

## TN5D51A — ExPD (Excellent-Performance Power & RF Device) Separately-Excited Step-Down Switching Regulator (12V Output type)

### Features

- High efficiency (ON resistance 100mΩ, Vertical-type P-ch Power MOSFET).
- Over current protection function (Self recovery type).
- Under voltage protection function.
- Over temperature protection function (Self recovery type).
- Soft start function (Variable subject to externally-connected capacitor).
- Stand-by mode function (Compatible with soft start terminal).

### Specifications

#### Absolute Maximum Ratings at Ta=25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum Input Voltage	V <sub>IN</sub> max		57	V
Maximum Output Current	I <sub>O</sub> max		5	A
Drain-to-Source Voltage of built-in MOSFET	V <sub>DSS</sub>		-60	V
Drain Current of built-in MOSFET (DC)	I <sub>D</sub>		-9	A
Drain Current of built-in MOSFET (Pulse)	I <sub>DP</sub>	PW≤10μs, duty cycle≤1%	-36	A
FB Pin Maximum Input Voltage	V <sub>fb</sub>		15	V
SS Pin Maximum Input Voltage	V <sub>SS</sub>		7	V
Allowable Power Dissipation	P <sub>D</sub>		2.0	W
		T <sub>C</sub> =25°C	15	W
Operating Temperature	T <sub>opr</sub>		-25 to +125	°C
Junction Temperature	T <sub>J</sub>		150	°C
Storage Temperature	T <sub>stg</sub>		-55 to +150	°C

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# TN5D51A

## Recommend Operating Conditions

Parameter	Symbol	Conditions	Ratings	Unit
Input Voltage	$V_{IN}$	$T_a=25^{\circ}\text{C}$	20 to 48	V
Output Current	$I_{OUT}$	$T_a=25^{\circ}\text{C}$	0 to 5	A
Operating Temperature Range	Topr rec		-10 to +85	$^{\circ}\text{C}$

## Electrical Characteristics at $T_a=25^{\circ}\text{C}$ , See Specified Test Circuit

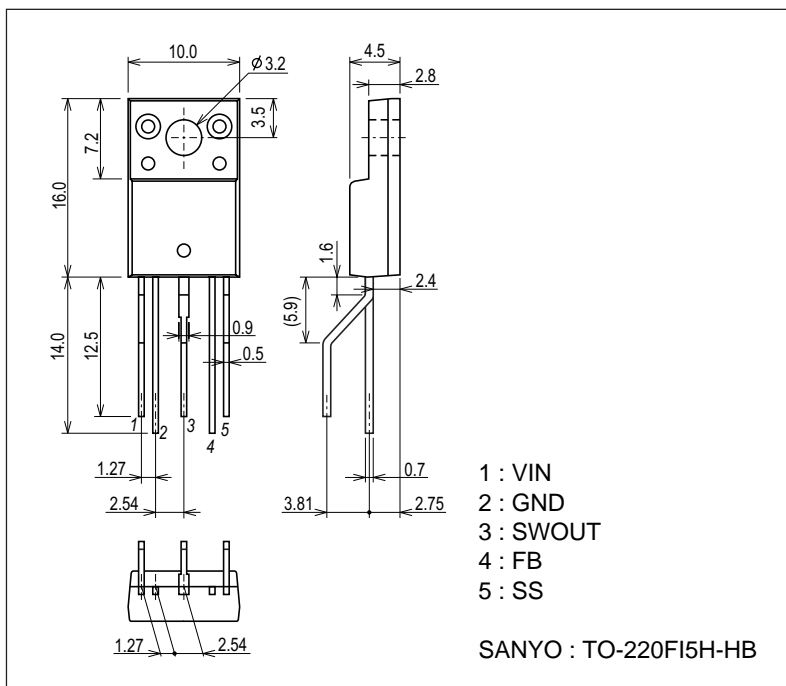
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Output Voltage	$V_{OUT}$	$V_{IN}=30\text{V}, I_{OUT}=3\text{A}$	11.7	12.0	12.4	V
Efficiency	$\eta$	$V_{IN}=30\text{V}, I_{OUT}=3\text{A}$		92		%
Drain-to-Source Breakdown Voltage of built-in MOSFET	$V_{(BR)DSS}$	$I_D=-1\text{mA}, V_{IN}, \text{GND}, V_{fb}, V_{SS}=0\text{V}$	-60			V
Drain-to-Source On Resistance of built-in MOSFET	$R_{DS(on)}$	$I_{SW}=5\text{A}$		100		$\text{m}\Omega$
Switching Frequency	Freq	$V_{IN}=30\text{V}, I_{OUT}=3\text{A}$	120	150	180	kHz
Maximum Duty	Duty max	$V_{IN}=30\text{V}, V_{fb}=0\text{V}$	88	92	96	%
Line Regulation	$\Delta V_{line}$	$V_{IN}=20 \text{ to } 40\text{V}, I_{OUT}=3\text{A}$		130	200	mV
Load Regulation	$\Delta V_{load}$	$V_{IN}=30\text{V}, I_{OUT}=0.5 \text{ to } 5\text{A}$		70	100	mV
Output Voltage Temperature Coefficient *1	$\Delta V_O / \Delta T_a$	$V_{IN}=30\text{V}, I_{OUT}=3\text{A}, T_a= -25 \text{ to } +125^{\circ}\text{C}$		$\pm 1.2$		$\text{mV} / ^{\circ}\text{C}$
Over-Current-Protection-Operation -Threshold Current	$I_{ocp}$	$V_{IN}=30\text{V}$	5.1	7.5	10	A
Under-Voltage-Protection-Operation -Threshold Voltage	$V_{uvlo \text{ on}}$		7.2	8.0	8.8	V
Under-Voltage-Protection-Operation -Release Voltage	$V_{uvlo \text{ off}}$		8.1	9.0	9.9	V
Under-Voltage-Protection Hysteresis Voltage	$V_{uvlo \text{ hys}}$			1.0		V
Over-Temperature-Protection-Operation -Threshold-Current *1	$T_{tsd \text{ on}}$			165		$^{\circ}\text{C}$
Over-Temperature-Protection-Operation -Release Temperature *1	$T_{tsd \text{ off}}$			140		$^{\circ}\text{C}$
Over-Temperature-Protection -Hysteresis Temperature *1	$T_{tsd \text{ hys}}$			25		$^{\circ}\text{C}$
SS Terminal Current	$I_{SS}$	$V_{IN}=30\text{V}$		10		$\mu\text{A}$
Standby Operating Voltage	$V_{stb \text{ on}}$	$V_{IN}=30\text{V}$		0.3		V
Standby Current	$I_{stb}$	$V_{IN}=30\text{V}, V_{SS}=0\text{V}$			500	$\mu\text{A}$

Note: the values with "\*"1" are our targeted values, but not guaranteed.

## Package Dimensions

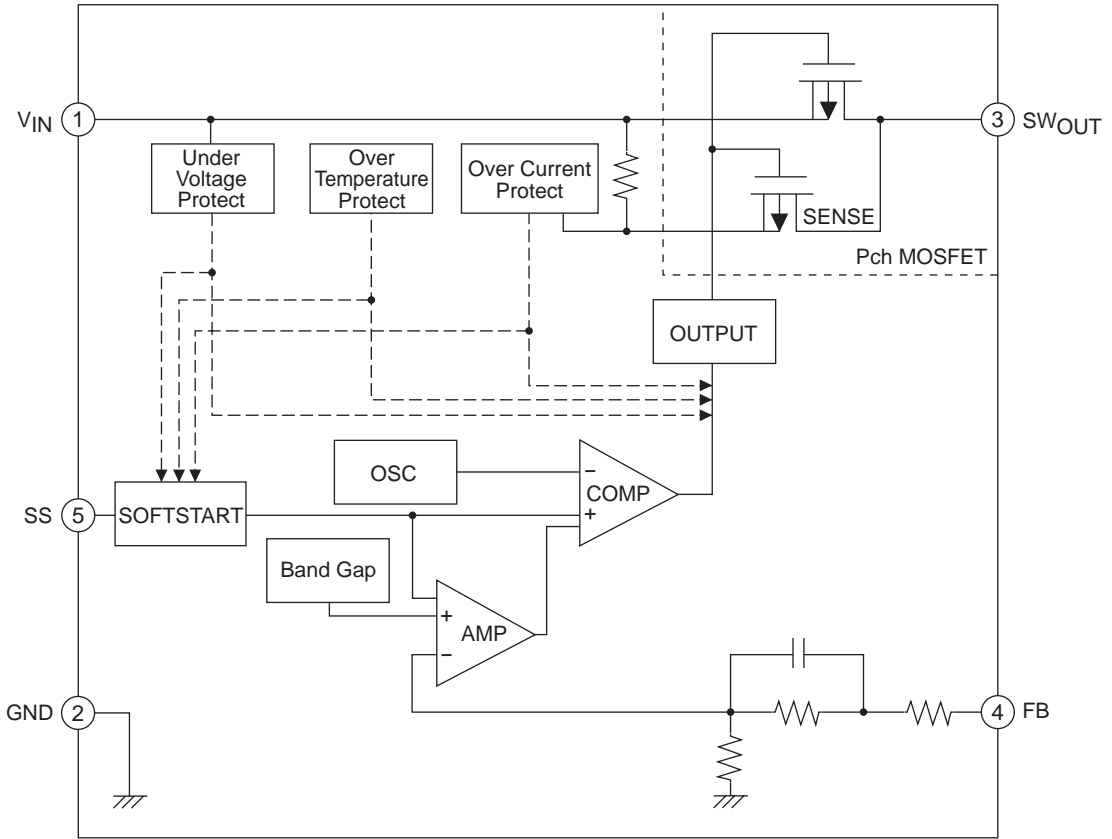
unit : mm (typ)

7527-001



# TN5D51A

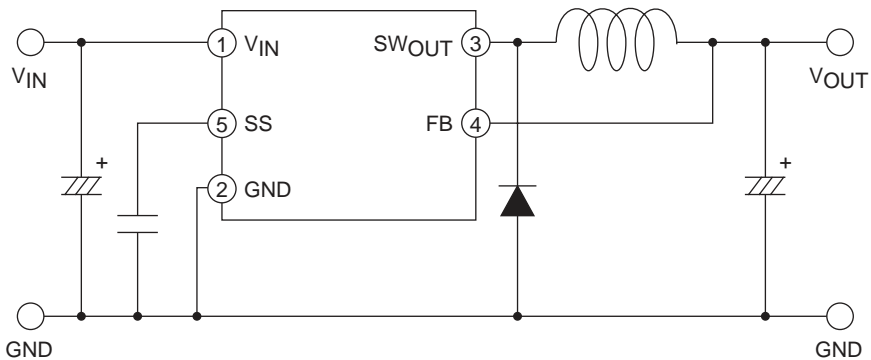
## Block Diagram



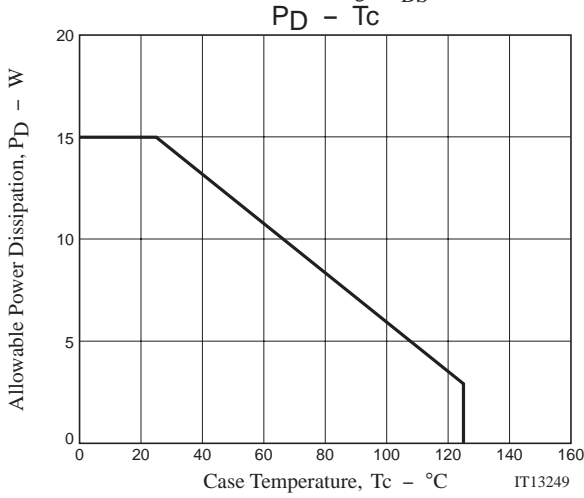
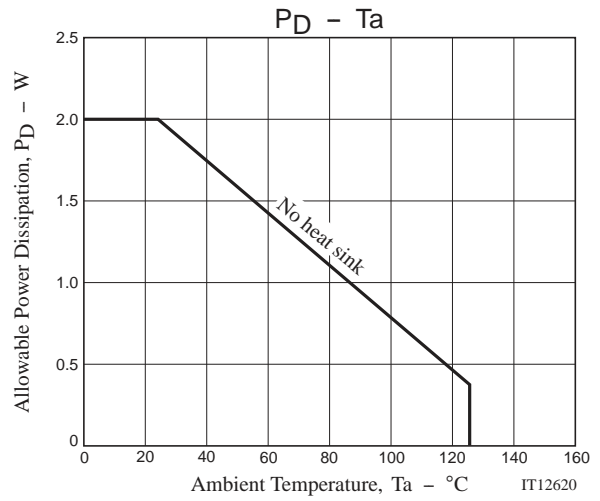
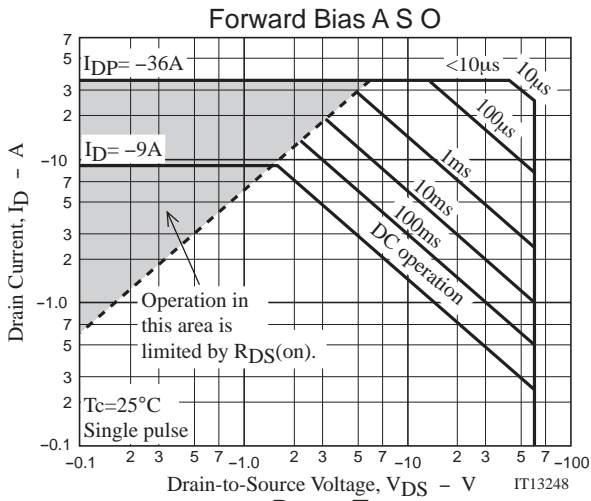
## Pin Functions

Pin No.	Symbol	Function
1	V <sub>IN</sub>	Power Supply Input (Maximum 57V)
2	GND	GND
3	SW <sub>OUT</sub>	Pulse Voltage Output
4	FB	Feedback from Output Voltage
5	SS	For Soft Start Capacitor Connection and Standby Mode Switching

## Application Circuit Example

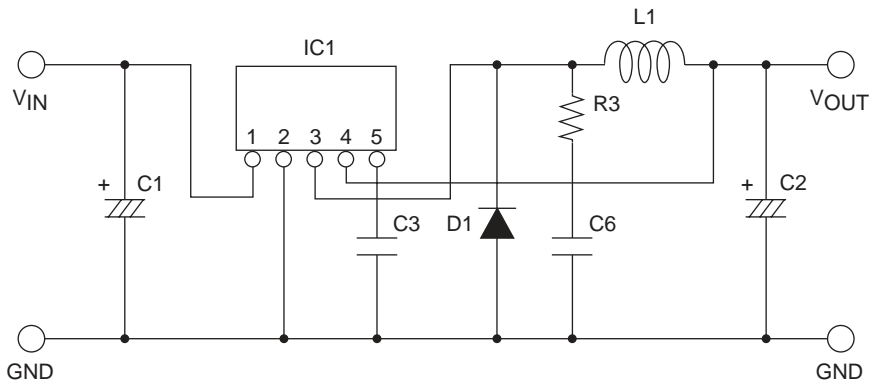


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## Specified Circuit for Electrical Characteristics

[Circuit]



[Components]

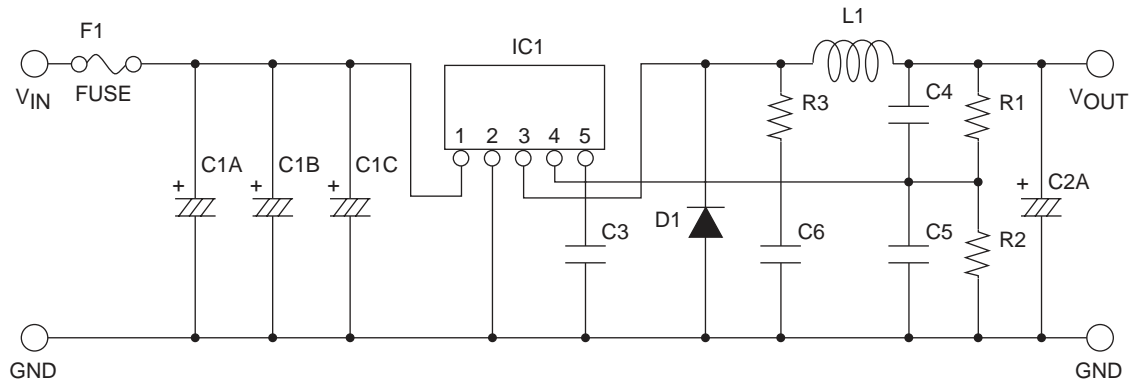
Symbol	Component	Specification
C1	Electrolytic Capacitor	3000 to 3600 $\mu F$
C2	Electrolytic Capacitor	2000 to 2200 $\mu F$
C3	Capacitor	0.1 $\mu F$
C6	Ceramic Capacitor	1000pF
R3	Metal Oxide Film Resistor	47 $\Omega$ / 2W
L1	Choke Coil	100 $\mu H$
D1	Schottky Barrier Diode	SBT250-06J

\* When measuring ripple noise voltage, put 47 $\mu F$  (electrolytic capacitor) and 0.1 $\mu F$  (ceramic or film capacitor) into measuring point.

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## Evaluation Board

[Circuit]



IT12638

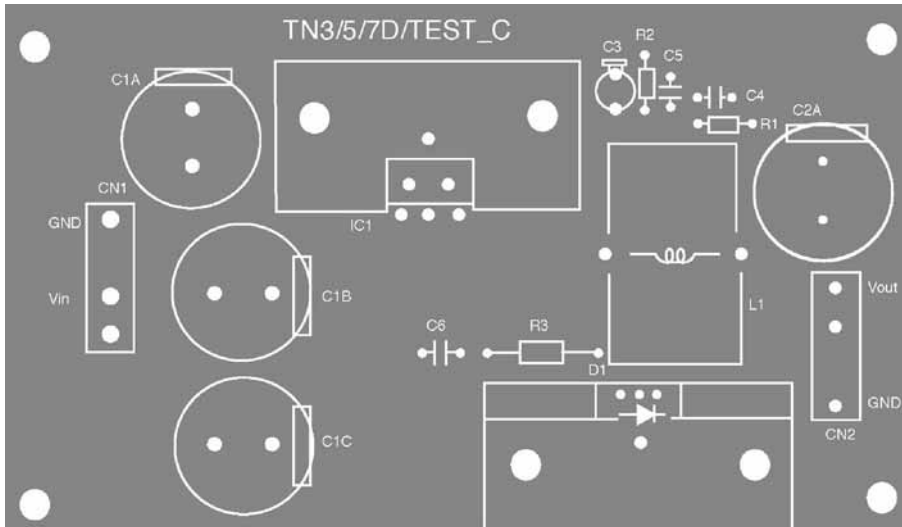
[Components]

Symbol	Component	Specification	Maker	Remark
F1	Fuse	4A	Littelfuse	452 004
C1A	Electrolytic Capacitor	1200 $\mu$ F / 80V	Nippon Chemi-Con Corp.	KZE
C1B	Electrolytic Capacitor	1200 $\mu$ F / 80V	Nippon Chemi-Con Corp.	KZE
C1C	Electrolytic Capacitor	1200 $\mu$ F / 80V	Nippon Chemi-Con Corp.	KZE
C2A	Electrolytic Capacitor	2200 $\mu$ F / 35V	SANYO Electronic Co., Ltd.	MV
C3	Film Capacitor	0.1 $\mu$ F / 100V	Matsushita Electronic Components Corp.	ECQ-B
C4	N.C.			
C5	N.C.			
C6	Ceramic Capacitor	1000pF	Murata Manufacturing Co., Ltd.	
R1	Jumper Line			
R2	N.C.			
R3	Metal Oxide Film Resistor	47 $\Omega$ / 2W	Matsushita Electronic Components Corp.	
L1	Choke Coil	HK-10S100-1010	TOHO ZINC CO.,LTD.	100 $\mu$ H
D1	Schottky Barrier Diode	SBT250-06J	SANYO Semiconductor Co., Ltd.	

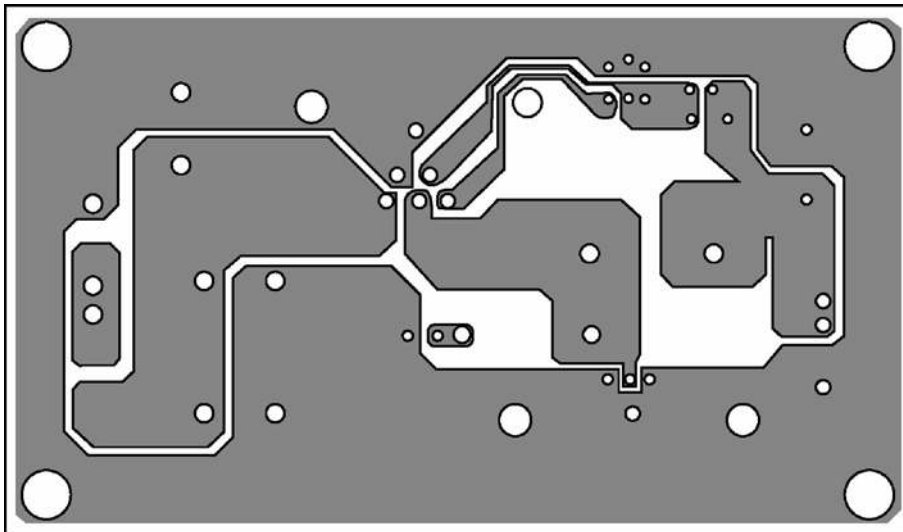
# TN5D51A

## Recommended PCB Pattern

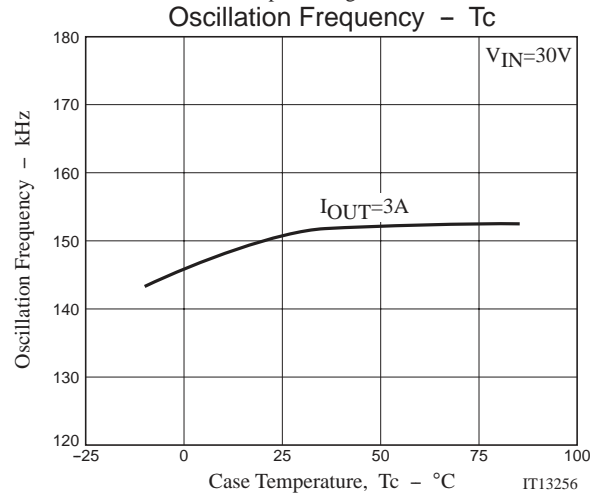
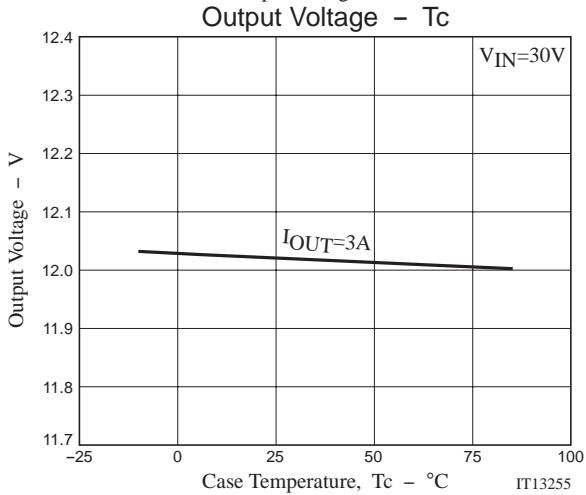
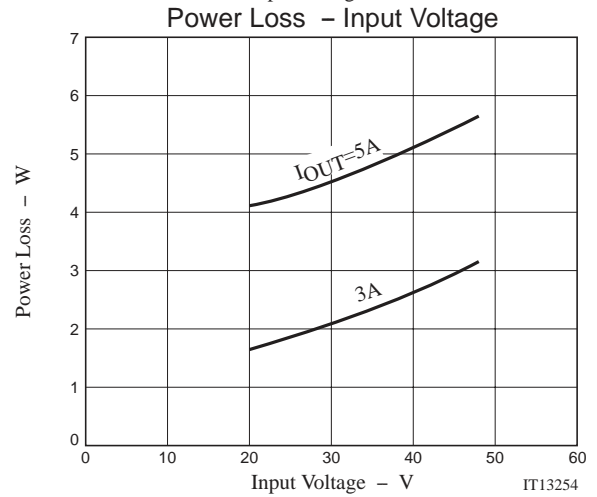
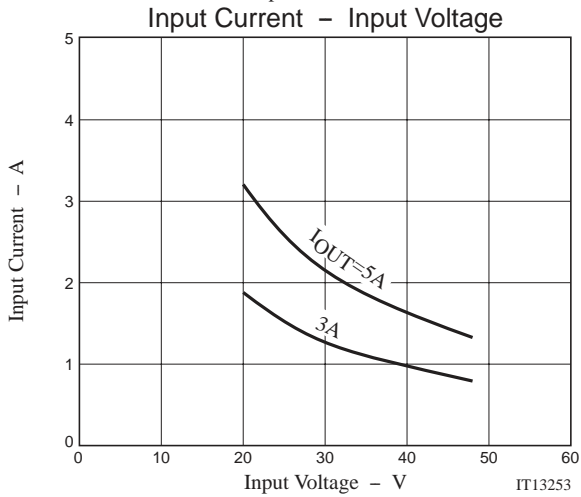
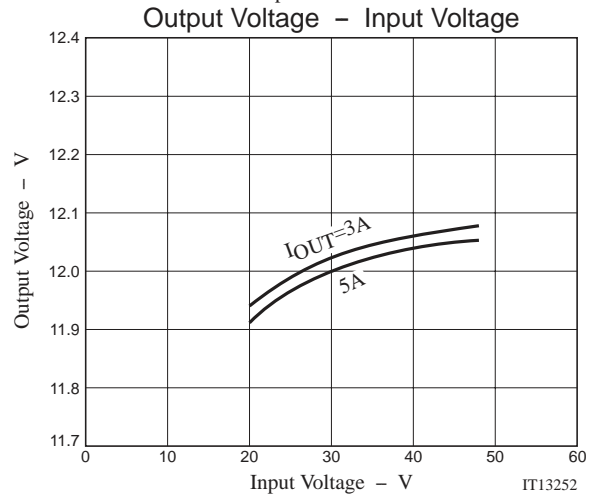
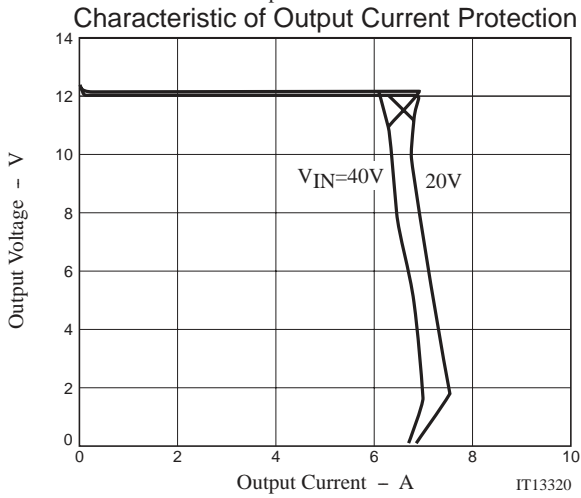
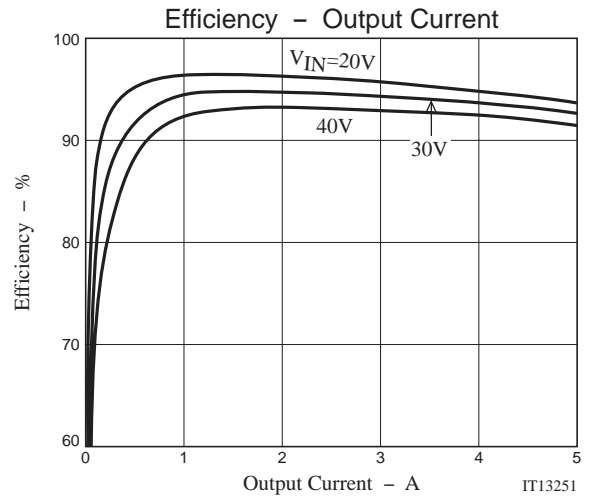
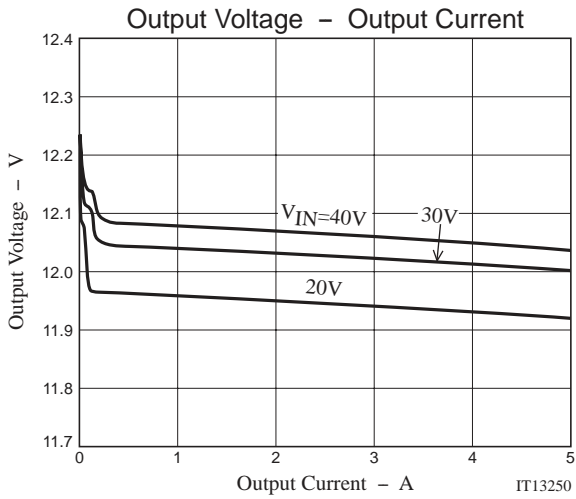
TO-220FI5H-HB Specification Silk Printing (Top View)



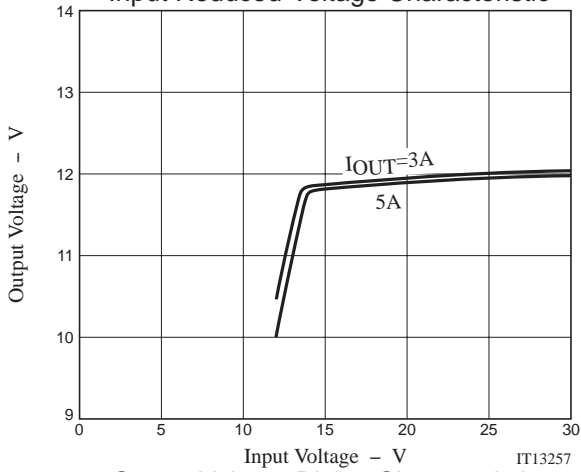
TO-220FI5H-HB Specification Pattern (Perspective View)



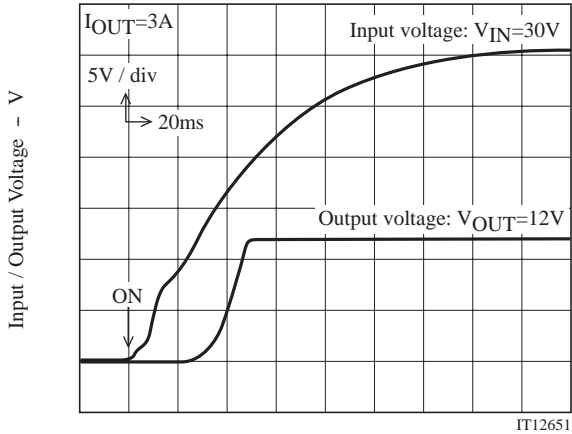
# TN5D51A



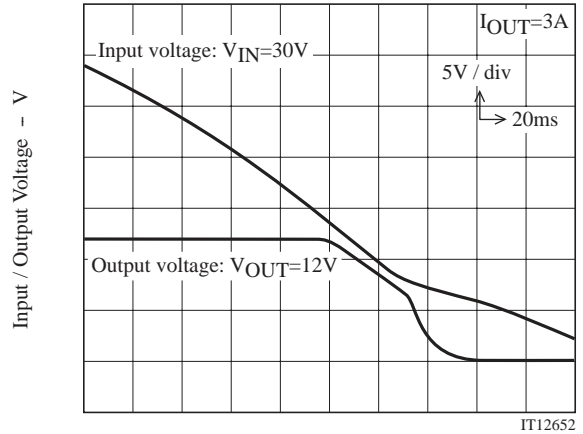
Input Reduced-Voltage Characteristic



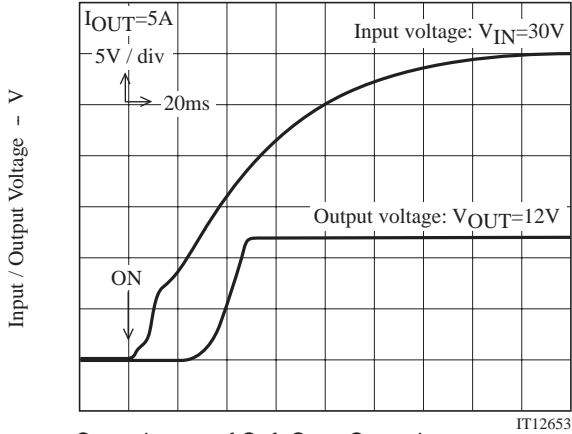
Output Voltage Rising Characteristic



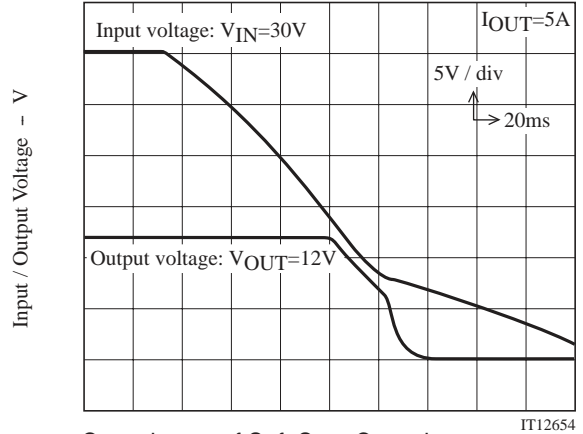
Output Voltage Falling Characteristic



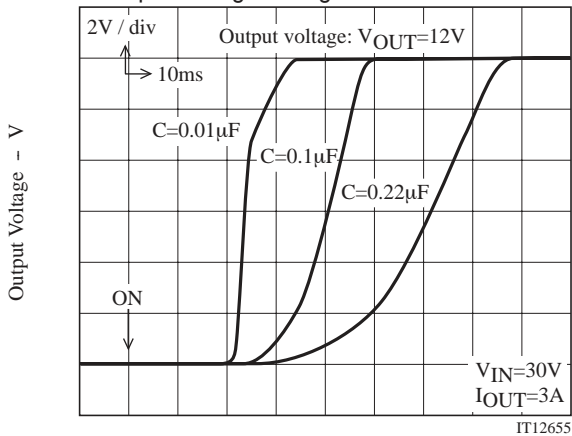
Output Voltage Rising Characteristic



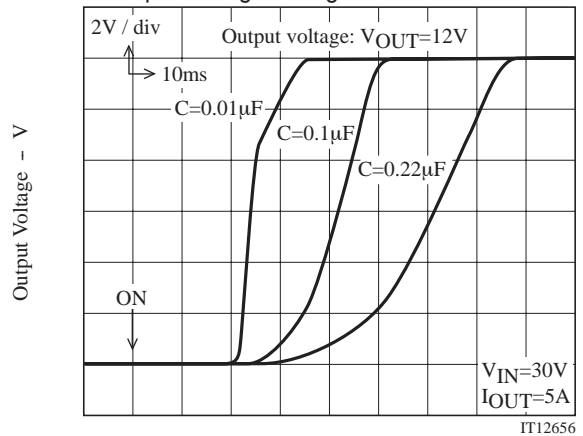
Output Voltage Falling Characteristic



Capacitance of Soft Start Capacitor - Output Voltage Rising Characteristic



Capacitance of Soft Start Capacitor - Output Voltage Rising Characteristic





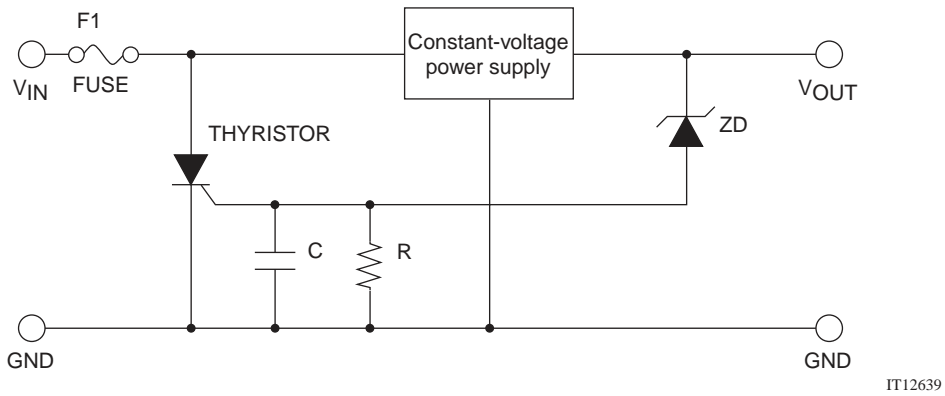
## Example of Over-voltage Protection Circuit.

Generally, in constant-voltage power supply circuit, output voltage will become higher than the specified value (over-voltage state) in case of any failures or PC board solderability defects. To minimize the damage caused by this over voltage, we recommend setting an over-voltage protection circuit.

In designing, the following confirmations are necessary in actual circuit.

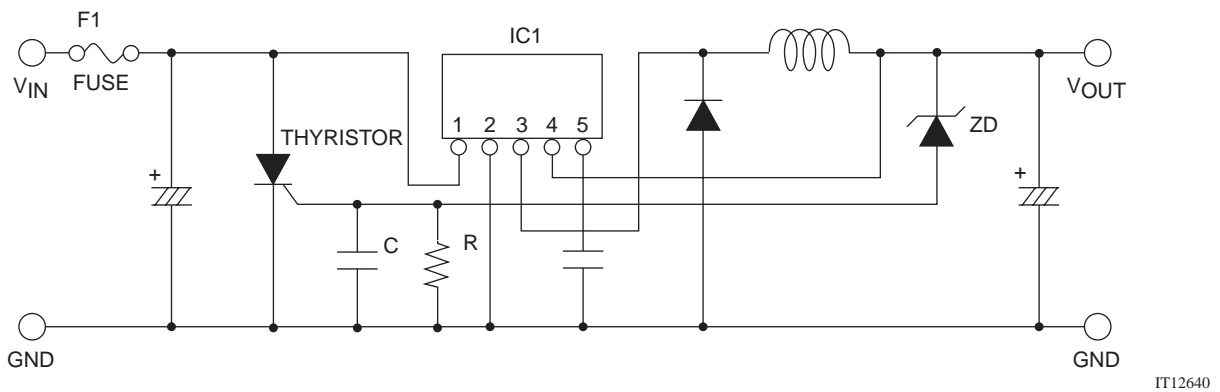
- 1) How the over-voltage protection circuit operates and its effects.
- 2) Is there any malfunction due to ambient temperature change of each device or exogenous noises?

Over-voltage Protection Circuit Example



## Example of Over-voltage Protection Circuit

The thyristor will operate when it accept an over-voltage ( $V_{OUT}$ ) signal, then the fuse is melted and the input power is cut off, then the operation of IC1 is stopped.



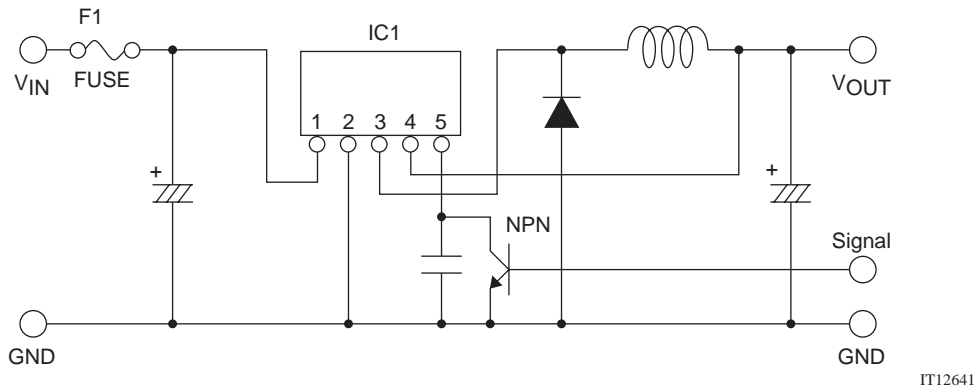
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SS terminal (5 pin) also acts as standby mode switch. By setting SS terminal (5 pin) voltage to be equal or less than  $0.3V_{typ}$ , the output ON/OFF is able to be controlled by external signals.

ON/OFF Control Circuit Example



In addition, confirmation of the following points is necessary in actual circuit.

- 1) How the output ON/OFF control operates and its effects.
- 2) Is there any malfunction due to the ambient temperature change of each device or exogenous noises?

### Points to Remember in Pattern Designing

- 1) Transient large current flows to  $V_{IN}$  terminal (1 pin), so we recommend the input capacitor should be  $3000\mu F$  and above. In addition, (+) (-) terminals of the input capacitor should be set near to  $V_{IN}$  terminal (1 pin) and GND terminal (2 pin).
  - 2) Large current flows to C1A to C,  $V_{IN}$  terminal (1 pin) of IC1, SWOUT terminal (3 pin), D1, L1, and C2A. So, the wiring should be thick and short.
  - 3) FB terminal (4 pin) of IC1 is the feedback terminal from output voltage. It should be near to the output capacitor C2A.
- For the purpose of ensuring the stability of oscillation, a capacitor should be inserted between SS terminal (5 pin) and GND terminal (2 pin).
  - The absolute maximum rated voltage of SS terminal (5 pin) is 7V. The absolute maximum rated voltage of FB terminal (4 pin) is within the range of 5 to 30V according to the output voltage type. When a voltage equal or higher than the rated value is applied to SS terminal (5 pin) or FB terminal (4 pin) in some cases such as abnormal test, protection measures like inserting fuses should be taken.
  - The built-in over-heat protection is a function to prevent the circuit from overheat state caused by transient temperature rise, but not a function to prevent from abnormal caused by a sudden heat generation. In addition, the reliability of over-heat protection function is guarantee.

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