

TOSHIBA

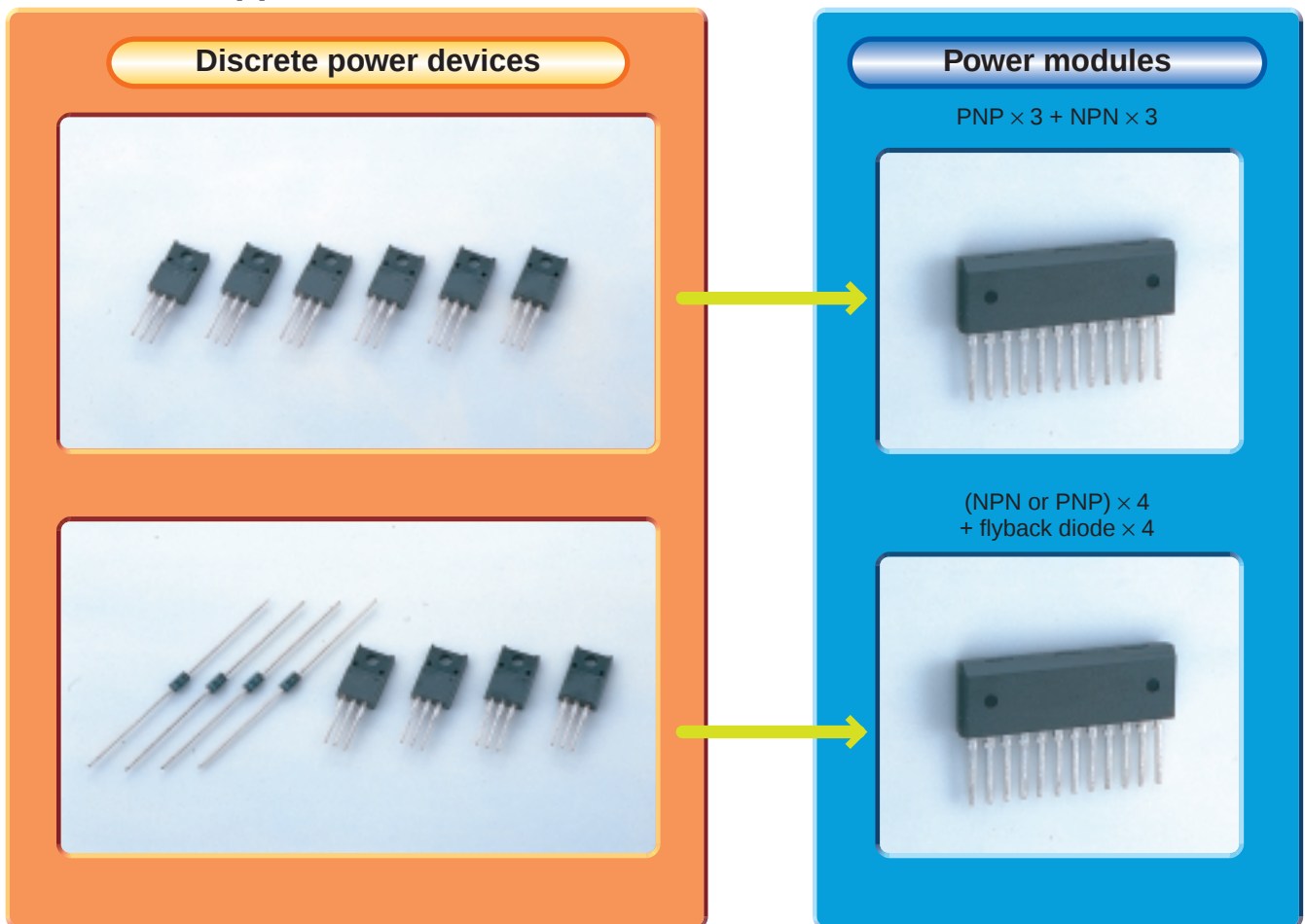
Power Modules

PRODUCT GUIDE

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■ External Appearance of Power Modules



1 Product List

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Features of MP Series of Power Modules

Rapid advances are being made in the miniaturization and level of integration of electronic devices, not only in the signal processing stages but also in the power stages.

Intelligent power devices, hybrid ICs and SMD technologies (among others) have helped to achieve these advances, but power module technology is the structurally simplest means of providing multiple elements in a single unit.

Power modules enable power devices to be easily mounted at high densities, and are ideal for use in general-purpose solenoid drives, matrix LED drives, printer head pin drives and as the power drivers for small motors such as stepping motors, forward-reverse control motors and 2-phase to 5-phase motors.

MP Series Features

1

Discrete multi-chip products

- Stable operation is enabled without parasitic elements such as ICs between units.
- Low loss and durability of discrete elements is maintained.
- Can be used in high-power applications because of the greater permissible loss and because operating temperatures are limited only by junction temperatures.

2

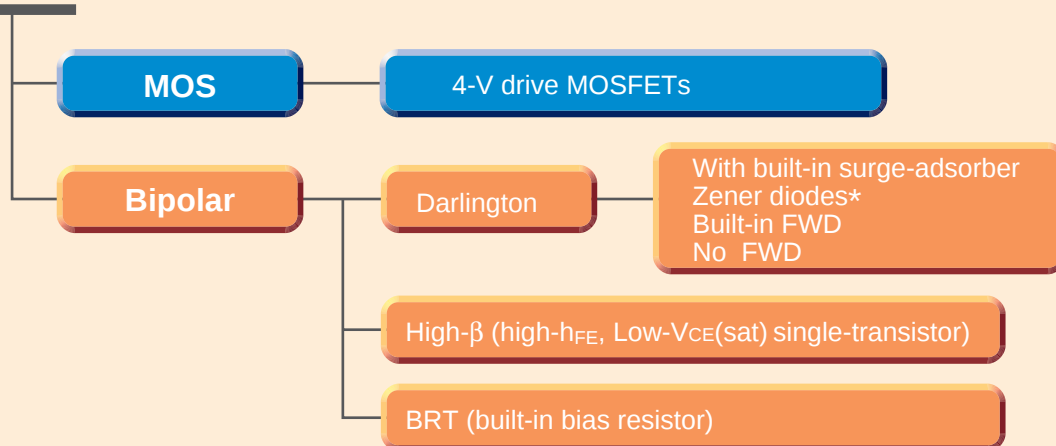
Voltage rating: 60 V~120 V. Current rating: 1.5 A~10 A

3

Line-ups include three package types and eight types of circuit structure.

4

Wide range of built-in chips.



*Zener voltage variation: 60 V ± 10 V, 80 V ± 10 V, 100 V ± 15 V

FWD: Flywheel diode

3 Structure and Dimensions

Toshiba's power modules are basically structured as multi-chip units with multiple discrete chips such as transistors and diodes built onto a frame. The required circuit structure is implemented by adjusting the frame dimensions and the bonding wire connections as required.

Power modules are therefore better suited to mass production than hybrid ICs. It is also relatively simple to develop different types of power module with the same circuit structure, but using transistor chips with different characteristics. In addition, the frame dimensions and bonding can be varied to yield a range of circuit configurations.

Figure 1 shows the internal structure of a full-mold type power module. Figure 2 shows the internal structure of a power module with an insulated heat sink for use in high-power applications. As shown in Figure 2, the internal circuitry of the power module is insulated using an insulated heat sink and resin. This means that no insulation is required when mounting the device on an external heat sink. This makes the mounting process simpler.

Figure 1. Internal structure of full-mold type

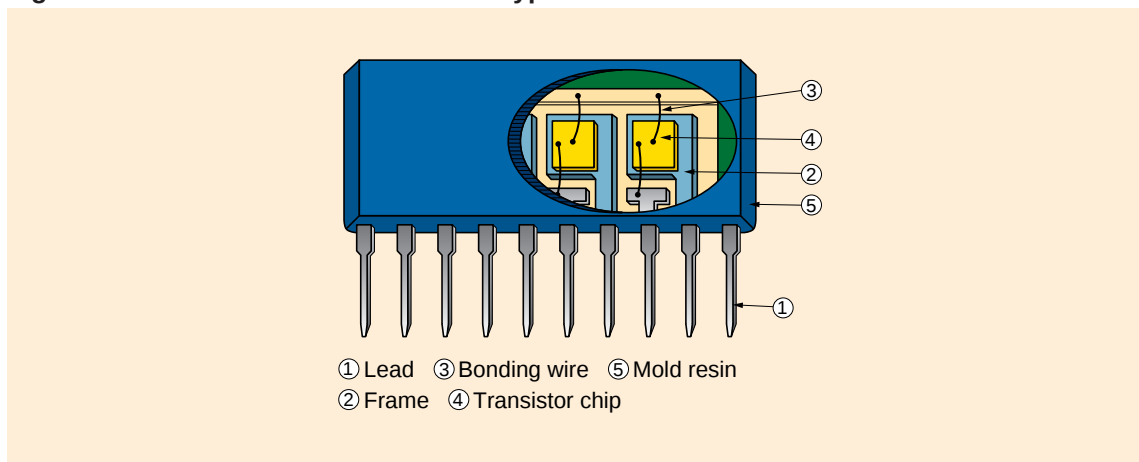


Figure 2. Internal structure of type with insulated heat sink

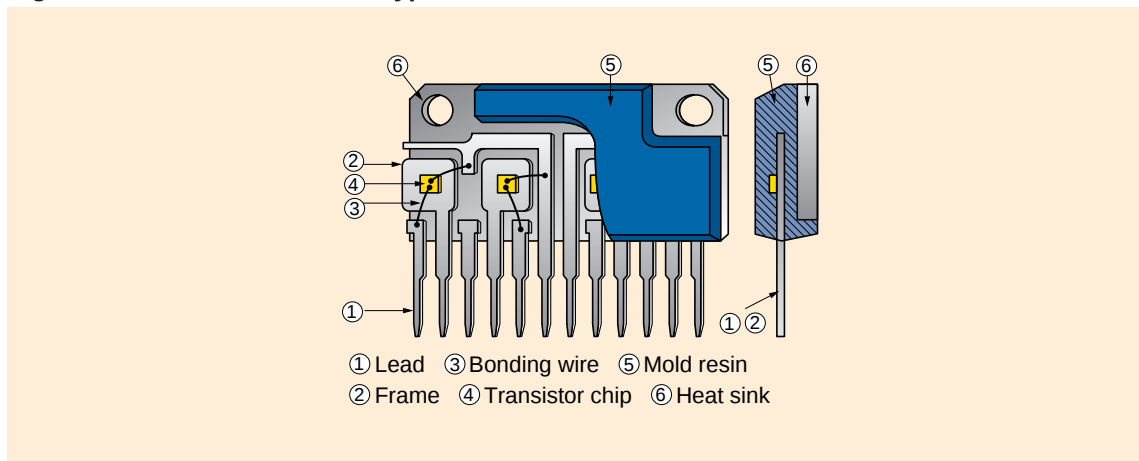
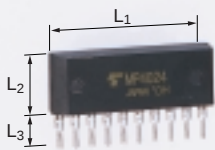


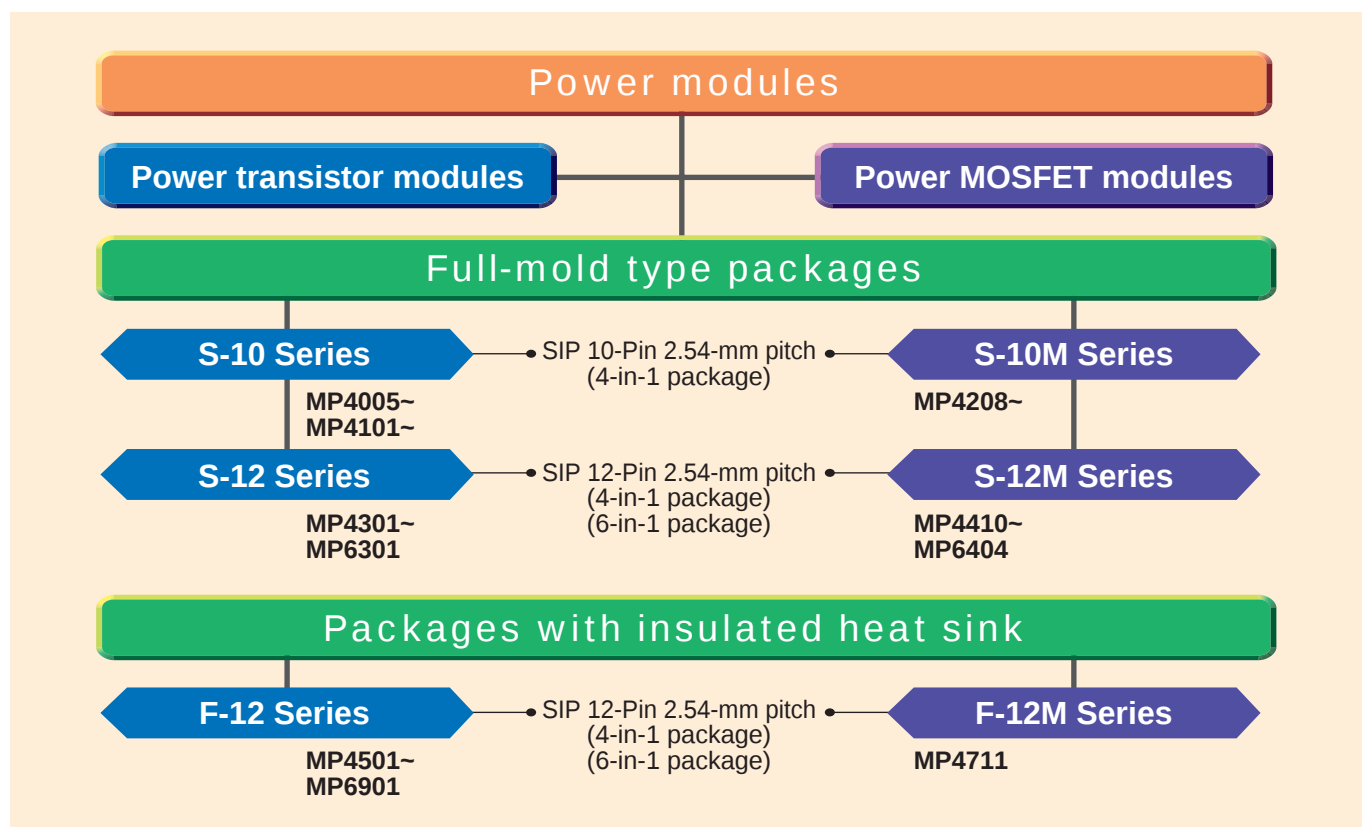
Table 1. Packaging and features of power modules

Name		S-10	S-12	F-12
Appearance				
	L1 (mm)	25.2	31.5	31.5
	L2 (mm)	9.0	10.5	16.1
	L3 (mm)	7.5	10.0	10.0
	Thickness (mm)	4.0	4.0	5.1
Structure		Full-mold type		Type with insulated heat sink
No. of Leads		SIP 10Pin	SIP 12Pin	SIP 12Pin
Lead Pitch (mm)		2.54	2.54	2.54
Weight (g)		2.1	3.9	6
No. of Transistors		4	4, 6	4, 6
Total Permissible Loss (W)*	Ta = 25°C	4	4.4	5
	Tc = 25°C	—	28	25 to 40

Note: In the S-12 and F-12 packages, the stand-off varies according to the type.

*Permissible loss is shown for typical products.

System Diagram of Power Module Products





Power Module Product Matrix

	Rating		Package Type	Full-Mold Type Package				Package with Insulated Heat Sink			
	V (V)	I (A)	Package Name	S-10		S-12		F-12			
			Lead Type	SIP-10		SIP-12		SIP-12			
			No. of Chips	4 in 1		4 in 1	6 in 1	4 in 1		6 in 1	
			Circuit Structure Chip Classification	N × 4 or P × 4	N × 2 + P × 2	N(P) × 2 + N(P) × 2 with FB-Di	N × 3 + P × 3	N × 4 or P × 4	N(P) × 2 + N(P) × 2 with FB-Di	N × 2 + P × 2	N × 3 + P × 3
Bipolar Transistors	60 ± 10	1.5	DTN + zener + R _B	MP4025							
	60 ± 10	2	DTN + zener	MP4020							
	60 ± 10	4	DTN + zener	MP4101							
	60 ± 10	5	DTN + zener	MP4015							
	80	2	DTN		MP4006						
	- 80	- 2	DTN								
	80 ± 10	2	DTN + zener	MP4013							
	80	3	High-β			MP4304					
	80	3	DTN				MP6301				
	- 80	- 3	DTN								
	80	4	DTN		MP4005					MP4503	MP6901
	- 80	- 4	DTN								
	100 ± 15	2	DTN + zener	MP4021							
	100	2	DTN			MP4303					
	100	3	DTN			MP4301		MP4502 MP4514	MP4501		
	100	4	DTN	MP4104							
	100 ± 15	3	DTN + zener + R _B	MP4024							
	100	5	DTN						MP4513		
	- 100	- 5	DTN			MP4305		MP4504			
	100	5	DTN					MP4506		MP4507	
	- 100	- 5	DTN	MP4009				MP4508			
MOSFETs	60	5	L ² - π - MOS	MP4210	MP4212	MP4410	MP6404				
	- 60	- 5	L ² - π - MOS	MP4211							
	- 60	- 5	L ² - π - MOS	MP4208							
	100	3	L ² - π - MOS	MP4209		MP4411					
	100	5	L ² - π - MOS			MP4412			MP4711		

Zener: Built-in zener diode between C-B
DTN: Darlington transistor
R_B: Built-in base series resistor

High-β: High-h_{FE} single transistor
FB-Di: Built-in diode for absorbing flyback voltage

Power Transistor Modules

S-10 Series
(4-in-1 package)

- 10-pin SIP
- Full mold



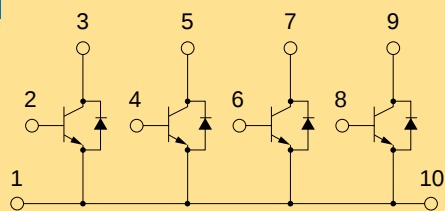
Product No.	Absolute Maximum ratings			Chip	h _{FE} (min)			V _{CE} (sat) (V)			Circuit	Remarks
	I _C (A)	V _{CEO} (V)	P _T (Ta=25°C) (W)			V _{CE} (V)	I _C (A)	(max)	I _C (A)	I _B (mA)		
MP4005	± 4	± 80	4	DTN	2000	± 2	± 1	± 1.5	± 3	± 6	D	NPN × 2 + PNP × 2
MP4006	± 2	± 80	4	DTN	2000	± 2	± 1	± 1.5	±1	± 1	D	NPN × 2 + PNP × 2
MP4009	− 5	− 100	4	DTN	1000	− 3	− 3	− 2.0	− 3	− 12	B	PNP × 4
MP4013	2	80 ± 10	4	DTN with zener	2000	2	1	1.5	1	1	C	NPN × 4
MP4015	5	60 ± 10	4	DTN with zener	1000	4	3	2.0	3	10	C	NPN × 4
MP4020	2	60 ± 10	4	DTN with zener	2000	2	1	1.5	1	1	C	NPN × 4
MP4021	2	100 ± 15	4	DTN with zener	2000	2	1	1.5	1	1	C	NPN × 4
MP4024	3	100 ± 15	4	BRT DTN with zener	2000	2	1	1.5	1	4.2 V	C	NPN × 4
MP4025	1.5	60 ± 10	4	BRT DTN with zener	2000	2	0.7	1.2	0.5	4.2 V	C	NPN × 4
MP4101	4	60 ± 10	4	DTN with zener	2000	2	1	1.5	3	10	C	NPN × 4
MP4104	4	100	4	DTN	2000	2	1.5	1.5	1.5	3	A	NPN × 4

With zener: Built-in zener diode between C-B
DTN: Darlington transistor

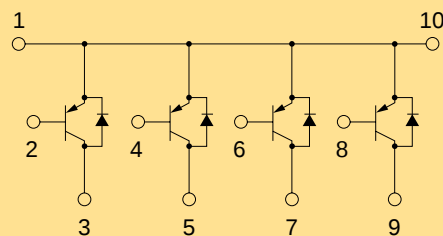
BRT: Transistor with built-in bias resistance

Circuit blocks

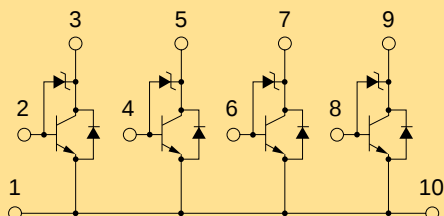
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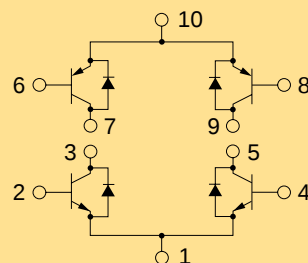
B



C



D



Power Transistor Modules

S-12 Series

(4-in-1 and 6-in-1 package)

- 12-pin SIP
- Full mold



Product No.	Absolute Maximum ratings			Chip	h_{FE}			$V_{CE(sat)}$ (V)			Circuit	Remarks
	I_C (A)	V_{CEO} (V)	P_T ($T_a=25^\circ\text{C}$) (W)		(min)	V_{CE} (V)	I_C (A)	(max)	I_C (A)	I_B (mA)		
MP4301	3	100	4.4	DTN	2000	2	1.5	1.5	1.5	3	A	NPN $\times$ 4 ▲
MP4303	2	100	4.4	DTN	2000	2	1	1.5	1	1	A	NPN $\times$ 4 ▲
MP4304	3	80	4.4	High- β	600	2	1	0.5	1.5	15	A	NPN $\times$ 4 ▲
MP4305	-5	-100	4.4	DTN	2000	-5	-3	-1.5	-3	-6	B	PNP $\times$ 4 ▲
MP6301	± 3	± 80	4.4	DTN	2000	± 2	± 1	± 1.8	± 2	± 4	C	NPN $\times$ 3 + PNP $\times$ 3

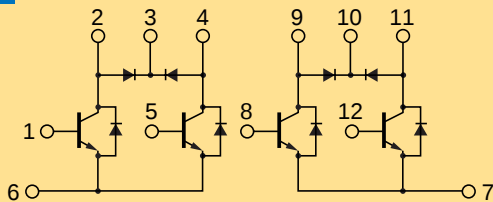
High- β : high- h_{FE} single transistor

DTN: Darlington transistor

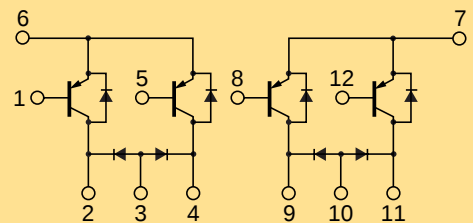
▲: Built-in diode for absorbing flyback voltage

Circuit blocks

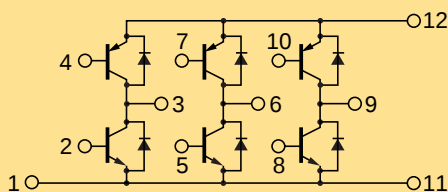
A



B



C



Power Transistor Modules

F-12 Series

(4-in-1 and 6-in-1 package)

- 12-pin SIP
- Insulated heat sink

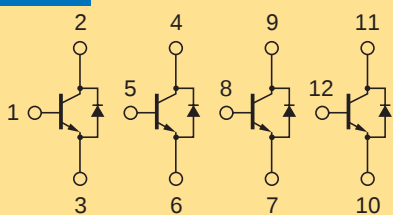


Product No.	Absolute Maximum ratings				Chip	h _{FE} (min)	V _{CE} (sat) (V)			Circuit	Remarks		
	I _C (A)	V _{CEO} (V)	P _T (W)				V _{CE} (V)	I _C (A)	(max)			I _C (A)	I _B (mA)
			Ta=25°C	Tc=25°C									
MP4501	3	100	5	25	DTN	2000	2	1.5	1.5	1.5	3	C	NPN × 4 ▲
MP4502	3	100	5	25	DTN	2000	2	1.5	1.5	1.5	3	A	NPN × 4
MP4503	± 4	± 80	5	25	DTN	2000	± 2	± 1	± 1.5	± 3	± 6	D	NPN × 2 + PNP × 2
MP4504	− 5	− 100	5	25	DTN	2000	− 5	− 3	− 1.5	− 3	− 6	B	PNP × 4
MP4506	5	100	5	25	DTN	1000	3	3	2.0	3	12	A	NPN × 4
MP4507	± 5	± 100	5	25	DTN	1000	± 3	± 3	± 2.0	± 3	± 12	D	NPN × 2 + PNP × 2
MP4508	− 5	− 100	5	25	DTN	1000	− 3	− 3	− 2.0	− 3	− 12	B	PNP × 4
MP4513	5	100	5	25	DTN	1000	3	3	2.0	3	12	C	NPN × 4 ▲
MP4514	3	100	5	25	DTN	4000	4	1	1.5	1	1	A	NPN × 4
MP6901	± 4	± 80	5	25	DTN	2000	± 2	± 1	± 1.5	± 3	± 6	E	NPN × 3 + PNP × 3

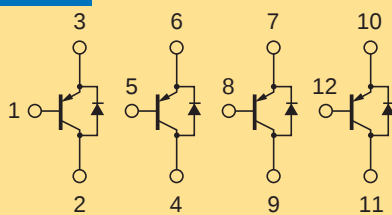
▲: Built-in diode for absorbing flyback voltage DTN: Darlington transistor

Circuit blocks

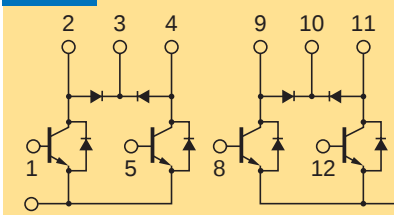
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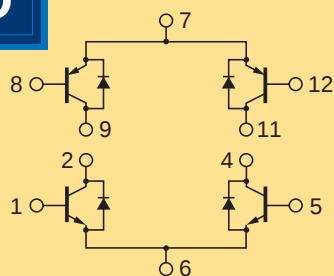
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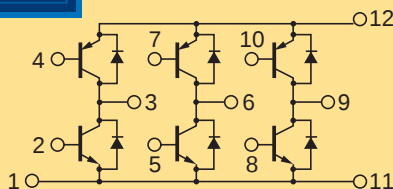
C



D



E



Power MOSFET Modules

S-10M Series

(4-in-1 package)

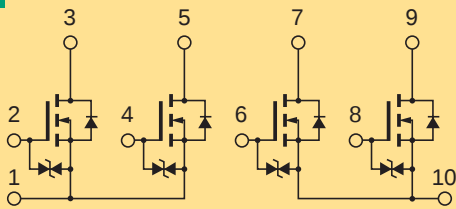
- 10-pin SIP
- Full mold



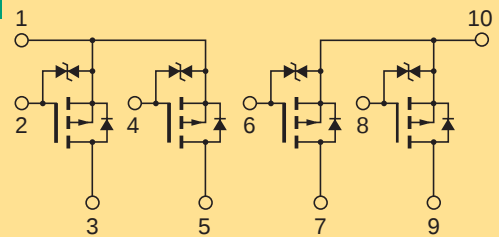
Product No.	Absolute Maximum ratings			$R_{DS(ON)max}$			$R_{DS(ON)max}$			Circuit	Remarks
	I_D (A)	V_{DSS} (V)	P_{DT} ($T_a=25^\circ\text{C}$) (W)	$R_{DS(ON)max}$ (Ω)	V_{GS} (V)	I_D (A)	$R_{DS(ON)max}$ (Ω)	V_{GS} (V)	I_D (A)		
MP4208	-5	-60	4	0.3	-10	-2.5	0.5	-4	-2.5	D	P-ch $\times 4$
MP4209	3	100	4	0.35	10	2	0.45	4	2	A	N-ch $\times 4$
MP4210	5	60	4	0.16	10	2.5	0.32	4	2.5	A	N-ch $\times 4$
MP4211	-5	-60	4	0.19	-10	-2.5	0.28	-4	-2.5	B	P-ch $\times 4$
MP4212	± 5	± 60	4	0.16/0.19	± 10	± 2.5	0.32/0.28	± 4	± 2.5	C	N-ch $\times 2$ + P-ch $\times 2$

Equivalent circuits

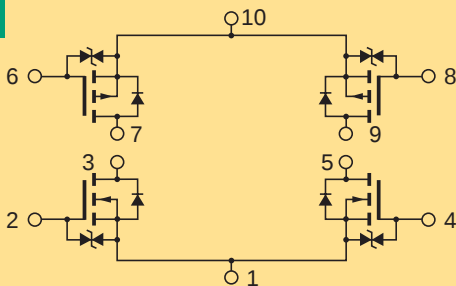
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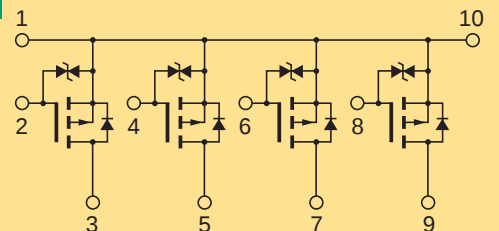
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C



D



Power MOSFET Modules

S-12M Series
(4-in-1 and 6-in-1 package)

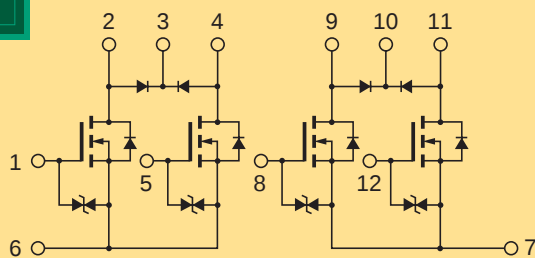
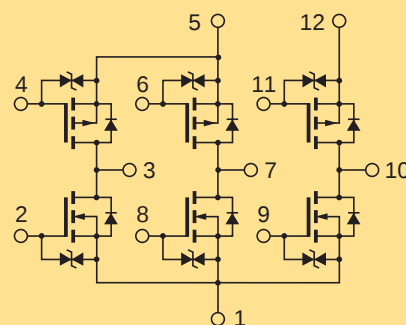
- 12-pin SIP
- Full mold



Product No.	Absolute Maximum ratings				R _{DS(ON)} max			R _{DS(ON)} max			Circuit	Remarks
	I _D	V _{DSS}	P _{DT} (W)									
			(A)	(V)	Ta=25° C	Tc=25° C	(Ω)	(V)	(A)	(Ω)		
MP4410	5	60	4.4	28	0.16	10	2.5	0.31	4	2.5	A	N-ch × 4 
MP4411	3	100	4.4	28	0.35	10	2	0.45	4	2	A	N-ch × 4 
MP4412	5	100	4.4	28	0.23	10	2.5	0.30	4	2.5	A	N-ch × 4 
MP6404	± 5	± 60	4.4	36	0.16/0.19	± 10	± 2.5	0.32/0.28	± 4	± 2.5	B	N-ch × 3 + P-ch × 3

$\blacktriangle$: Diode for absorbing flyback voltage

Equivalent circuits

A**B**

Power MOSFET Modules

F-12M Series

(4-in-1 and 6-in-1 package)

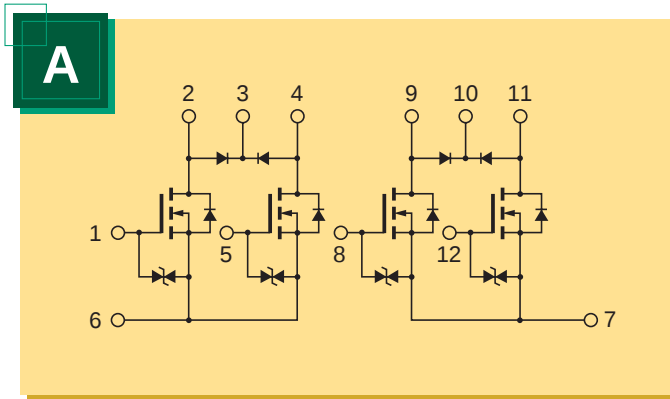
- 12-pin SIP
- Insulated heat sink



Product No.	Absolute Maximum ratings				$R_{DS(ON)max}$ (Ω)	$R_{DS(ON)max}$		$R_{DS(ON)max}$			Circuit	Remarks
	I_D (A)	V_{DSS} (V)	P_{DT} (W)			V_{GS} (V)	I_D (A)	$R_{DS(ON)max}$ (Ω)	V_{GS} (V)	I_D (A)		
			$T_a=25^{\circ}C$	$T_c=25^{\circ}C$								
MP4711	5	100	5	36	0.23	10	2.5	0.30	4	2.5	A	N-ch $\times$ 4 

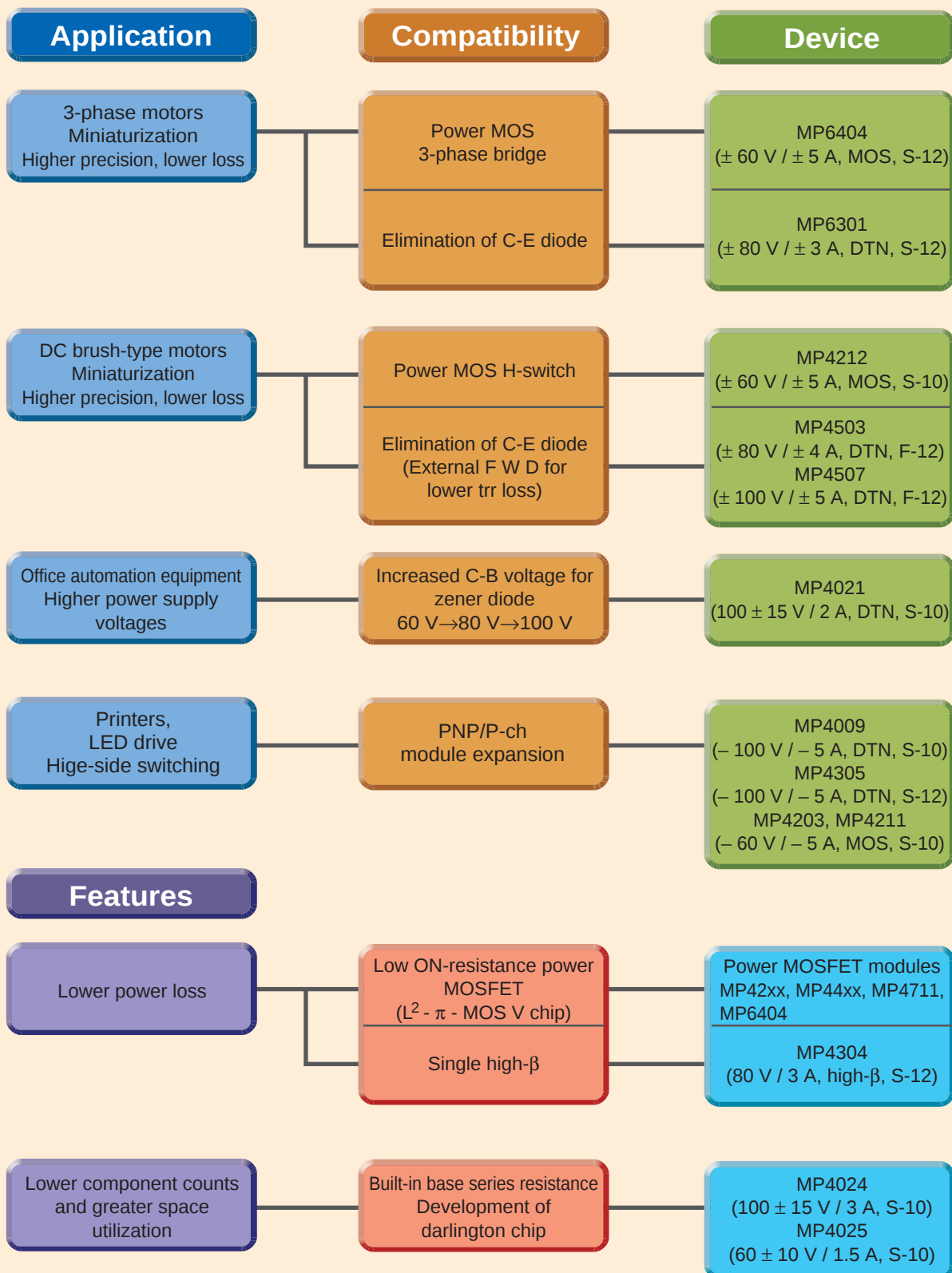
: Diode for absorbing flyback voltage

Equivalent circuits



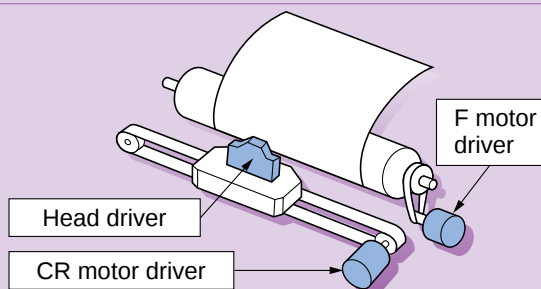


Toshiba Power Module Products



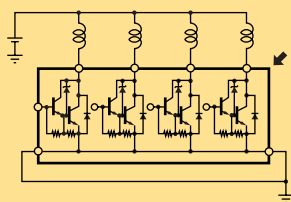
9 Applications and Line-ups

Application Printers



Internal Zener Clamp Method for Head Pins or Stepping Motors

- Extremely simple structure

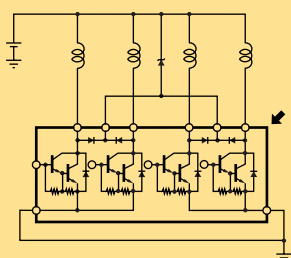


Recommended type: series with built-in zener diode between C-B

Product No.	Structure	Rating		Package
		Voltage (V)	Current (A)	
MP4020	Darlington	60 ± 10	2	S-10
MP4021	Darlington	100 ± 15	2	S-10

External Zener Clamp Method for Head Pins and Stepping Motors

- Increased freedom in selecting clamp values and reduced clamp value fluctuation make it comparatively easy to achieve faster printing speeds.



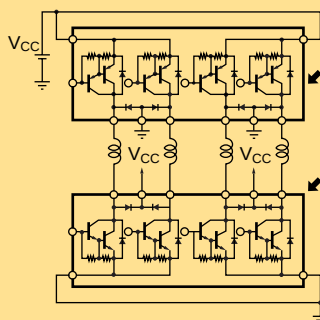
Recommended type: series with built-in FB-Di

Product No.	Structure	Rating		Package
		Voltage (V)	Current (A)	
MP4303	Darlington	100	2	S-12
MP4301	Darlington	100	3	S-12
MP4304	High-β	80	3	S-12
MP4501	Darlington	100	3	F-12
MP4513	Darlington	100	5	F-12

FB-Di: Diode for regenerating flyback energy

Two-Stage Energy Regeneration Method for Head Pin Drives

- Print speed and quality is increased the incorporation of transistors for switching and diodes for energy regeneration at both ends of the drive coil.



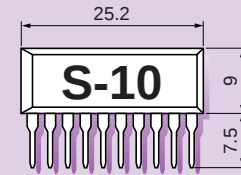
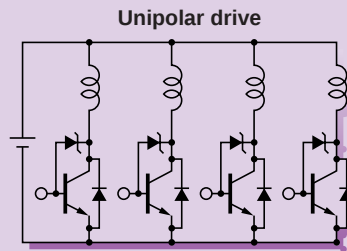
Recommended type

Product No.	Polarity	Structure	Rating		Package
			Voltage (V)	Current (A)	
MP4305	PNP	Darlington	- 100	- 5	S-12
MP4303	NPN	Darlington	100	2	S-12
MP4301	NPN	Darlington	100	3	S-12
MP4304	NPN	High-β	80	3	S-12
MP4501	NPN	Darlington	100	3	F-12
MP4514	NPN	Darlington	100	3	F-12
MP4513	NPN	Darlington	100	5	F-12

9 Applications and Line-ups

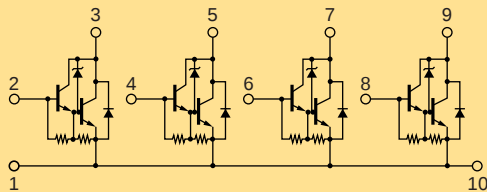
Application Printers

4-in-1 module for 2-phase stepping motor



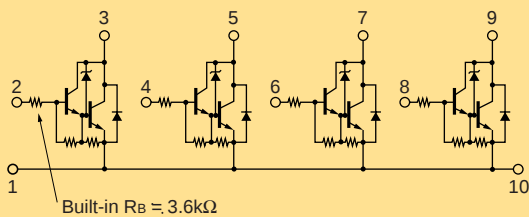
Unit: mm

NPN darlington with built-in zener diode



	MP4020	MP4021
V_{CE0} (V)	60 ± 10	100 ± 15
I_C (A)	2	2
P_T (W) ($T_a=25^\circ\text{C}$)	4	4
h_{FE} (min)	2000	2000
V_{CE} (sat) (V)	1.5 (max)	1.5 (max)
Built-in C-B zener diode for surge absorption		

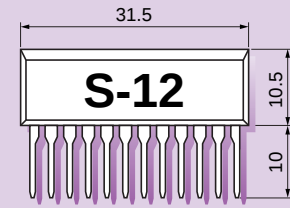
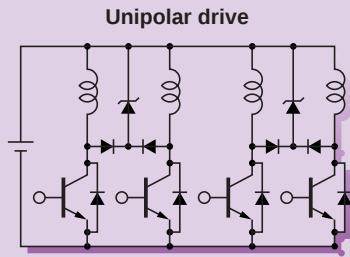
NPN darlington with built-in R_B and built-in zener diode



	MP4024	
V_{CE0} (V)	100 ± 15	
I_C (A)	3	
P_T (W) ($T_a=25^\circ\text{C}$)	4	
h_{FE} (min)	2000	
V_{CE} (sat) (V)	1.5 (max)	
4-V drive and lower component counts are achieved by building in bias resistance. Built-in zener diode performs surge absorption.		

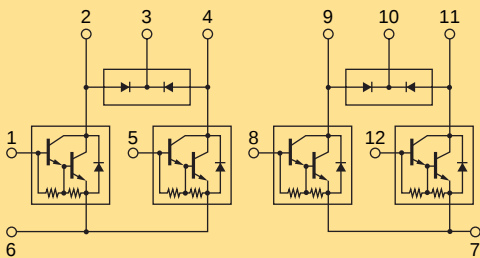
Application Motors

4-in-1 module for 2-phase
stepping motor



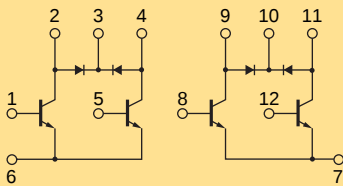
Products with built-in diodes for absorbing flyback voltage

NPN darlington



	MP4301	MP4303
V_{CE0} (V)	100	100
I_C (A)	3	2
P_T (W) ($T_a=25^\circ\text{C}$)	4.4	4.4
h_{FE} (min)	2000	2000
$V_{CE}(\text{sat})$ (V)	1.5 (max)	1.5 (max)

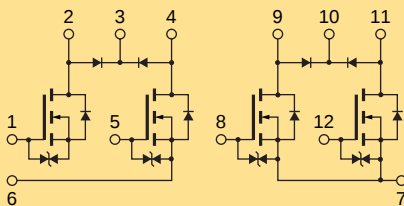
NPN High- β



	MP4304	
V_{CE0} (V)	80	
I_C (A)	3	
P_T (W) ($T_a=25^\circ\text{C}$)	4.4	
h_{FE} (min)	600	
$V_{CE}(\text{sat})$ (V)	0.5 (max)	

High- h_{FE} single transistor
Low $V_{CE}(\text{sat})$ for lower loss

N-ch MOSFET



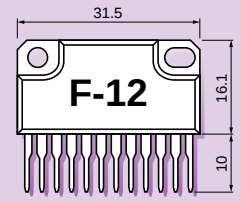
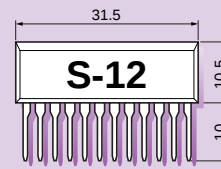
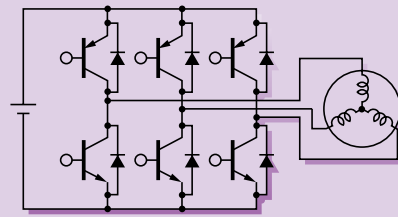
	MP4410	MP4411	MP4412
V_{DSS} (V)	60	100	100
I_D (A)	5	3	5
P_{DT} (W) ($T_a=25^\circ\text{C}$)	4.4	4.4	4.4
$R_{DS(ON)}$ (Ω)	0.16 (max)	0.35 (max)	0.23 (max)

Low ON-resistance MOSFET for lower loss
4-V gate drive

9 Applications and Line-ups

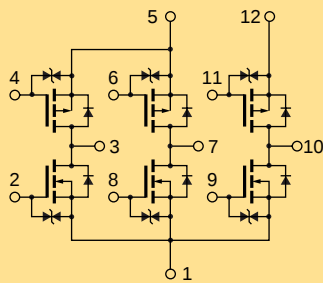
Application Motors

6-in-1 module for 3-phase motor



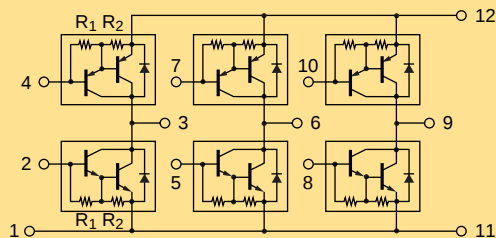
Unit: mm

P-ch × 3 + N-ch × 3



	MP6404	MP6801
V_{DS} (V)	± 60	± 60
I_D (A)	± 5	± 10
P_{DT} (W) ($T_c=25^\circ\text{C}$)	36	40
$R_{DS(ON)}$ (N-ch/P-ch)	160/190 mΩ (max)	80/125 mΩ (max)
Package	S-12	F-12
High current and low ON-resistance for lower loss 4-V gate drive		

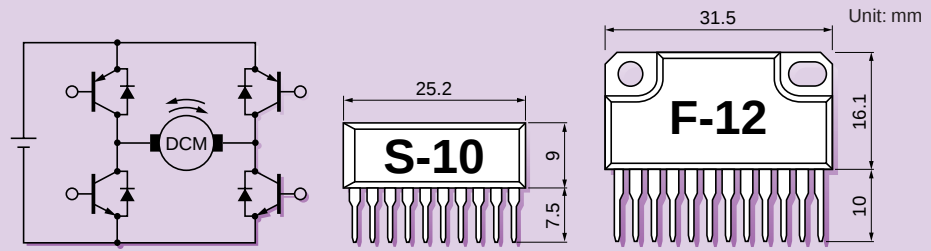
PNP × 3 + NPN × 3



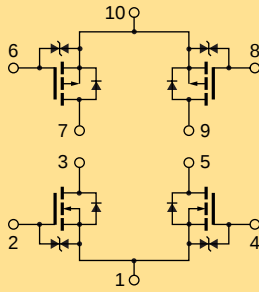
	MP6301	MP6901
V_{CE0} (V)	± 80	± 80
I_C (A)	± 3	± 4
P_T (W) ($T_a=25^\circ\text{C}$)	4.4	25*
h_{FE} (min)	2000	2000
Package	S-12	F-12
* $T_c = 25^\circ\text{C}$		

Application Motors

4-in-1 module for forward
and reverse operation of
DC motor with brush

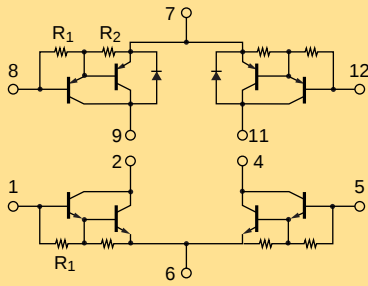


P-ch $\times$ 2 + N-ch $\times$ 2



	MP4212
V_{DS} (V)	± 60
I_D (A)	± 5
P_{DT} (W) ($T_a=25^\circ\text{C}$)	4
$R_{DS(ON)}$ (N-ch/P-ch) (Ω)	0.16/0.19 (max)
Package	S-10
Low ON-resistance MOSFET for lower loss 4-V gate drive	

PNP $\times$ 2 + NPN $\times$ 2



	MP4005	MP4006	MP4503	MP4507
V_{CE0} (V)	± 80	± 80	± 80	± 100
I_C (A)	± 4	± 2	± 4	± 5
P_T (W) ($T_a=25^\circ\text{C}$)	4	4	25*	25*
h_{FE} (min)	2000	2000	2000	1000
Package	S-10	S-10	F-12	F-12
* $T_C = 25^\circ\text{C}$				

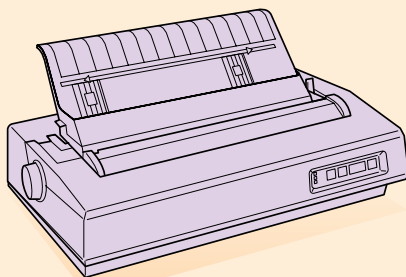
10 Typical Applications

Actuator (Motor and Solenoid) Drivers Incorporated into Moving Parts Toshiba Power Modules

Printers

Head pin and stepping motor drive

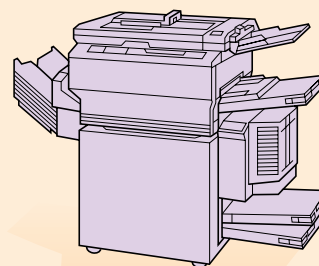
MP4000 Series
MP4100 Series
MP4300 Series
MP4400 Series



Photocopiers

Motor drive

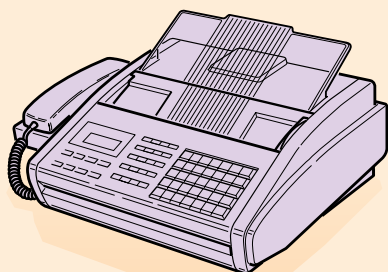
MP4000 Series
MP4100 Series
MP4212
MP4503
MP4507
MP6901



Fax machines

Stepping motor drive

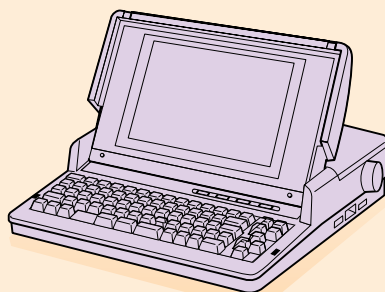
MP4000 Series
MP4100 Series



Word-processors

Printer stepping motor drive

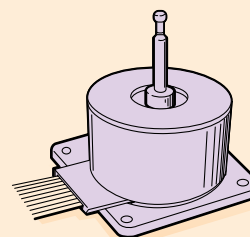
MP4000 Series
MP4100 Series
MP4400 Series



Small motors and solenoids

All MP Series

MP4024
MP6404



Air-conditioners

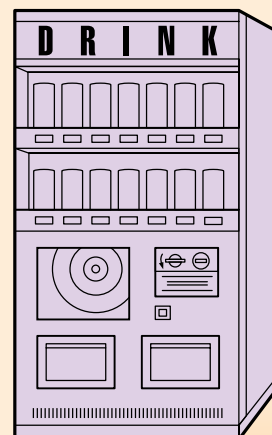
Fan motor drive

MP6301
MP6404
MP6901



Vending machines

MP4000 Series
MP4100 Series

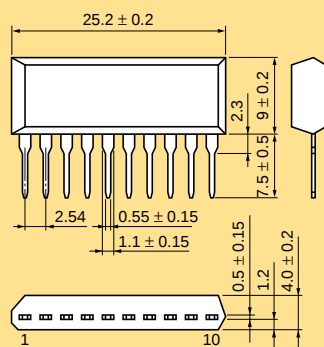


11 Dimensions of Power Module Packages

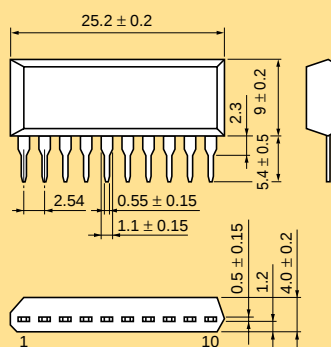
Some S-10 and S-12 products are available with short leads

S-10

Standard long lead



Short lead

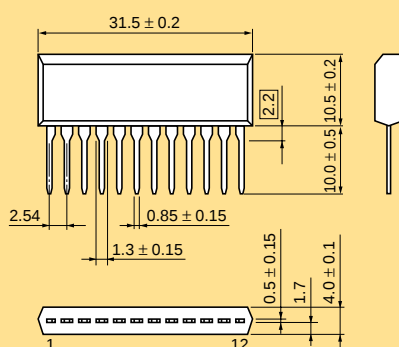


Unit: mm

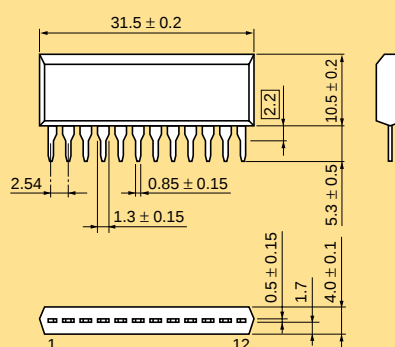
※Available only as set out in the diagram 2-25A1A.

S-12

Standard long lead



Short lead

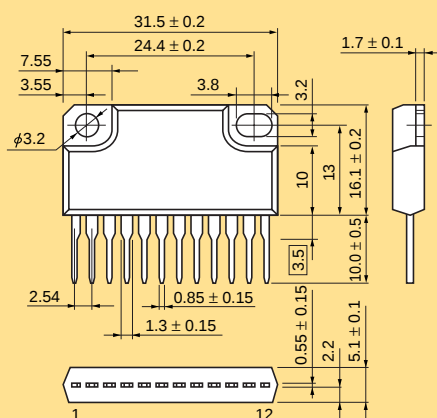


Unit: mm

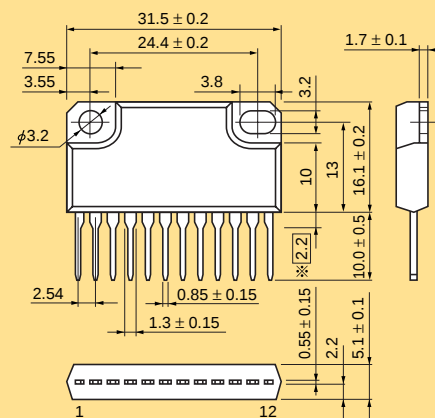
※Available with products with 2.2-mm stand-off.

F-12

Standard long lead



Short stand-off type



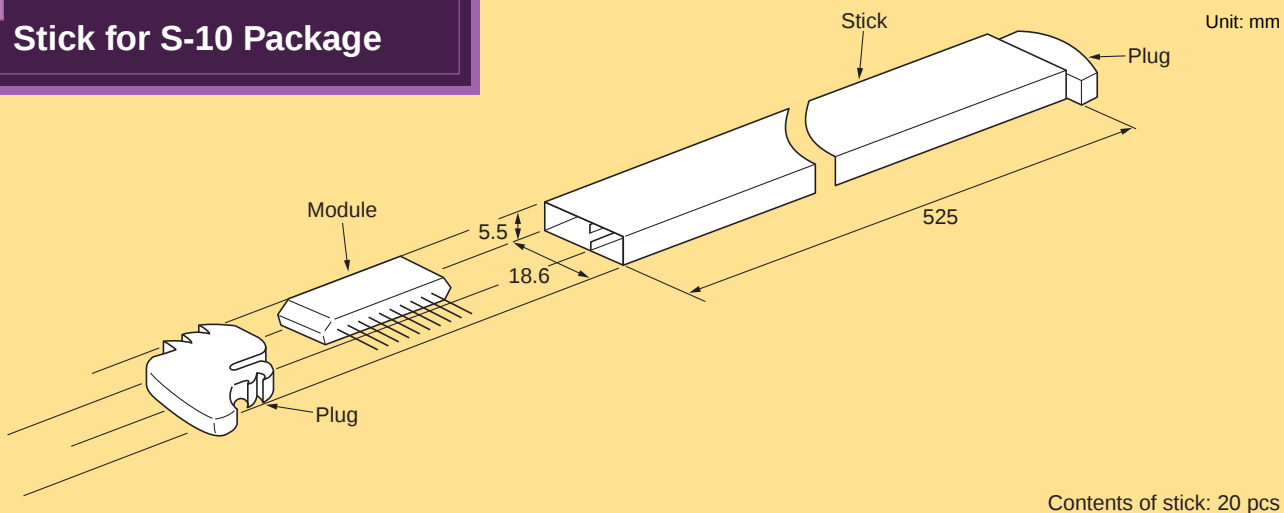
Unit: mm

※ Some products have a stand-off which differs from the standard 3.5 mm.

12 Power Module Packing

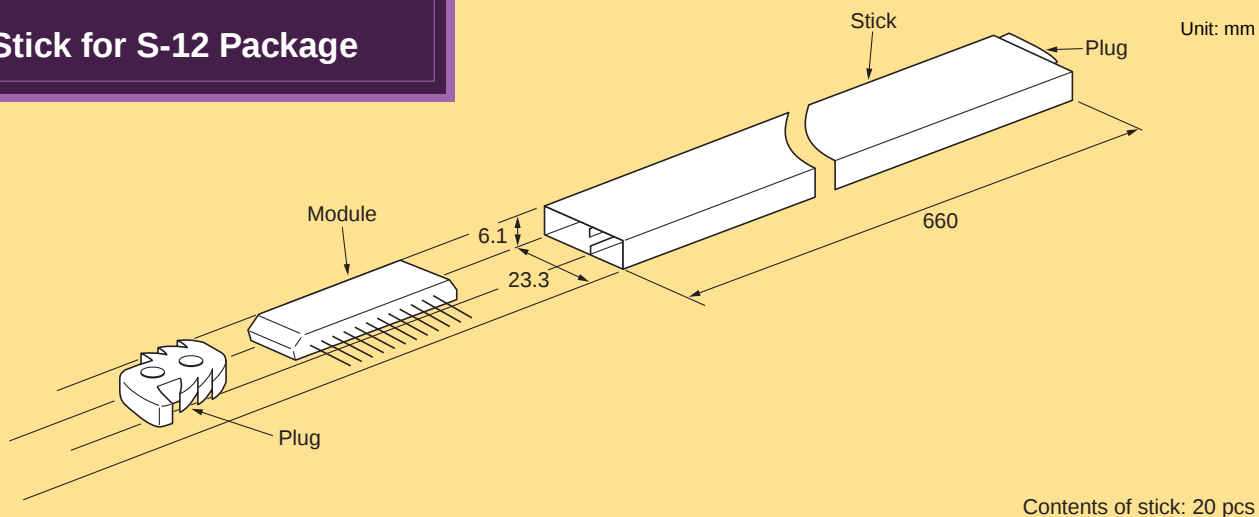
1

Stick for S-10 Package



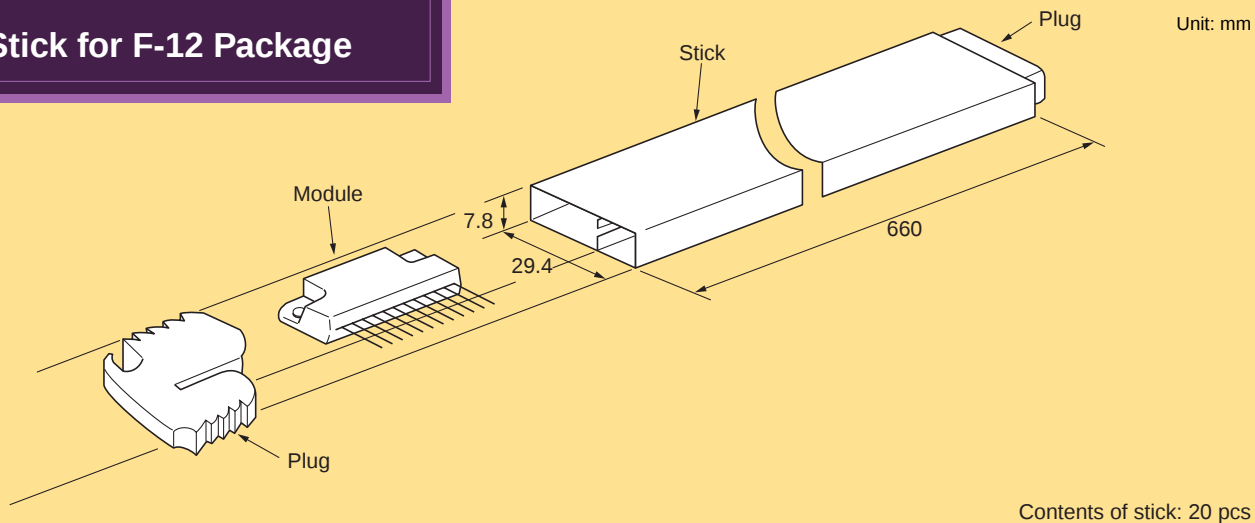
2

Stick for S-12 Package



3

Stick for F-12 Package



13 Final-Phase Production List

Final-Phase Production

The table right lists products in final-phase production. Please consider using the corresponding recommended alternative product instead of the intended final-phase production.

Product No.	Product No. of Recommended Alternative Product
MP4201	MP4209
MP4202	MP4210
MP4203	MP4211
MP4207	MP4212
MP4401	MP4411
MP4403	MP4412
MP4703	MP4711
MP6403	MP6404
MP6801	MP6404

14 List of Discontinued Products

The table below lists discontinued products. Please consider using the corresponding recommended alternative product instead of the intended discontinued products.

Product No.	Product No. of Recommended Alternative Product
MP3001	MP4101
MP3002	—
MP3003	MP4104
MP3004	MP4013
MP3005	MP4104
MP3006	—
MP3007	MP4009
MP3008	MP4104
MP3009	MP4009
MP3010	MP4104
MP3011	MP4009
MP3102	MP4104
MP3103	MP4104
MP3107	MP4009
MP3201	MP4209
MP3202	—
MP3801	—
MP4001	MP4101
MP4002	MP4020
MP4003	MP4104
MP4004	MP4104
MP4008	MP4021
MP4010	MP4104
MP4011	MP4015
MP4012	MP4101
MP4014	MP4104
MP4017	MP4021
MP4018	MP4009
MP4022	MP4021
MP4023	MP4020
MP4025	MP4210
MP4302	MP4305

Product No.	Product No. of Recommended Alternative Product
MP4307	MP4305
MP4402	MP4412
MP4404	MP4412
MP4406	MP4410
MP4407	MP4410
MP4408	MP4412
MP4409	MP4412
MP4505	MP4513
MP4511	MP4504
MP4512	MP4503
MP4605	MP4513
MP4701	MP4711
MP4702	MP4711
MP4704	MP4711
MP4708	MP4711
MP4709	—
MP4710	—
MP4801	—
MP5001	—
MP5301	—
MP5302	—
MP5401	—
MP5402	—
MP6001	—
MP6002	—
MP6003	—
MP6004	—
MP6005	—
MP6101	—
MP6302	MP6301
MP6401	MP6404
MP6902	MP6901

**Toshiba America
Electronic Components, Inc.**

Headquarters-Irvine, CA
9775 Toledo Way, Irvine, CA 92618, U.S.A.
Tel: (949)455-2000 Fax: (949)859-3963

Boulder, CO
3100 Arapahoe Avenue, Ste. 500,
Boulder, CO 80303, U.S.A.
Tel: (303)442-3801 Fax: (303)442-7216

Boynton Beach, FL(Orlando)
11924 W. Forest Hill Blvd., Ste. 22-337,
Boynton Beach, FL 33414, U.S.A.
Tel: (561)374-6193 Fax: (561)374-6194

Deerfield, IL(Chicago)
One Pkwy., North, Suite 500, Deerfield,
IL 60015-2547, U.S.A.
Tel: (847)945-1500 Fax: (847)945-1044

Duluth, GA(Atlanta)
3700 Crestwood Parkway, Ste. 460,
Duluth, GA 30096, U.S.A.
Tel: (770)931-3363 Fax: (770)931-7602

Edison, NJ
2035 Lincoln Hwy. Ste. #3000, Edison
NJ 08817, U.S.A.
Tel: (732)248-8070 Fax: (732)248-8030

Orange County, CA
2 Venture Plaza, #500 Irvine, CA 92618, U.S.A.
Tel: (949)453-0224 Fax: (949)453-0125

Portland, OR
1700 NW 167th Place, #240,
Beaverton, OR 97006, U.S.A.
Tel: (503)629-0818 Fax: (503)629-0827

Richardson, TX(Dallas)
777 East Campbell Rd., Suite 650, Richardson,
TX 75081, U.S.A.
Tel: (972)480-0470 Fax: (972)235-4114

San Jose Engineering Center, CA
1060 Rincon Circle, San Jose, CA 95131, U.S.A.
Tel: (408)526-2400 Fax: (408)526-2410

Wakefield, MA(Boston)
401 Edgewater Place, Suite #360, Wakefield,
MA 01880-6229, U.S.A.
Tel: (781)224-0074 Fax: (781)224-1095

Toshiba Do Brasil S.A.

Electronic Components Div.
Estrada Dos Alvarengas, 5. 500-Bairro Alvarenga
09850-550-Sao Bernardo do campo - SP
Tel: (011)7689-7171 Fax: (011)7689-7189

Toshiba Electronics Europe GmbH

Düsseldorf Head Office
Hansaallee 181, D-40549 Düsseldorf
Germany
Tel: (0211)5296-0 Fax: (0211)5296-400

München Office
Büro München Hofmannstrasse 52,
D-81378, München, Germany
Tel: (089)748595-0 Fax: (089)748595-42

Toshiba Electronics France SARL
Immeuble Robert Schumann 3 Rue de Rome,
F-93561, Rosny-Sous-Bois, Cedex, France
Tel: (1)48-12-48-12 Fax: (1)48-94-51-15

Toshiba Electronics Italiana S.R.L.
Centro Direzionale Colleoni
Palazzo Perseo Ingr. 2-Piano 6,
Via Paracelso n.12,
1-20041 Agrate Brianza Milan, Italy
Tel: (039)68701 Fax: (039)6870205

Toshiba Electronics España, S.A.
Parque Empresarial San Fernando Edificio Europa,
1ª Planta, ES-28831 Madrid, Spain
Tel: (91)660-6700 Fax: (91)660-6799

Toshiba Electronics(UK) Limited
Riverside Way, Camberley Surrey,
GU15 3YA, U.K.
Tel: (01276)69-4600 Fax: (01276)69-4800

Toshiba Electronics Scandinavia AB
Gustavslundsvägen 12, 2nd Floor
S-161 15 Bromma, Sweden
Tel: (08)704-0900 Fax: (08)80-8459

**Toshiba Electronics Asia
(Singapore) Pte. Ltd.**

Singapore Head Office
438B Alexandra Road, #06-08/12 Alexandra
Technopark, Singapore.119968
Tel: (278)5252 Fax: (271)5155

Bangkok Office
135 Moo 5 Bangkadi Industrial Park, Tivanon Rd.,
Bangkadi Amphur Muang Pathumthani, Bangkok, 12000,
Thailand
Tel: (02)501-1635 Fax: (02)501-1638

**Toshiba Electronics Trading
(Malaysia)Sdn. Bhd.**

Kuala Lumpur Head Office
Suite W1203, Wisma Consplant, No.2,
Jalan SS 16/4, Subang Jaya, 47500 Petaling Jaya,
Selangor Darul Ehsan, Malaysia
Tel: (3)731-6311 Fax: (3)731-6307

Penang Office
Suite 13-1, 13th Floor, Menard Penang Garden,
42-A, Jalan Sultan Ahmad Shah,
100 50 Penang, Malaysia
Tel: 4-226-8523 Fax: 4-226-8515

Toshiba Electronics Philippines, Inc.

26th Floor, Citibank Tower, Valero Street, Makati,
Manila, Philippines
Tel: (02)750-5510 Fax: (02)750-5511

Toshiba Electronics Asia, Ltd.

Hong Kong Head Office
Level 11, Top Glory Insurance Building, Grand Century
Place, No.193, Prince Edward Road West,
Mong Kok, Kowloon, Hong Kong
Tel: 2375-6111 Fax: 2375-0969

Beijing Office
Rm 714, Beijing Fortune Building,
No.5 Dong San Huan Bei-Lu, Chao Yang District,
Beijing, 100004, China
Tel: (010)6590-8795 Fax: (010)6590-8791

Chengdu Office
Unit F, 18th Floor, New Times Plaza, 42 Wenwu Road,
Xinhua Avenue, Chengdu, 610017, China
Tel: (028)675-1773 Fax: (028)675-1065

Shenzhen Office
Rm 3010-3012, Office Tower Shun Hing Square,
Di Wang Commercial Centre, 333 ShenNan
East Road, Shenzhen, 518008, China
Tel: (0755)246-1582 Fax: (0755)246-1581

Toshiba Electronics Korea Corporation

Seoul Head Office
14/F, KEC B/D, 257-7 Yangjae-Dong,
Seocho-ku, Seoul, Korea
Tel: (02)589-4334 Fax: (02)589-4302

Gumi Office
6/F, Ssangyong Investment Securities B/D,
56 Songjung-Dong, Gumi City
Kyeongbuk, Korea
Tel: (82)54-456-7613 Fax: (82)54-456-7617

**Toshiba Technology Development
(Shanghai) Co., Ltd.**

23F, Shanghai Senmao International Building, 101
Yin Cheng East Road, Pudong New Area, Shanghai,
200120, China
Tel: (021)6841-0666 Fax: (021)6841-5002

**Tsurong Xiamen Xiangyu Trading
Co., Ltd.**

8N, Xiamen SEZ Bonded Goods Market Building,
Xiamen, Fujian, 361006, China
Tel: (0592)562-3798 Fax: (0592)562-3799

**Toshiba Electronics Taiwan
Corporation**

Taipei Head Office
17F, Union Enterprise Plaza Bldg. 109
Min Sheng East Rd., Section 3, 0446 Taipei,
Taiwan R.O.C.
Tel: (02)514-9988 Fax: (02)514-7892

Kaohsiung Office
16F-A, Chung-Cheng Bldg., Chung-Cheng 3Rd.,
80027, Kaohsiung, Taiwan R.O.C.
Tel: (07)222-0826 Fax: (07)223-0046

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TOSHIBA CORPORATION

Electronic Devices Sales & Marketing Group
1-1, Shibaura 1-chome, Minato-ku, Tokyo, 105-8001, Japan
Tel: (03)3457-3405 Fax: (03)5444-9431