

TOSHIBA

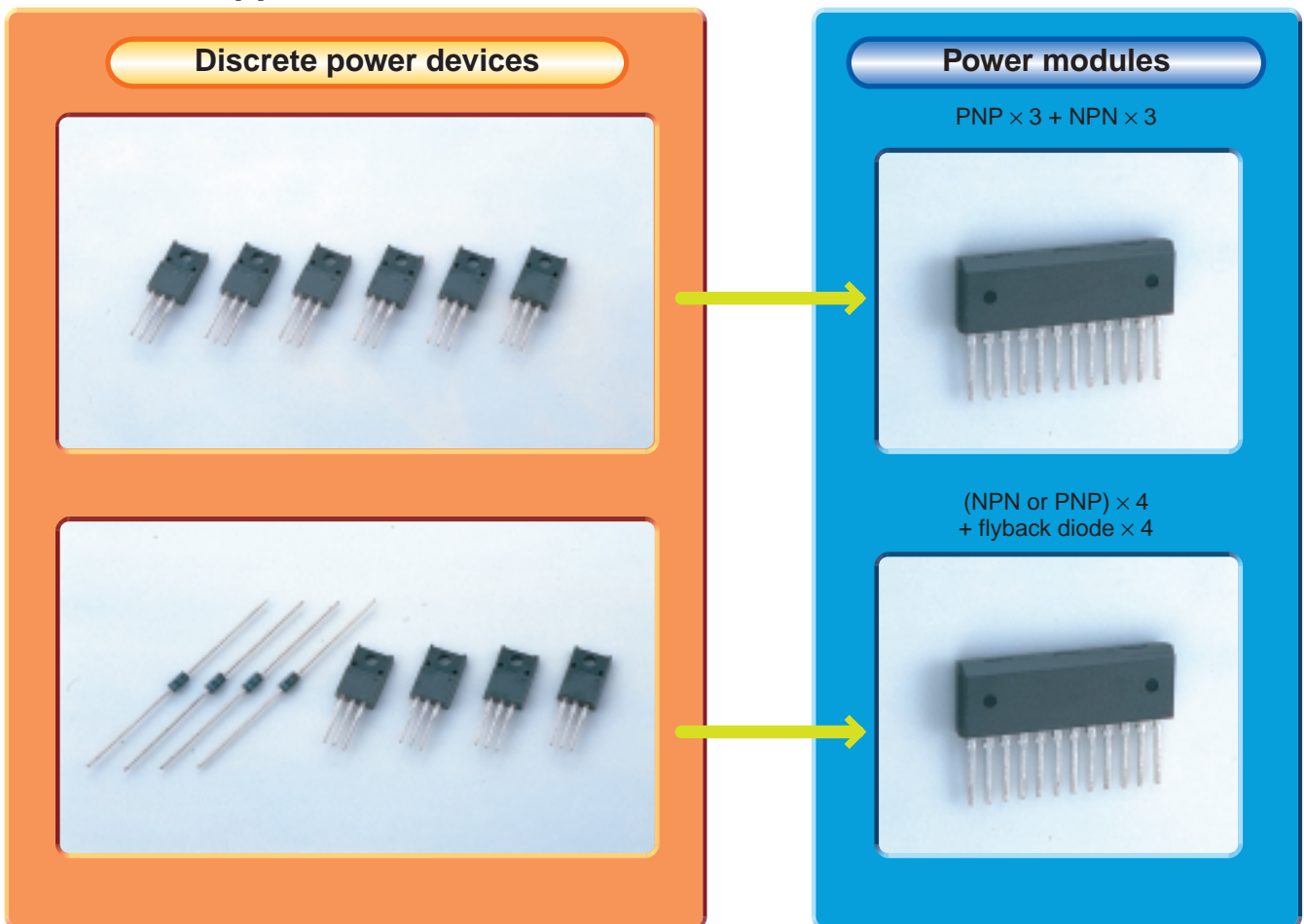
Power Modules

PRODUCT GUIDE

CONTENTS

1. Product List	3
2. Introduction to the Products and Their Features	4
3. Structure and Dimensions	5
4. Power Module Packages	6
5. System Diagram of Power Module Products	6
6. Power Module Product Matrix	7
7. Product Line-ups Listed by Package	8
Power Transistor Modules	
S-10 Series MP4005~, MP4101~	8
S-12 Series MP4301~, MP6301	9
F-12 Series MP4501~, MP6901	10
Power MOSFET Modules	
S-10M Series MP4208~	11
S-12M Series MP4410~, MP6404	12
F-12M Series MP4711	13
8. Toshiba Power Module Products	14
9. Applications and Line-ups	15
10. Typical Applications	20
11. Dimensions of Power Module Packages	21
12. Power Module Packing	22
13. Final-Phase Production List	23
14. List of Discontinued Products	23

■ External Appearance of Power Modules



1 Product List

Product No.	Page
MP4005	8
MP4006	8
MP4009	8
MP4013	8
MP4015	8
MP4020	8
MP4021	8
MP4024	8
MP4025	8
MP4101	8
MP4104	8
MP4208	11
MP4209	11
MP4210	11
MP4211	11
MP4212	11
MP4301	9
MP4303	9
MP4304	9
MP4305	9
MP4410	12

Product No.	Page
MP4411	12
MP4412	12
MP4501	10
MP4502	10
MP4503	10
MP4504	10
MP4506	10
MP4507	10
MP4508	10
MP4513	10
MP4514	10
MP4711	13
MP6301	9
MP6404	12
MP6901	10

2

Introduction to the Products and Their Features

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



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.



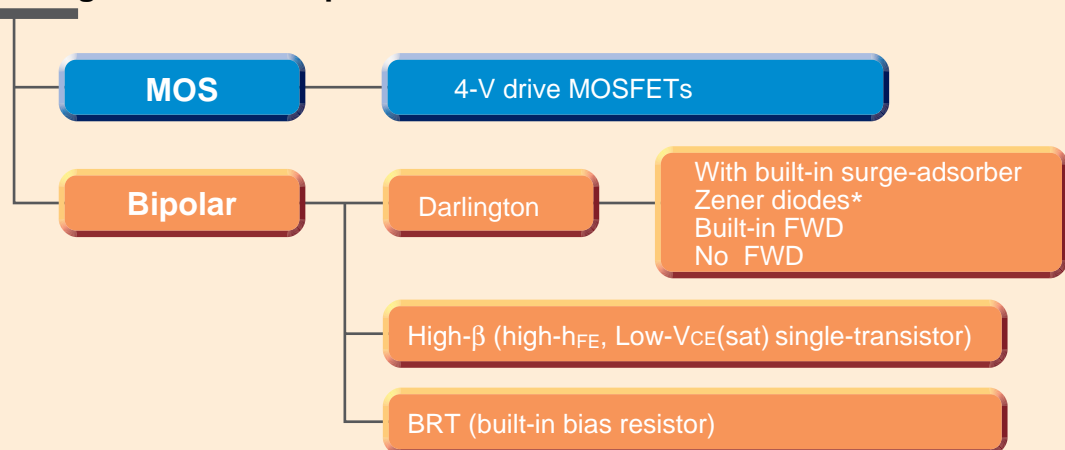
Voltage rating: 60 V~120 V. Current rating: 1.5 A~10 A



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



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

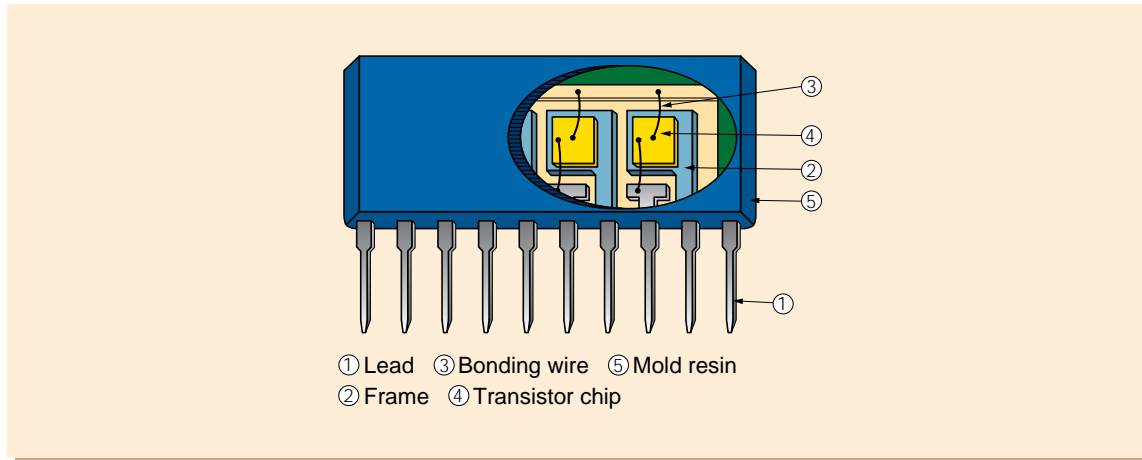
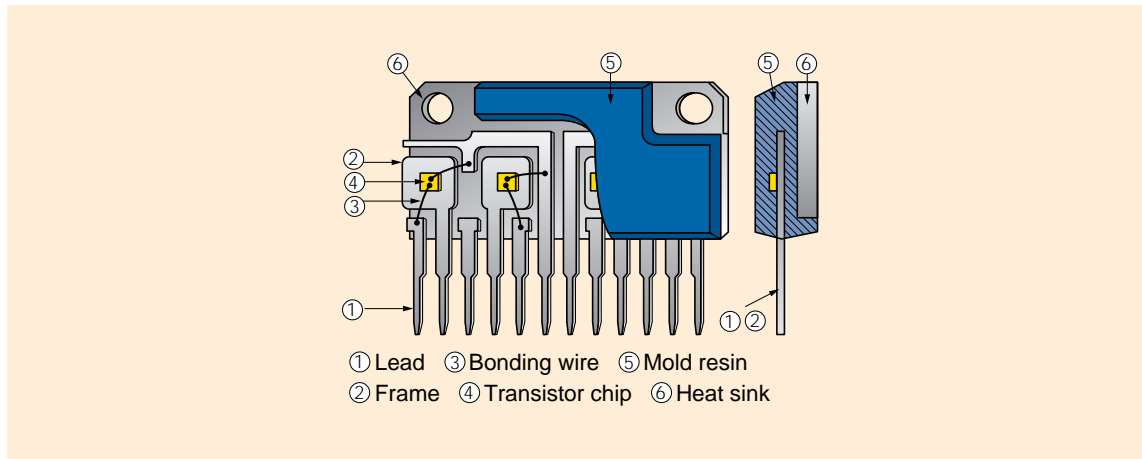


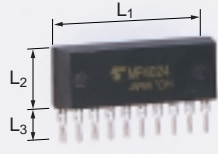


Figure 2. Internal structure of type with insulated heat sink



4

Power Module Packages

Table 1. Packaging and features of power modules

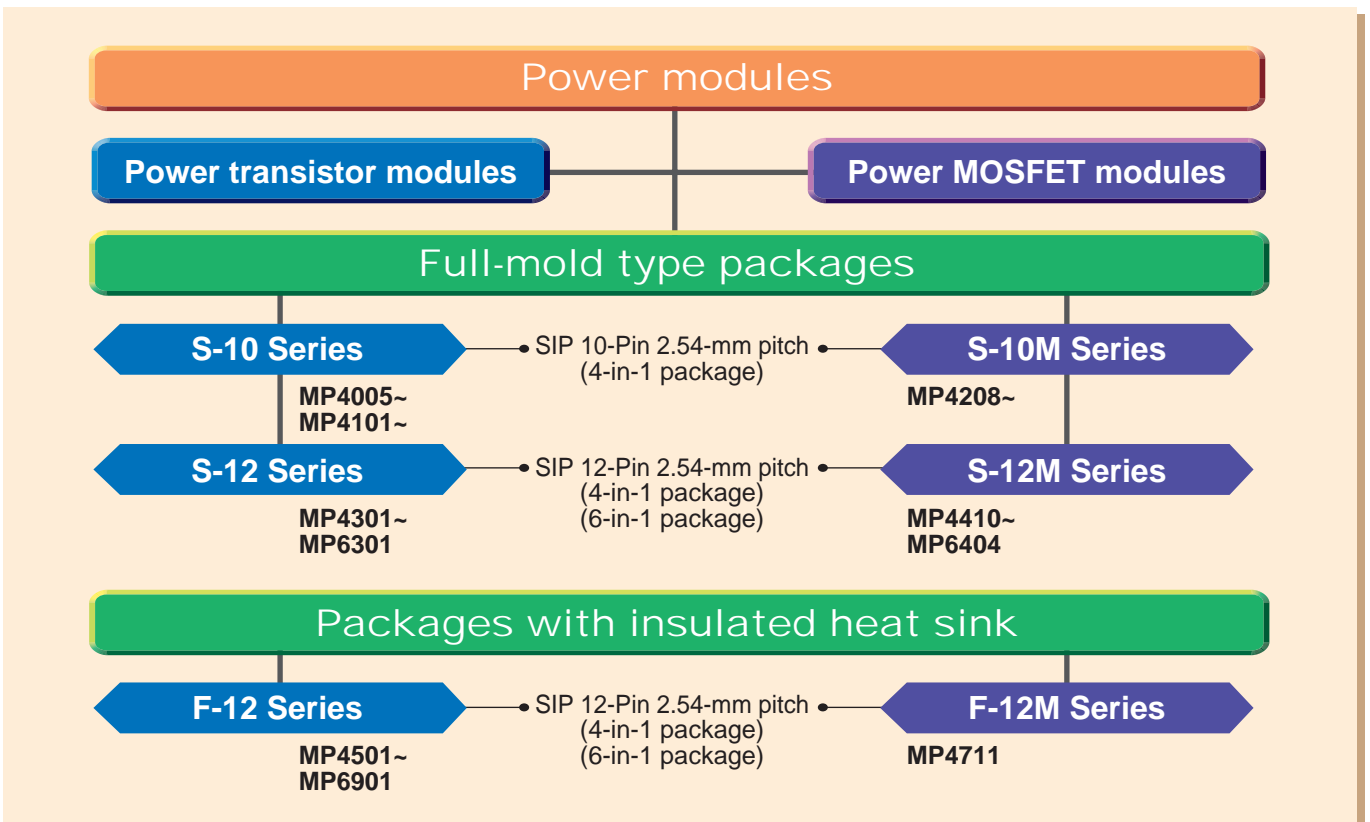
Name		S-10	S-12	F-12
Appearance				
	L1 (mm)	25.2	31.5	31.5
	L2 (mm)	9.0	10.5	16.1
	L3 (mm)	7.5	10.0	10.0
	Thickness (mm)	4.0	4.0	5.1
Structure		Full-mold type		Type with insulated heat sink
No. of Leads		SIP 10Pin	SIP 12Pin	SIP 12Pin
Lead Pitch (mm)		2.54	2.54	2.54
Weight (g)		2.1	3.9	6
No. of Transistors		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.

5

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		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		
Chip Classification											
Bipolar Transistors	60 ± 10	1.5	DTN + zener + Rb	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 + Rb	MP4024							
	100	5	DTN						MP4513		
	- 100	- 5	DTN			MP4305		MP4504			
	100	5	DTN					MP4506			
- 100	- 5	DTN	MP4009				MP4508		MP4507		
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

7

Product Line-ups Listed by Package

Power Transistor Modules

S-10 Series

(4-in-1 package)

- 10-pin SIP
- Full mold

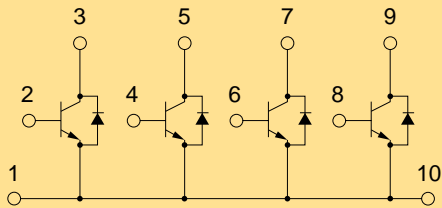


Product No.	Absolute Maximum ratings			Chip	h _{FE} (min)	V _{CE(sat)} (V)			Circuit	Remarks		
	I _c (A)	V _{CEO} (V)	P _T (Ta=25°C) (W)			V _{CE} (V)	I _c (A)	I _B (mA)				
MP4005	± 4	± 80	4	DTN	2000	± 2	± 1	± 1.5	± 3	± 6	D	NPN × 2 + PNP × 2
MP4006	± 2	± 80	4	DTN	2000	± 2	± 1	± 1.5	± 1	± 1	D	NPN × 2 + 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

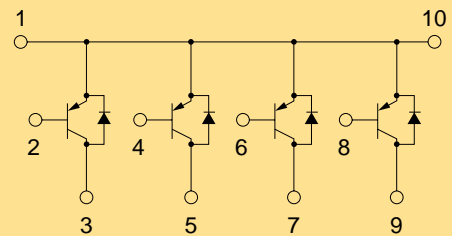
With zener: Built-in zener diode between C-B BRT: Transistor with built-in bias resistance
DTN: Darlington transistor

■ Circuit blocks

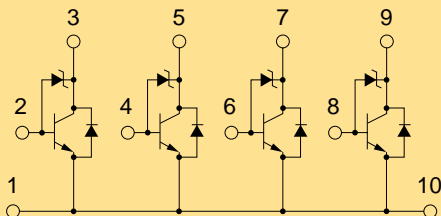
A



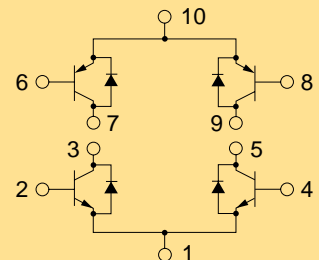
B



C



D



Power Transistor Modules

S-12 Series

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

- 12-pin SIP
- Full mold



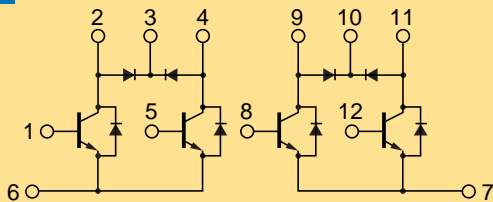
Product No.	Absolute Maximum ratings			Chip	h _{FE}			V _{CE(sat)} (V)			Circuit	Remarks
	I _C (A)	V _{CEO} (V)	P _T (Ta=25°C) (W)		(min)	V _{CE} (V)	I _C (A)	(max)	I _C (A)	I _B (mA)		
MP4301	3	100	4.4	DTN	2000	2	1.5	1.5	1.5	3	A	NPN × 4 ▲
MP4303	2	100	4.4	DTN	2000	2	1	1.5	1	1	A	NPN × 4 ▲
MP4304	3	80	4.4	High-β	600	2	1	0.5	1.5	15	A	NPN × 4 ▲
MP4305	-5	-100	4.4	DTN	2000	-5	-3	-1.5	-3	-6	B	PNP × 4 ▲
MP6301	±3	±80	4.4	DTN	2000	±2	±1	±1.8	±2	±4	C	NPN × 3 + PNP × 3

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

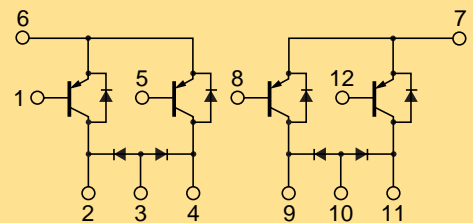
▲: Built-in diode for absorbing flyback voltage

■ Circuit blocks

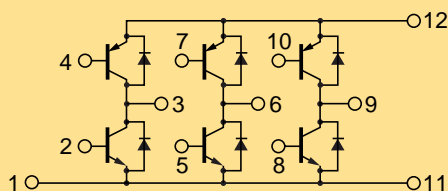
A



B



C



7

Product Line-ups Listed by Package

Power Transistor Modules

F-12 Series

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

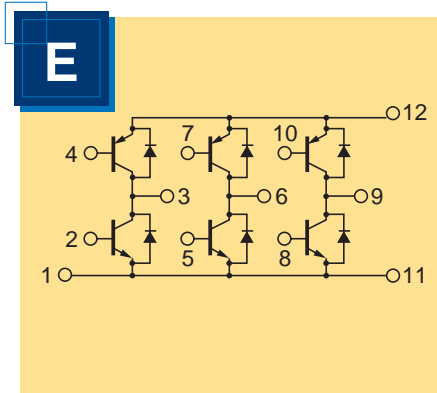
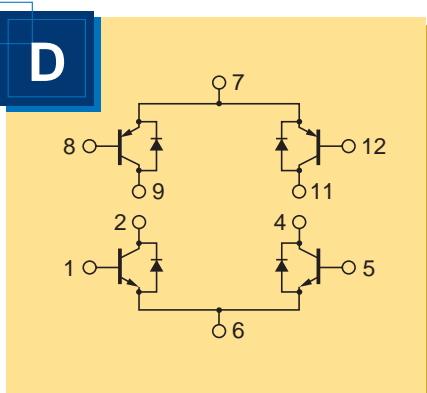
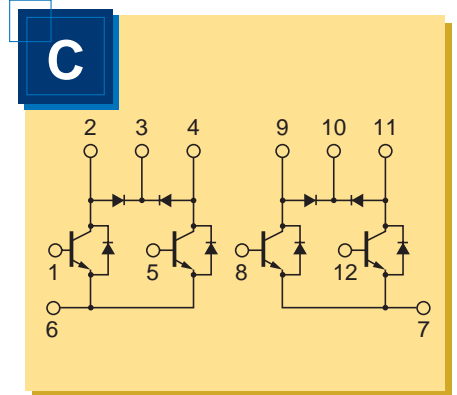
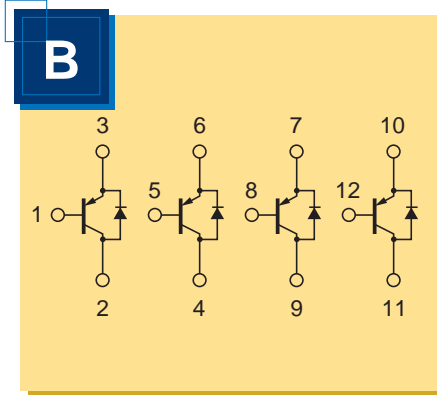
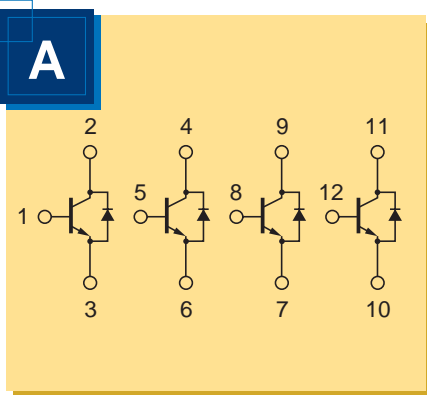
- 12-pin SIP
- Insulated heat sink



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)	I _B (mA)				
			T _a =25°C	T _c =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



Power MOSFET Modules

S-10M Series

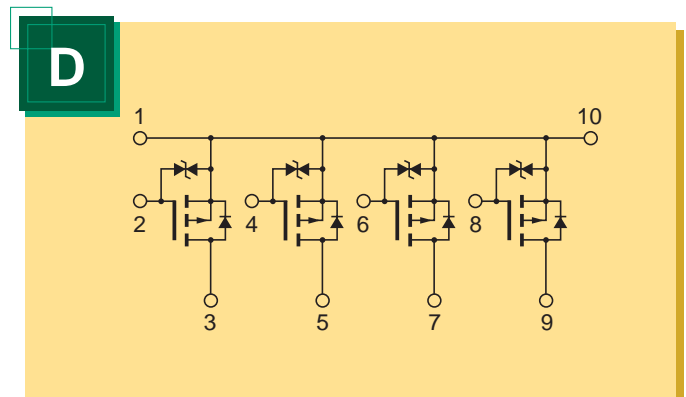
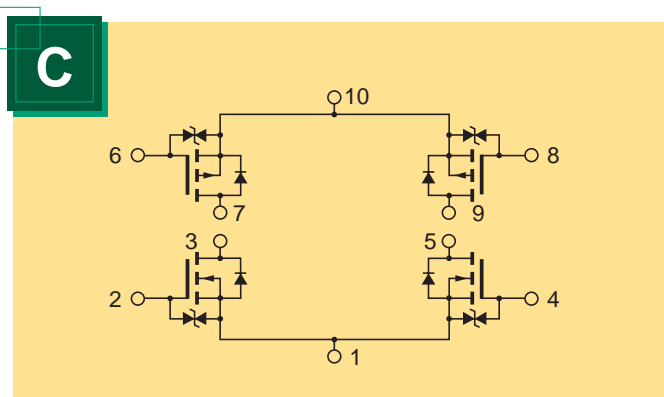
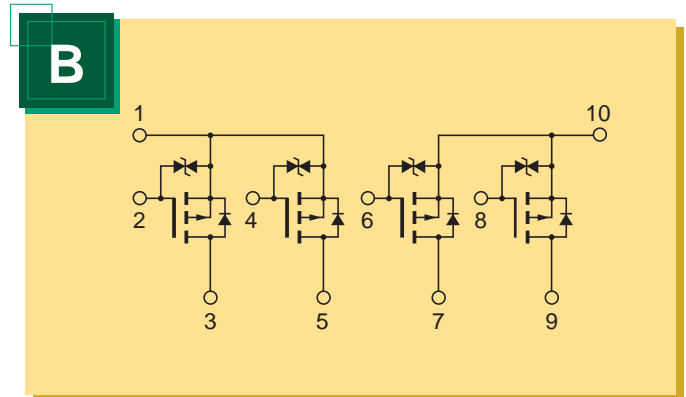
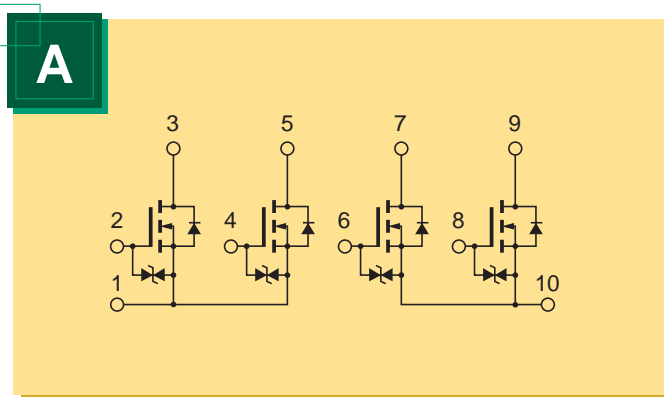
(4-in-1 package)

- 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)	(Ω)	V_{GS} (V)	I_D (A)	(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



7

Product Line-ups Listed by Package

Power MOSFET Modules

S-12M Series

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

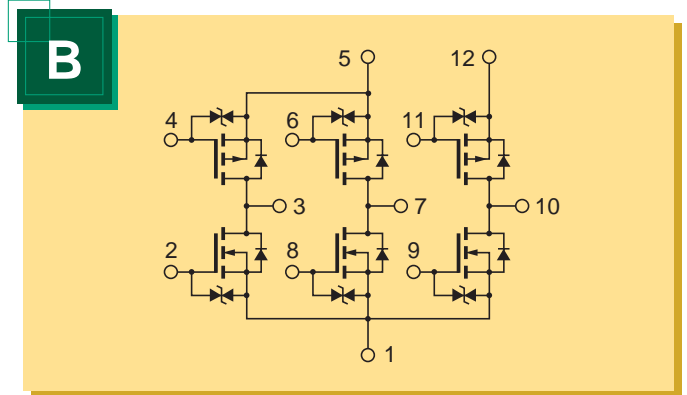
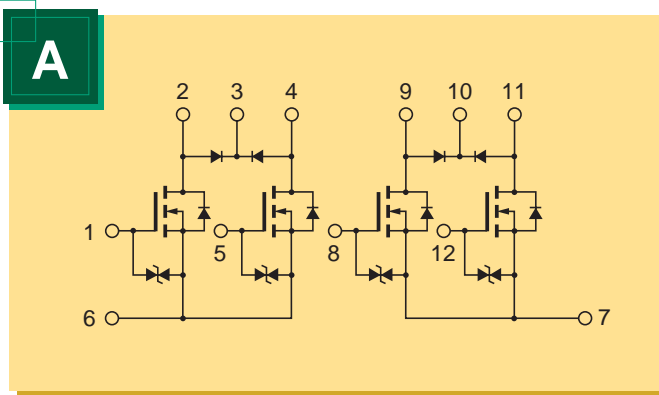
- 12-pin SIP
- Full mold



Product No.	Absolute Maximum ratings				$R_{DS(ON)max}$			$R_{DS(ON)max}$			Circuit	Remarks
	I_D (A)	V_{DSS} (V)	P_{DT} (W)		$R_{DS(ON)max}$ (Ω)	V_{GS} (V)	I_D (A)	$R_{DS(ON)max}$ (Ω)	V_{GS} (V)	I_D (A)		
			$T_a=25^\circ\text{C}$	$T_c=25^\circ\text{C}$								
MP4410	5	60	4.4	28	0.16	10	2.5	0.31	4	2.5	A	N-ch \times 4 \uparrow
MP4411	3	100	4.4	28	0.35	10	2	0.45	4	2	A	N-ch \times 4 \uparrow
MP4412	5	100	4.4	28	0.23	10	2.5	0.30	4	2.5	A	N-ch \times 4 \uparrow
MP6404	± 5	± 60	4.4	36	0.16/0.19	± 10	± 2.5	0.32/0.28	± 4	± 2.5	B	N-ch \times 3 + P-ch \times 3

\uparrow : Diode for absorbing flyback voltage

Equivalent circuits



Power MOSFET Modules

F-12M Series

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

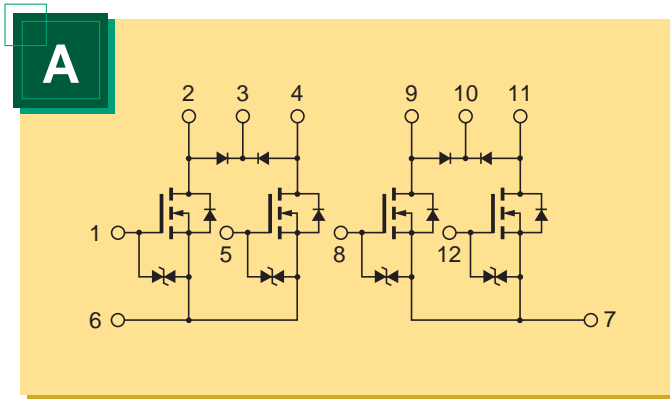


- 12-pin SIP
- Insulated heat sink

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

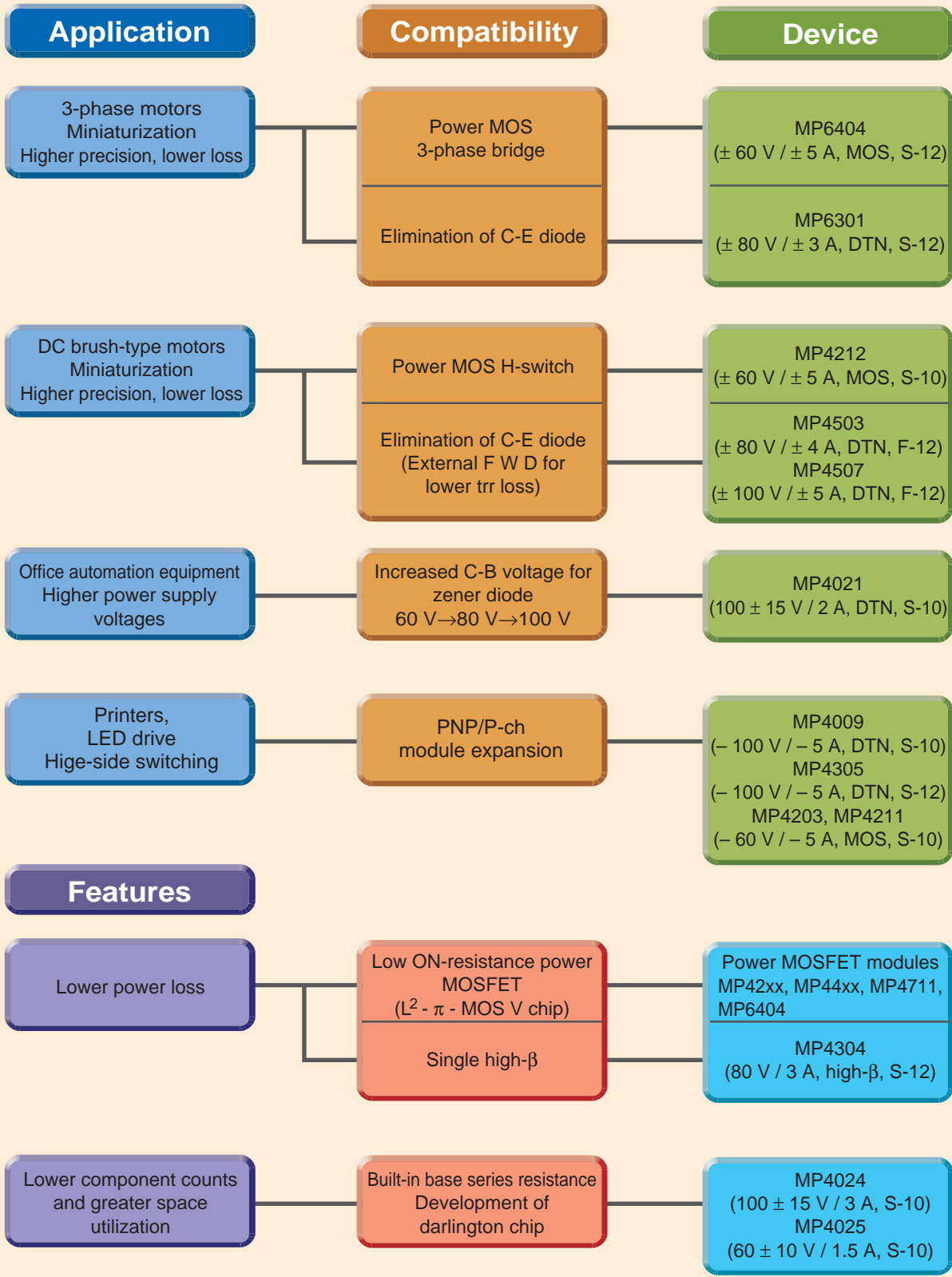
: Diode for absorbing flyback voltage

Equivalent circuits



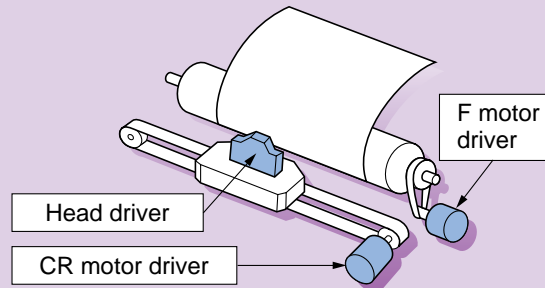


Toshiba Power Module Products



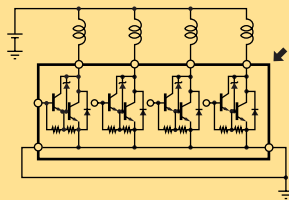
9 Applications and Line-ups

Application Printers



Internal Zener Clamp Method for Head Pins or Stepping Motors

- Extremely simple structure

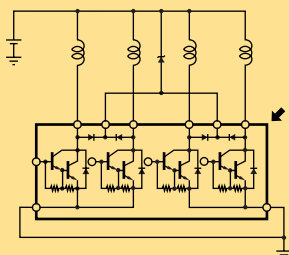


Recommended type: series with built-in zener diode between C-B

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.



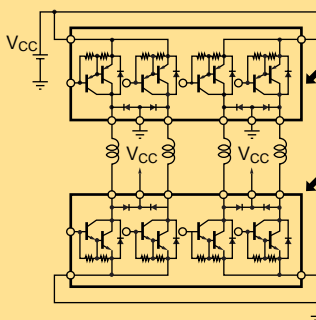
Recommended type: series with built-in FB-Di

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.



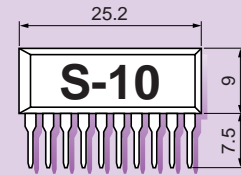
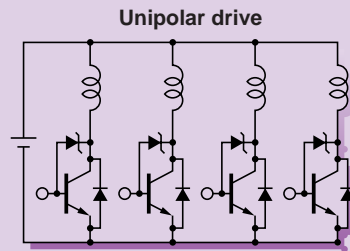
Recommended type

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

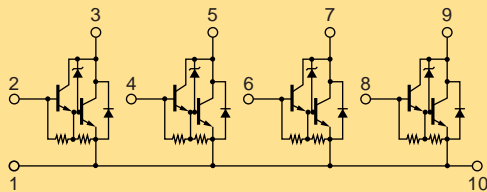
Application Printers

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



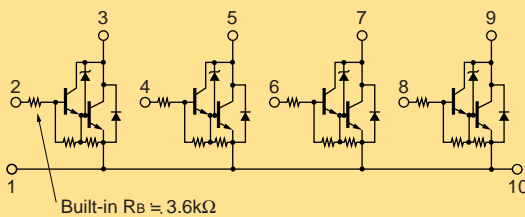
Unit: mm

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		

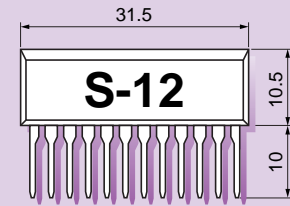
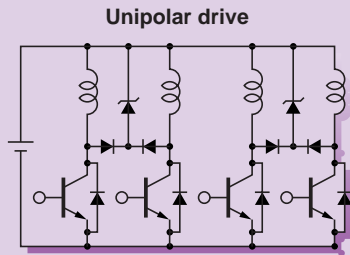
NPN darlington with built-in R_B and built-in zener diode



	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.		

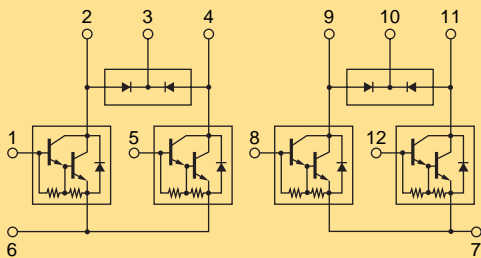
Application Motors

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

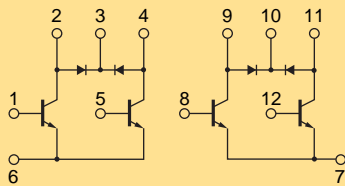
2000

$V_{CE(sat)}$ (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)

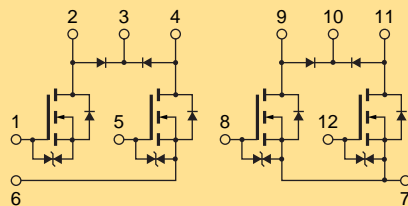
600

$V_{CE(sat)}$ (V)

0.5 (max)

High- h_{FE} single transistor
Low $V_{CE(sat)}$ 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)

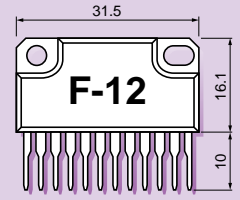
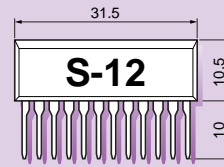
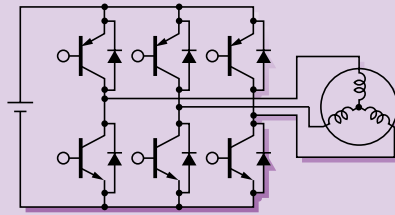
0.23 (max)

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

9 Applications and Line-ups

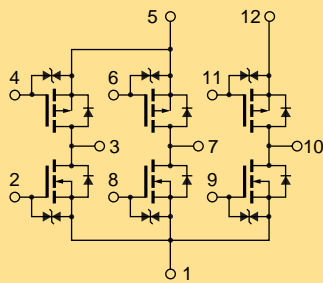
Application Motors

6-in-1 module for
3-phase motor



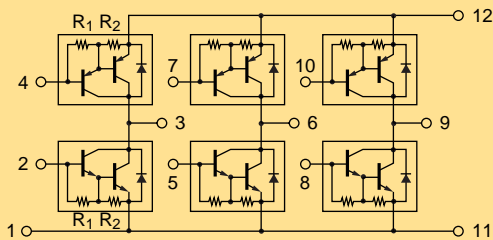
Unit: mm

P-ch × 3 + N-ch × 3



	MP6404	MP6801
V_{DSS} (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		

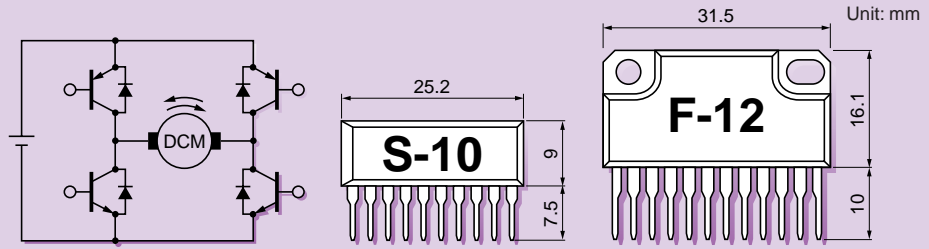
PNP × 3 + NPN × 3



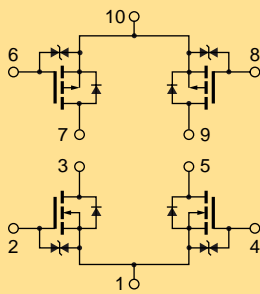
	MP6301	MP6901
V_{CE0} (V)	± 80	± 80
I_c (A)	± 3	± 4
P_T (W) ($T_a=25^\circ\text{C}$)	4.4	25*
h_{FE} (min)	2000	2000
Package	S-12	F-12
* $T_c = 25^\circ\text{C}$		

Application Motors

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

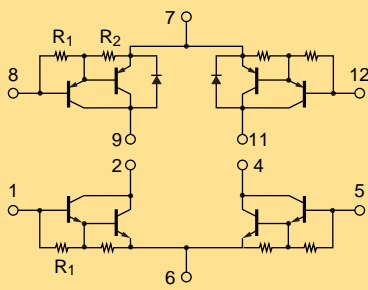


P-ch × 2 + N-ch × 2



	MP4212
V_{DSS} (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 × 2 + NPN × 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
* $T_C = 25^\circ\text{C}$				

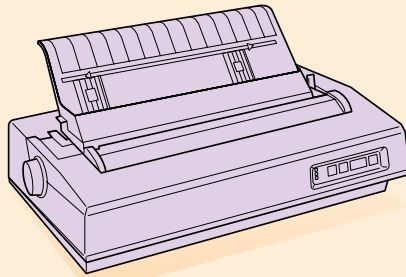
10 Typical Applications

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

Printers

Head pin and stepping motor drive

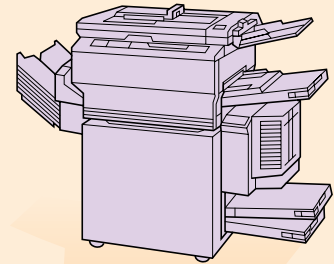
MP4000 Series
MP4100 Series
MP4300 Series
MP4400 Series



Photocopiers

Motor drive

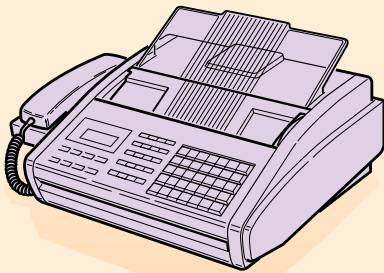
MP4000 Series
MP4100 Series
MP4212
MP4503
MP4507
MP6901



Fax machines

Stepping motor drive

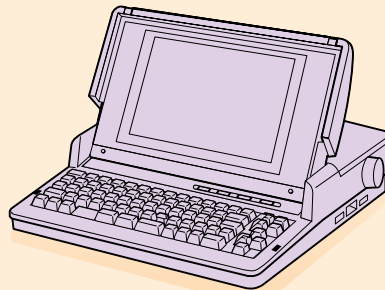
MP4000 Series
MP4100 Series



Word-processors

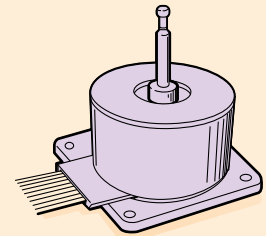
Printer stepping motor drive

MP4000 Series
MP4100 Series
MP4400 Series



Small motors and solenoids

All MP Series
MP4024
MP6404



Air-conditioners

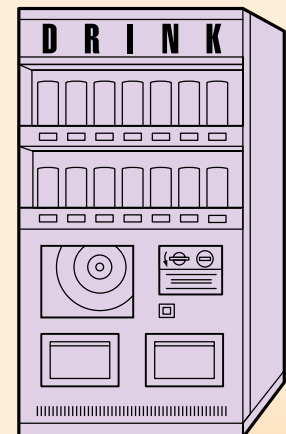
Fan motor drive

MP6301
MP6404
MP6901



Vending machines

MP4000 Series
MP4100 Series

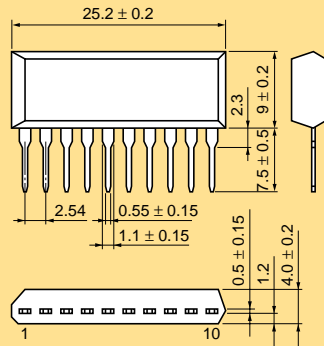


11 Dimensions of Power Module Packages

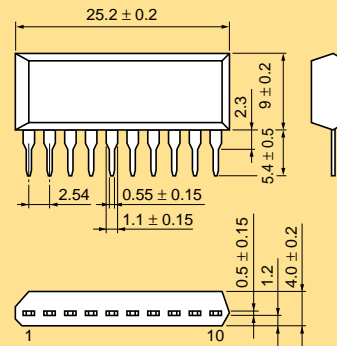
Some S-10 and S-12 products are available with short leads

S-10

Standard long lead



Short lead

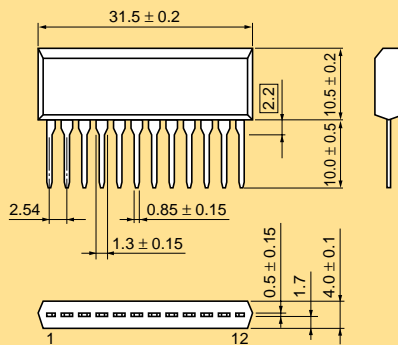


Unit: mm

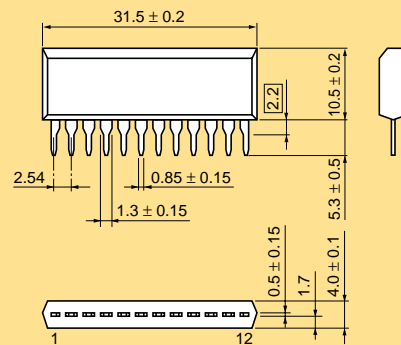
※Available only as set out in the diagram 2-25A1A.

S-12

Standard long lead



Short lead

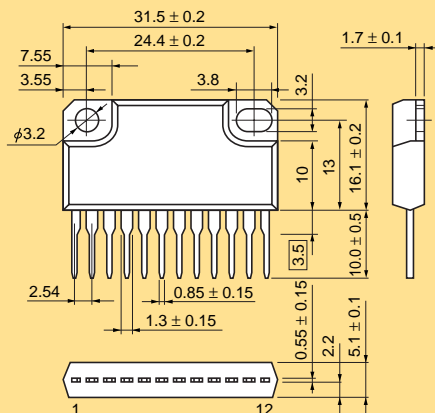


Unit: mm

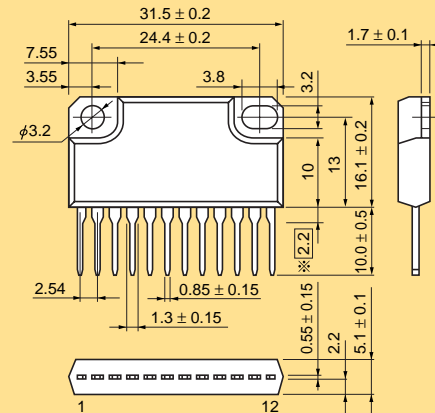
※Available with products with 2.2-mm stand-off.

F-12

Standard long lead



Short stand-off type



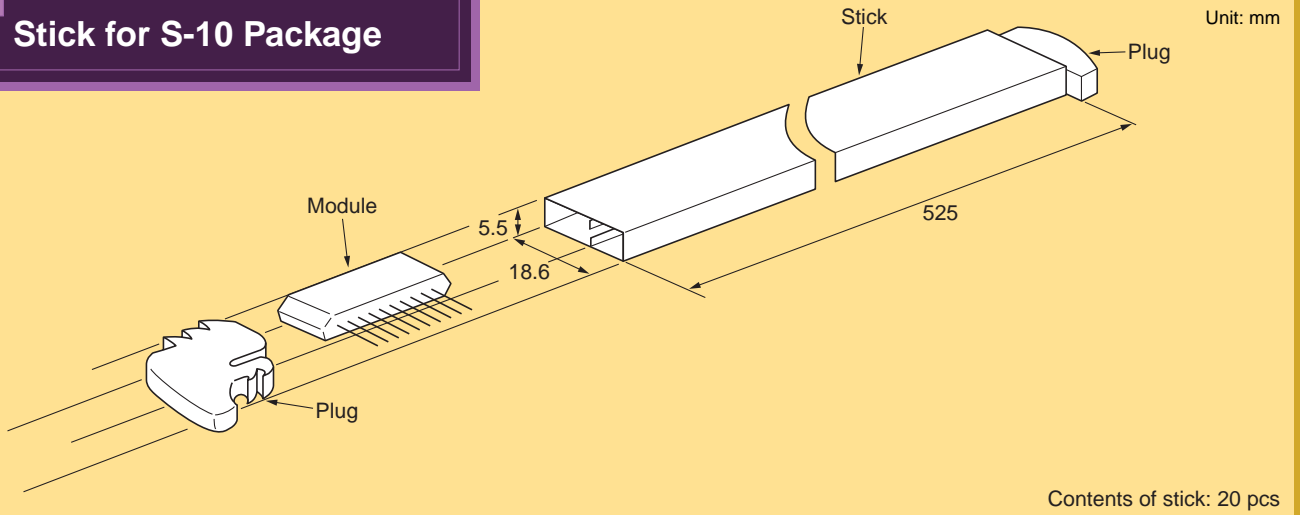
Unit: mm

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

12 Power Module Packing

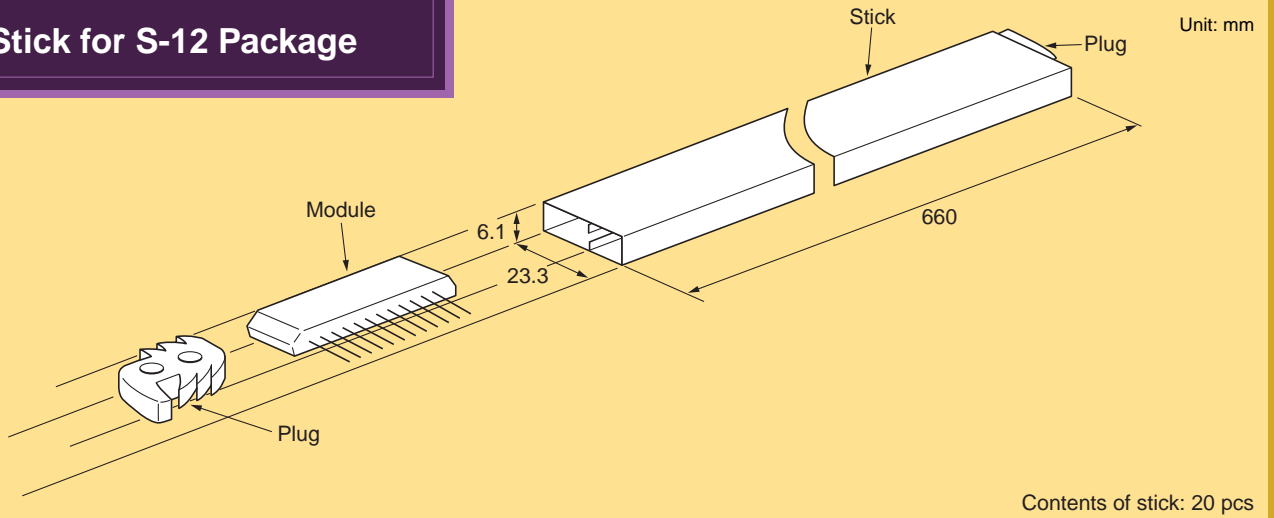
1

Stick for S-10 Package



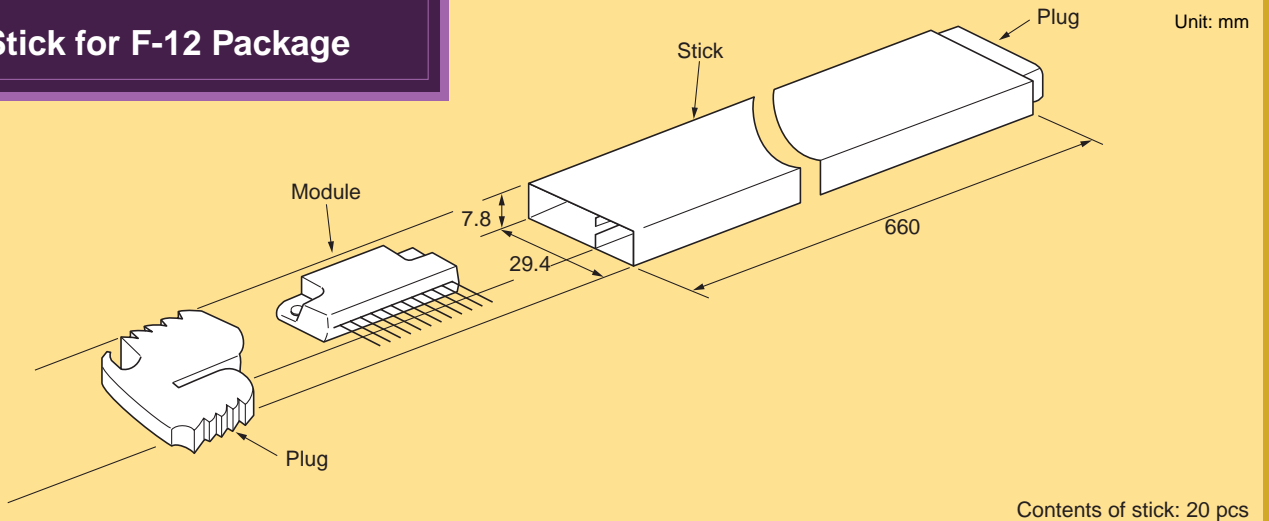
2

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

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