



# SANYO Semiconductors

## DATA SHEET

# 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    |
|                                            |                     | Tc=25°C                | 15          | W    |
| Operating Temperature                      | Topr                |                        | -25 to +125 | °C   |
| Junction Temperature                       | T <sub>J</sub>      |                        | 150         | °C   |
| Storage Temperature                        | T <sub>stg</sub>    |                        | -55 to +150 | °C   |

■ Any and all SANYO Semiconductor Co.,Ltd. products described or contained herein are, with regard to "standard application", intended for the use as general electronics equipment (home appliances, AV equipment, communication device, office equipment, industrial equipment etc.). The products mentioned herein shall not be intended for use for any "special application" (medical equipment whose purpose is to sustain life, aerospace instrument, nuclear control device, burning appliances, transportation machine, traffic signal system, safety equipment etc.) that shall require extremely high level of reliability and can directly threaten human lives in case of failure or malfunction of the product or may cause harm to human bodies, nor shall they grant any guarantee thereof. If you should intend to use our products for applications outside the standard applications of our customer who is considering such use and/or outside the scope of our intended standard applications, please consult with us prior to the intended use. If there is no consultation or inquiry before the intended use, our customer shall be solely responsible for the use.

■ Specifications of any and all SANYO Semiconductor Co.,Ltd. products described or contained herein stipulate the performance, characteristics, and functions of the described products in the independent state, and are not guarantees of the performance, characteristics, and functions of the described products as mounted in the customer's products or equipment. To verify symptoms and states that cannot be evaluated in an independent device, the customer should always evaluate and test devices mounted in the customer's products or equipment.

**SANYO Semiconductor Co., Ltd.**

TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110-8534 JAPAN

# 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 | $T_{opr\ rec}$ |                          | -10 to +85 | $^{\circ}\text{C}$ |

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

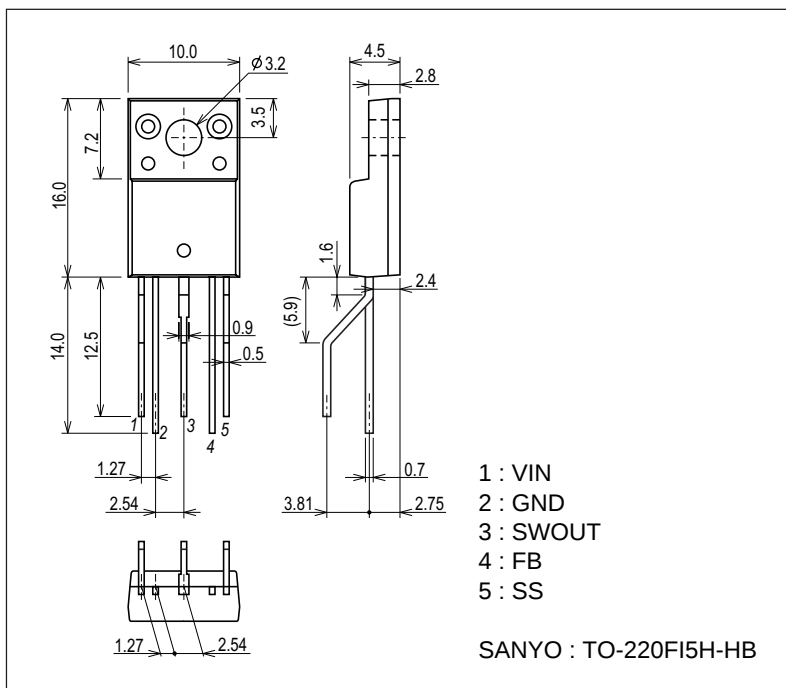
| Parameter                                                     | Symbol                    | Conditions                                                                        | Ratings |           |      | Unit                           |
|---------------------------------------------------------------|---------------------------|-----------------------------------------------------------------------------------|---------|-----------|------|--------------------------------|
|                                                               |                           |                                                                                   | 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          | $V_{(BR)DSS}$             | $I_D=-1\text{mA}$ , $V_{IN}$ , 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                                               | $\Delta V_{line}$         | $V_{IN}=20$ to $40\text{V}$ , $I_{OUT}=3\text{A}$                                 |         | 130       | 200  | mV                             |
| Load Regulation                                               | $\Delta V_{load}$         | $V_{IN}=30\text{V}$ , $I_{OUT}=0.5$ to $5\text{A}$                                |         | 70        | 100  | mV                             |
| Output Voltage Temperature Coefficient *1                     | $\Delta V_O / \Delta T_a$ | $V_{IN}=30\text{V}$ , $I_{OUT}=3\text{A}$ , $T_a = -25$ 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         | $V_{uvlo\ on}$            |                                                                                   | 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-Current *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 -Hysteresis Temperature *1        | $T_{tsd\ hys}$            |                                                                                   |         | 25        |      | $^{\circ}\text{C}$             |
| SS Terminal Current                                           | $I_{SS}$                  | $V_{IN}=30\text{V}$                                                               |         | 10        |      | $\mu\text{A}$                  |
| Standby Operating Voltage                                     | $V_{stb\ on}$             | $V_{IN}=30\text{V}$                                                               |         | 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 "\*" are our targeted values, but not guaranteed.

## Package Dimensions

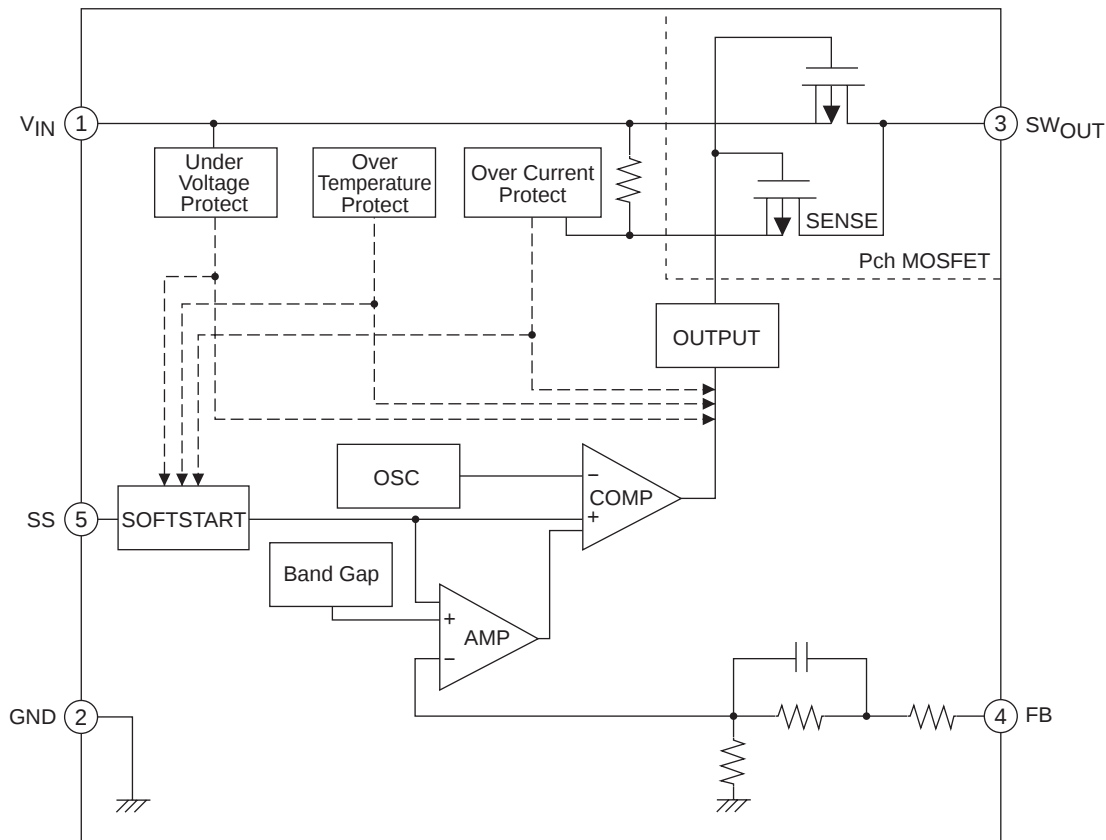
unit : mm (typ)

7527-001



# TN5D51A

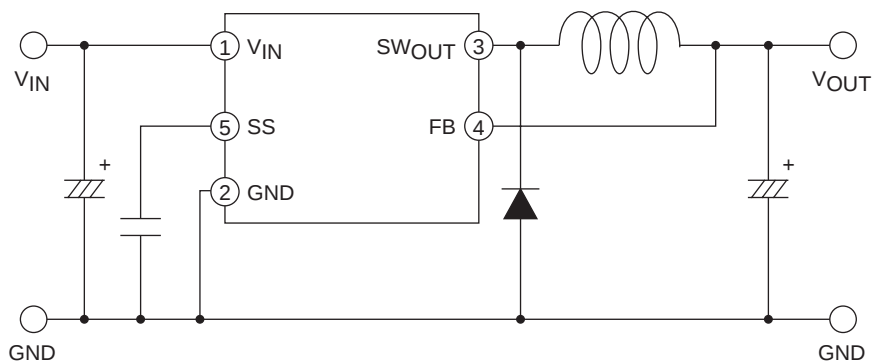
## Block Diagram

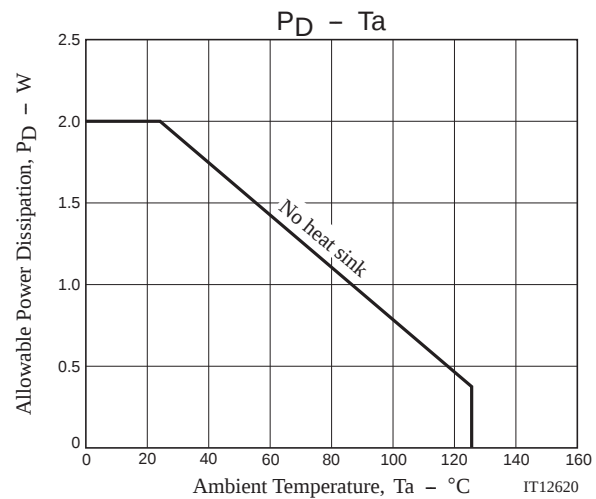
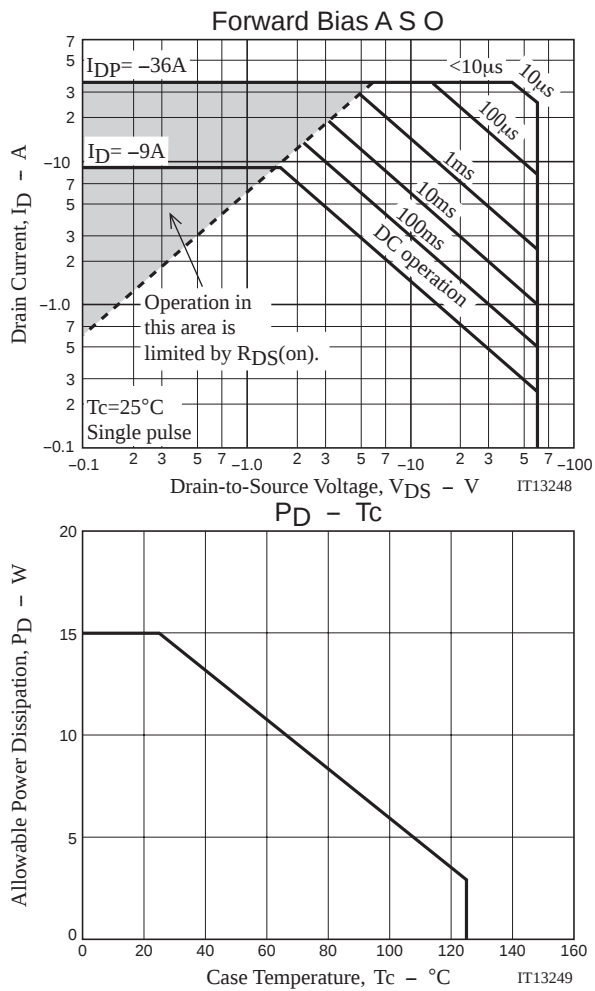


## Pin Functions

| Pin No. | Symbol     | Function                                                       |
|---------|------------|----------------------------------------------------------------|
| 1       | $V_{IN}$   | Power Supply Input (Maximum 57V)                               |
| 2       | GND        | GND                                                            |
| 3       | $SW_{OUT}$ | Pulse Voltage Output                                           |
| 4       | FB         | Feedback from Output Voltage                                   |
| 5       | SS         | For Soft Start Capacitor Connection and Standby Mode Switching |

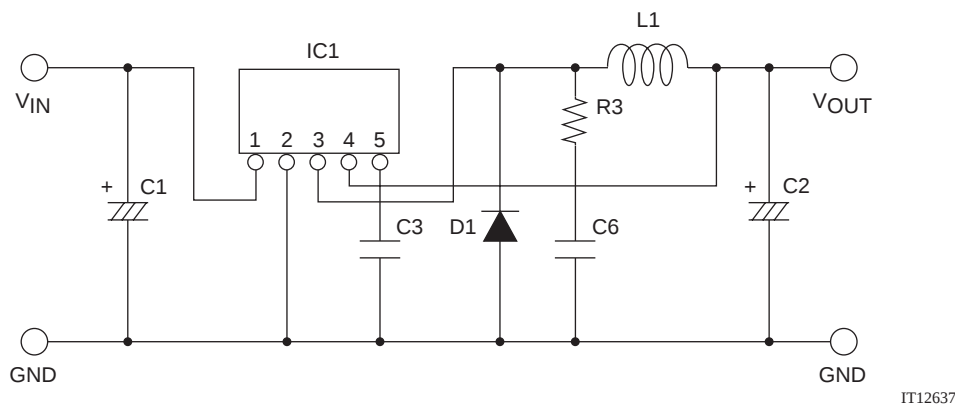
## Application Circuit Example





Specified Circuit for Electrical Characteristics

[Circuit]



[Components]

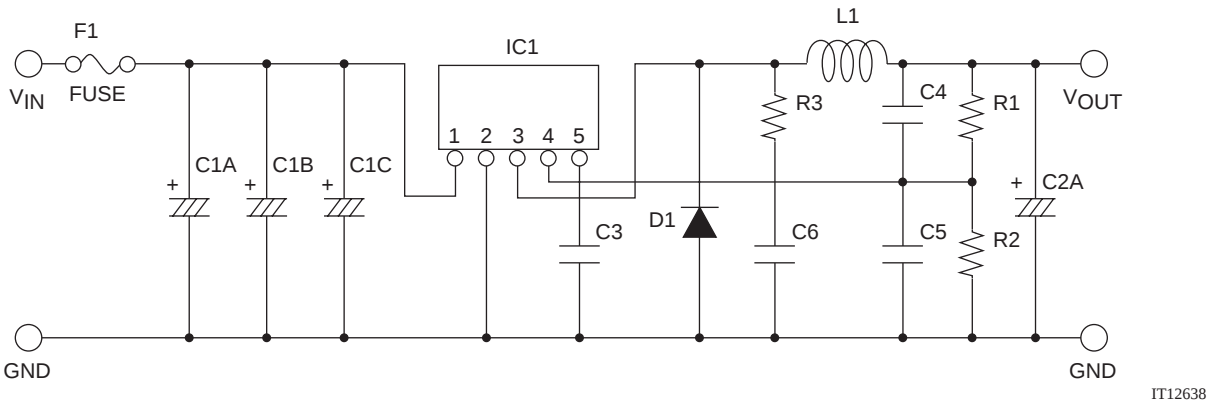
| Symbol | Component                 | Specification        |
|--------|---------------------------|----------------------|
| C1     | Electrolytic Capacitor    | 3000 to 3600 $\mu F$ |
| C2     | Electrolytic Capacitor    | 2000 to 2200 $\mu F$ |
| C3     | Capacitor                 | 0.1 $\mu F$          |
| 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.

TN5D51A

Evaluation Board

[Circuit]

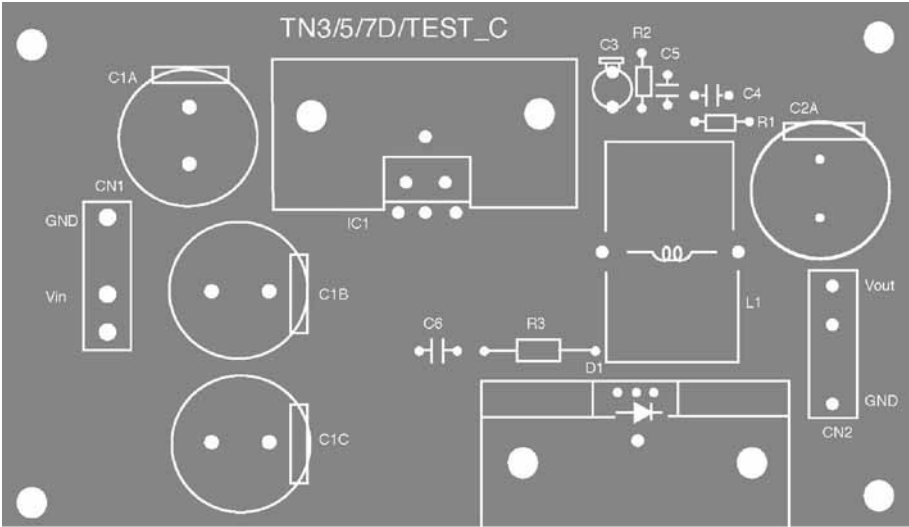


[Components]

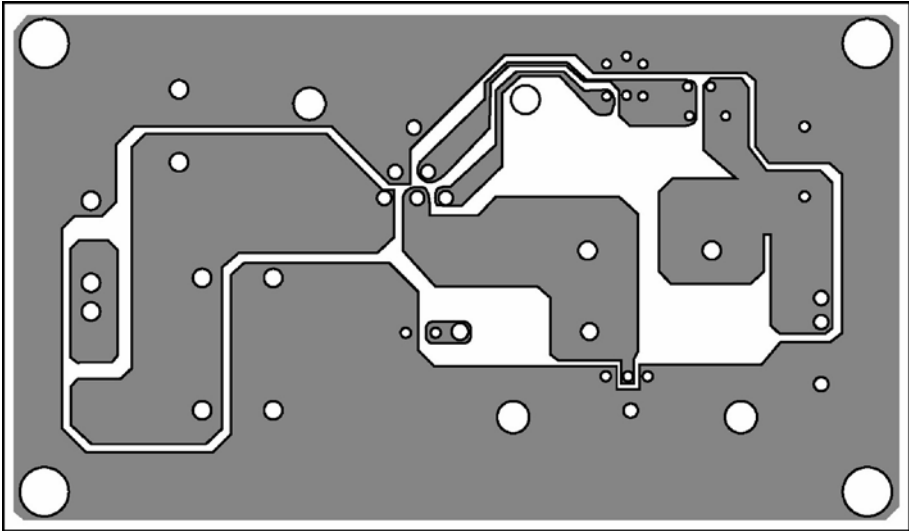
| Symbol | Component                 | Specification      | Maker                                  | Remark      |
|--------|---------------------------|--------------------|----------------------------------------|-------------|
| F1     | Fuse                      | 4A                 | Littelfuse                             | 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.          |             |

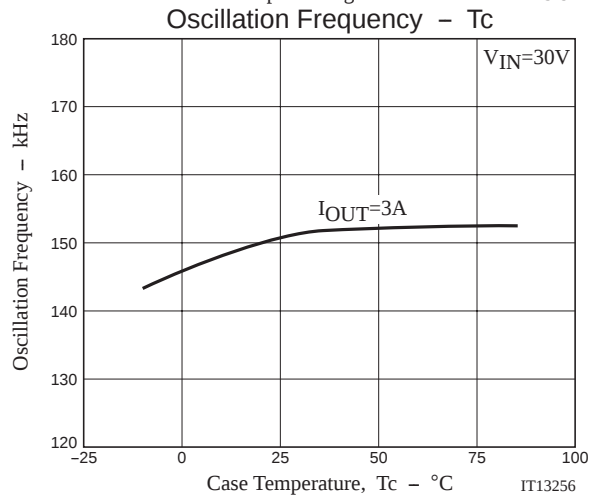
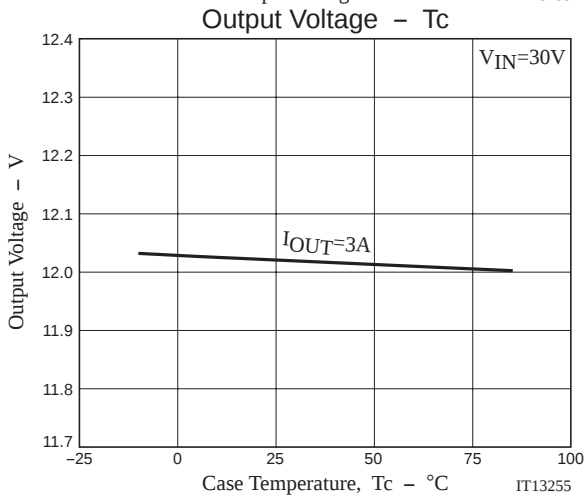
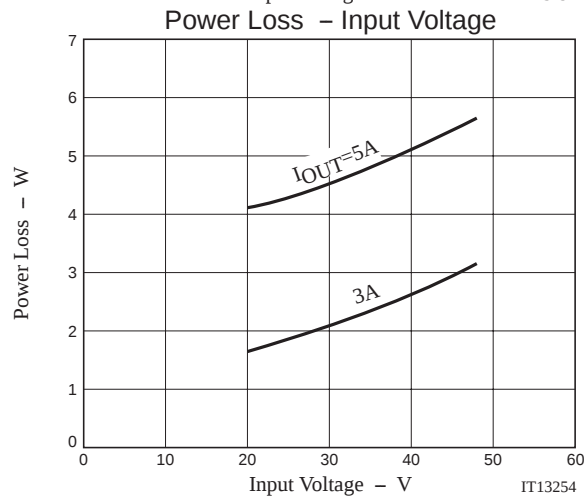
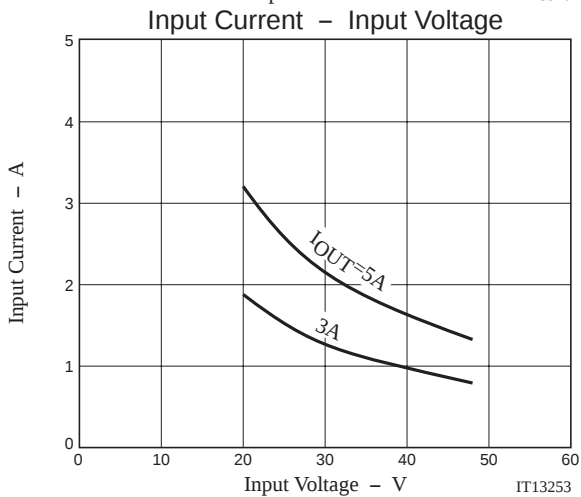
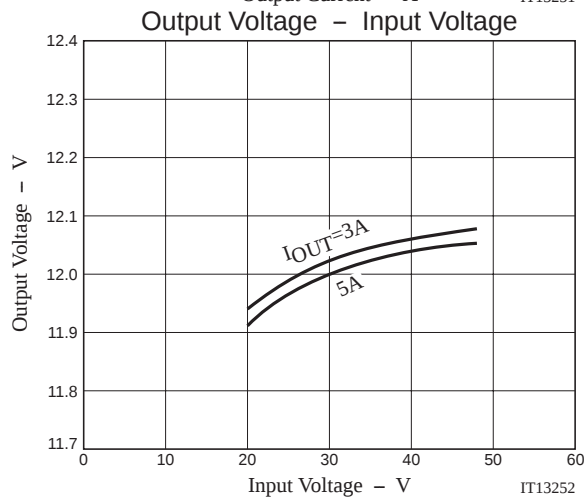
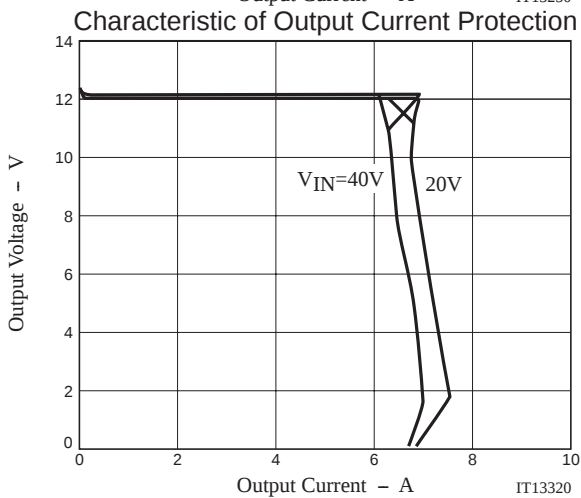
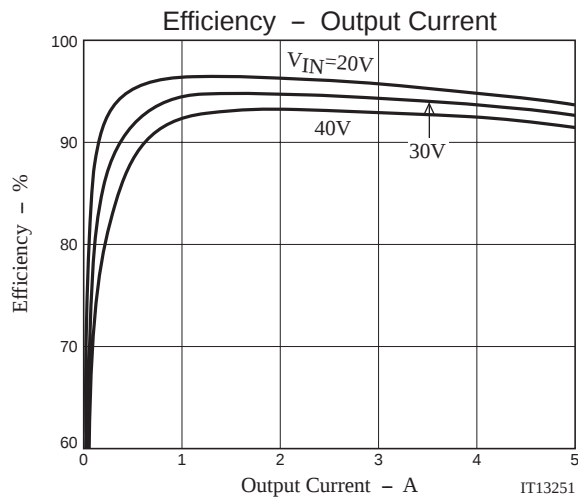
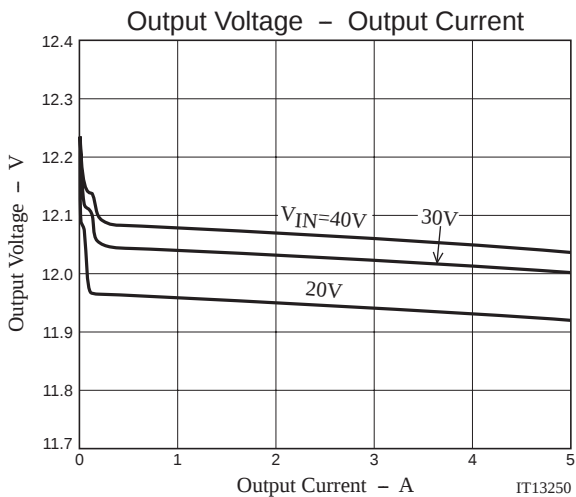
Recommended PCB Pattern

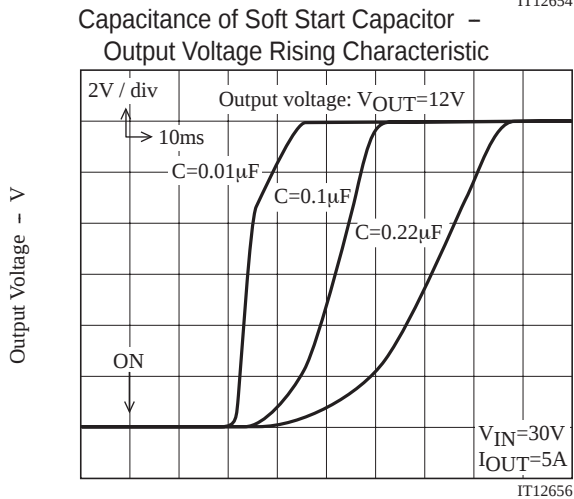
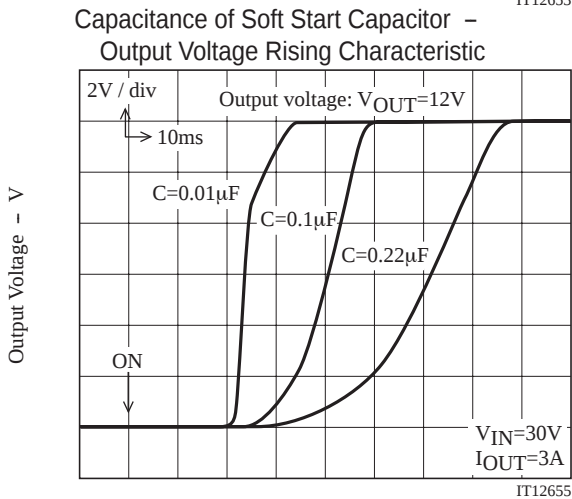
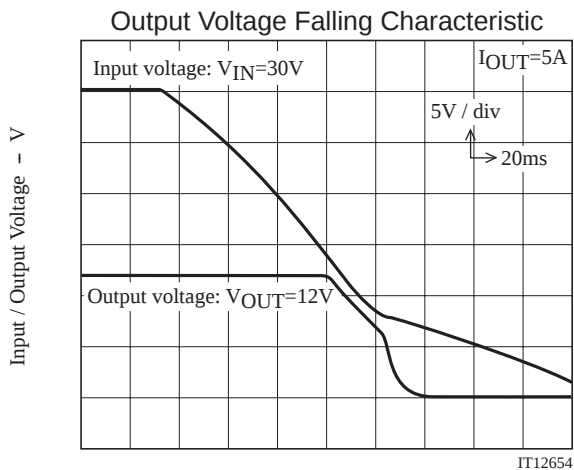
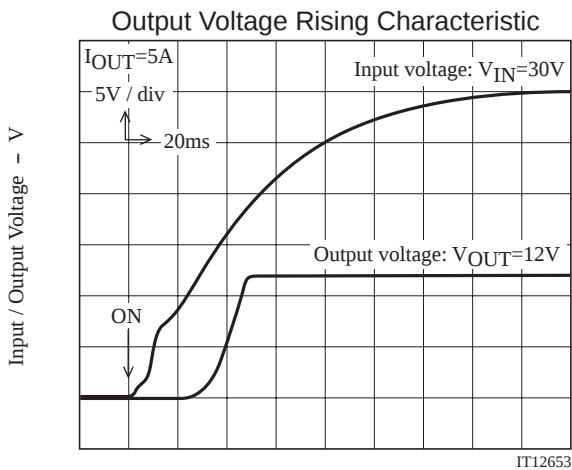
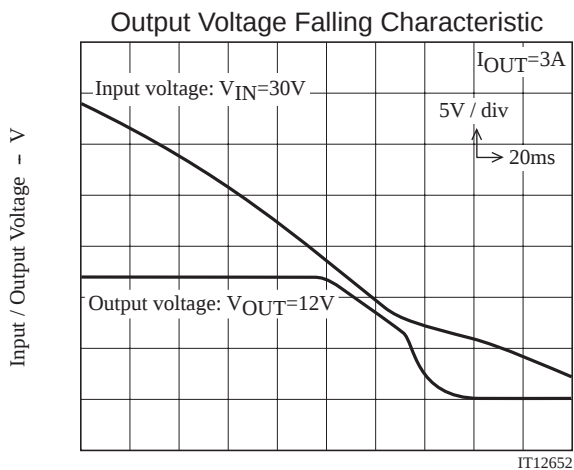
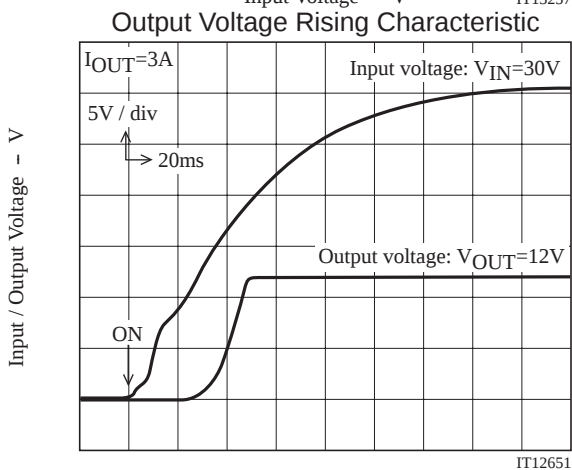
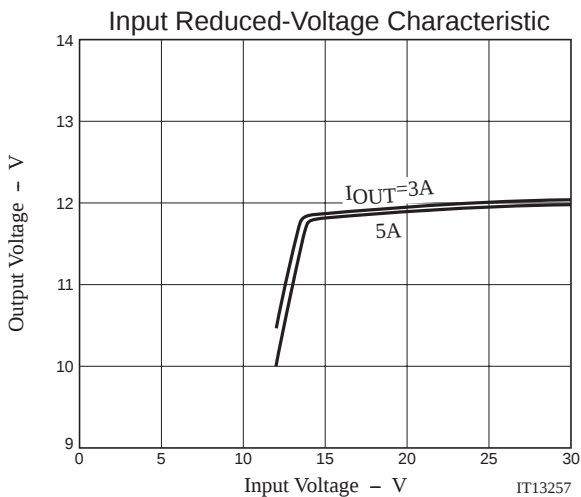
TO-220FI5H-HB Specification Silk Printing (Top View)



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







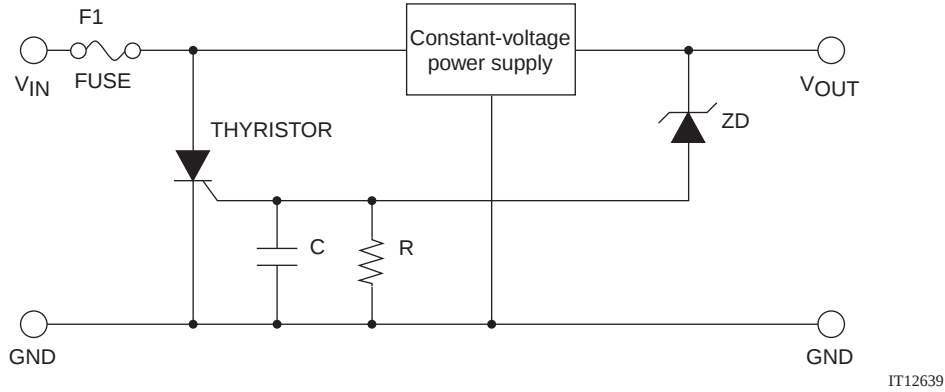
## Example of Over-voltage Protection Circuit.

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.

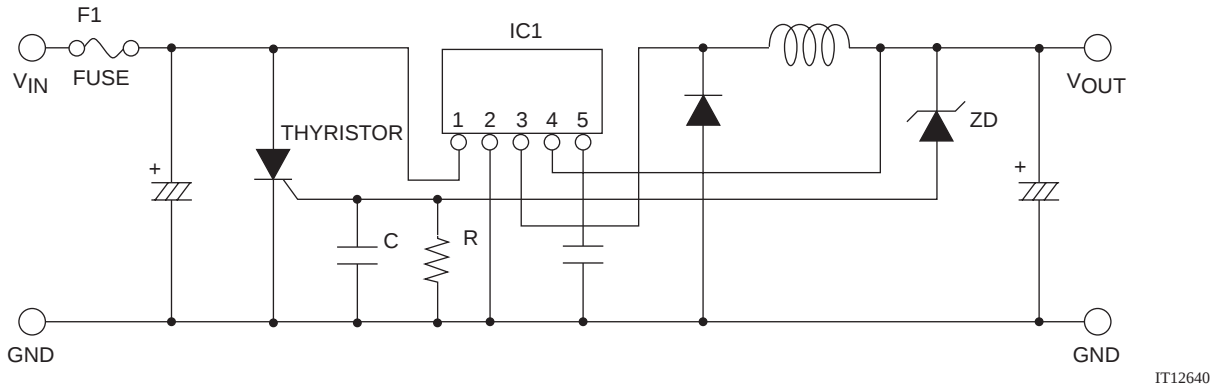
- 1) How the over-voltage protection circuit operates and its effects.
- 2) Is there any malfunction due to ambient temperature change of each device or exogenous noises?

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.

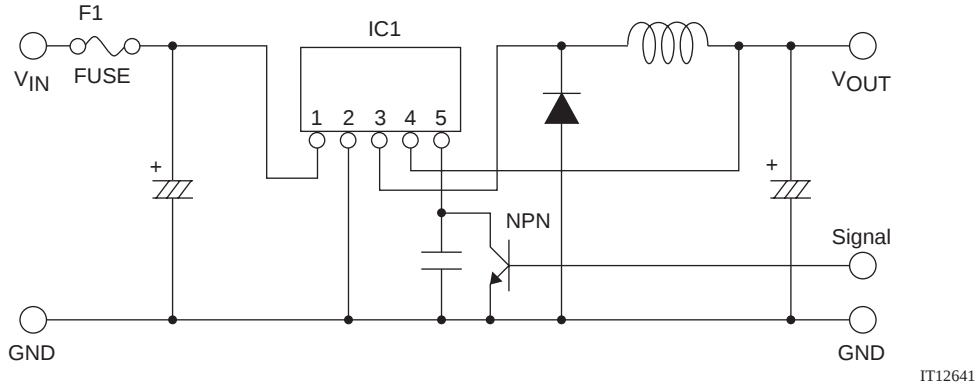


Continued on next page.

Continued from preceding page.

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.

- SANYO Semiconductor Co.,Ltd. assumes no responsibility for equipment failures that result from using products at values that exceed, even momentarily, rated values (such as maximum ratings, operating condition ranges, or other parameters) listed in products specifications of any and all SANYO Semiconductor Co.,Ltd. products described or contained herein.
- SANYO Semiconductor Co.,Ltd. strives to supply high-quality high-reliability products, however, any and all semiconductor products fail or malfunction with some probability. It is possible that these probabilistic failures or malfunction could give rise to accidents or events that could endanger human lives, trouble that could give rise to smoke or fire, or accidents that could cause damage to other property. When designing equipment, adopt safety measures so that these kinds of accidents or events cannot occur. Such measures include but are not limited to protective circuits and error prevention circuits for safe design, redundant design, and structural design.
- In the event that any or all SANYO Semiconductor Co.,Ltd. products described or contained herein are controlled under any of applicable local export control laws and regulations, such products may require the export license from the authorities concerned in accordance with the above law.
- No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, or any information storage or retrieval system, or otherwise, without the prior written consent of SANYO Semiconductor Co.,Ltd.
- Any and all information described or contained herein are subject to change without notice due to product/technology improvement, etc. When designing equipment, refer to the "Delivery Specification" for the SANYO Semiconductor Co.,Ltd. product that you intend to use.
- Information (including circuit diagrams and circuit parameters) herein is for example only; it is not guaranteed for volume production.
- Upon using the technical information or products described herein, neither warranty nor license shall be granted with regard to intellectual property rights or any other rights of SANYO Semiconductor Co.,Ltd. or any third party. SANYO Semiconductor Co.,Ltd. shall not be liable for any claim or suits with regard to a third party's intellectual property rights which has resulted from the use of the technical information and products mentioned above.

This catalog provides information as of February, 2008. Specifications and information herein are subject to change without notice.