



# NXP three-quadrant Hi-Com triacs

## Get the Hi-Com advantage

Our three-quadrant Hi-Com triacs are your ideal choice for controlling any load, delivering outstanding reliability and simplifying circuit design. Going beyond traditional four-quadrant triacs, they offer huge design efficiency and performance benefits. And our extensive portfolio means you're sure to find the perfect match to your applications needs.

### Key benefits

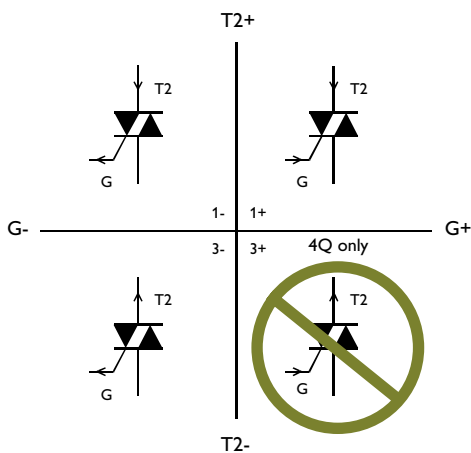
- ▶ Less circuit protection required (e.g. snubbers, inductors)
  - Simplifies circuit design
  - Reduces component count
  - Improves reliability
  - Cuts overall cost
- ▶ Excellent immunity to false triggering
- ▶ Extensive portfolio allows optimal balance between gate sensitivity and false triggering immunity

### Key features

- ▶ Better  $dV_D/dt$ ,  $dV_{com}/dt$ ,  $dI_{com}/dt$  capabilities than traditional 4Q triacs
- ▶ Choice of gate sensitivity levels ( $I_{GT}$ ) from 5 to 50 mA
- ▶ Choice of load current ( $I_T$ ) capabilities from 0.8 A up to 25 A
- ▶ 600, 800 and 1000 V types available
- ▶ 6 packages available including through-hole and surface-mount options

### Key applications

- ▶ Electrically noisy environments
- ▶ 'Difficult' loads e.g. non-linear, inductive, capacitive, high inrush or PTC resistive
- ▶ Any application where uncontrolled turn-on must be avoided
- ▶ Any application demanding high immunity to electromagnetic interference (EMI)

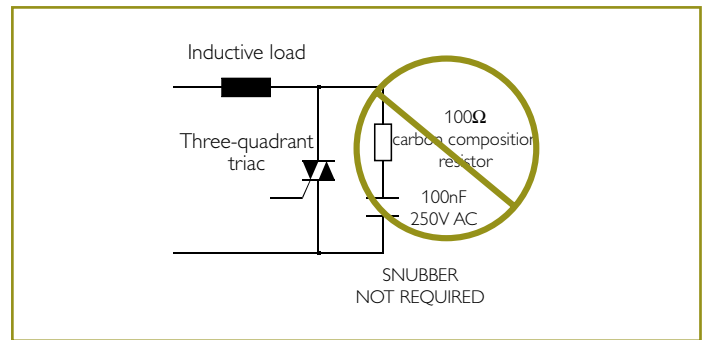
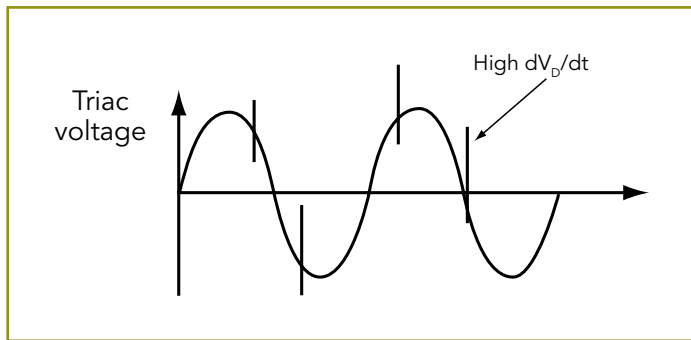


The simple, reliable and inexpensive triac is used to control power in many modern appliances. For equipment using motors or inductive / capacitive loads, our three-quadrant Hi-Com triacs are the ideal solution. These next-generation devices deliver higher immunity to false triggering and electrical noise without additional protection components, ensuring maximum reliability.

## A closer look at the Hi-Com advantages

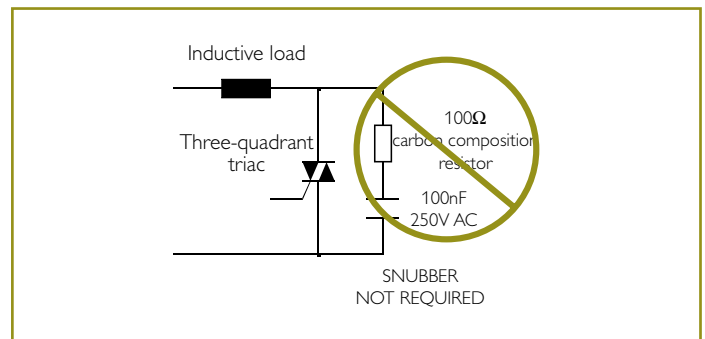
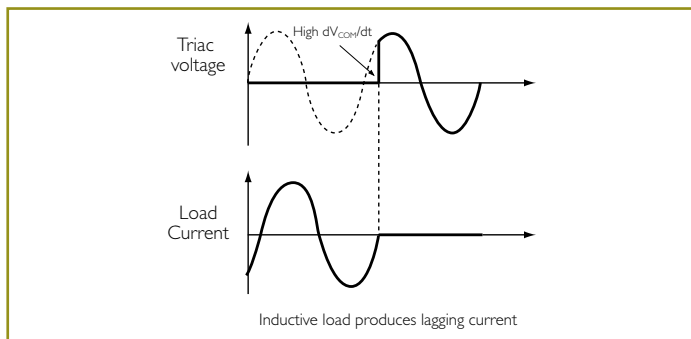
### ► Higher $dV_o/dt$ capability

- Prevents triggering by high  $dV/dt$  mains transients when off
- Reduces risk of damage from uncontrolled turn-on
- Eliminates need for snubber circuit



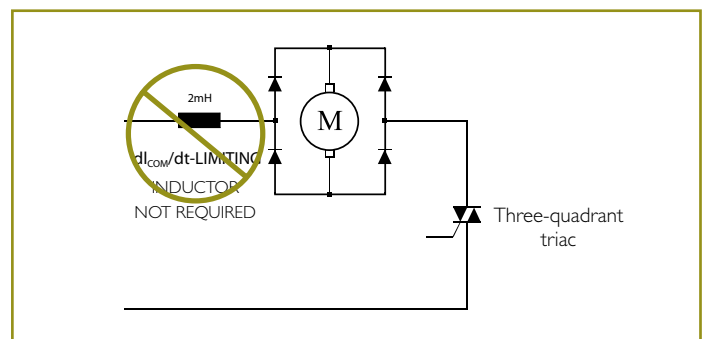
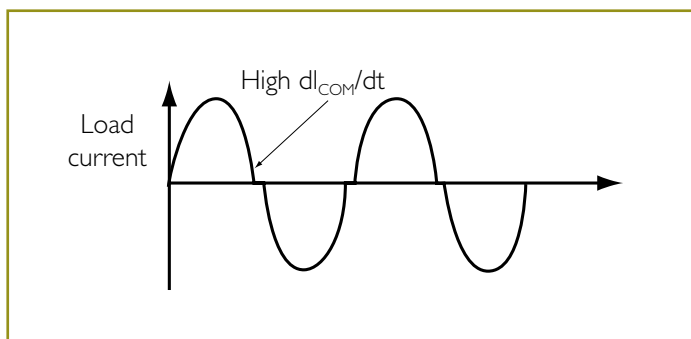
### ► Higher $dV_{com}/dt$ capability

- Improves ability to switch off reactive or noisy loads that cause high  $dV/dt$  during commutation
- Eliminates need for snubber circuit

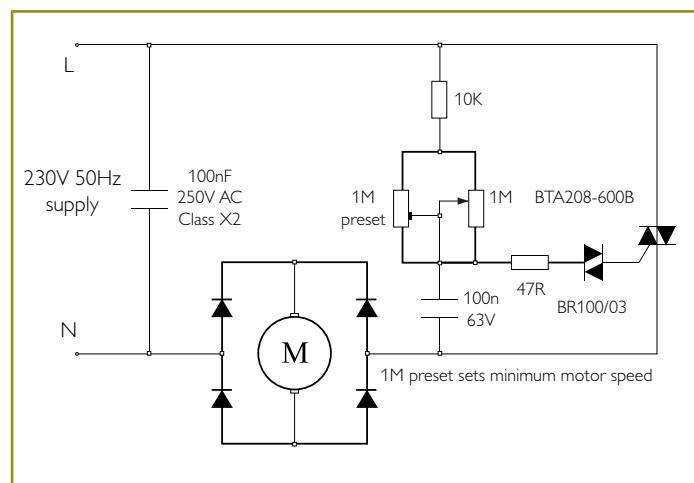


### ► Higher $dI_{com}/dt$ capability

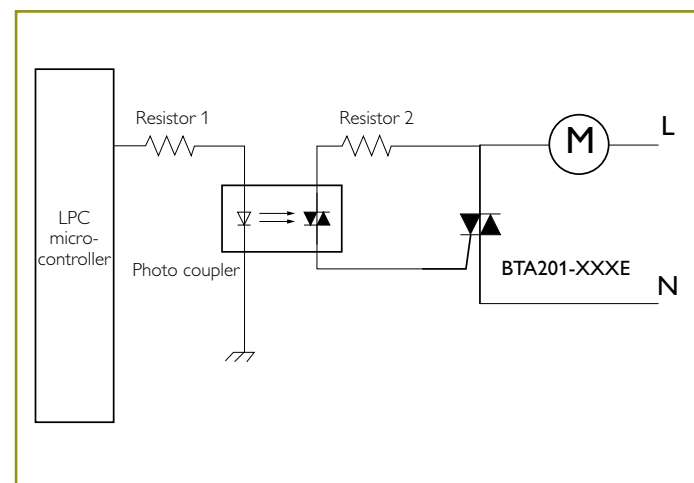
- Allows commutation of high  $dI/dt$  loads e.g. rectifier-fed inductive loads
- Eliminates need for additional  $dI_{com}/dt$ -limiting series inductor



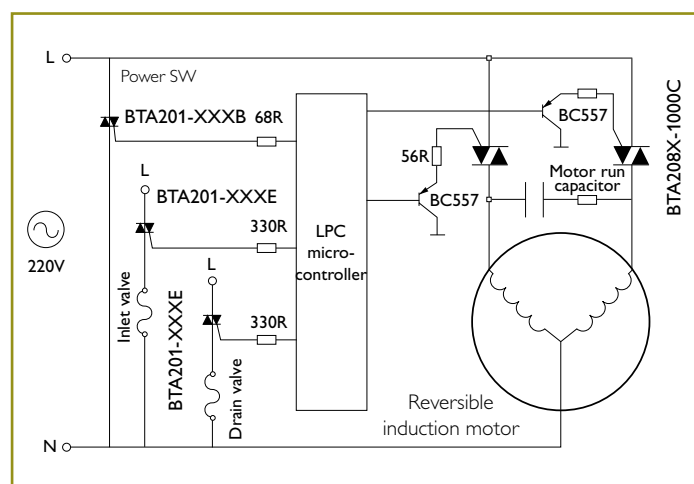
Analog phase control in a blender



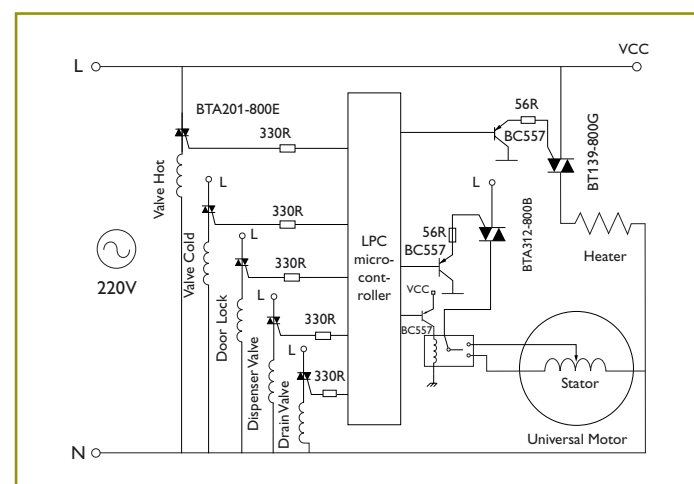
Isolated variable speed control in an air conditioner

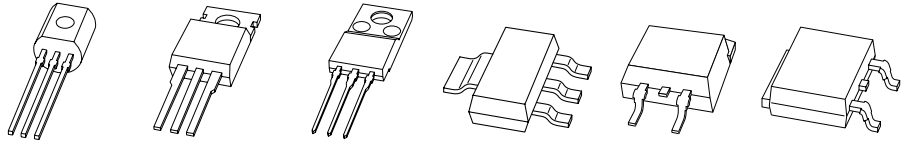


MCU-controlled on / off switch in a vertical-axis washing machine



Variable speed control in a horizontal-axis washing machine





$I_{T[RMS]}$ [A]	$V_{DRM}$ [V]	$I_{GT[max]}$	SOT54 TO92	SOT78 TO220AB	SOT186A [isolated TO220AB]	SOT223	SOT404 D²PAK	SOT428 DPAK
0.8	600/800	D/E	BTA2008					
1	600/800	B/E/ER	BTA201					
1	600/800	E				BTA201W		
1	600	B/C/D/E/F				BTA204W		
1	800	C/E				BTA204W		
4	600	B/C/D/E/F		BTA204	BTA204X			BTA204S
4	800	B/C/E		BTA204	BTA204X			BTA204S
8	600	B/D/E/F		BTA208	BTA208X			BTA208S
8	800	B/E		BTA208	BTA208X			BTA208S
8	1000	C			BTA208X		BTA208B	
12	600	B/D/E/F		BTA212	BTA212X		BTA212B	
12	600	B/C/D/E		BTA312	BTA312X		BTA312B	
12	600	CT		BTA312			BTA312B	
12	800	B/E		BTA212	BTA212X		BTA212B	
12	800	B/E		BTA312	BTA312X		BTA312B	
12	800	C/ET		BTA312			BTA312B	
16	600	B/D/E/F		BTA216	BTA216X		BTA216B	
16	600	BT		BTA216				
16	600	BT/D		BTA316				
16	600/800	B/C/E		BTA316	BTA316X		BTA316B	
16	800	B		BTA216	BTA216X		BTA216B	
25	600	BT		BTA225				
25	600/800	B		BTA225			BTA225B	

$I_{GT[max]}$  ratings: B, BT = 50 mA; C, CT = 35 mA; D = 5 mA; E = 10 mA; F = 25 mA

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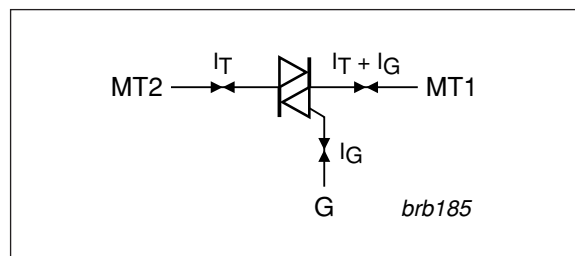
## NXP Hi-Com triacs BTA series

# Best-in-class triacs for horizontal- and vertical-axis washing machines

Delivering the highest immunity to false triggering, along with very robust commutation performance, these three-quadrant, Hi-Com triacs improve performance in washing machines and other white goods.

### Features

- ▶ Highest  $V_{DRM}$  and high  $dV_D/dt$  for increased static stability
- ▶ High  $dI_T/dt$  for greater resistance to fast current transients
- ▶ High  $dI_{com}/dt$  and  $dV_{com}/dt$  for better commutation performance
- ▶ Increased reliability with simpler circuitry
- ▶ Benchmark cost position
- ▶ Excellent quality records
- ▶ Optimized for use with logic ICs
- ▶ Wide variety of package options for best mounting



NXP Hi-Com triacs

Designed for use in washing machines and other white goods, NXP's three-quadrant, Hi-Com triacs provide low-cost, efficient electronic control of AC loads. They use an innovative implementation to deliver higher static stability, higher resistance to fast current transients, and very robust commutation performance. Simple circuitry leads to increased reliability, while the wide range of package options makes them easy to mount. In addition, when used in combination with one of NXP's logic ICs, they eliminate the need for a separate gate driver.

The triacs are intended for 50/60 Hz AC mains and become latched ON (positive or negative load current) in response to a negative current pulse on the gate. They turn off, or commute, when the load current falls to zero.

### BTA208X-1000C for high-voltage applications

In vertical-axis machines, controlling the induction motor can pose a particular challenge. NXP's BTA208X-1000C triac offers best-in-class performance in this high-voltage application.

To reverse the induction motor, designs often use two triacs that connect two motor terminals alternately to the AC mains supply. Each triac's operation has to be mutually exclusive, to avoid uncontrolled discharge of the motor running capacitor through both triacs. The motor coil generates high, continuous sinusoidal voltage (higher than the mains supply voltage), and the triac needs to be able to block the voltage without false triggering.

The NXP BTA208X-1000C is the only three-quadrant Hi-Com triac to guarantee a  $V_{\text{DRM}}$  of 1000 V in this application. It withstands voltage-change rates as high as 1000 V/ $\mu\text{s}$  (min) or 4000 V/ $\mu\text{s}$  (typ), so it has higher immunity to voltage noise and transients. It also withstands a current rise rate as high as 100 A/ $\mu\text{s}$  if the gate drive is strong, so it's better able to withstand fast inrush load current.

In addition to high immunity, the BTA208X-1000C also has a better ability to commute highly inductive and non-linear loads, for higher reliability and additional immunity to noise. The  $di_{\text{com}}/dt$  is 12 A/ms with unlimited  $dV_{\text{com}}/dt$  (without a snubber) at  $T_j = 125^\circ\text{C}$ .

The BTA208X-1000C is housed in an isolated TO220AB (SOT186A) package. An alternative version, the BTA208B-1000C, is available in an SMD D<sup>2</sup>PAK (SOT404).

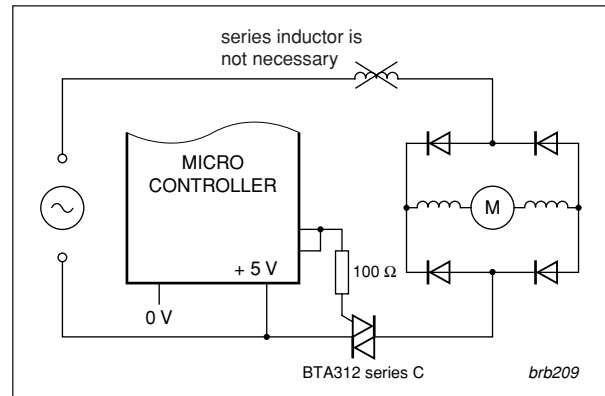
### BTA312 series for universal motor control in horizontal-axis washing machines

Most horizontal-axis machines use a universal motor to drive the main drum. During the wash and spin-dry functions, motor speed varies widely. A triac is typically used to control the speed, via phase-control of the motor current.

Motors that are optimized for DC operation usually have a bridge rectifier for full-wave rectification of the motor current. This can create an extremely demanding load-current for the triac on the AC side of the bridge, presenting a square wave with very fast rate of change of current at the zero-crossings. This in turn can cause a very high  $di_{\text{com}}/dt$  every half cycle, when the triac needs to turn off.

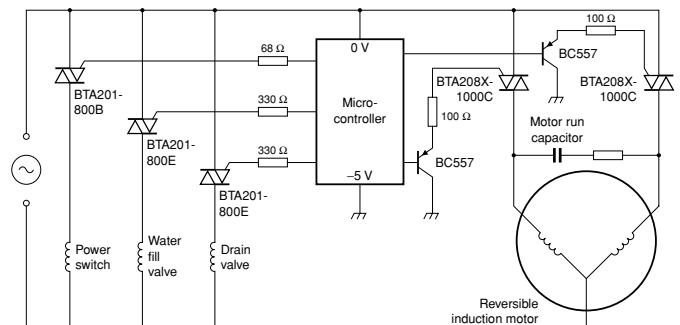
The BTA312 series of three-quadrant, Hi-Com triacs delivers very high commutation performance, for excellent control in motors that are optimized for either AC or DC operation. For example, the BTA312 series C versions (12 A, 600 V,  $I_{\text{GT}} = 35 \text{ mA}$ ) have a minimum  $di_{\text{com}}/dt$  of 20 A/ms with unlimited  $di_{\text{com}}/dt$  (without a snubber) at  $T_j = 125^\circ\text{C}$ . A very high minimum  $dV_{\text{D}}/dt$  of 500 V/ $\mu\text{s}$  at  $T_j = 125^\circ\text{C}$  also makes the C versions immune to voltage transients and noise.

The B versions, with an  $I_{\text{GT}}$  of 50 mA, offer even higher commutation performance and immunity to false triggering. They have a minimum  $di_{\text{com}}/dt$  of 30 A/ms with unlimited  $dV_{\text{com}}/dt$  (without a snubber) at  $T_j = 125^\circ\text{C}$ , and a minimum  $dV_{\text{D}}/dt$  of 1000 V/ $\mu\text{s}$  at  $T_j = 125^\circ\text{C}$ .



The BTA312 series C versions are available in an internally insulated TO220 package (NXP designation SOT78D, specified by a "Y" in the part number) in 600 and 800 V grades.

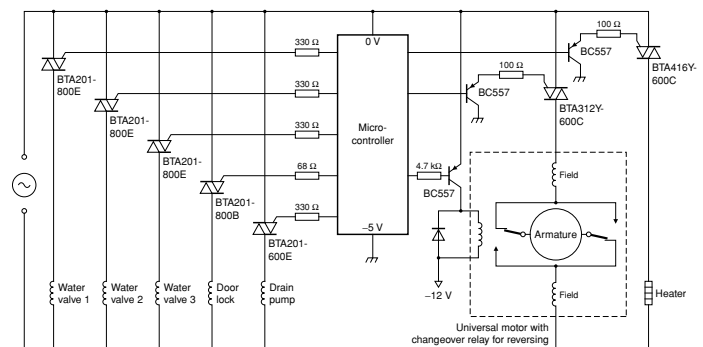
### Vertical axis washer



Note: 0 V may be described as +5 V and -5 V may be described as 0 V in your system

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### Horizontal axis washer

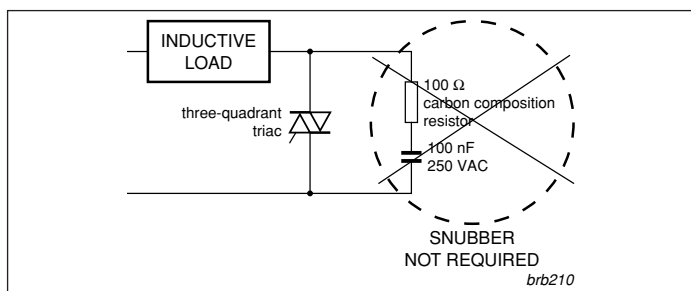
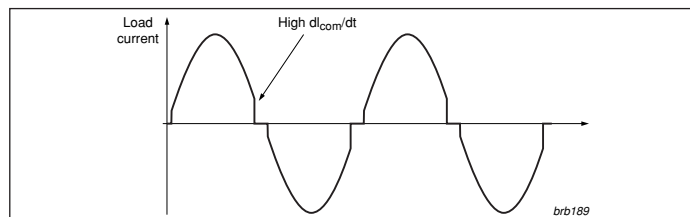
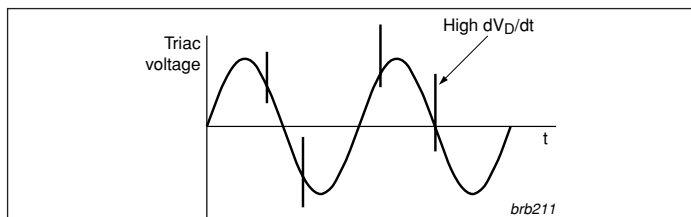


Note: 0 V may be described as +5 V and -5 V may be described as 0 V in your system

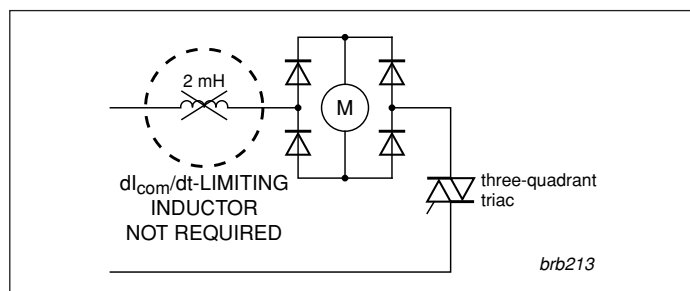
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## Design rules for triac selection

Most low-current triacs for small loads are 'E' types, with an  $I_{GT}$  of 10 mA. This provides the best compromise between ease of triggering from one microcontroller output and immunity to false triggering. However, for certain loads, such as the Power Switch, the Detergent Dispenser, and the Door Lock, immunity to false triggering may be more important than high trigger sensitivity, since false triggering can impair machine operation. For these loads, using a less sensitive triac, with an  $I_{GT}$  of 50 mA, offers the highest possible immunity to false triggering



NXP three-quadrant triacs deliver the highest possible immunity to false triggering



NXP three-quadrant triacs offer very robust commutation performance

## Recommended products for washing machines

For vertical axis washer

Water Fill Valve	Induction Motor	Power Switch	Drain Valve / Pump
BTA201-600E	BTA208X-1000C	BTA201-600B	BTA201-600E
BTA201-800E	BTA208B-1000C	BTA201-800B	BTA201-800E
			BTA202X-600E
			BTA202X-800E

For horizontal axis washer

Water Fill Valve	Universal Motor	Heater Control	Door Lock	Drain Pump
BTA201-600E	BTA312-600C	BTA316-600C	BTA201-600B	BTA201-600E
BTA201-800E	BTA312-800C	BTA416Y-600C	BTA201-800B	BTA201-800E
	BTA312Y-600C		BTA201-600E	BTA202X-600E
	BTA312Y-800C		BTA201-800E	BTA202X-800E

## Comparison of key parameters

For vertical axis washer

Load	Part number	$V_{DRM}$ (V)	$dV_D/dt$ (V/ $\mu$ s)	$dI_T/dt$ (A/ $\mu$ s)	$dI_{com}/dt$ (A/ms)	$dV_{com}/dt$ (V/ $\mu$ s)
	<b>BTA201-800E(R)</b>	<b>800</b>	<b>600</b>	<b>100</b>	<b>2.5</b>	<b>20</b>
Valve/pump	ACS108-6SA	600	500	100	0.3	15
	SM1L43	800	Not specified	Not specified	Not specified	Not specified
	<b>BTA208X-1000C</b>	<b>1000</b>	<b>1000</b>	<b>100</b>	<b>12</b>	<b>Without snubber</b>
Motor	T830-800W	800	300	50	5.5	Without snubber
	SM8LZ47	800	300 (typ)	50	4.5	10

#### For horizontal axis washer

Load	Part number	$V_{\text{DRM}}$ (V)	$dV_{\text{D}}/dt$ (V/ $\mu$ s)	$di_{\text{T}}/dt$ (A/ $\mu$ s)	$di_{\text{com}}/dt$ (A/ms)	$dV_{\text{com}}/dt$ (V/ $\mu$ s)
	<b>BTA201-800E</b>	<b>800</b>	<b>600</b>	<b>100</b>	<b>2.5</b>	<b>20</b>
Valve/door	ACS108-6SA	600	500	100	0.3	15
lock/pump	SM1L43	800	Not specified	Not specified	Not specified	Not specified
	<b>BTA312-800B</b>	<b>800</b>	<b>1000</b>	<b>100</b>	<b>30</b>	<b>Without snubber</b>
Motor	BTB12-800BW	800	1000	50	12	Without snubber
	SM12JZ47	600	300 (typ)	50	6.5	10

Rows in Blue represent NXP products

Rows in White represent competitors' products

#### NXP portfolio of three-quadrant, Hi-Com triacs

$I_{\text{T(RMS)}}$ (A)	$V_{\text{DRM}}$ (V)	$I_{\text{GT}}$ (max) (mA)	SOT54 (TO92)	SOT78 (TO220AB)	SOT78D (internally insulated TO220AB)	SOT186A (isolated TO220AB)	SOT223	SOT404 (D <sup>2</sup> PAK)	SOT428 (DPAK)
0.8	600 / 800	D/E	<b>BTA2008</b>						
1	600 / 800	B/E/ER	BTA201						
1	600 / 800	E					<b>BTA201W</b>		
1	600	B/C/D/E/F					BTA204W		
1	800	C/E					BTA204W		
2	600 / 800	D/E				<b>BTA202X</b>			
4	600	B/C/D/E/F		BTA204		BTA204X			BTA204S
4	800	B/C/E		BTA204		BTA204X			BTA204S
8	600	B/D/E/F		BTA208		BTA208X			BTA208S
8	800	B/E		BTA208		BTA208X			BTA208S
8	1000	C				<b>BTA208X</b>		<b>BTA208B</b>	
12	600	B/D/E/F		BTA212		BTA212X		BTA212B	
12	600	D		<b>BTA312</b>		<b>BTA312X</b>		<b>BTA312B</b>	
12	600	CT		<b>BTA312</b>				<b>BTA312B</b>	
12	600 / 800	B/C/E		<b>BTA312</b>		<b>BTA312X</b>		<b>BTA312B</b>	
12	600 / 800	C			<b>BTA312Y</b>				
12	800	B/E		BTA212		BTA212X		BTA212B	
12	800	ET		<b>BTA312</b>				<b>BTA312B</b>	
12	600 / 800	B/C			<b>BTA412Y</b>				
16	600	B/D/E/F		BTA216		BTA216X		BTA216B	
16	600	BT		BTA216					
16	600	BT/D		<b>BTA316</b>				<b>BTA316B</b>	
16	600 / 800	B/C/E		<b>BTA316</b>		<b>BTA316X</b>		<b>BTA316B</b>	
16	800	B		BTA216		BTA216X		BTA216B	
16	600 / 800	B/C			<b>BTA416Y</b>				
25	600	BT		BTA225					
25	600 / 800	B		BTA225				BTA225B	

$I_{\text{GT}}$ (max) ratings: D = 5 mA; E, ET, ER = 10 mA; F = 25 mA; C, CT = 35 mA; B, BT = 50 mA

Types in **bold red** represent new products

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