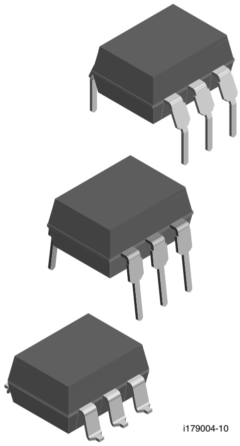
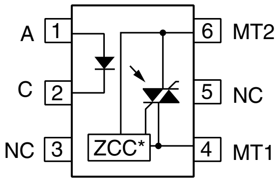
Optocoupler, Phototriac Output, Zero Crossing





*Zero crossing circuit

DESCRIPTION

The BRT21, BRT22, BRT23 product family consists of AC switch optocouplers with zero voltage detectors with two electrically insulated lateral power ICs which integrate a thyrister system, a photo detector and noise suppression at the output and an IR GaAs diode input.

High input sensitivity is achieved by using an emitter follower phototransistor and a SCR predriver resulting in an LED trigger current of less than 2 mA or 3 mA (DC). Inverse parallel SCRs provide commutating dV/dt greater than 10 kV/µs.

The zero cross line voltage detection circuit consists of two MOSFETS and a photodiode.

The BRT21, BRT22, BRT23 product family isolates low-voltage logic from 120, 230, and 380 VAC lines to control resistive, inductive or capacitive loads including motors, solenoids, high current thyristers or TRIAC and relays.

FEATURES

- High input sensitivity I_{FT} = 1 mA
- I_{TRMS} = 300 mA
- High static dV/dt 10 000 V/µs
- Electrically insulated between input and output circuit
- Microcomputer compatible
- Trigger current
  - (I_{FT} < 1.2 mA) BRT22**F**, BRT23**F**,
  - (I_{FT} < 2 mA) BRT21**H**, BRT22**H**, BRT23**H**
  - (I_{FT} < 3 mA) BRT21**M**, BRT22**M**, BRT23**M**
- Available surface mount and on on tape and reel
- Zero voltage crossing detector
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

Pb-free

e3

RoHS
COMPLIANT

APPLICATIONS

- Industrial controls
- Office equipment
- Consumer appliances

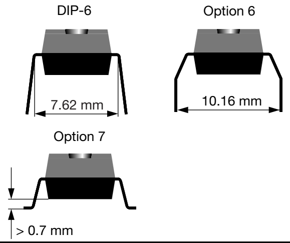
AGENCY APPROVALS

- UL file no. E52744 system code J
- DIN EN 60747-5-2 (VDE 0844)
- DIN EN 60747-5-5 (pending) available with option 1

ORDERING INFORMATION

B R T 2 # x - X 0 # # T

PART NUMBER (B R T 2 # x) — PACKAGE OPTION (X 0 # #) — TAPE AND REEL (T)



AGENCY CERTIFIED/ PACKAGE	V_{DRM} (V)							
	≤ 400		≤ 600			≤ 800		
UL	**I_{FT} = 2 mA**	**I_{FT} = 3 mA**	**I_{FT} = 1.2 mA**	**I_{FT} = 2 mA**	**I_{FT} = 3 mA**	**I_{FT} = 1.2 mA**	**I_{FT} = 2 mA**	**I_{FT} = 3 mA**
DIP-6	BRT21H	BRT21M	BRT22F	BRT22H	BRT22M	BRT23F	BRT23H	BRT23M
DIP-6, 400 mil, option 6	-	-	BRT22F-X006	-	-	BRT23F-X006	BRT22H-X006	-
SMD-6, option 7	BRT21H-X007	-	BRT22F-X007T (1)	BRT22H-X007T (1)	-	BRT23F-X007T (1)	BRT23H-X007T (1)	BRT23M-X007T
SMD-6, option 9	-	-	BRT22F-X009T (1)	-	-	BRT23F-X009T	-	-

AGENCY CERTIFIED/ PACKAGE	V_{DRM} (V)							
	≤ 400		≤ 600			≤ 800		
UL, VDE	I_{FT} = 2 mA	I_{FT} = 3 mA	I_{FT} = 1.2 mA	I_{FT} = 2 mA	I_{FT} = 3 mA	I_{FT} = 1.2 mA	I_{FT} = 2 mA	I_{FT} = 3 mA
DIP-6	-	-	BRT22F-X001	BRT22H-X001	-	-	BRT23H-X001	-
DIP-6, option 16	BRT21H-X016	BRT21M-X016	BRT22F-X016	BRT22H-X016	BRT22M-X016	-	BRT22H-X016	BRT23M-X016
SMD-6, option 17	-	-	BRT22F-X017T	BRT22H-X017	-	-	-	-
SMD-6, option 18	-	-	-	-	-	-	BRT23H-X018T	-

Note

[1] Also available in tube, do not put T on the end.

ABSOLUTE MAXIMUM RATINGS [1] (T_{amb} = 25 °C, unless otherwise specified)

PARAMETER	TEST CONDITION	PART	SYMBOL	VALUE	UNIT
INPUT					
Reverse voltage	I_R = 10 µA		V_R	6	V
Forward current			I_F	60	mA
Surge current			I_{FSM}	2.5	A
Power dissipation			P_{diss}	100	mW
Derate from 25 °C				1.33	mW/°C
OUTPUT					
Peak off-state voltage	$I_{D(RMS)}$ = 70 µA	BRT21	V_{DM}	400	V
		BRT22	V_{DM}	600	V
		BRT23	V_{DM}	800	V
RMS on-state current			I_{TM}	300	mA
Single cycle surge current				3	A
Power dissipation			P_{diss}	600	mW
Derate from 25 °C				6.6	mW/°C
COUPLER					
Isolation test voltage (between emitter and detector, climate per DIN 500414, part 2, Nov. 74)	t = 1 s		V_{ISO}	5300	V_{RMS}
Pollution degree (DIN VDE 0109)				2	
Creepage distance				≥ 7	mm
Clearance distance				≥ 7	mm
Comparative tracking index per DIN IEC 112/VDE 0303 part 1, group IIIa per DIN VDE 6110			CTI	≥ 175	
Isolation resistance	V_{IO} = 500 V, T_{amb} = 25 °C		R_{IO}	$\geq 10^{12}$	Ω
	V_{IO} = 500 V, T_{amb} = 100 °C		R_{IO}	$\geq 10^{11}$	Ω
Storage temperature range			T_{stg}	- 40 to + 150	°C
Ambient temperature range			T_{amb}	- 40 to + 100	°C
Soldering temperature [2]	max. ≤ 10 s dip soldering ≥ 0.5 mm from case bottom		T_{sld}	260	°C

Notes

[1] Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of this document. Exposure to absolute maximum ratings for extended periods of the time can adversely affect reliability.

[2] Refer to reflow profile for soldering conditions for surface mounted devices (SMD). Refer to wave profile for soldering conditions for through hole devices (DIP).

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)

PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
INPUT						
Forward voltage	I_F = 10 mA	V_F		1.16	1.35	V
Reverse current	V_R = 6 V	I_R		0.1	10	µA
Capacitance	f = 1 MHz, V_F = 0 V	C_O		25		pF
Thermal resistance, junction to ambient		R_{thJA}		750		K/W
OUTPUT						
Off-state voltage	$I_{D(RMS)}$ = 70 µA	$V_{D(RMS)}$	424	460		V
Repetitive peak off-state voltage	I_{DRM} = 100 µA	V_{DRM}	600			V
Off-state current	$V_D = V_{DRM}$, T_{amb} = 100 °C, I_F = 0 mA	$I_{D(RMS)}$		10	100	µA
On-state voltage	I_T = 300 mA	V_{TM}		1.7	3	V
On-state current	PF = 1, $V_{T(RMS)}$ = 1.7 V	I_{TM}			300	mA
Surge (non-repetitive), on-state current	f = 50 Hz	I_{TSM}			3	A
Trigger current temp. gradient		$\Delta I_{FT1}/\Delta T_j$		7	14	µA/K
		$\Delta I_{FT2}/\Delta T_j$		7	14	µA/K
Inhibit voltage temp. gradient		$\Delta V_{DINH}/\Delta T_j$		- 20		mV/K
Off-state current in inhibit state	$I_F = I_{FT1}$, V_{DRM}	I_{DINH}		50	200	µA
Holding current		I_H		65	500	µA
Latching current	V_T = 2.2 V	I_L		5		mA
Zero cross inhibit voltage	I_F = rated I_{FT}	V_{IH}		15	25	V
Turn-on time	$V_{RM} = V_{DM} = V_{D(RMS)}$	t_{on}		35		µs
Turn-off time	PF = 1, I_T = 300 mA	t_{off}		50		µs
Critical rate of rise of off-state voltage	V_D = 0.67 V_{DRM}, T_j = 25 °C	dV/dt_{cr}	10 000			V/µs
	V_D = 0.67 V_{DRM}, T_j = 80 °C	dV/dt_{cr}	5000			V/µs
Critical rate of rise of voltage at current commutation	V_D = 230 V_{RMS}, I_D = 300 mA_{RMS}, T_j = 25 °C	dV/dt_{crq}		8		V/µs
	V_D = 230 V_{RMS}, I_D = 300 mA_{RMS}, T_j = 85 °C	dV/dt_{crq}		7		V/µs
Critical rate of rise of on-state at current commutation	V_D = 230 V_{RMS}, I_D = 300 mA_{RMS}, T_j = 25 °C	dI/dt_{crq}		12		A/ms
Thermal resistance, junction to ambient		R_{thJA}		125		K/W
COUPLER						
Critical rate of rise of coupled input/output voltage	I_T = 0 A, $V_{RM} = V_{DM} = V_{D(RMS)}$	dV_{IO}/dt		10 000		V/µs
Common mode coupling capacitance		C_{CM}		0.01		pF
Capacitance (input to output)	f = 1 MHz, V_{IO} = 0 V	C_{IO}		0.8		pF
Isolation resistance	V_{IO} = 500 V, T_{amb} = 25 °C	R_{is}		$\geq 10^{12}$		Ω
	V_{IO} = 500 V, T_{amb} = 100 °C	R_{is}		$\geq 10^{11}$		Ω
Trigger current	V_D = 5 V, F - versions	I_{FT}			1.2	mA
	V_D = 5 V, H - versions	I_{FT}			2	mA
	V_D = 5 V, M - versions	I_{FT}			3	mA

Note

- Minimum and maximum values are testing requirements. Typical values are characteristics of the device and are the result of engineering evaluation. Typical values are for information only and are not part of the testing requirements.

SAFETY AND INSULATION RATINGS						
PARAMETER	**TEST CONDITION**	**SYMBOL**	**MIN.**	**TYP.**	**MAX.**	**UNIT**
Climatic classification (according to IEC 68 part 1)				40/100/21		
Comparative tracking index		CTI	175		399	
V_{IOTM}			6000			V
V_{IORM}			630			V
P_{SO}					200	mW
I_{SI}					400	mA
T_{SI}					175	°C
Creepage distance	standard DIP-6		7			mm
Clearance distance	standard DIP-6		7			mm
Creepage distance	400 mil DIP-6		8			mm
Clearance distance	400 mil DIP-6		8			mm

Note

- As per IEC 60747-5-2, § 7.4.3.8.1, this optocoupler is suitable for "safe electrical insulation" only within the safety ratings. Compliance with the safety ratings shall be ensured by means of protective circuits.

POWER FACTOR CONSIDERATIONS

A snubber is not needed to eliminate false operation of the TRIAC driver because of the high static and commutating dV/dt with loads between 1.0 and 0.8 power factors. When inductive loads with power factors less than 0.8 are being driven, include a RC snubber or a single capacitor directly across the device to damp the peak commutating dV/dt spike. Normally a commutating dV/dt causes a turning-off device to stay on due to the stored energy remaining in the turning-off device.

But in the case of a zero voltage crossing optotriac, the commutating dV/dt spikes can inhibit one half of the TRIAC from turning on. If the spike potential exceeds the inhibit voltage of the zero cross detection circuit, half of the TRIAC will be heldoff and not turn-on. This hold-off condition can be eliminated by using a snubber or capacitor placed directly across the optotriac as shown in figure 1. Note that the value of the capacitor increases as a function of the load current.

The hold-off condition also can be eliminated by providing a higher level of LED drive current. The higher LED drive provides a larger photocurrent which causes the phototransistor to turn-on before the commutating spike has activated the zero cross network. Figure 2 shows the relationship of the LED drive for power factors of less than 1.0. The curve shows that if a device requires 1.5 mA for a resistive load, then 1.8 times 2.7 mA) that amount would be required to control an inductive load whose power factor is less than 0.3.

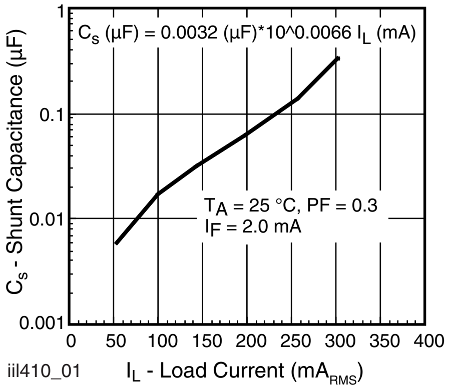


Fig. 1 - Shunt Capacitance vs. Load Current

TYPICAL CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)

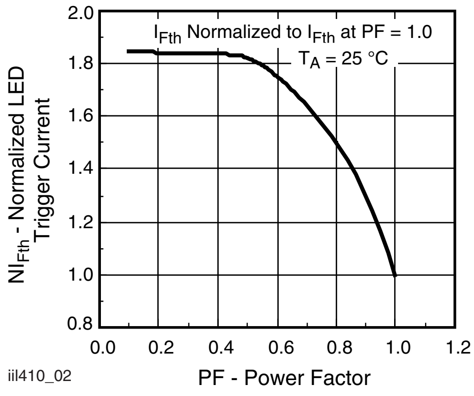


Fig. 2 - Normalized LED Trigger Current vs. Power Factor

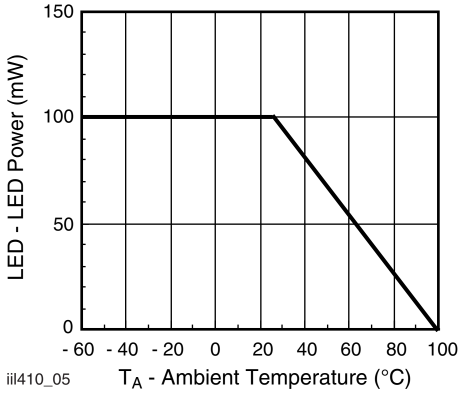


Fig. 5 - Maximum LED Power Dissipation

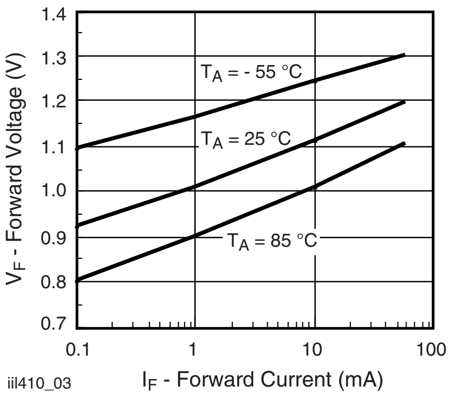


Fig. 3 - Forward Voltage vs. Forward Current

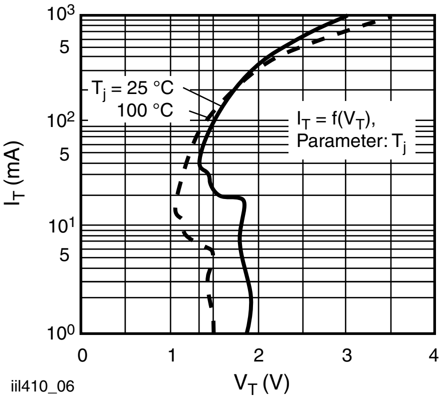


Fig. 6 - Typical Output Characteristics

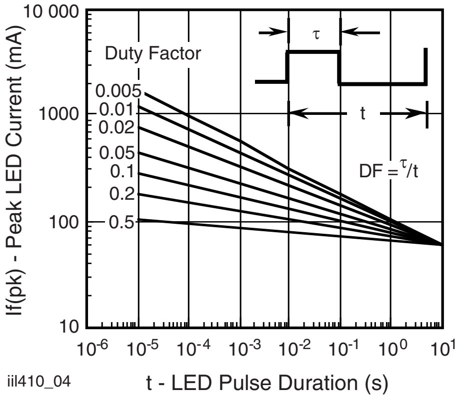


Fig. 4 - Peak LED Current vs. Duty Factor, Tau

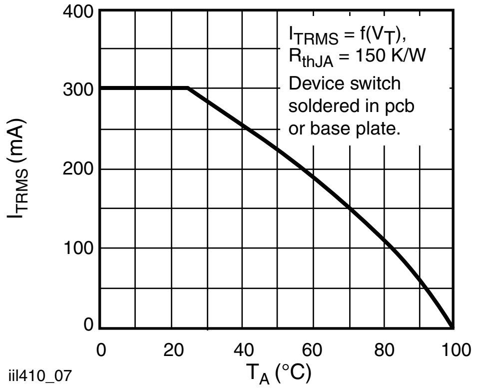


Fig. 7 - Current Reduction

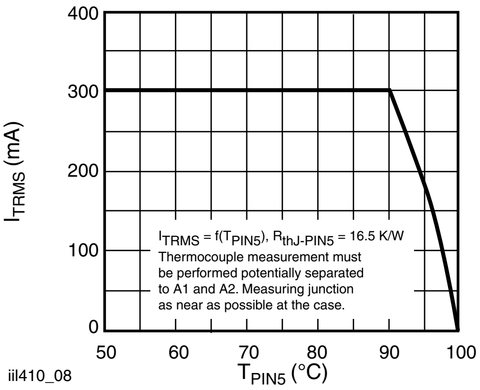


Fig. 8 - Current Reduction

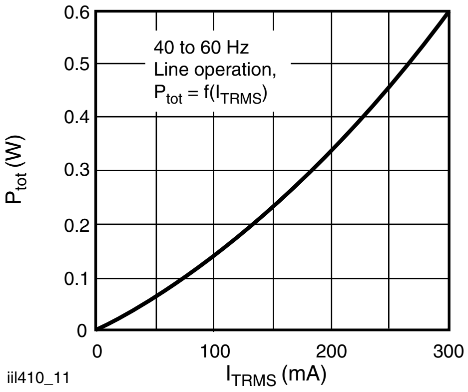


Fig. 11 - Power Dissipation 40 to 60 Hz Line Operation

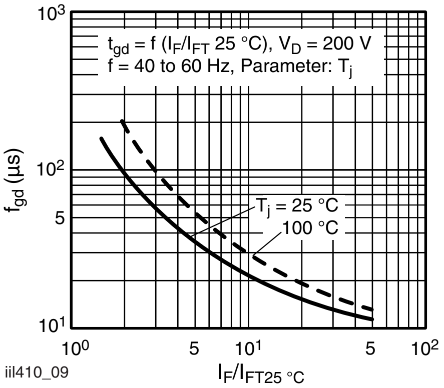


Fig. 9 - Typical Trigger Delay Time

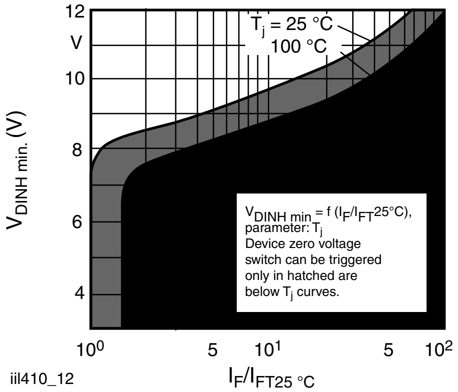


Fig. 12 - Typical Static Inhibit Voltage Limit

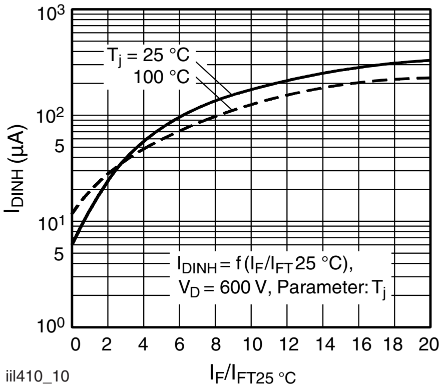


Fig. 10 - Typical Inhibit Current

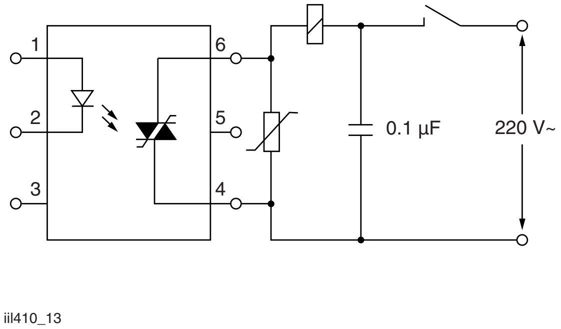


Fig. 13 - Apply a Capacitor to the Supply Pins at the Load-Side

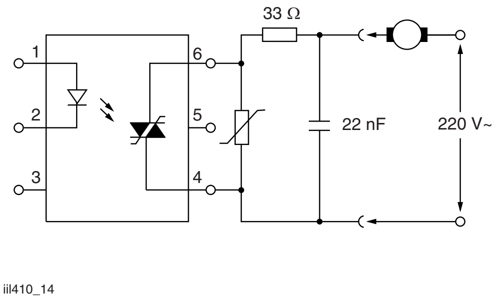


Fig. 14 - Connect a Series Resistor to the Output and Bridge Both by a Capacitor

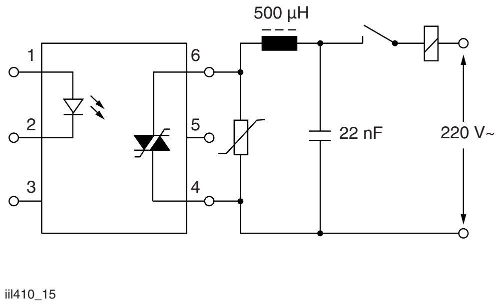
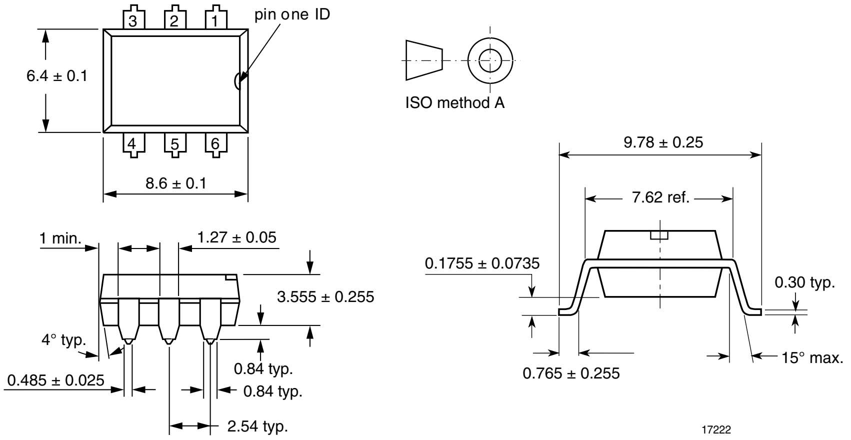


Fig. 15 - Connect a Choke of Low Winding Cap. in Series, e.g., a Ringcore Choke, with Higher Load Currents

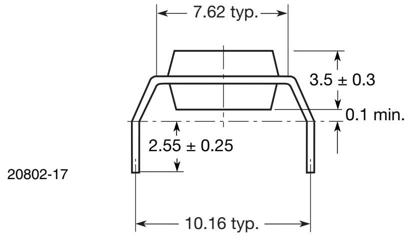
TECHNICAL INFORMATION

See Application Note for additional information.

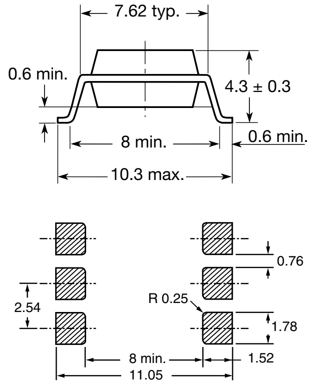
PACKAGE DIMENSIONS in millimeters



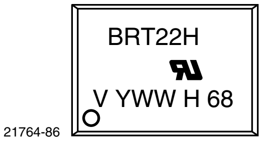
Option 6



Option 7



PACKAGE MARKING



Note

- Basic product marking only, refer to option information document number 83713 for option marking

Disclaimer

All product specifications and data are subject to change without notice.

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