



SANYO Semiconductors

## DATA SHEET

ExPD (Excellent-Performance Power &amp; RF Device)

TN5D01A

# Separately-Excited Step-Down Switching Regulator (Variable 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 <sub>≤</sub> 10μs, duty cycle <sub>≤</sub> 1%	-36	A
FB Pin Maximum Input Voltage	V <sub>fb</sub>		5	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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## Recommended Operating Conditions

Parameter	Symbol	Conditions	Ratings	Unit
Input Voltage	$V_{IN}$	$T_a=25^{\circ}\text{C}$	10 to 30	V
Output Voltage	$V_{OUT}$	$T_a=25^{\circ}\text{C}$ , $V_{OUT} / V_{IN} \geq 0.1$	2.7 to 4.9	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 ( $V_{OUT}=3.3\text{V}$ )

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Reference Voltage	$V_{FB}$	$V_{IN}=20\text{V}$ , $I_{OUT}=3\text{A}$	1.12	1.15	1.18	V
Efficiency	$\eta$	$V_{IN}=20\text{V}$ , $I_{OUT}=3\text{A}$		82		%
Drain-to-Source Breakdown Voltage of built-in MOSFET	$V_{(BR)DSS}$	$I_D=-1\text{mA}$ , $V_{IN}$ , 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	$V_{IN}=20\text{V}$ , $I_{OUT}=3\text{A}$	120	150	180	kHz
Maximum Duty	Duty max	$V_{IN}=20\text{V}$ , $V_{fb}=0\text{V}$	88	92	96	%
Line Regulation	$\Delta V_{line}$	$V_{IN}=10$ to 30V, $I_{OUT}=3\text{A}$		30	60	mV
Load Regulation	$\Delta V_{load}$	$V_{IN}=20\text{V}$ , $I_{OUT}=0.5$ to 5A		35	60	mV
Output Voltage Temperature Coefficient *1	$\Delta V_O/\Delta T_a$	$V_{IN}=20\text{V}$ , $I_{OUT}=3\text{A}$ , $T_a=-25$ to $125^{\circ}\text{C}$		$\pm 0.33$		$\text{mV} / ^{\circ}\text{C}$
Over-Current-Protection-Operation -Threshold Current	$I_{ocp}$	$V_{IN}=20\text{V}$	5.1	7.5	10	A
Under-Voltage-Protection-Operation -Threshold Voltage	$V_{uvlo\ on}$		7.2	8.0	8.8	V
Under-Voltage-Protection-Operation -Release Voltage	$V_{uvlo\ off}$		8.1	9.0	9.9	V
Under-Voltage-Protection Hysteresis Voltage	$V_{uvlo\ hys}$			1.0		V
Over-Temperature-Protection-Operation -Threshold-Temperature *1	$T_{tsd\ on}$			165		$^{\circ}\text{C}$
Over-Temperature-Protection-Operation -Release Temperature *1	$T_{tsd\ off}$			140		$^{\circ}\text{C}$
Over-Temperature-Protection-Operation -Hysteresis Temperature *1	$T_{tsd\ hys}$			25		$^{\circ}\text{C}$
SS Terminal Current	$I_{SS}$	$V_{IN}=20\text{V}$		10		$\mu\text{A}$
Standby Operating Voltage	$V_{stb\ on}$	$V_{IN}=20\text{V}$		0.3		V
Standby Current	$I_{stb}$	$V_{IN}=20\text{V}$ , $V_{SS}=0\text{V}$			500	$\mu\text{A}$

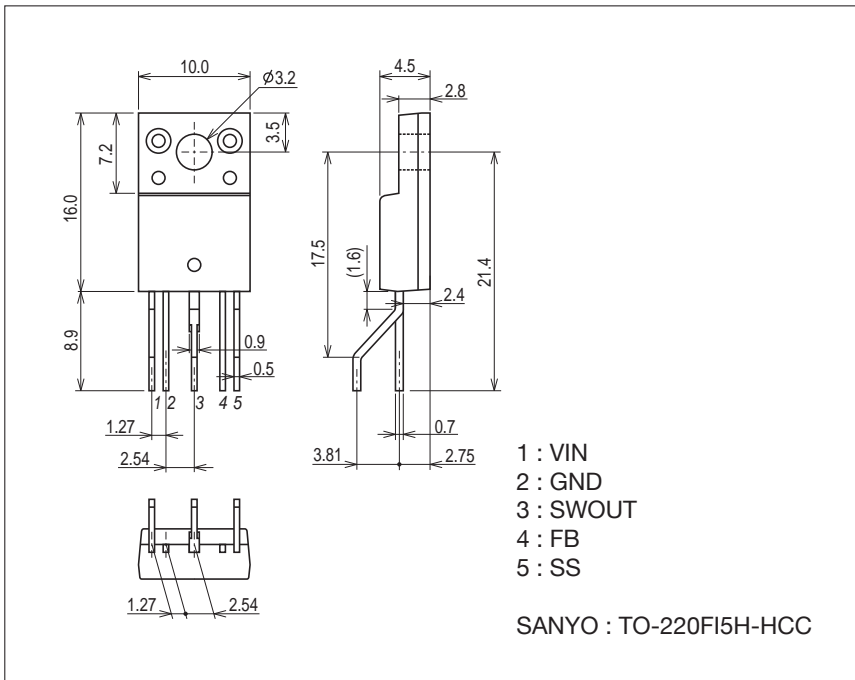
Note: the values with “\*1” are our targeted values, but not guaranteed.

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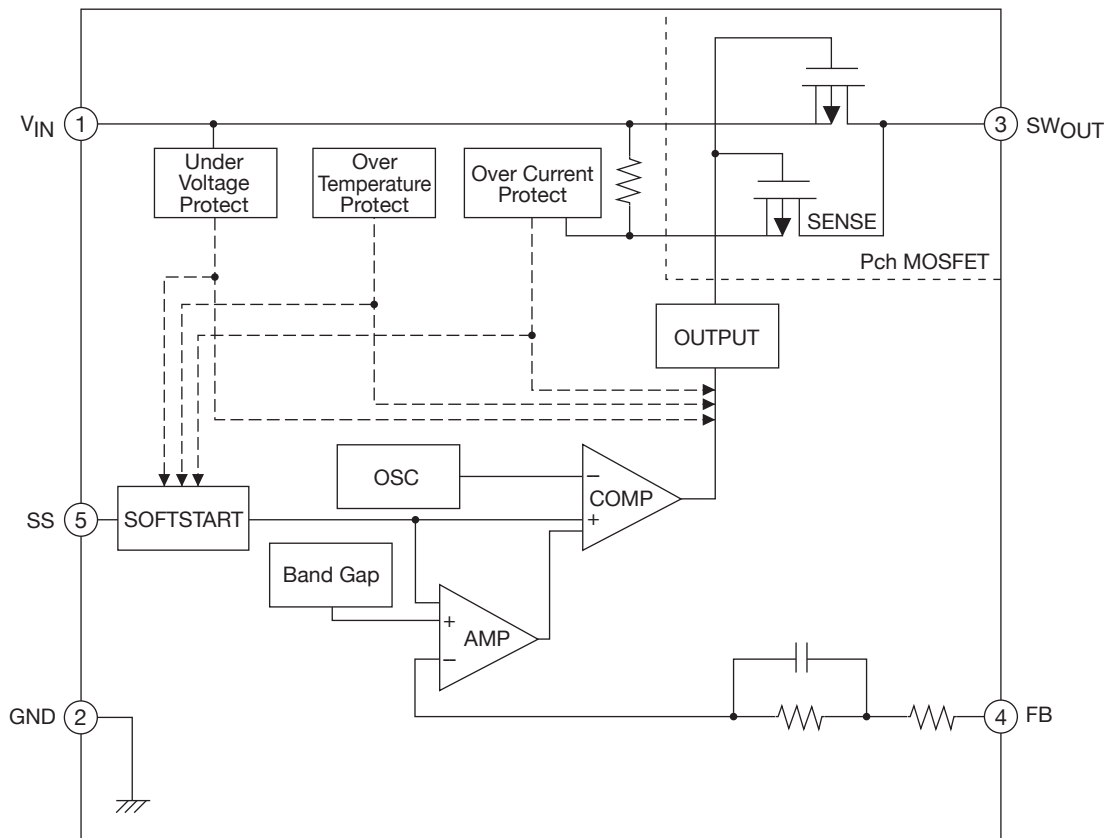
## Package Dimensions

unit : mm (typ)

7531-001



## Block Diagram

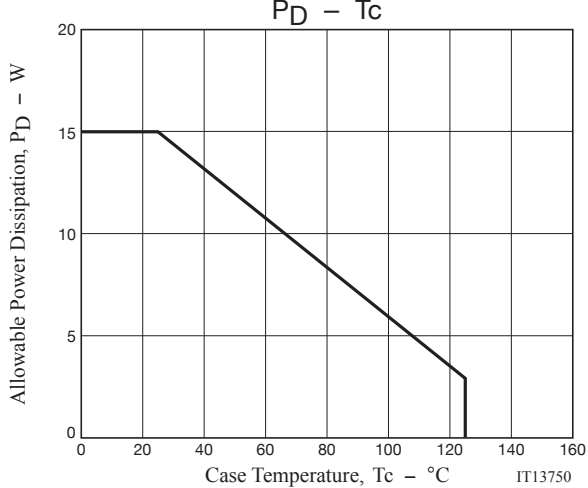
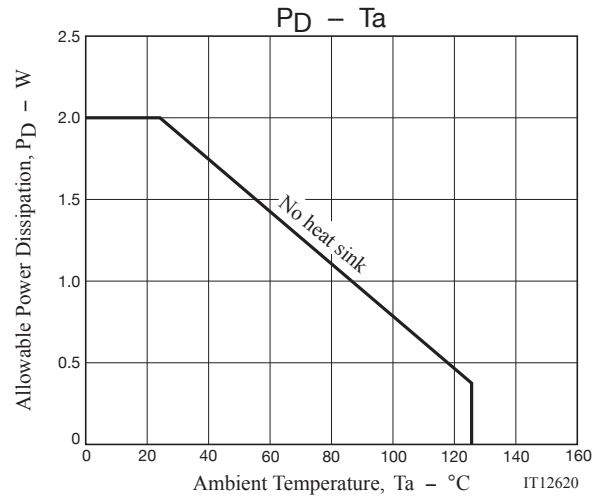
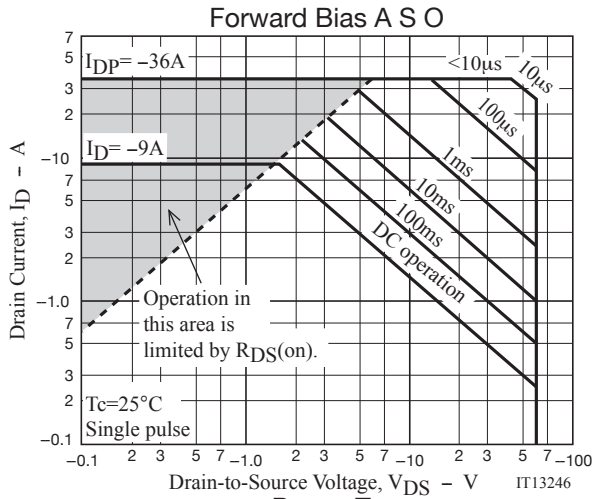
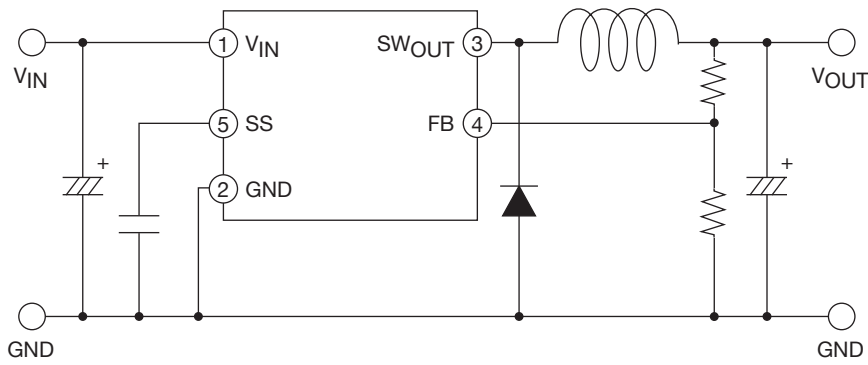


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## Pin Functions

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

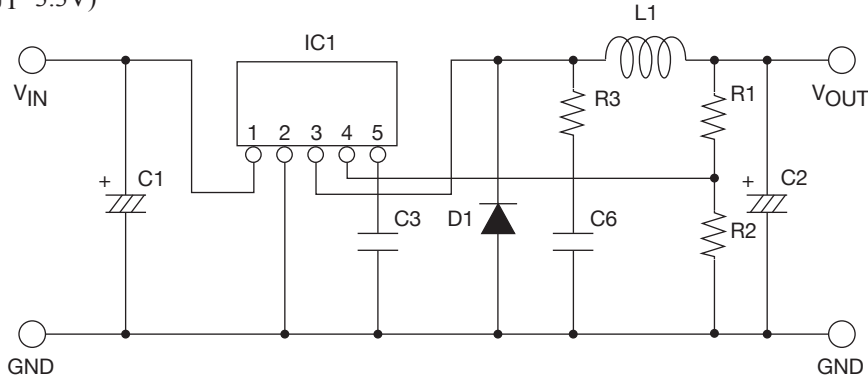
## Application Circuit Example



# TN5D01A

## Specified Circuit for Electrical Characteristics

[Circuit] ( $V_{OUT}=3.3V$ )



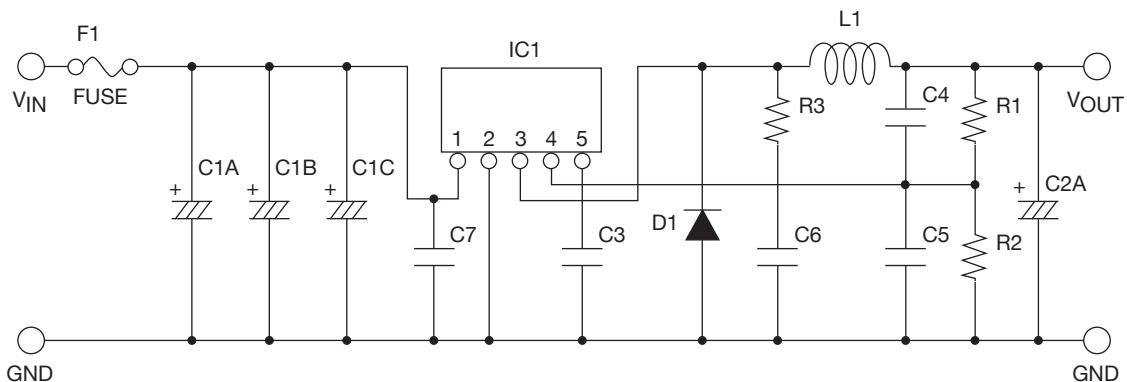
[Components] ( $V_{OUT}=3.3V$ )

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
R1	Carbon Resistor	1.8k $\Omega$ /1/2W
R2	Carbon Resistor	1k $\Omega$ /1/2W
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.

## Evaluation Board

[Circuit] ( $V_{OUT}=3.3V$ )



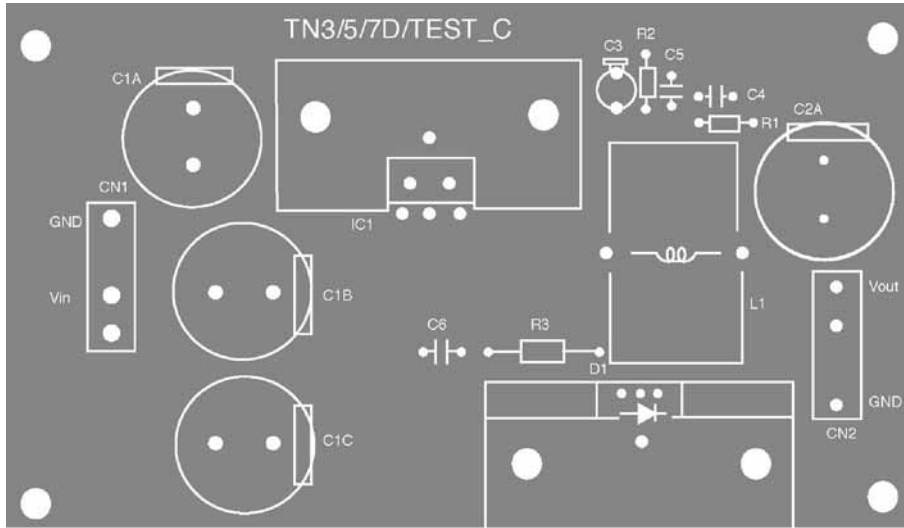
[Components]

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/80V	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.	
C7	Ceramic Capacitor	47000pF	Murata Manufacturing Co., Ltd.	
R1	Carbon Resistor	1.8k $\Omega$ /1/2W	Matsushita Electronic Components Corp.	
R2	Carbon Resistor	1k $\Omega$ /1/2W	Matsushita Electronic Components Corp.	
R3	Metal Oxide Film Resistor	22 $\Omega$ /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.	

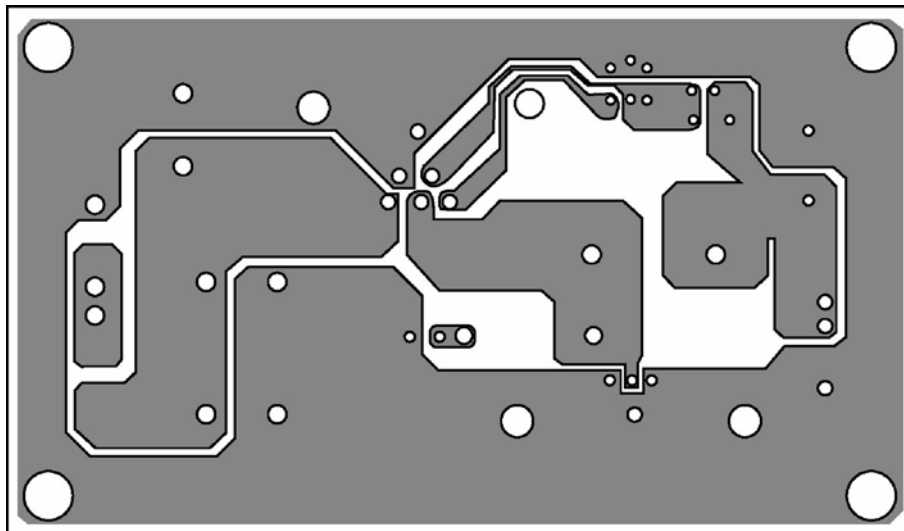
# TN5D01A

## Recommended PCB Pattern

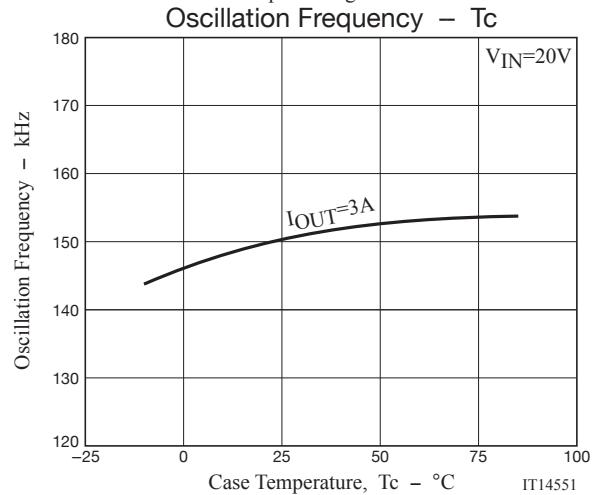
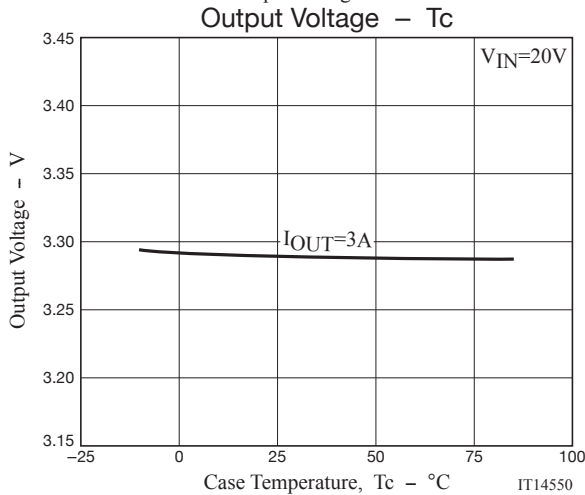
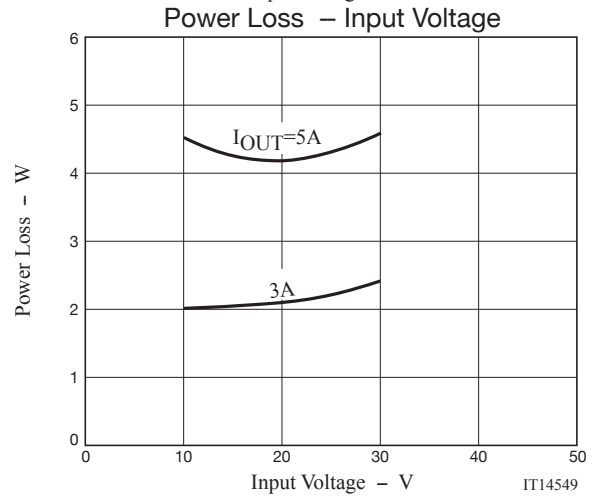
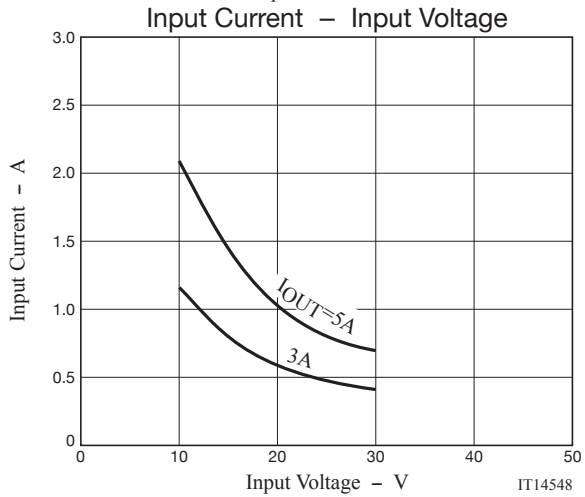
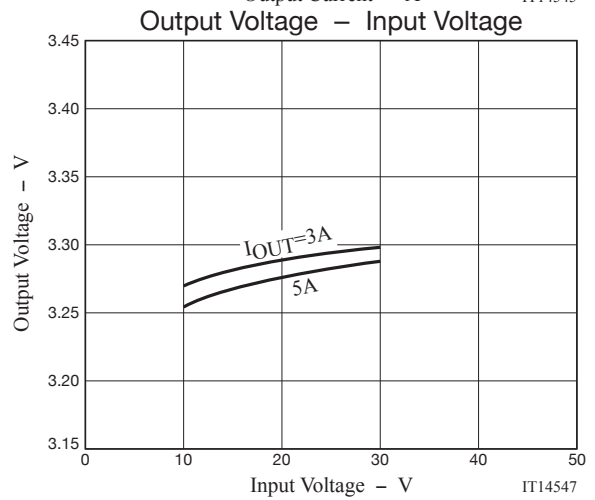
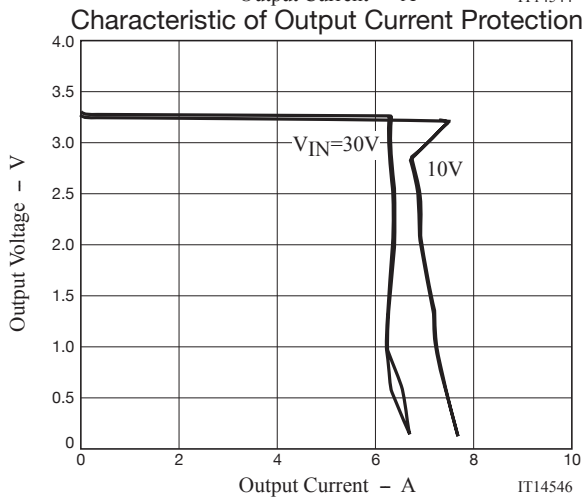
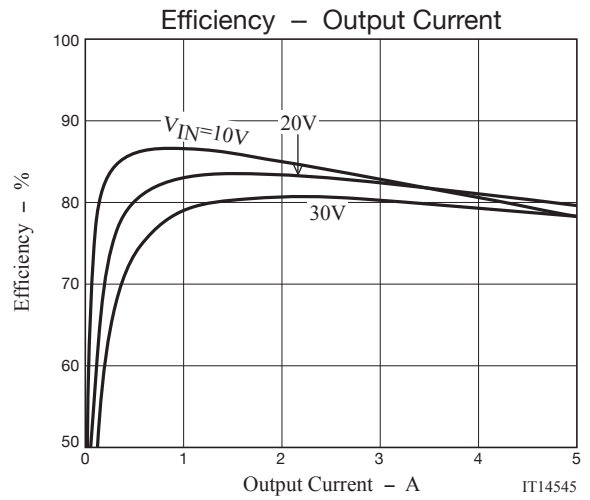
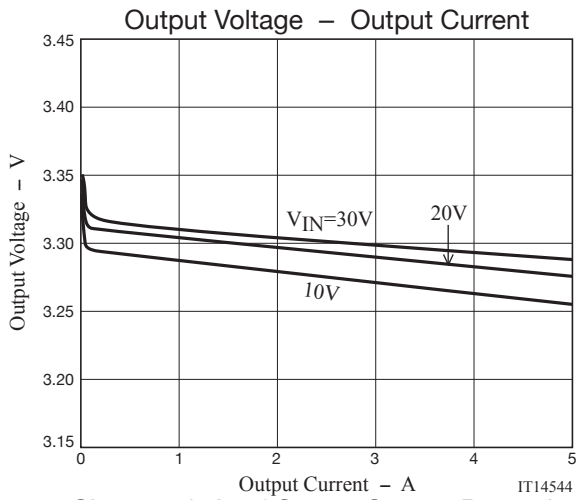
Silk Printing (Top View)



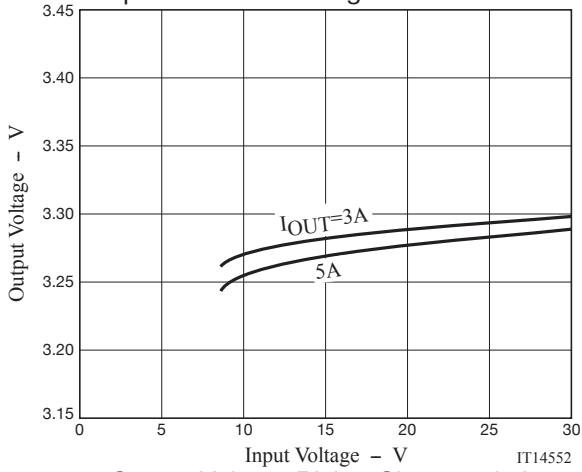
Pattern (Perspective View)



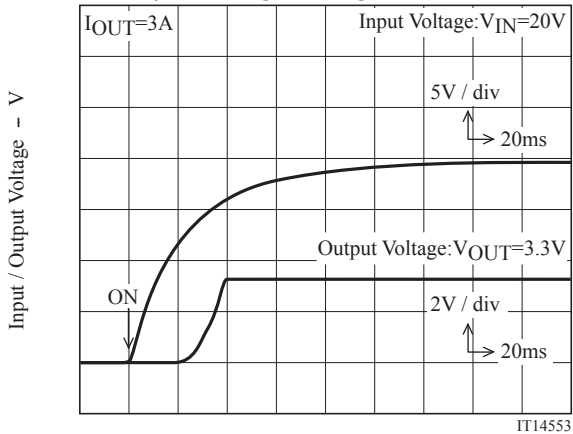
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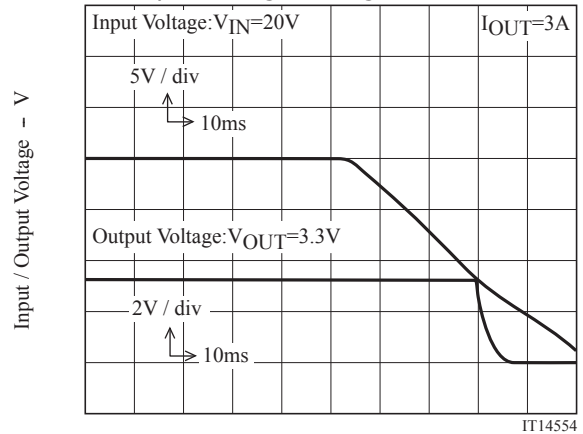
Input Reduced-Voltage Characteristic



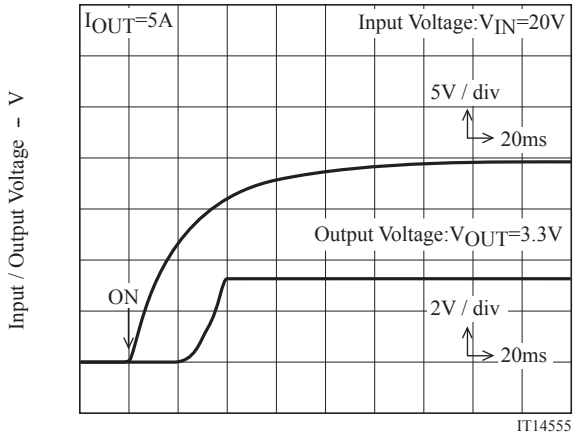
Output Voltage Rising Characteristic



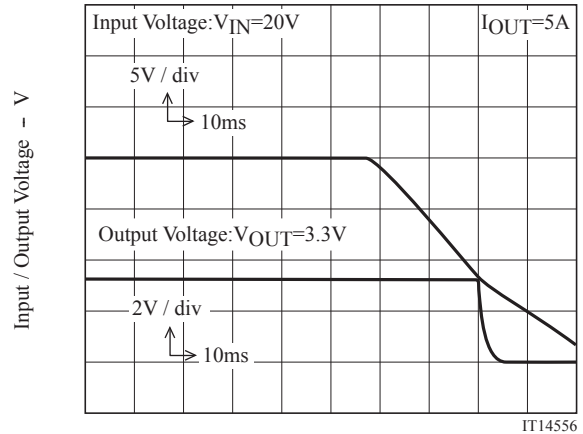
Output Voltage Falling Characteristic



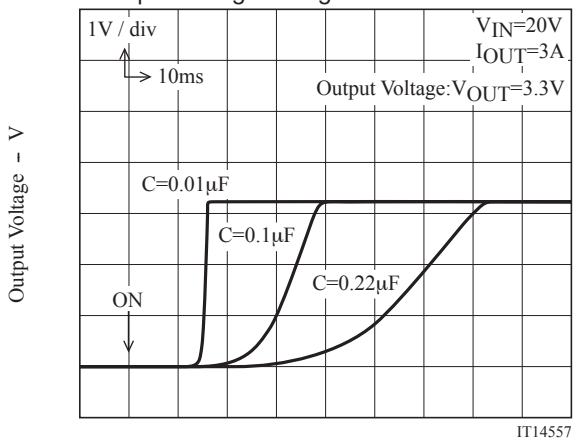
Output Voltage Rising Characteristic



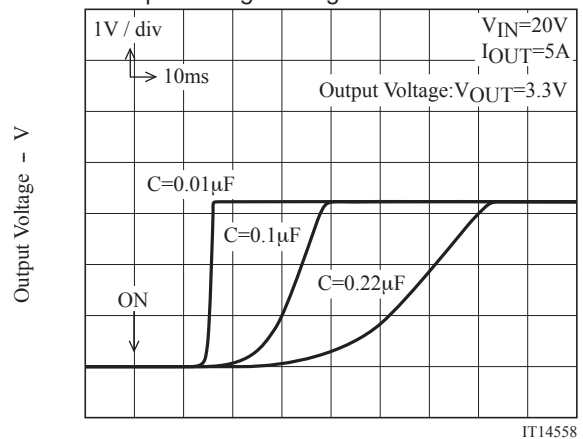
Output Voltage Falling Characteristic



Capacitance of Soft Start Capacitor - Output Voltage Rising Characteristic



Capacitance of Soft Start Capacitor - Output Voltage Rising Characteristic





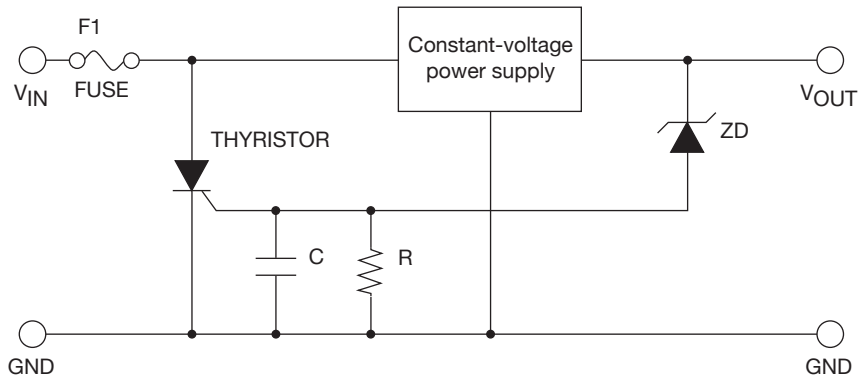
**Example of Over-voltage Protection Circuit.**

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.

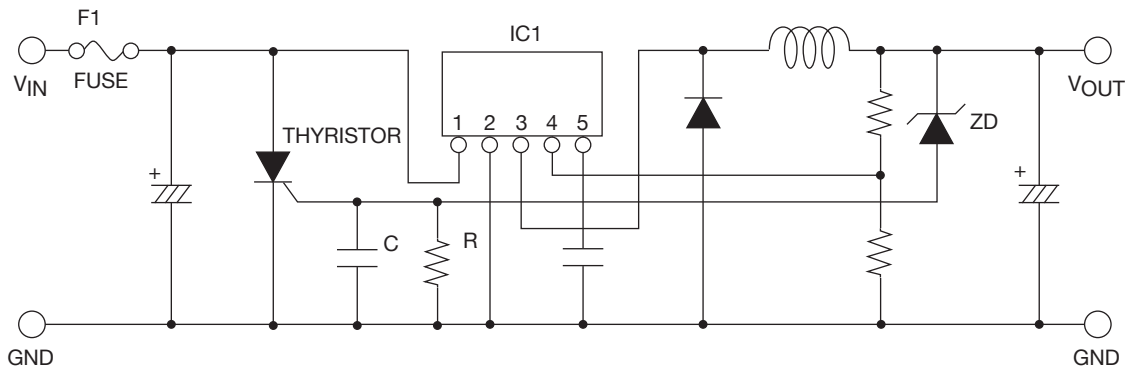
- 1) How the over-voltage protection circuit operates and its effects.
- 2) Is there any malfunction due to ambient temperature change of each device or exogenous noises?

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.

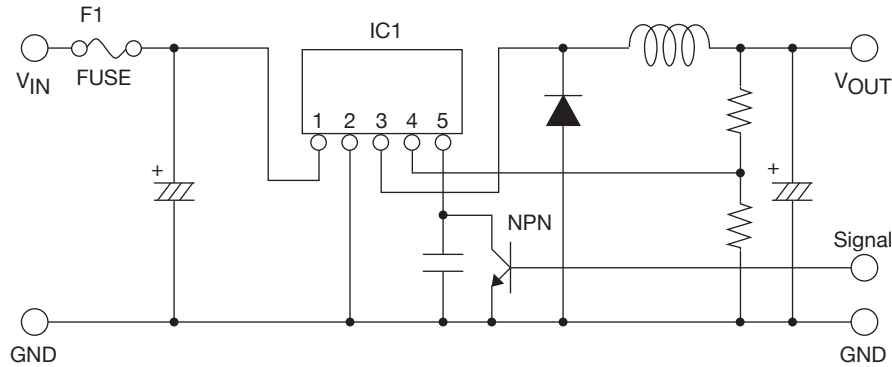


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SS terminal (5 pin) also acts as standby mode switch. By setting SS terminal (5 pin) voltage to be equal or less than  $0.3V_{typ}$ , the output ON/OFF is able to be controlled by external signals.

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 a 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 not guarantee.

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