

Selection Guide for HEV/EV

- ICs (For Power Supply, Motor Drive, Linear Solenoid Drive)
- Discrete Devices (Diodes, Power MOSFETs)

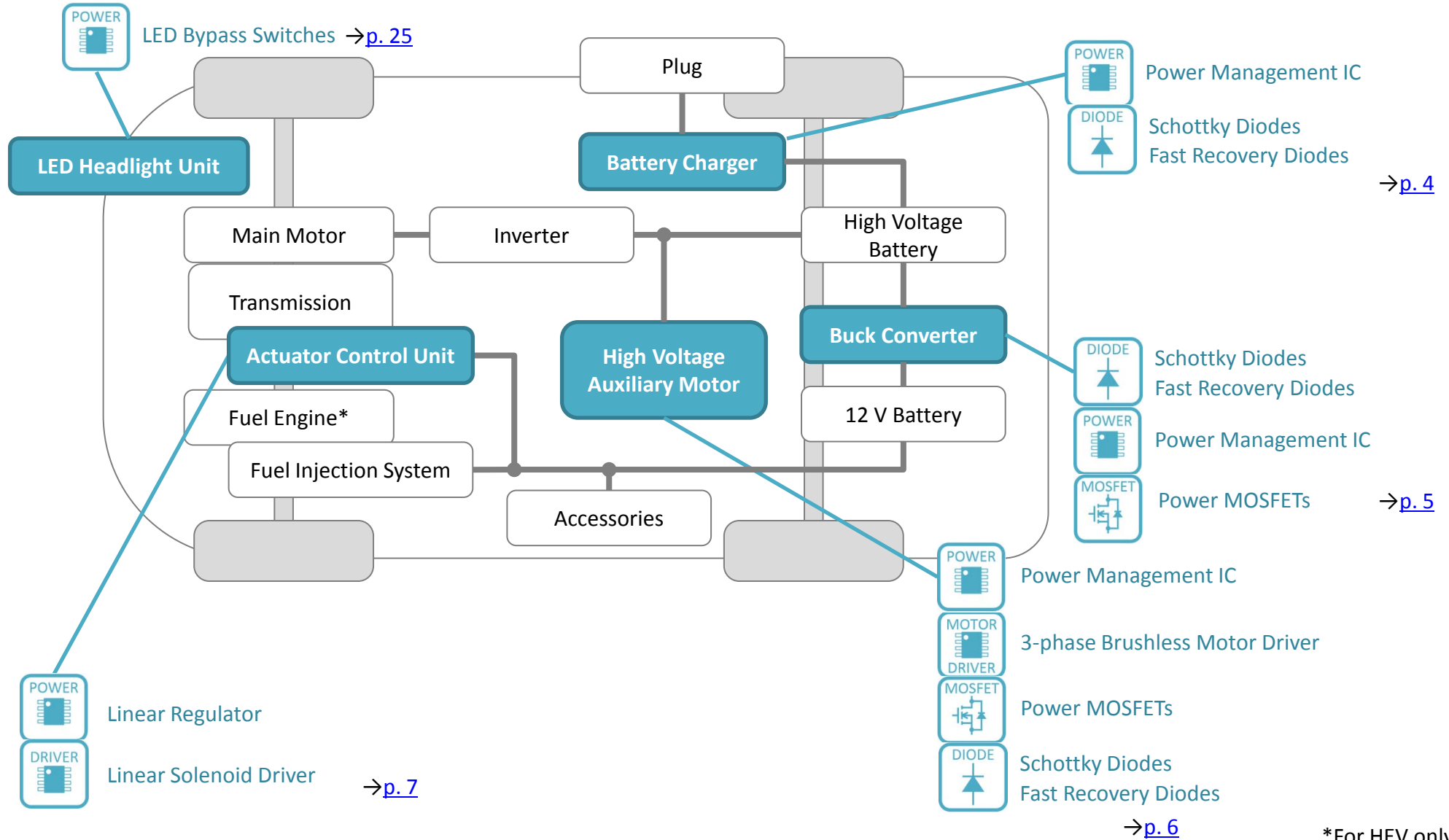
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<https://www.sanken-ele.co.jp/en>

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SanKen provides various devices for HEV and EV systems that have a high voltage battery.

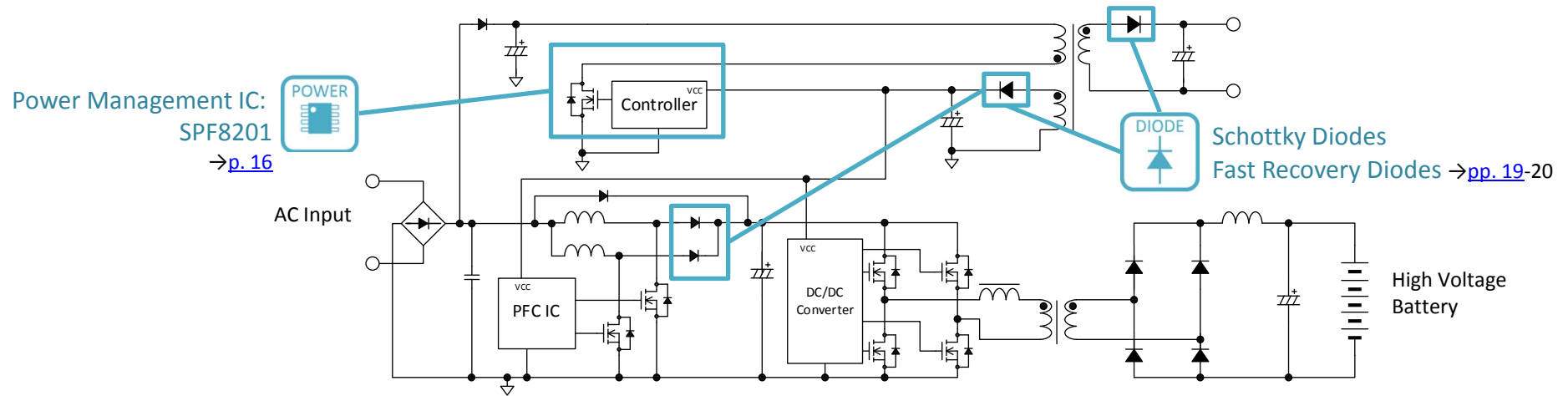


*For HEV only

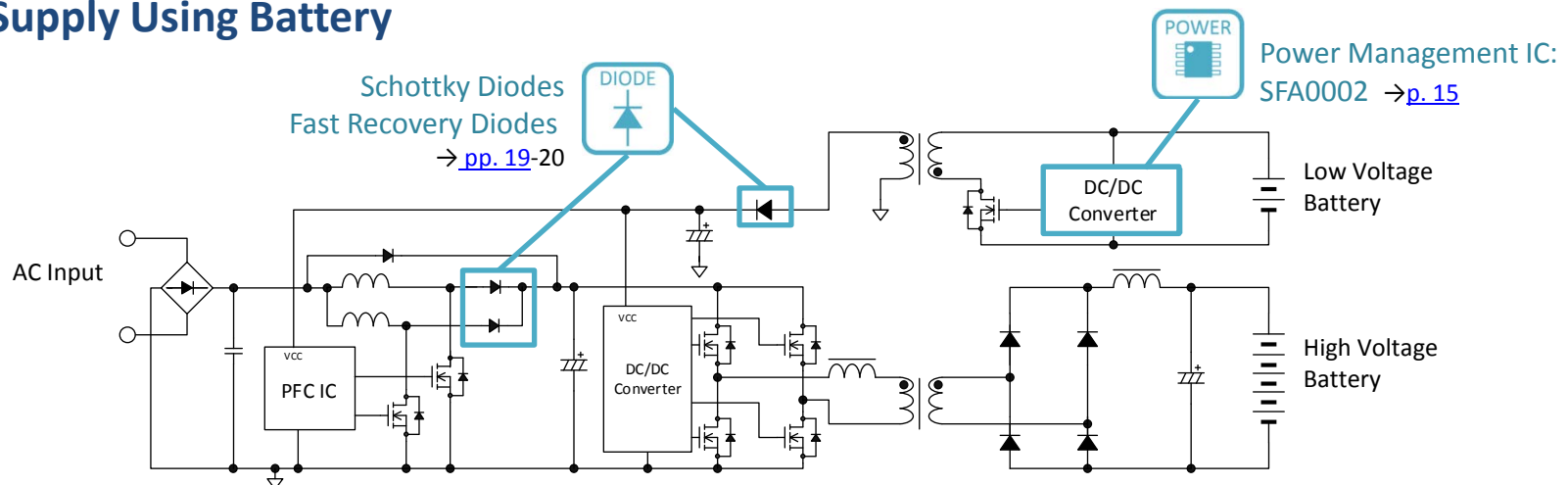
HEV/EV System: Battery Charger System

For the battery charging circuit from a power plug, SanKen provides devices such as auxiliary power supply ICs and rectification diodes.

Auxiliary Power Supply Using AC Input

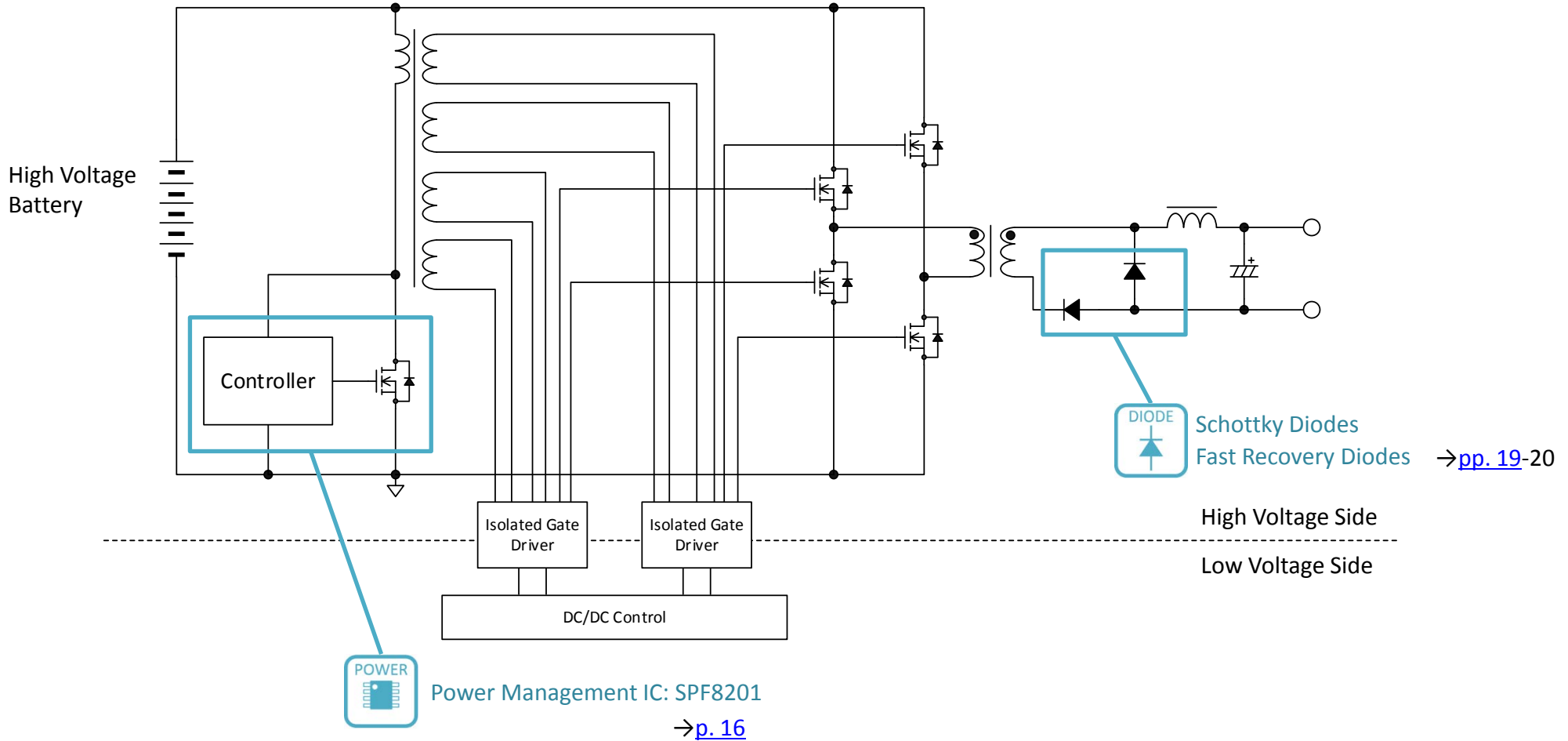


Auxiliary Power Supply Using Battery



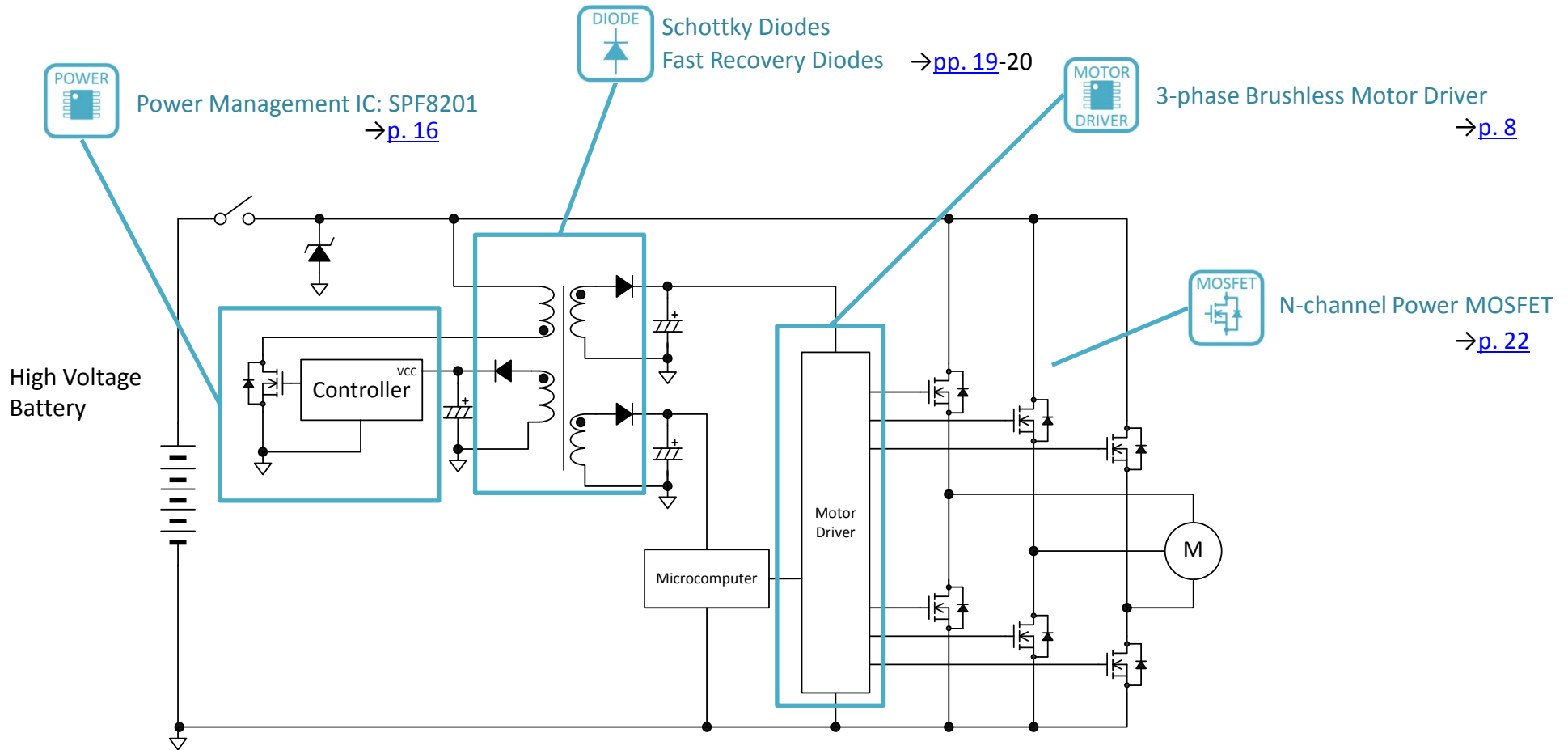
HEV/EV System: Buck Converter Circuit

For the buck converter circuit from a high voltage battery, SanKen provides devices such as power management ICs and rectification diodes.



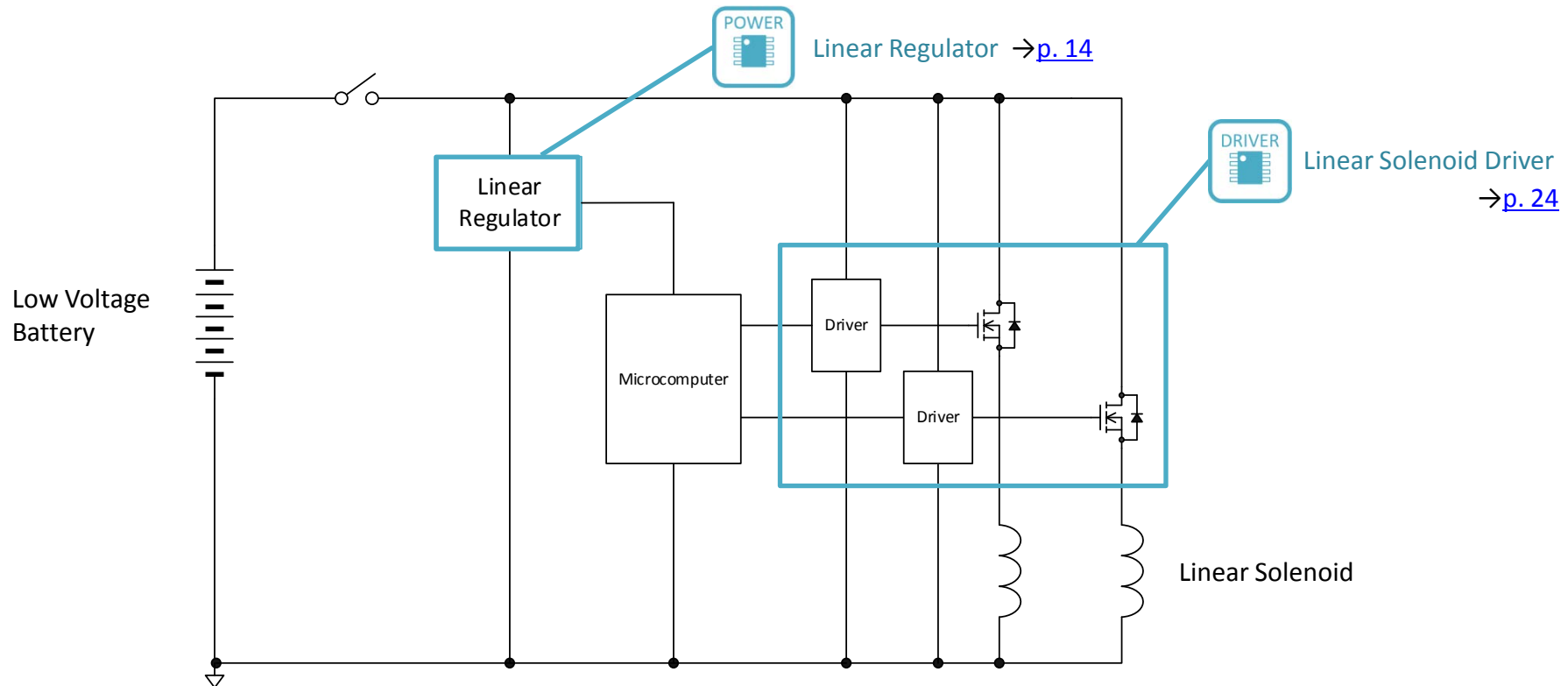
HEV/EV System: High Voltage Auxiliary Motor

For the high voltage auxiliary motor circuit, SanKen provides devices such as power management ICs, motor drive ICs, and discrete devices.



HEV/EV System: Actuator Control Unit (ACU)

For the Actuator Control Unit (ACU) of a linear solenoid valve in the transmission, SanKen provides various devices such as linear solenoid drivers.



Motor Drivers (35 V to 650 V)

SanKen's motor drivers for automotive applications are AEC-Q100 qualified high-quality ICs. SanKen provides the optimal ICs according to the application and system of the DC motors.

3-phase Brushless Motor: Low Noises, Long Life, Fast Rotation, High Efficiency

◆ SPF6102

Selectable External Power MOSFET
($V_{CC} = 35\text{ V}$)

HSOP48



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For the 3-phase brushless motor drivers used in:

- Inverter
- 24 V and 450 V Battery Management System (BMS)
- Integrated Starter Generator (ISG) Hybrid System
- High Voltage Auxiliary Circuit (Compressor, etc.)

DC Brush Motor: Smaller Circuit Size

◆ SPF6001

Half-bridge Driver
Selectable External Power MOSFET ($V_{CC} = 35\text{ V}$)

HSOP16



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For the DC brush motor drivers used in:

- Radiator Pump
- Fan for Air Conditioner
- Electric Power Steering (EPS)

◆ SPF7302

Full-bridge Driver
Built-in Power MOSFET (40 V, 3 A)

HSOP16



[→p. 11](#)

Stepper Motor (Bipolar Drive): Easy Position Control, Long Life, Large Torque in Slow Rotation

◆ SPF7211

Built-in Power MOSFET
40 V, 1 A

HSOP24



[→p. 12](#)

For the stepper motor drivers used in:

- Power Window
- Windshield Wiper

SPF6102

Package

HSOP48



Features

- AEC-Q100 Qualified
- Pb-free (RoHS Compliant)
- Built-in Bootstrap Diodes
- Built-in Auxiliary Power Supply (VREGx)
- Enable Function (All Phases Shutdown with EN = Logic Low)
- Fault Signal Output at Protect Circuit Activated
- Protections

Simultaneous On-state Prevention

VBB Pin Overvoltage Protection (VBB_OVP)

Overcurrent Protection (OCP)

Under Voltage Protection

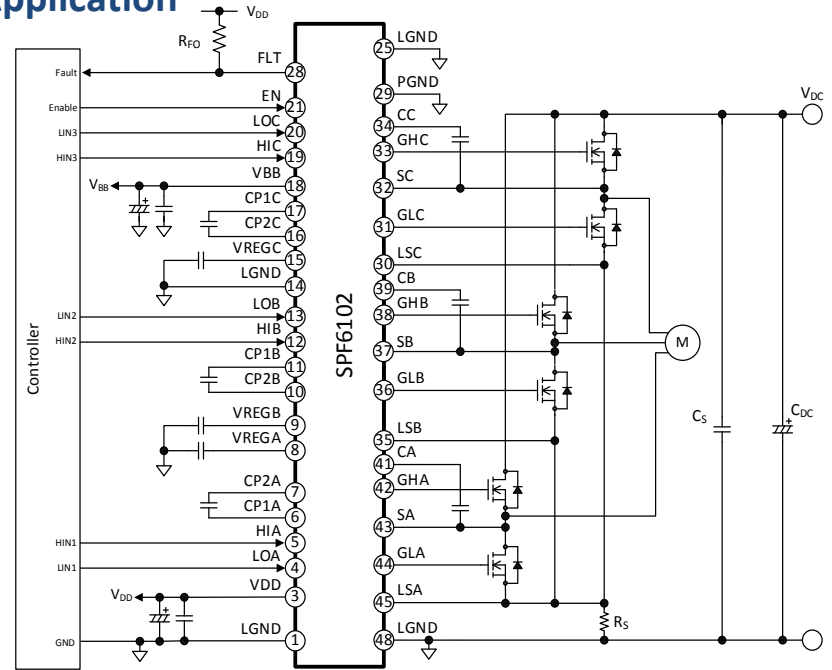
- VBB Pin (VBB_UVLO)

- VDD Pin (VDD_UVLO)

- VREGx Pin (VREGx_UVLO)

Thermal Shutdown (TSD)

Typical Application



Specifications

Part Number	V _{DC}	V _{BB}	On-resistance of Internal Driver
SPF6102	150 V	35 V	Sink: 7 Ω (typ.) Source: 10 Ω (typ.)

SPF6001

Package

HSOP16



Features

- AEC-Q100 Qualified
- Pb-free (RoHS Compliant)
- Built-in Bootstrap Diodes
- Built-in Auxiliary Power Supply
- Enable Function (All Phases Shutdown with EN = Logic Low)
- Fault Signal Output at Protect Circuit Activated
- Protections

VBB Pin Overvoltage Protection (VBB_OVP)

Overcurrent Protection (OCP)

Under Voltage Protection

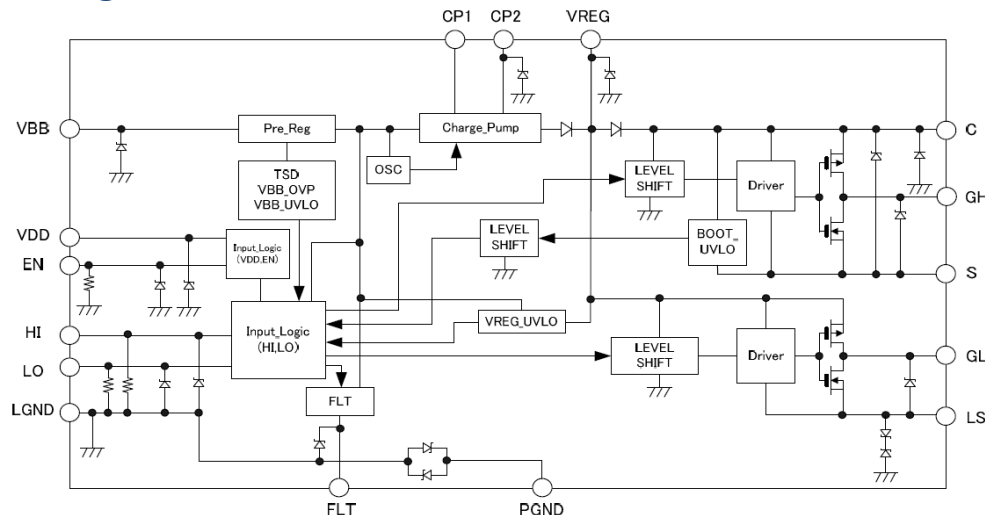
- VBB Pin (VBB_UVLO)

- VDD Pin (VDD_UVLO)

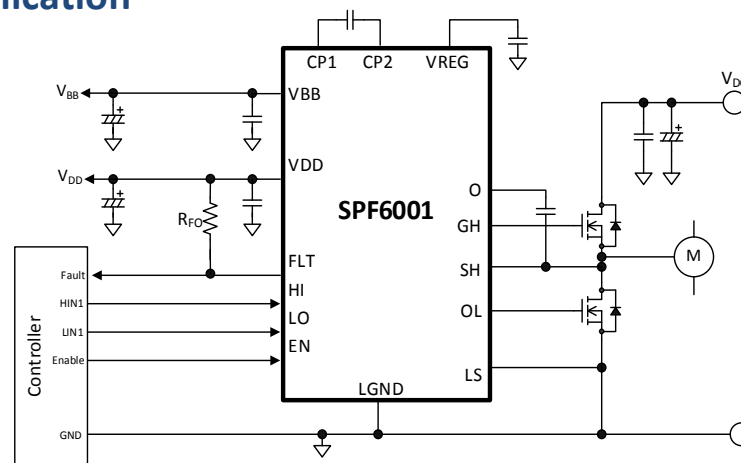
- VREGx Pin (VREGx_UVLO)

Thermal Shutdown (TSD)

Block Diagram



Typical Application



SPF7302

Package

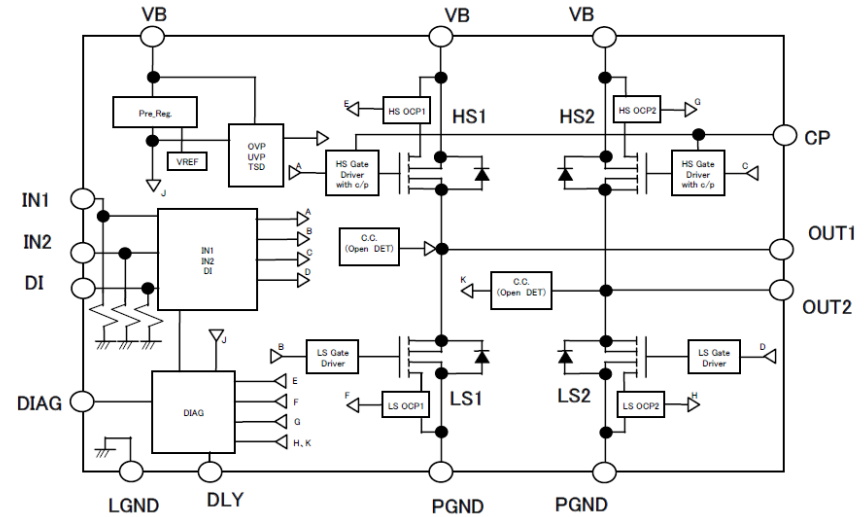
HSOP16



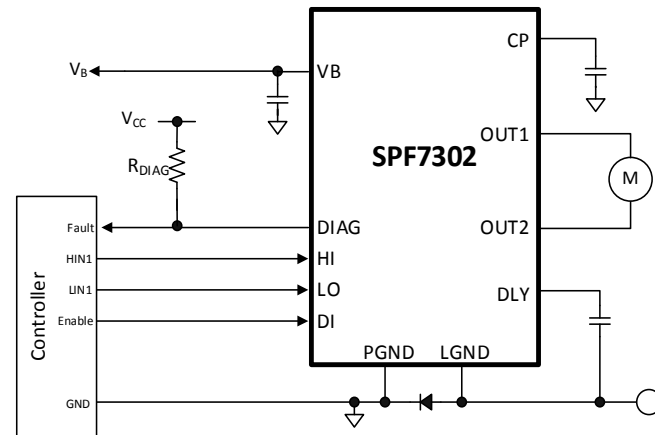
Features

- AEC-Q100 Qualified
- Pb-free (RoHS Compliant)
- Enable Function (All Phases Shutdown with DI = Logic Low)
- Protections
 - Overcurrent Protection (OCP)
 - Overvoltage Protection (OVP)
 - Under Voltage Protection (UVLO)
 - Thermal Shutdown (TSD)

Block Diagram



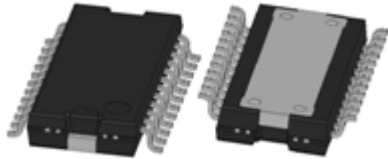
Typical Application



SPF7211

Package

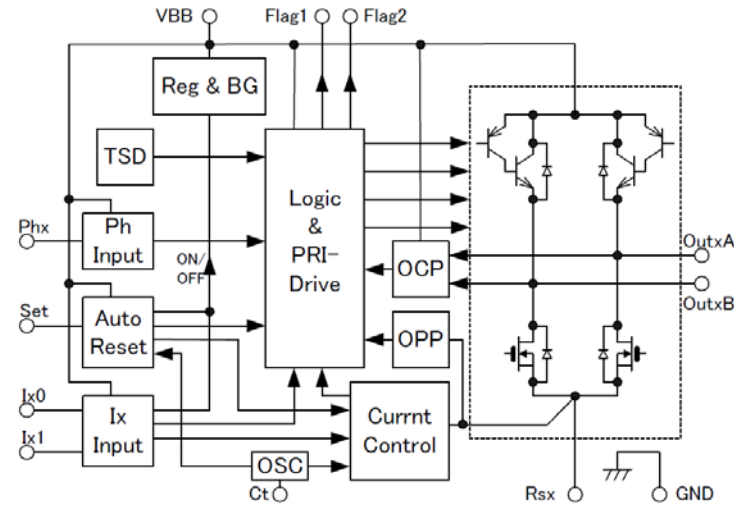
HSOP24



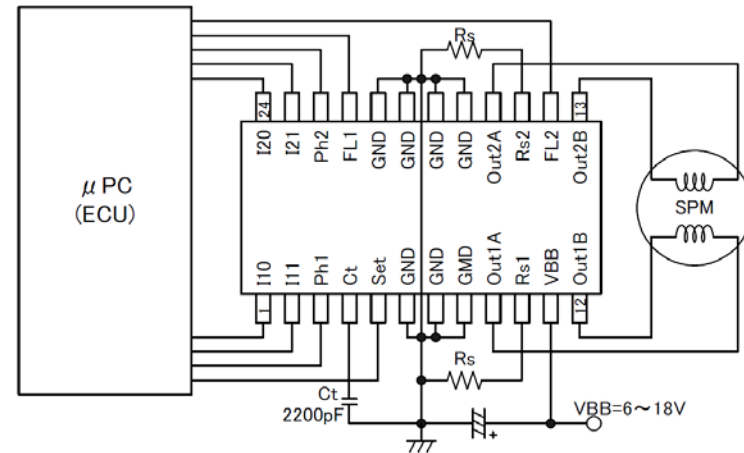
Features

- AEC-Q100 Qualified
- Pb-free (RoHS Compliant)
- Two Full-bridge Circuits
- Standby Circuit
- Fault Signal Output at Protect Circuit Activated
- Protections
 - Overload and Open Detection
 - Overcurrent Protection (OCP)
 - Under Voltage Protection (UVLO)
 - Thermal Shutdown (TSD)

Block Diagram



Typical Application



Power Management ICs

SanKen's power management ICs for automotive applications are AEC-Q100 qualified high-quality ICs. SanKen provides the optimal ICs according to the application and system of a power supply.

Two Outputs Linear Regulator

◆ SPF3000 Series

- One Input, Two Outputs Linear Regulator
 - Built-in Power MOSFET
- $I_O = 0.2 \text{ A to } 0.4 \text{ A}$
 $V_{IN} = 35 \text{ V}$

HSOP16



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For the buck converters used in:

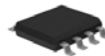
- Inverter
- On Board Charger (OBC)
- Battery Management System (BMS)

Off-line PWM Controllers (Primary-side Regulation)

◆ SFA0002

Selectable External Power MOSFET
 $(V_{CC} = 35 \text{ V})$

SOP8



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◆ SPF8201

Built-in Power MOSFET
 $600 \text{ V, } 3 \text{ A}$

HSOP16



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For the isolated auxiliary power supply circuits used in:

- Inverter
- On Board Charger (OBC)
- Battery Management System (BMS)

SPF3000 Series

Package

SOP16



Features

- One Input, Two Outputs Linear Regulator
- AEC-Q100 Qualified
- Pb-free (RoHS Compliant)
- High Accuracy Output Voltage (Output 1: $\pm 2\%$)
- Power-on Reset Function
- Built-in Watchdog Timer
- Enable Function
- Protections
Overcurrent Protection: Drooping
Thermal Shutdown (Output 1)

Selection Guide

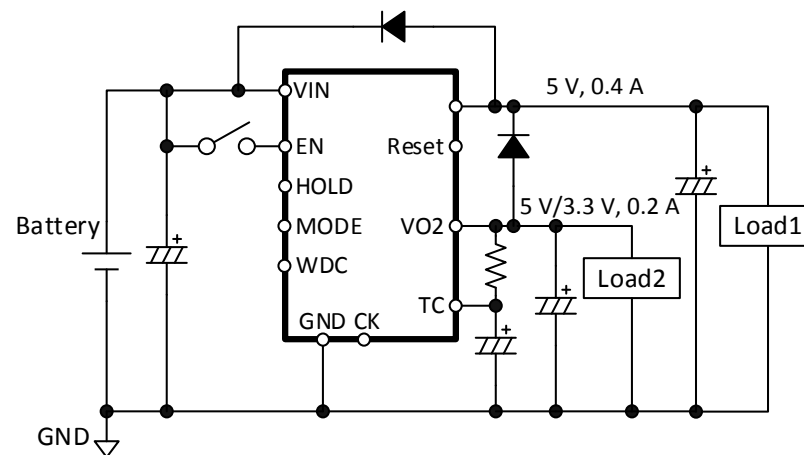
Part Number	Output 1		Output 2		V_{IN} (max.)	P_D
	I_o	V_o	I_o	V_o		
SPF3006	0.4 A	5.0 V	0.2 A	5.0 V	35 V	3 W
SPF3009	0.4 A	5.0 V	0.2 A	3.3 V		

Applications

For the buck converters used in:

- Inverter
- On Board Charger (OBC)
- Battery Management System (BMS)

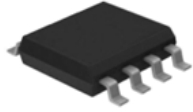
Typical Application



SFA0002

Package

SOP8



Features

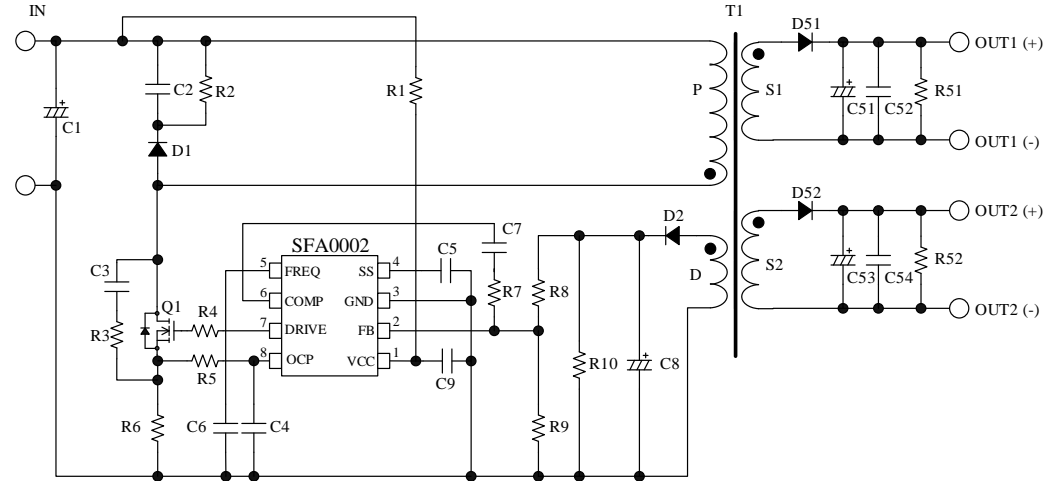
- AEC-Q100 Qualified
- Pb-free (RoHS Compliant)
- Current Mode Type PWM Control
- Switching Frequency: 20 kHz to 200 kHz (Adjusted by External Capacitor)
- Reducing External Component Count by Primary-side Regulation
- Built-in High Accuracy Error Amplifier ($V_{FB} = 2.5 \text{ V} \pm 2\%$, $-40 \text{ }^\circ\text{C}$ to $125 \text{ }^\circ\text{C}$)
- Operating Mode
Normal Operation: PWM Mode
Light Load Operation: Burst Oscillation
- Soft Start Function (Startup time can be adjusted by an external capacitor)
- Drive Output Stop Function
- Protections
Overcurrent Protection (OCP): Pulse-by-Pulse
Overload Protection (OLP): Auto-restart
Thermal Shutdown (TSD): Auto-restart

Applications

For the isolated auxiliary power supply circuits used in:

- Inverter
- On Board Charger (OBC)
- Battery Management System (BMS)

Typical Application



Specifications

Part Number	V_{CC}	Switching Frequency	Output Characteristics
SFA0002	36 V(max.)	20 kHz to 200 kHz	Sink: 180 mA Source: -90 mA Gate Voltage: 4 V (min.)

SPF8201

Package

HSOP40



Features

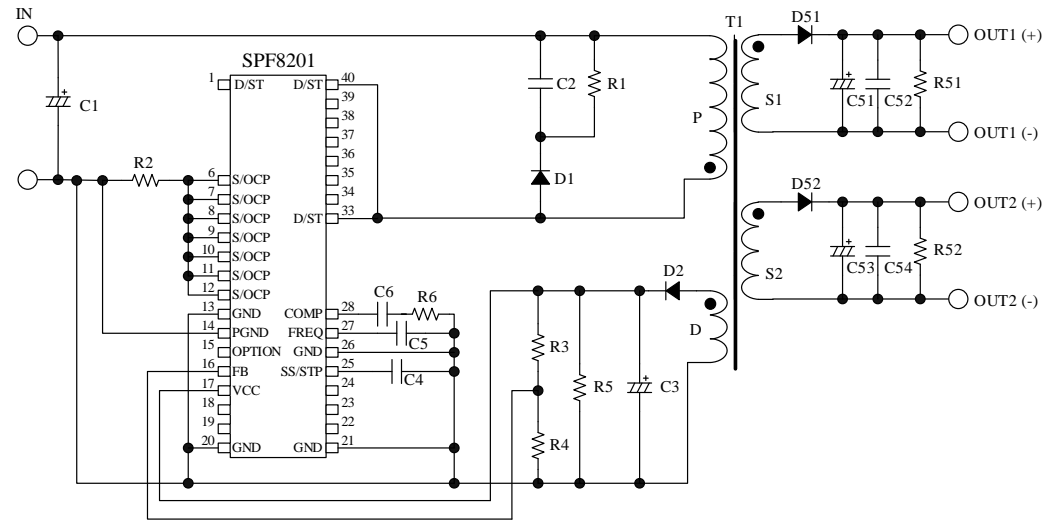
- AEC-Q100 Qualified
- Pb-free (RoHS Compliant)
- Current Mode Type PWM Control
- Switching Frequency: 20 kHz to 200 kHz (Adjusted by External Capacitor)
- Reducing External Component Count by Primary-side Regulation
- Built-in High Accuracy Error Amplifier ($V_{FB} = 2.5 \text{ V} \pm 2\%$, $-40 \text{ }^\circ\text{C}$ to $125 \text{ }^\circ\text{C}$)
- Operating Mode
Normal Operation: PWM Mode
Light Load Operation: Burst Oscillation
- Soft Start Function (Startup time can be adjusted by an external capacitor)
- Drive Output Stop Function
- Protections
Overcurrent Protection (OCP): Pulse-by-Pulse
Overload Protection (OLP): Auto-restart
Thermal Shutdown (TSD) : Auto-restart

Applications

For the isolated auxiliary power supply circuits used in:

- Inverter
- On Board Charger (OBC)
- Battery Management System (BMS)

Typical Application



Specifications

Part Number	V_{CC}	Switching Frequency	Built-in Power MOSFET
SPF8201	36 V (max.)	20 kHz to 200 kHz	V_{DSS} (DC): 600 V V_{DSS} (Pulse): 800 V $R_{DS(ON)}$ (25 °C): 6.5 Ω (max.) I_D (Pulse): 3 A (Peak)

Diodes

SanKen provides the optimal diodes according to the automotive application.

The TVS diodes have high surge capability, and protect automotive electronic units, especially from the surge generated during load dump conditions and voltage transients induced by inductive loads. These are provided in high thermal dissipation package.

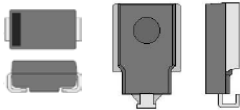
The various diodes for high speed switching such as switching power supply are provided.

Features

- AEC-Q101 Qualified
- $T_j = 175\text{ }^\circ\text{C}$ Capability Suitable for High Reliability and Automotive Requirement
- Flammability UL94V-0 (Equivalent)
- Bare Lead Frame: Pb-free (RoHS Compliant)

TVS Diodes

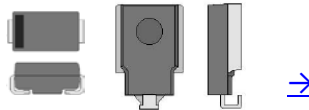
- $P_D = 1\text{ W to }6\text{ W}$
- For Circuit using 12 V or 24 V Battery
- Meets the Surge Protection Requirements in ISO7637-2



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Schottky Diodes

- $V_{RM} = 40\text{ V to }150\text{ V}$
- $I_{F(AVG)} = 1\text{ A to }3\text{ A, and }45\text{ A to }65\text{ A}$



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Fast Recovery Diodes

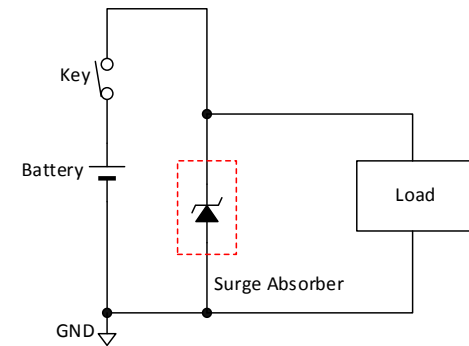
- $V_{RM} = 200\text{ V to }600\text{ V}$
- 1 A to 3 A



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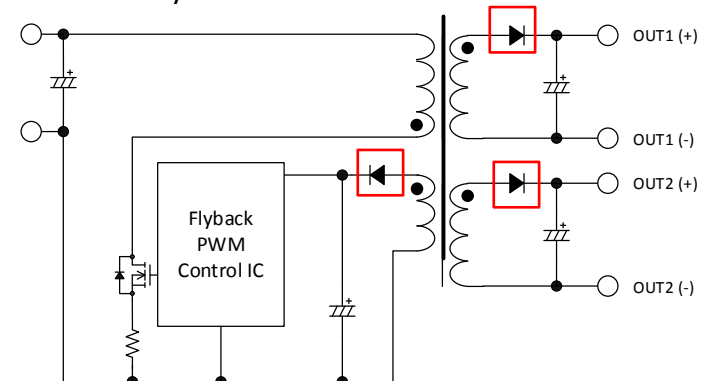
Typical Application

◆TVS Diodes



◆Schottky Diodes

◆Fast Recovery Diodes

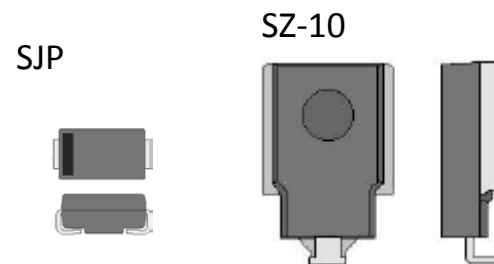


TVS Diodes

Features

- AEC-Q101 Qualified
- Meets the Surge Protection Requirements in ISO7637-2
- for High Reliability and Automotive Requirement
- SZ-10 Series: $T_j = 175\text{ }^\circ\text{C}$ Capability Suitable
- Flammability UL94V-0 (Equivalent)
- Bare Lead Frame: Pb-free (RoHS Compliant)

Packages



Selection Guide

P_D	Part Number	V_Z (min.)	V_Z (max.)	I_{RSM}	I_R	Package	ISO7637-2
1 W	SJPZ-K28	25.0 V	31.0 V	2 A	10 μA	SJP	Pulse 1 to 3
2 W	SJPZ-N18	16.8 V	19.1 V	—	1 μA		
	SJPZ-N27	25.1 V	28.9 V	—	1 μA		
	SJPZ-N33	31.0 V	35.0 V	—	1 μA		
5 W	SZ-10N27	24.0 V	30.0 V	70 A	10 μA	SZ-10	Pulse 5a
6 W	SZ-10NN27	24.0 V	30.0 V	90 A	10 μA		
	SZ-10NN40	36.0 V	44.0 V	70 A	10 μA		

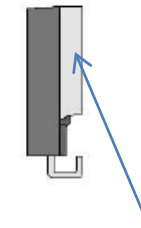
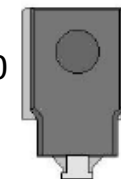
Schottky Diodes

Features

- AEC-Q101 Qualified
- Guaranteed Avalanche Energy for SZ-10EF
- Flammability UL94V-0 (Equivalent)
- Bare Lead Frame: Pb-free (RoHS Compliant)

Packages

SJP

SZ-10
SZ-E10

Anode

Selection Guide

Package	V_{RM}	$I_{F(AVG)}$	Part Number	I_{FSM} (50 Hz Half-wave)	V_F	
					V_F (max.)	I_F Condition
SJP	40 V	2.0 A	SJPE-H4	40 A	0.60 V	2.0 A
		2.0 A	SJPB-H4	50 A	0.55 V	2.0 A
		3.0 A	SJPB-L4	60 A	0.55 V	3.0 A
	60 V	1.0 A	SJPB-D6	20 A	0.68 V	1.0 A
		1.5 A	SJPW-F6	25 A	0.70 V	1.5 A
		2.0 A	SJPB-H6	40 A	0.69 V	2.0 A
		3.0 A	SJPB-L6	50 A	0.70 V	3.0 A
	90 V	1.0 A	SJPB-D9	20 A	0.85 V	1.0 A
		2.0 A	SJPB-H9	40 A	0.85 V	2.0 A
SZ-10	80 V	45 A	SZ-10EF	300 A	0.82 V	45 A
SZ-E10	150 V	45 A	SZ-E10ET415	300 A	1.10 V	45 A
		65 A	SZ-E10ET615*	300 A	1.00 V	65 A

Fast Recovery Diodes

Features

- AEC-Q101 Qualified
- Flammability UL94V-0 (Equivalent)
- Bare Lead Frame: Pb-free (RoHS Compliant)

Package

SJP



Selection Guide

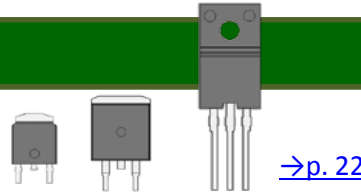
V_{RM}	$I_{F(AVG)}$	Part Number	I_{FSM} (50 Hz Half-wave)	V_F		t_{rr} $I_F : I_R = 1 : 1$
				V_F (max.)	I_F Condition	
200 V	1.0 A	SJPL-D2	25 A	0.98 V	1.0 A	50 ns
	1.5 A	SJPX-F2	30 A	0.98 V	1.5 A	30 ns
	2.0 A	SJPL-H2	25 A	0.98 V	2.0 A	50 ns
	3.0 A	SJPL-L2	60 A	0.98 V	3.0 A	50 ns
300 V	2.0 A	SJPX-H3	20 A	1.3 V	2.0 A	30 ns
400 V	1.5 A	SJPL-F4	25 A	1.3 V	1.5 A	50 ns
	3.0 A	SJPL-L4	30 A	1.3 V	3.0 A	50 ns
500 V	1.0 A	SJPD-D5	20 A	1.4 V	1.0 A	40 ns
	3.0 A	SJPD-L5	50 A	1.4 V	3.0 A	50 ns
600 V	2.0 A	SJPL-H6	30 A	1.5 V	2.0 A	50 ns
	2.0 A	SJPX-H6	20 A	1.5 V	2.0 A	30 ns

Power MOSFETs

SanKen provides various power MOSFETs according to the automotive application. The high-quality power MOSFETs have low on-resistance, and are optimal for the automotive applications including inverters and switch.

N-channel Power MOSFETs

- $V_{DSS} = 40\text{ V to }300\text{ V}$
- $I_D = \pm 20\text{ A to } \pm 100\text{ A}$

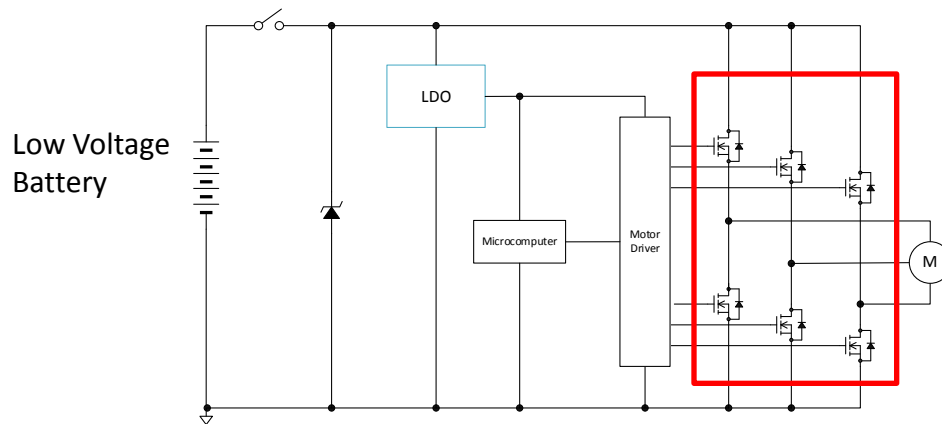


Features

- AEC-Q101 Qualified
- Bare Lead Frame: Pb-free (RoHS Compliant)
- Guaranteed Avalanche Energy

Applications

- Motor Drive
- Injection Switch
- Power Management Circuit



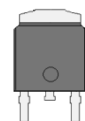
N-channel Power MOSFETs

Features

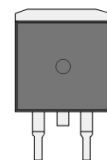
- $V_{DSS} = 40 \text{ V to } 300 \text{ V}$
- Low On-resistance
- AEC-Q101 Qualified
- Bare Lead Frame: Pb-free (RoHS Compliant)
- Guaranteed Avalanche Energy

Packages

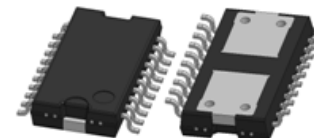
TO252



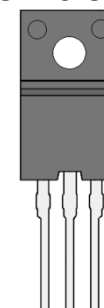
TO263



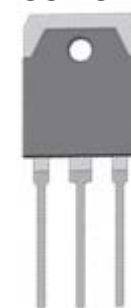
SOP20



TO220-3L



TO3P-3L



*Built-in two elements

Selection Guide

V_{DSS}	I_D	Part Number	Package	P_D	V_{GSS}	V_{TH} (max.)	C_{iss}		$R_{DS(ON)}$ (max.)
							$V_{DS} = 10 \text{ V}, V_{GS} = 0 \text{ V}$		
40 V	$\pm 60 \text{ A}$	FKV460S	TO263	60 W	+ 20 , -10 V	2.5 V	2800 pF	600 pF	9 m Ω
	$\pm 70 \text{ A}$	2SK3800	TO263	80 W	$\pm 20 \text{ V}$	4.0 V	5100 pF	860 pF	6 m Ω
		2SK3801	TO3P-3L	100 W					
		FLD470	TO220F-3L	35 W					
60 V	$\pm 60 \text{ A}$	FKV660S	TO263	60 W					
60 V	$\pm 70 \text{ A}$	2SK3710	TO263	90 W	$\pm 20 \text{ V}$	4.0 V	8000 pF	1000 pF	6 m Ω
		2SK3711	TO3P-3L	130 W					
	$\pm 100 \text{ A}$	2SK4161D	TO3P-3L	132 W					
100 V	$\pm 20 \text{ A}$	DKG1020	TO252	40 W	$\pm 20 \text{ V}$	2.5 V	2200 pF	110 pF	52 m Ω
275 V	$\pm 6 \text{ A}$	SPF0004*	SOP20	2.5 W	$\pm 20 \text{ V}$	2.6 V	960 pF	36 pF	260 m Ω
300 V	$\pm 15 \text{ A}$	SUK3015	TO263	89 W	$\pm 20 \text{ V}$	2.5 V	1800 pF	85 pF	150 m Ω

Linear Solenoid Driver

SanKen's linear solenoid driver can control according to a load by an internal 16-bit serial communication. It is optimal for a system using multiple linear solenoids.

◆ SPF5035

- Two Outputs, $V_{DD} = 32\text{ V}$ (max.), High-side Detection
- 16-bit Serial Communication

HSOP48



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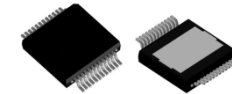
LED Headlight Driver

SanKen's LED headlight driver is a bypass switch for the highbrightness matrix LEDs used in applications such as automotive headlights. Each LED has open and short detections that can send fault flags to the CPU.

◆ SPF5047

- 4 Series LED Bypass Switches
- $V_{POS} = -65\text{ V}$, $R_{DS(ON)} = 120\text{ m}\Omega$
- LED Open / Short Detection

HSOP24



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SPF5035

Package

HSOP48



Features

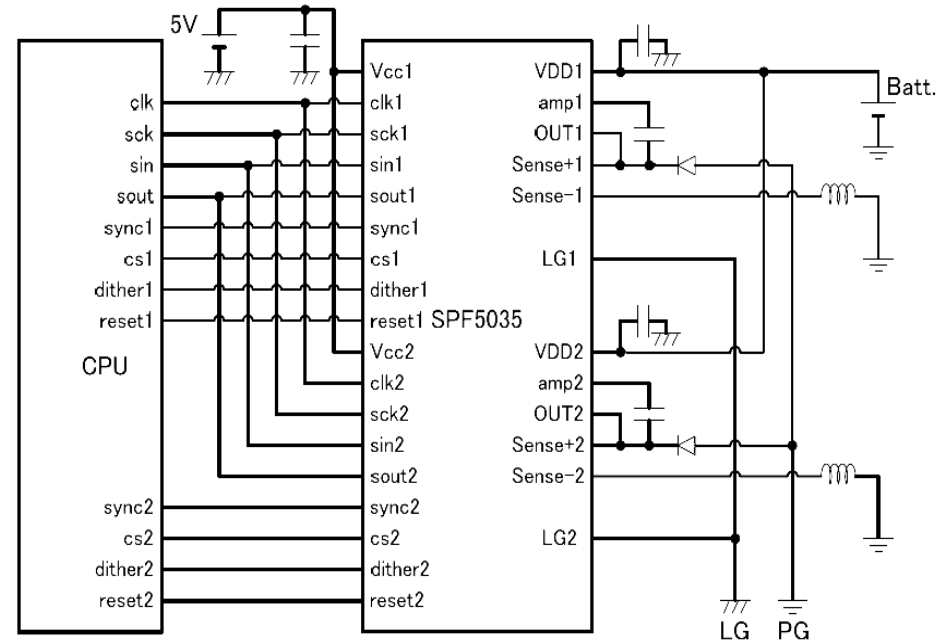
- AEC-Q100 Qualified
- Pb-free (RoHS Compliant)
- Two Outputs
- High-side Detection
- Built-in Power MOSFETs
- High Accuracy Output Current: ± 10 mA ($I_D = 0.1$ A to 0.8 A)
- 16-bit Serial Communication

Setting Value: Output Current, Frequency, Feedback Ratio, Dither, etc.

Output Signal: Load Current Value in 9-bit, Diagnostic Signals

- Diagnostic Function
 - Open Load Detection
 - No Reference Clock
- Protections
 - Overvoltage Protection (VBB_OVP)
 - Overcurrent Protection (OCP)
 - Thermal Shutdown (TSD)

Typical Application



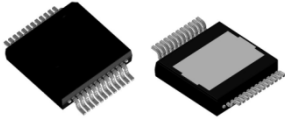
Specifications

Part Number	V_{DC}	$R_{DS(ON)}$	Control Frequency
SPF5035	40 V (400 ms) 32 V (DC)	0.3 Ω	122 Hz to 1953 Hz

SPF5047

Package

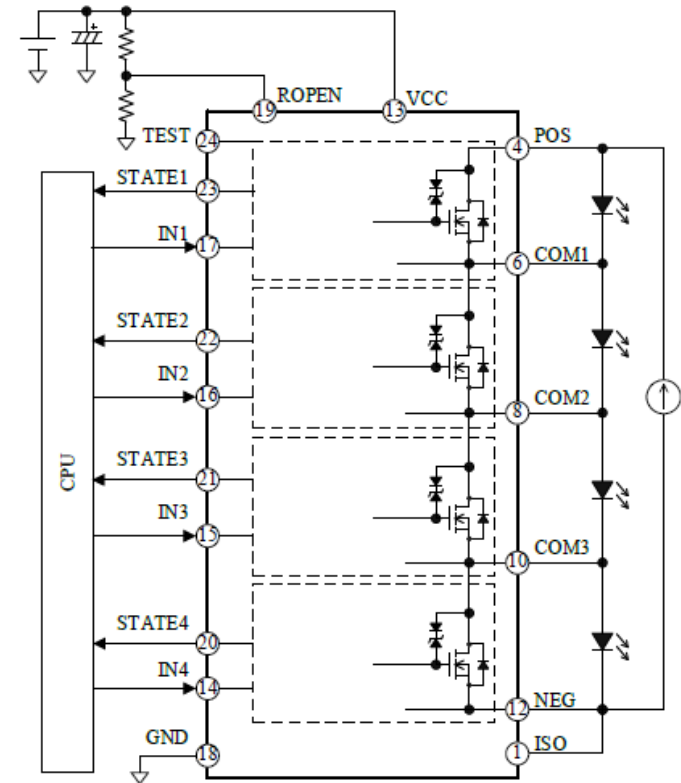
HSOP24



Features

- Four Series LED Bypass Switches
- Drives Up to 16 LEDs in Series (with 4 ICs; at V_F of an LED is approx. 3 V)
- Low Noise:
No charge-current-induced noise occurs as each gate driver uses a negative power source which requires no charge-pump circuit.
- High Efficiency:
Optimized trade-offs between switching loss and switching noise allow highly-accurate control in t_r and t_f .
- Fault Flag Reporting
- LED Open Detection
- LED Short Detection

Typical Applicati



Specifications

Part Number	V_{POS}	I_{OUT}	$R_{DS(ON)}$
SPF5047	-65 V (max.)	2 A (max.)	120 m Ω (typ.)

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- No anti-radioactive ray design has been adopted for the SanKen Products.
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