VP060-50
- 7MBR100VP060-50
- 600V Power Integrated Module only.

2. Features

- Input voltage: AC170~264V, 50/60Hz
- Rated output power: up to 7.5kW motor
- Control signals 3.3V Logic compatible
- Single control power supply of DC+15V
- Built-in high and low side Gate Driver IC
- Built-in Bootstrap circuit
- Built-in Current sensor of DC-bus line

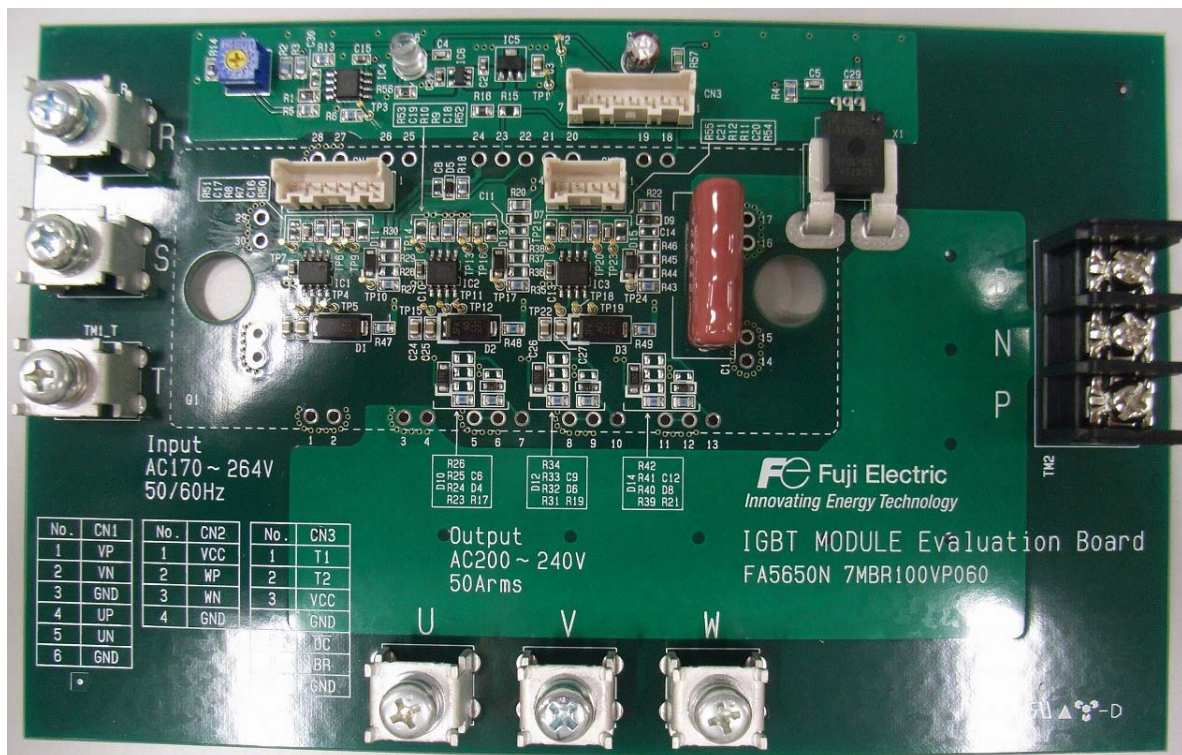


Figure 1 Evaluation Board FA5650N_7MBR100VP060

190 x 120 mm

Evaluation Board for IGBT Module

4. Block Diagram

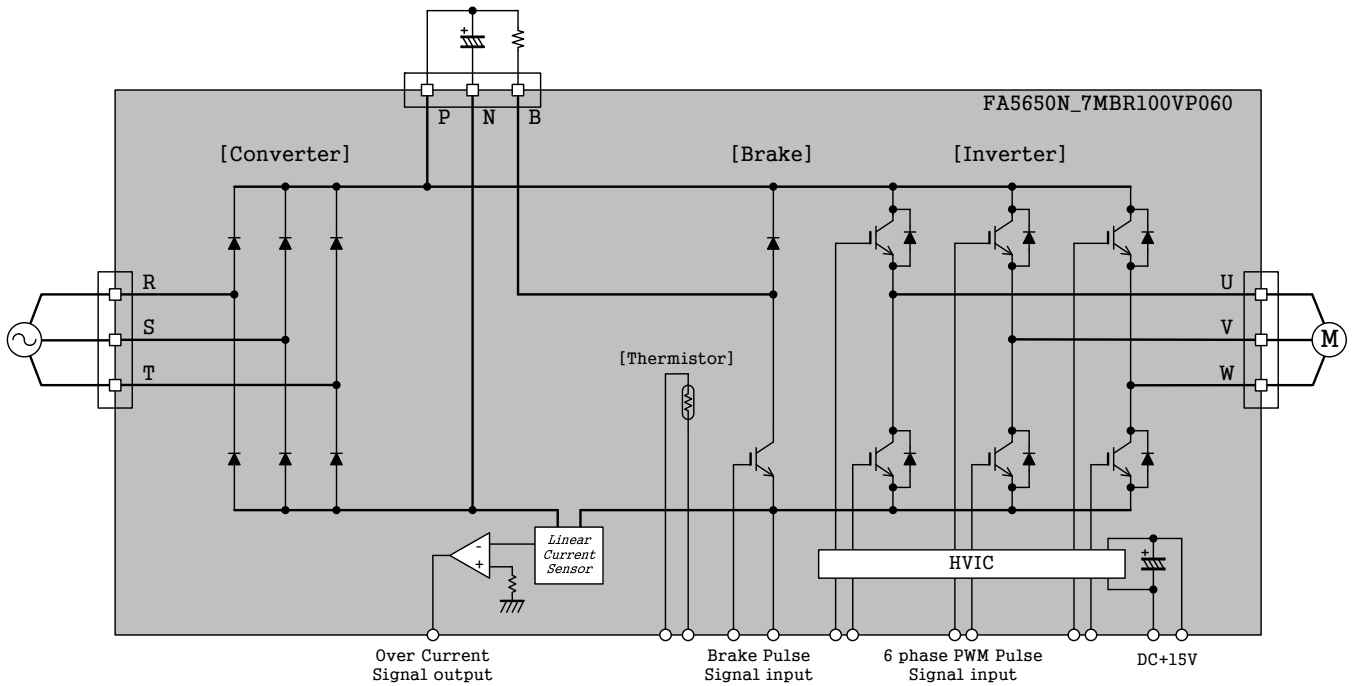


Figure 2 Evaluation Board Block Diagram

5. Preparations for use

- Soldering of the IGBT module to this evaluation board.
- Apply a thermal compound to a copper base side of the IGBT module.
- Screw fastening of the IGBT module is carried out to a cooling fin by rated torque.
- Connect AC power supply to the R,S,T terminals of this evaluation board in screw.
- Connect the electrolytic capacitors to the P,N terminals of this evaluation board in screw.
- Connect the motor cables to the U,V,W terminals of this evaluation board in screw.
- Connect the DC+15V power supply to the VCC pins and GND pins of CN1, CN2 and CN3 by connectors.
- Connect the PWM Pulses input wires to the UP/UN pins, VP/VN pins and WP/WN pins by connectors.

Evaluation Board for IGBT Module

6. Circuit

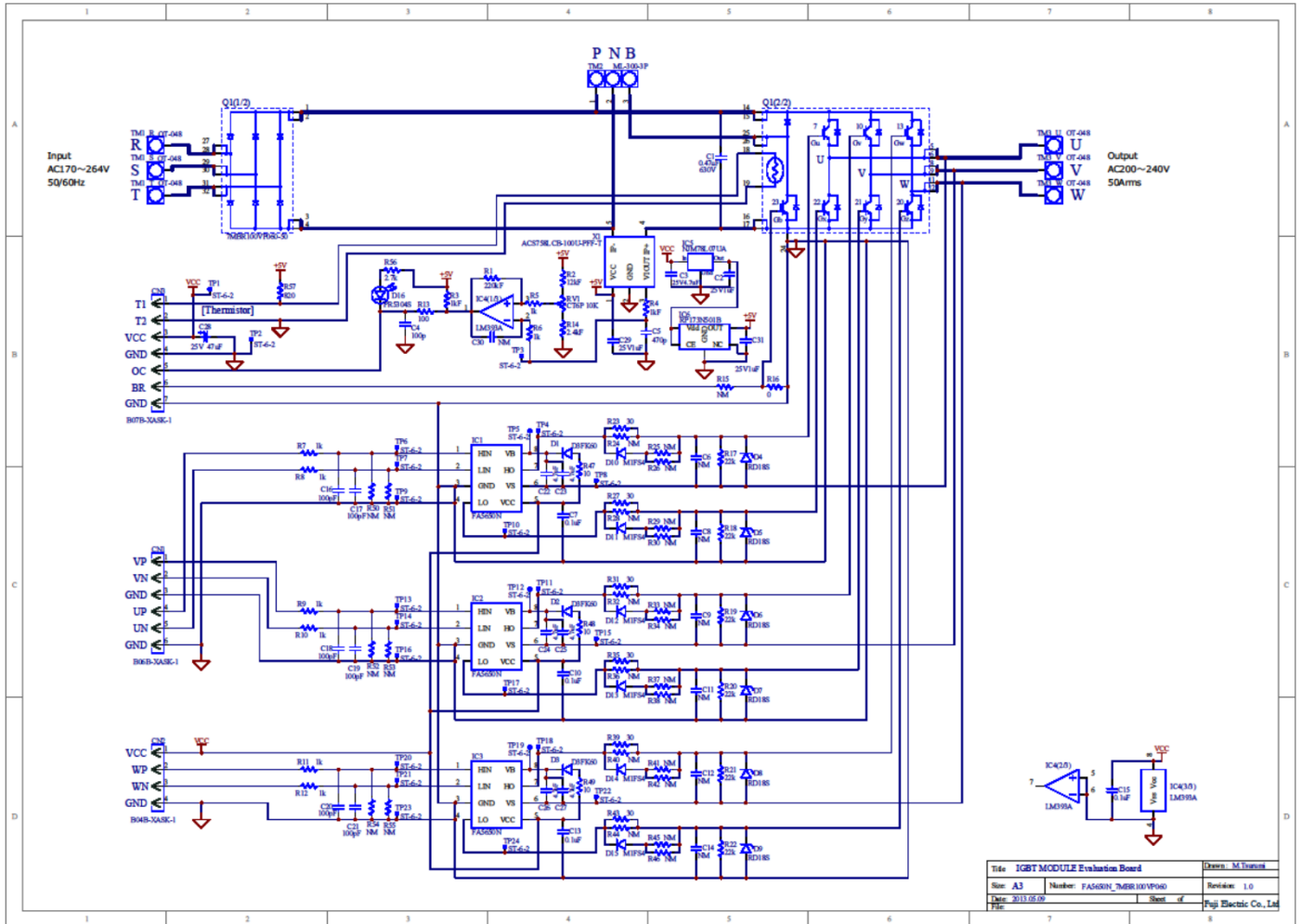


Figure 3 Evaluation Board Block Circuit

Evaluation Board for IGBT Module

7. Pin assignment

Table 1. Main terminals

TM1	
Symbol	Function
R	AC power supply input R-phase
S	AC power supply input S-phase
T	AC power supply input T-phase
TM2	
Symbol	Function
P	DC-bus line +
N	DC-bus line -
B	Collector terminal of Brake IGBT
TM3	
Symbol	Function
U	Inverter output terminal U-phase
V	Inverter output terminal V-phase
W	Inverter output terminal W-phase

Table 2. Control terminals

CN1		
No.	Symbol	Function
1	VP	PWM pulse input for High-side of V-phase
2	VN	PWM pulse input for Low-side of V-phase
3	GND	Ground terminal for control power supply
4	UP	PWM pulse input for High-side of U-phase
5	UN	PWM pulse input for Low-side of U-phase
6	VCC	Control power supply
CN2		
No.	Symbol	Function
1	VCC	Control power supply
2	WP	PWM pulse input for High-side of W-phase
3	WN	PWM pulse input for Low-side of W-phase
4	GND	Ground terminal for control power supply
CN3		
No.	Symbol	Function
1	T1	Thermistor output terminal
2	T2	Thermistor output terminal
3	VCC	Control power supply
4	GND	Ground terminal for control power supply
5	OC	Logic signal output of over current
6	BR	Gate signal input for Brake IGBT
7	GND	Ground terminal for control power supply

CN1: Housing Model No. XAP-06V-1, 2.5mm pitch

CN2: Housing Model No. XAP-04V-1, 2.5mm pitch

CN3: Housing Model No. XAP-07V-1, 2.5mm pitch

JST

Evaluation Board for IGBT Module

8. Typical test result

Table 3. Test Conditions

Item	Value
Input DC Voltage	300V
Inverter output Current	50Apeak
Inverter output frequency	50Hz
Switching frequency	8kHz
Dead time	4usec

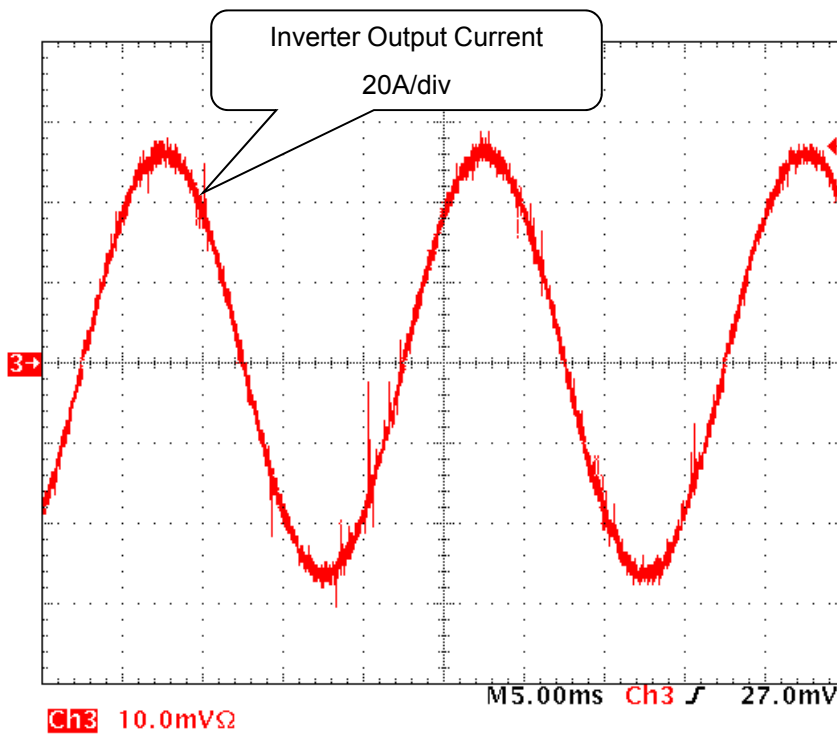


Figure 4 Output Current waveform

Table 4. Current Sensor amp. Output characteristics

DC Current (A)	Output Voltage (V)
5	0.8023
10	1.0017
15	1.2016
20	1.4000
25	1.5955

Evaluation Board for IGBT Module

9. Bill of Material of FA5650N_7MBR100VP060 (1/3)

Description	Designator	Quantity	Text Field1	Text Field2	Comment	Text Field5	NM
CAPACITOR	C1	1	ECQE6474kF	630V	0.47uF	松下	
CAPACITOR	C2	1	TMK107BJ105KA	25V	25V1uF	Taiyo Yuden	
CAPACITOR	C3	1	GRM21BB31E475KA75L	25V	25V4.7uF	MURATA	
CAPACITOR	C4	1	GRM1882C1H101JA01D	50V	100p	MURATA	
CAPACITOR	C5	1	GRM1882C1H471JA01D	50V	470p	MURATA	
CAPACITOR	C6	0	GRM188B31H104KA92D	50V	NM	MURATA	○
CAPACITOR	C7	1	GRM188B31H104KA92D	50V	0.1uF	MURATA	
CAPACITOR	C8	0	GRM188B31H104KA92D	50V	NM	MURATA	○
CAPACITOR	C9	0	GRM188B31H104KA92D	50V	NM	MURATA	○
CAPACITOR	C10	1	GRM188B31H104KA92D	50V	0.1uF	MURATA	
CAPACITOR	C11	0	GRM188B31H104KA92D	50V	NM	MURATA	○
CAPACITOR	C12	0	GRM188B31H104KA92D	50V	NM	MURATA	○
CAPACITOR	C13	1	GRM188B31H104KA92D	50V	0.1uF	MURATA	
CAPACITOR	C14	0	GRM188B31H104KA92D	50V	NM	MURATA	○
CAPACITOR	C15	1	GRM188B31H104KA92D	50V	0.1uF	MURATA	
CAPACITOR	C16	1	GRM1882C1H101JA01D	50V	100pF	MURATA	
CAPACITOR	C17	1	GRM1882C1H101JA01D	50V	100pF	MURATA	
CAPACITOR	C18	1	GRM1882C1H101JA01D	50V	100pF	MURATA	
CAPACITOR	C19	1	GRM1882C1H101JA01D	50V	100pF	MURATA	
CAPACITOR	C20	1	GRM1882C1H101JA01D	50V	100pF	MURATA	
CAPACITOR	C21	1	GRM1882C1H101JA01D	50V	100pF	MURATA	
CAPACITOR	C22	1	GRM21BB31E475KA75L	25V	4.7uF	MURATA	
CAPACITOR	C23	1	GRM21BB31E475KA75L	25V	4.7uF	MURATA	
CAPACITOR	C24	1	GRM21BB31E475KA75L	25V	4.7uF	MURATA	
CAPACITOR	C25	1	GRM21BB31E475KA75L	25V	4.7uF	MURATA	
CAPACITOR	C26	1	GRM21BB31E475KA75L	25V	4.7uF	MURATA	
CAPACITOR	C27	1	GRM21BB31E475KA75L	25V	4.7uF	MURATA	
CAPACITOR	C28	1	EKMG250ELL470ME11D	25V		日本ケミコン	
CAPACITOR	C29	1	TMK107BJ105KA	25V	25V1uF	Taiyo Yuden	
CAPACITOR	C30	1	GRM188B31H104KA92D	50V	NM	MURATA	○
CAPACITOR	C31	1	TMK107BJ105KA	25V	25V1uF	Taiyo Yuden	
CONNECTOR	CN1	1	B06B-XASK-1	250V		日本圧着端子	
CONNECTOR	CN2	1	B04B-XASK-1	250V		日本圧着端子	
CONNECTOR	CN3	1	B07B-XASK-1	250V		日本圧着端子	
SMT-DIODE-ST	D1	1	D3FK60	600V	D3FK60	新電元	
SMT-DIODE-ST	D2	1	D3FK60	600V	D3FK60	新電元	
SMT-DIODE-ST	D3	1	D3FK60	600V	D3FK60	新電元	
ZENER-DIODE	D4	1	RD18S-A	18V	DZ-18S	Renesas	
ZENER-DIODE	D5	1	RD18S-A	18V	DZ-18S	Renesas	
ZENER-DIODE	D6	1	RD18S-A	18V	DZ-18S	Renesas	
ZENER-DIODE	D7	1	RD18S-A	18V	DZ-18S	Renesas	
ZENER-DIODE	D8	1	RD18S-A	18V	DZ-18S	Renesas	
ZENER-DIODE	D9	1	RD18S-A	18V	DZ-18S	Renesas	
SMT-DIODE-SCHOTTKY	D10	1	M1FS4	40V	M1FS4	新電元	
SMT-DIODE-SCHOTTKY	D11	1	M1FS4	40V	M1FS4	新電元	
SMT-DIODE-SCHOTTKY	D12	1	M1FS4	40V	M1FS4	新電元	
SMT-DIODE-SCHOTTKY	D13	1	M1FS4	40V	M1FS4	新電元	
SMT-DIODE-SCHOTTKY	D14	1	M1FS4	40V	M1FS4	新電元	
SMT-DIODE-SCHOTTKY	D15	1	M1FS4	40V	M1FS4	新電元	

Evaluation Board for IGBT Module

9. Bill of Material of FA5650N_7MBR100VP060 (2/3)

Description	Designator	Quantity	Text Field1	Text Field2	Comment	Text Field5	NM
LED	D16	1	PR5304S	RED LED	PR5304S	スタンレー	
High Side Driver	IC1	1	FA5650N-A2	830V	U-FA5650N	FUJIDENKI	
High Side Driver	IC2	1	FA5650N-A2	830V	U-FA5650N	FUJIDENKI	
High Side Driver	IC3	1	FA5650N-A2	830V	U-FA5650N	FUJIDENKI	
DUAL Comparator	IC4	1	LM393AD	MONO POWER	LM393A	Renesas	
3TERM REGULATOR	IC5	1	NJM78L07UA	5V	NJM78L07UA	JRC	
3TERM REGULATOR	IC6	1	RP173N501B	5V(1%)		JRC	
IGBT Module	Q1	1	7MBR100VP060-50	600V100A		Fuji electric	
Resistor	R1	1	RK73H2ATTD2203F	1/8W	100kF	KOA	
Resistor	R2	1	RK73H2ATTD1202F	1/8W	12kF	KOA	
Resistor	R3	1	RK73H2ATTD1001F	1/8W	1kF	KOA	
Resistor	R4	1	RK73H2ATTD1001F	1/8W	1kF	KOA	
Resistor	R5	1	RK73H2ATTD1001F	1/8W	1k	KOA	
Resistor	R6	1	RK73H2ATTD1001F	1/8W	1k	KOA	
Resistor	R7	1	RK73H2ATTD1001F	1/8W	1k	KOA	
Resistor	R8	1	RK73H2ATTD1001F	1/8W	1k	KOA	
Resistor	R9	1	RK73H2ATTD1001F	1/8W	1k	KOA	
Resistor	R10	1	RK73H2ATTD1001F	1/8W	1k	KOA	
Resistor	R11	1	RK73H2ATTD1001F	1/8W	1k	KOA	
Resistor	R12	1	RK73H2ATTD1001F	1/8W	1k	KOA	
Resistor	R13	1	RK73H2ATTD1001F	1/8W	100	KOA	
Resistor	R14	1	RPC10KT242F	1/8W	2.4kF	太陽舎	
Resistor	R15	0	RK73Z2ATTD 000	2A	0	KOA	○
Resistor	R16	1	RK73Z2ATTD 000	2A	0	KOA	
Resistor	R17	1	RK73H2ATTD2202F	1/8W	22k	KOA	
Resistor	R18	1	RK73H2ATTD2202F	1/8W	22k	KOA	
Resistor	R19	1	RK73H2ATTD2202F	1/8W	22k	KOA	
Resistor	R20	1	RK73H2ATTD2202F	1/8W	22k	KOA	
Resistor	R21	1	RK73H2ATTD2202F	1/8W	22k	KOA	
Resistor	R22	1	RK73H2ATTD2202F	1/8W	22k	KOA	
Resistor	R23	1	RK73H2ATTD30R0F	1/8W	30	KOA	
Resistor	R24	0	RK73H2ATTD30R0F	1/8W	NM	KOA	○
Resistor	R25	0	RK73H2ATTD30R0F	1/8W	NM	KOA	○
Resistor	R26	0	RK73H2ATTD30R0F	1/8W	NM	KOA	○
Resistor	R27	1	RK73H2ATTD30R0F	1/8W	30	KOA	
Resistor	R28	0	RK73H2ATTD30R0F	1/8W	NM	KOA	○
Resistor	R29	0	RK73H2ATTD30R0F	1/8W	NM	KOA	○
Resistor	R30	0	RK73H2ATTD30R0F	1/8W	NM	KOA	○
Resistor	R31	1	RK73H2ATTD30R0F	1/8W	30	KOA	
Resistor	R32	0	RK73H2ATTD30R0F	1/8W	NM	KOA	○
Resistor	R33	0	RK73H2ATTD30R0F	1/8W	NM	KOA	○
Resistor	R34	0	RK73H2ATTD30R0F	1/8W	NM	KOA	○
Resistor	R35	1	RK73H2ATTD30R0F	1/8W	30	KOA	
Resistor	R36	0	RK73H2ATTD30R0F	1/8W	NM	KOA	○
Resistor	R37	0	RK73H2ATTD30R0F	1/8W	NM	KOA	○
Resistor	R38	0	RK73H2ATTD30R0F	1/8W	NM	KOA	○
Resistor	R39	1	RK73H2ATTD30R0F	1/8W	30	KOA	
Resistor	R40	0	RK73H2ATTD30R0F	1/8W	NM	KOA	○
Resistor	R41	0	RK73H2ATTD30R0F	1/8W	NM	KOA	○

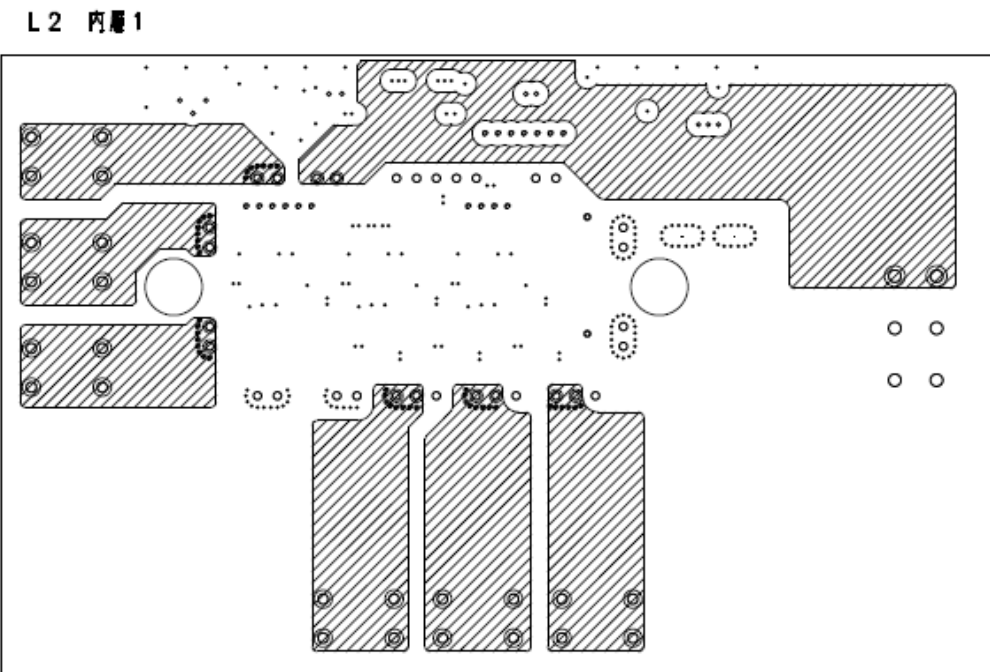
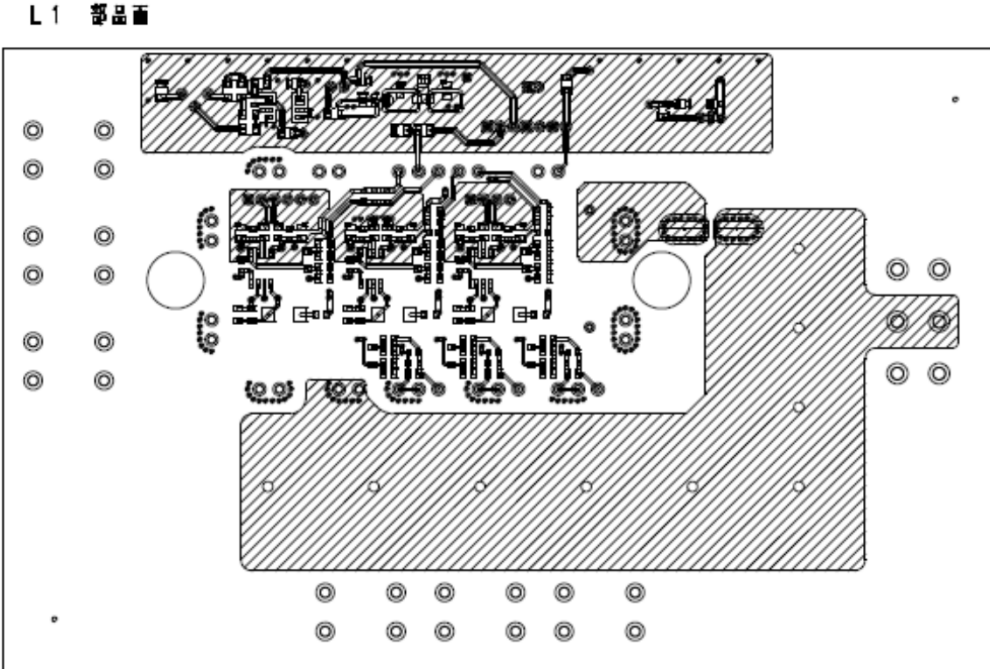
Evaluation Board for IGBT Module

9. Bill of Material of FA5650N_7MBR100VP060 (3/3)

Description	Designator	Quantity	Text Field1	Text Field2	Comment	Text Field5	NM
Resistor	R42	0	RK73H2ATTD30R0F	1/8W	NM	KOA	○
Resistor	R43	1	RK73H2ATTD30R0F	1/8W	30	KOA	
Resistor	R44	0	RK73H2ATTD30R0F	1/8W	NM	KOA	○
Resistor	R45	0	RK73H2ATTD30R0F	1/8W	NM	KOA	○
Resistor	R46	0	RK73H2ATTD30R0F	1/8W	NM	KOA	○
Resistor	R47	1	RK73H2ATTD10R0F	1/8W	10	KOA	
Resistor	R48	1	RK73H2ATTD10R0F	1/8W	10	KOA	
Resistor	R49	1	RK73H2ATTD10R0F	1/8W	10	KOA	
Resistor	R50	0	RK73H2ATTD1002F	1/8W	10kF	KOA	○
Resistor	R51	0	RK73H2ATTD1002F	1/8W	10kF	KOA	○
Resistor	R52	0	RK73H2ATTD1002F	1/8W	10kF	KOA	○
Resistor	R53	0	RK73H2ATTD1002F	1/8W	10kF	KOA	○
Resistor	R54	0	RK73H2ATTD1002F	1/8W	10kF	KOA	○
Resistor	R55	0	RK73H2ATTD1002F	1/8W	10kF	KOA	○
Resistor	R56	1	RPC10KT272F	1/8W	2.7k	太陽舎	
Resistor	R57	1	RN732ATTD8200C25	1/8W	820	KOA	
VOLUME	RV1	1	CT-6EP 10K	10K OHM MAX	CT6P 10K	コバル電子	
TERMINAL	TM1_R	1	OT-048	60A	OT-048	OSADA	
TERMINAL	TM1_S	1	OT-048	60A	OT-048	OSADA	
TERMINAL	TM1_T	1	OT-048	60A	OT-048	OSADA	
TERMINAL	TM2	1	ML-300-3P	3P	ML-300-3P	サトーパーツ	
TERMINAL	TM3_U	1	OT-048	60A	OT-048	OSADA	
TERMINAL	TM3_V	1	OT-048	60A	OT-048	OSADA	
TERMINAL	TM3_W	1	OT-048	60A	OT-048	OSADA	
TEST PIN	TP1	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP2	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP3	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP4	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP5	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP6	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP7	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP8	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP9	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP10	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP11	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP12	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP13	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP14	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP15	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP16	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP17	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP18	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP19	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP20	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP21	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP22	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP23	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
TEST PIN	TP24	1	ST-6-2	φ1.0	ST-6-2	マックエイト	
Current Transducer	X1	1	ACS758LCB-100U-PFF-T	100A 5V		Allegro	

Evaluation Board for IGBT Module

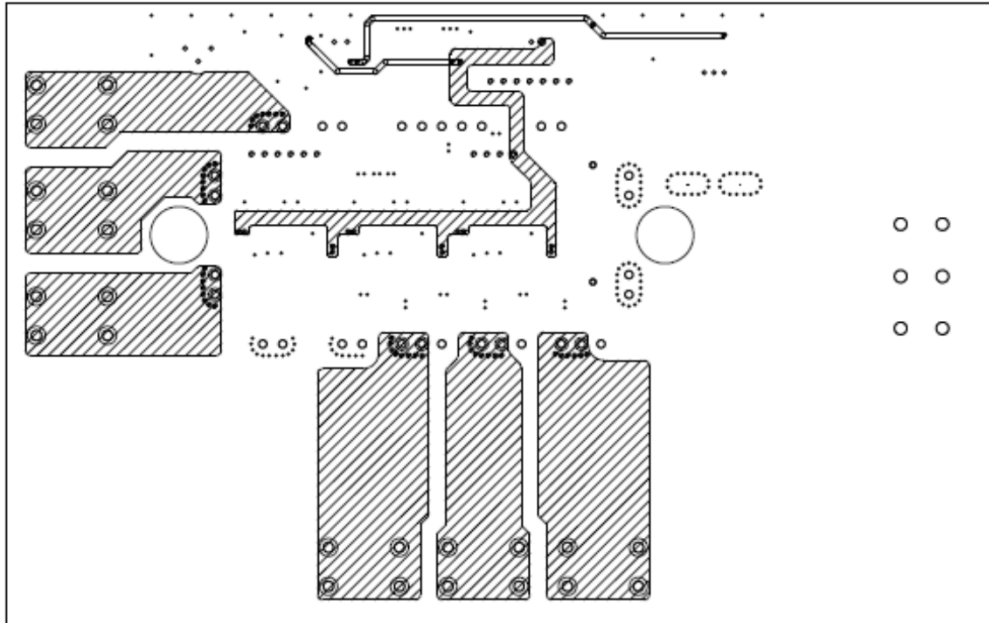
10. Layout (1/3)



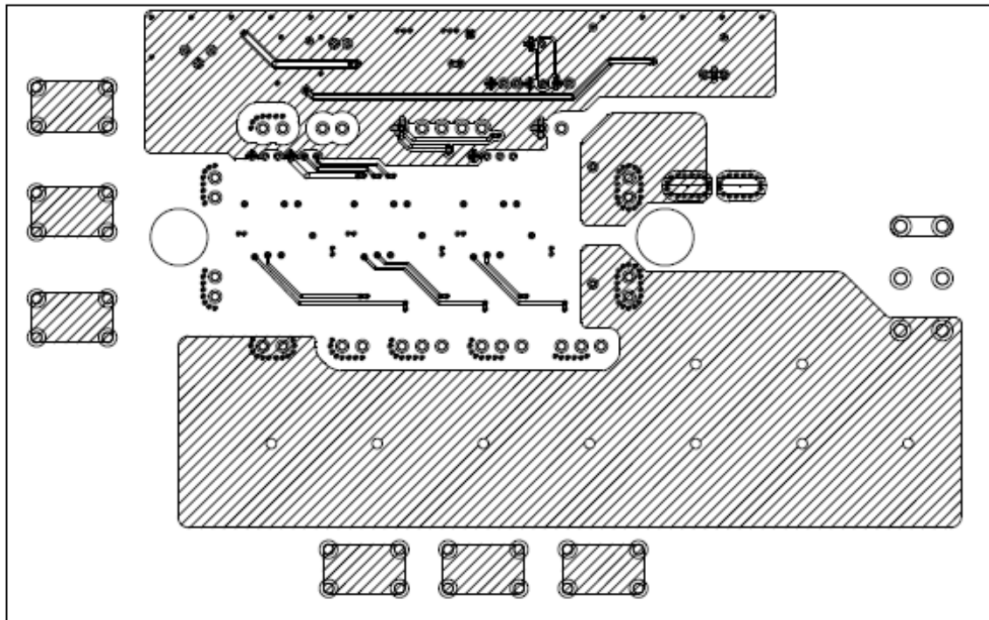
Evaluation Board for IGBT Module

10. Layout (2/3)

L3 内層2

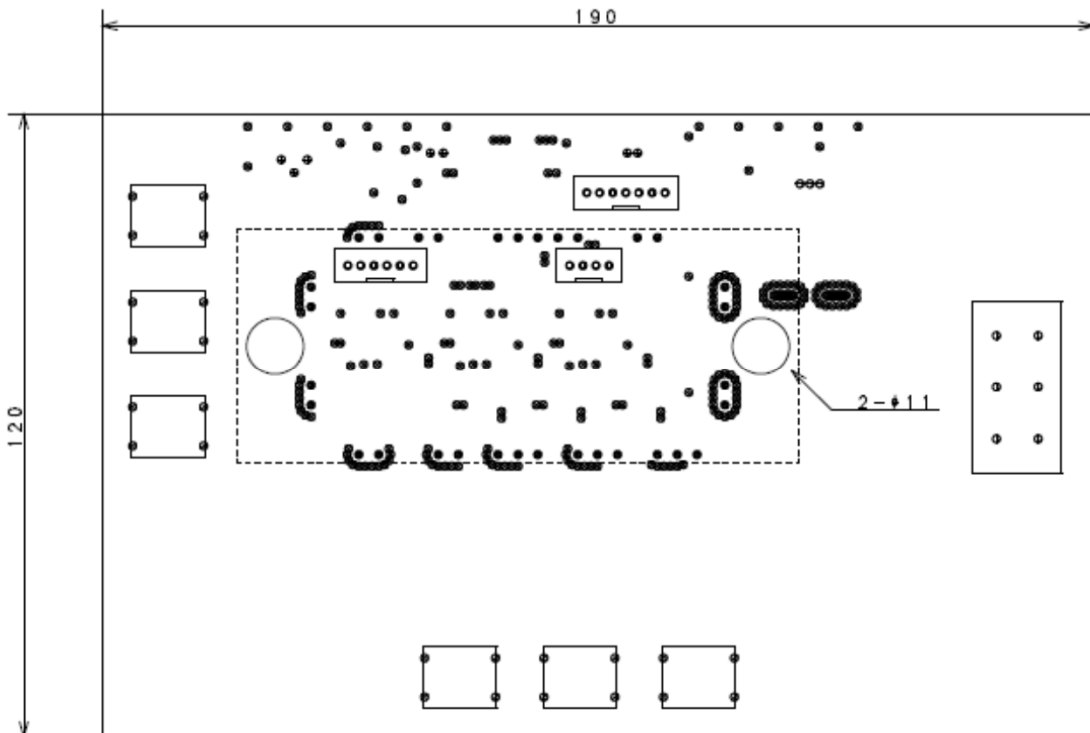
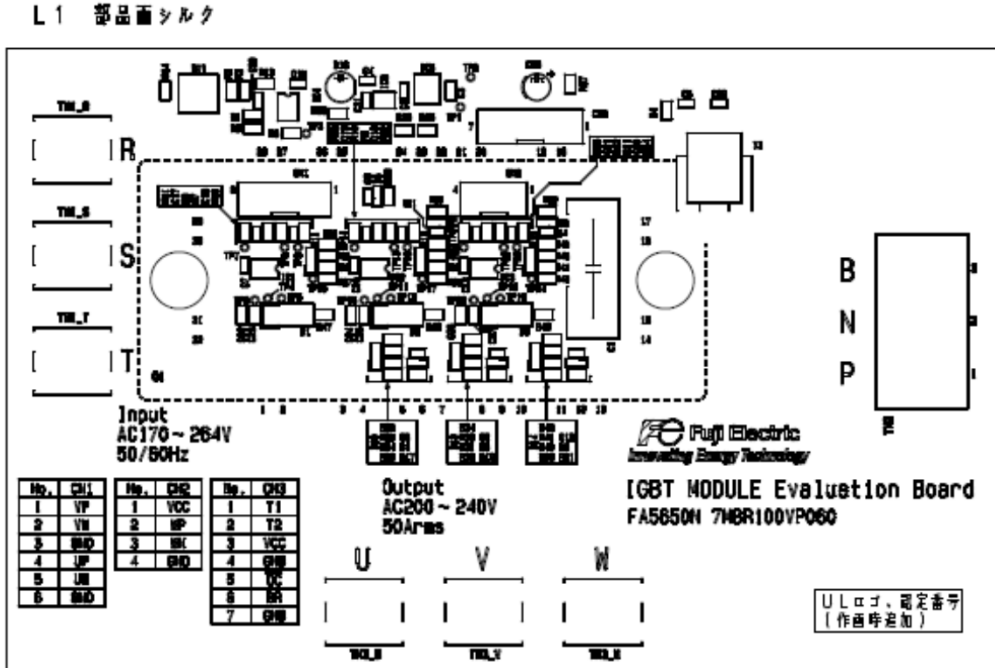


面田半 4 J



Evaluation Board for IGBT Module

10. Layout (3/3)

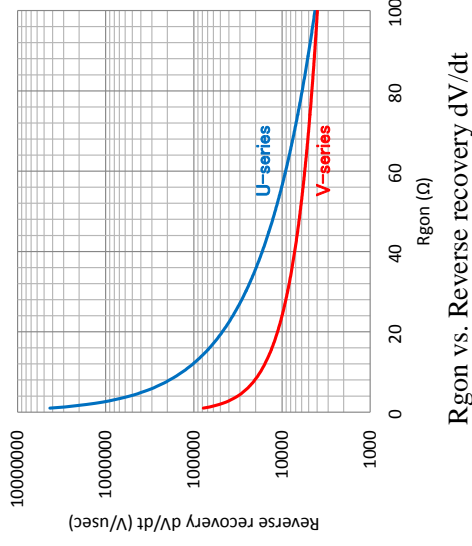
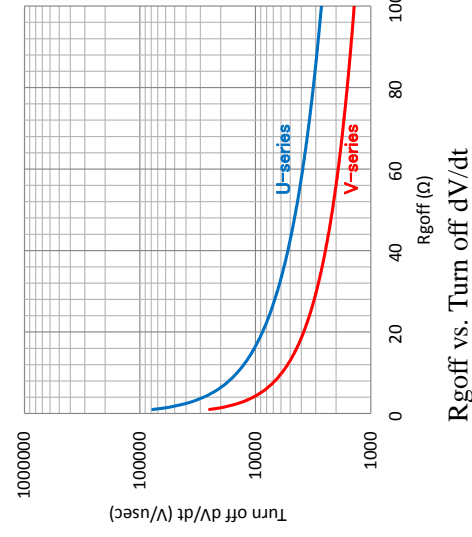
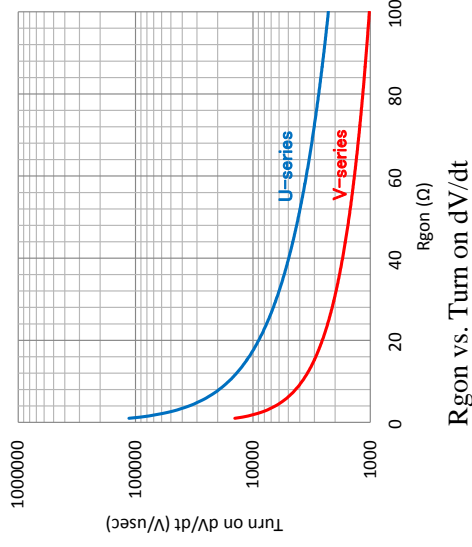


— **Fuji IGBT module S,U,V-series 600V** —

Rg-dV/dt dependency of S,U,V-series

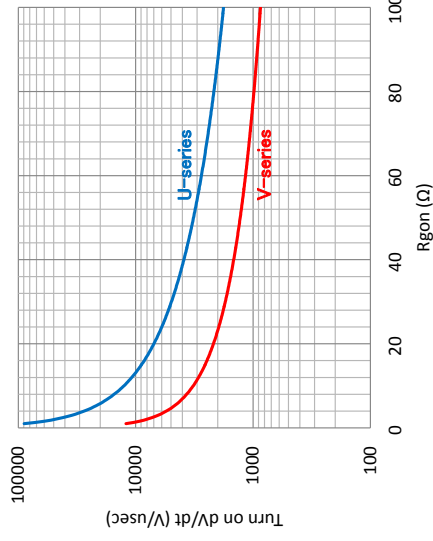
Test module : 2MBI150U2A-060-50, 2MBI150VA-060-50

Test condition : V_{dc}=300V, I_c=15A(turn on, reverse recovery), 150A(turn off), V_{ge}=+/-15V, T_j=25deg.C, R_g=vari.

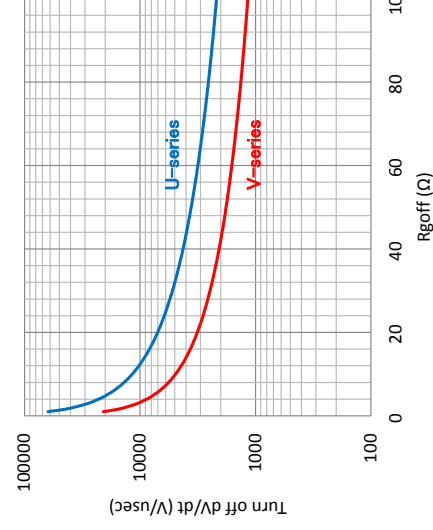


Test module : 2MBI200U2A-060-50, 2MBI200VA-060-50

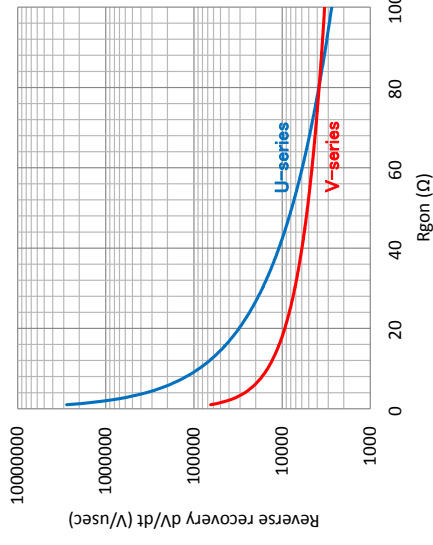
Test condition : $V_{dc}=300V$, $I_c=20A$ (turn on, reverse recovery), $200A$ (turn off), $V_{ge}=\pm 15V$, $T_j=25\text{deg.C}$, $R_g=\text{vari.}$



Rgon vs. Turn on dV/dt



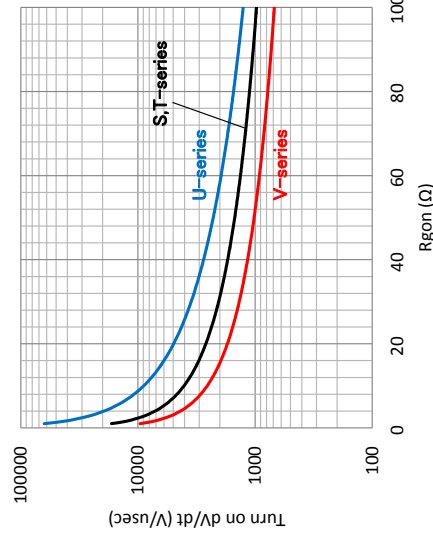
Rgoff vs. Turn off dV/dt



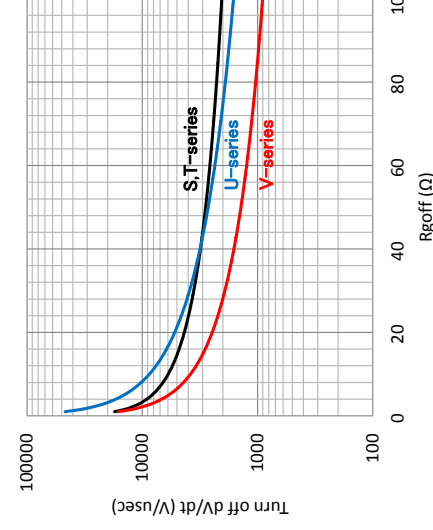
Rgon vs. Reverse recovery dV/dt

Test module : 2MBI300S-060, 2MBI300TA-060, 2MBI300U2B-060-50, 2MBI300VB-060-50

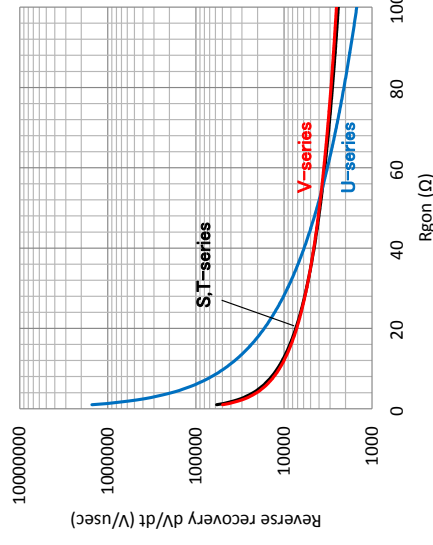
Test condition : $V_{dc}=300V$, $I_c=30A$ (turn on, reverse recovery), $300A$ (turn off), $V_{ge}=\pm 15V$, $T_j=25\text{deg.C}$, $R_g=\text{vari.}$



Rgon vs. Turn on dV/dt



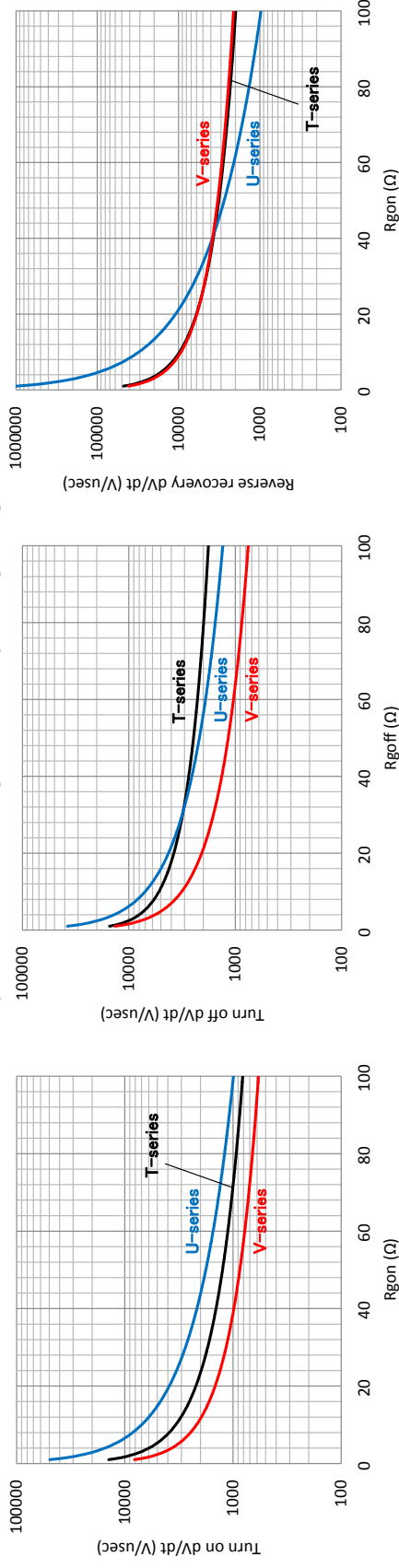
Rgoff vs. Turn off dV/dt



Rgon vs. Reverse recovery dV/dt

Test module : 2MBI400TB-060, 2MBI400U2B-060-50, 2MBI400VB-060-50, 2MBI400VD-060-50

Test condition : $V_{dc}=300V$, $I_c=40A$ (turn on, reverse recovery), $400A$ (turn off), $V_{ge}=\pm 15V$, $T_j=25deg.C$, $R_g=vari.$



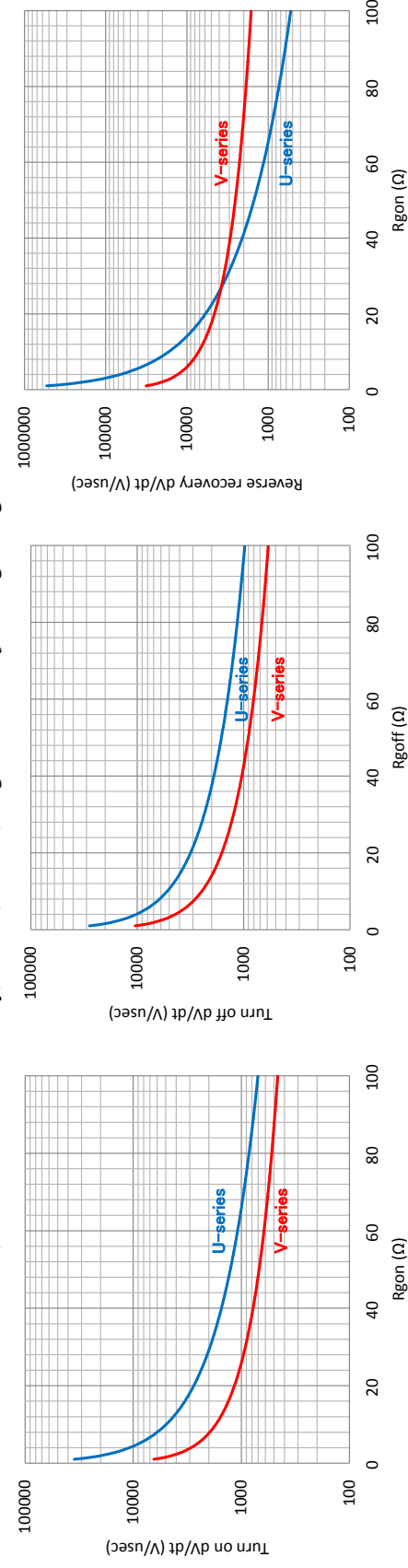
Rgon vs. Turn on dV/dt

Rgoff vs. Turn off dV/dt

Rgon vs. Reverse recovery dV/dt

Test module : 2MBI600U2E-060, 2MBI600VD-060-50, 2MBI600VE-060-50

Test condition : $V_{dc}=300V$, $I_c=60A$ (turn on, reverse recovery), $600A$ (turn off), $V_{ge}=\pm 15V$, $T_j=25deg.C$, $R_g=vari.$



Rgon vs. Turn on dV/dt

Rgoff vs. Turn off dV/dt

Rgon vs. Reverse recovery dV/dt

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