

TSI 40 Series are ultra small size, light, and large capacity non-isolated type step-down DC-DC converters, which have ultra high efficiency (93~95%) by using the latest synchronous rectification circuit technology. They can supply 40W output power without an additional heat sink.

Input: +5V to +12V    Output: +3.3V, 12A (+1.0V~+3.3V)  
Input :        +12V    Output: +5.0V, 8A (+5.0V~+6.0V)

#### Features

- Thin, Ultra Small Size
- Output Voltage +1.0~+3.3V/ +5V~+6V
- Output Current 0~12A/ 0~8A
- Ultra High Efficiency 93%~95%
- Wide Operating Temp. Range -10°C~+70°C
- MTBF 900,000Hrs, All products received aging
- No Heat Sink required
- High Reliability , Long Life, High Performance
- ON/OFF Control
- Remote Sensing
- Over-Current Protection
- Input/Output Non-Isolated Type
- Adjustable Output
- Wide Input Voltage Range



Models	Standard Input Voltage Vdc	Input Voltage Range Vdc~Vdc	Standard Output Voltage Vdc	Adjustable Output Range Vdc~Vdc	Output Current A	Non-Load Current mA(typ)	Ripple & Noise mVpp(typ)	Efficiency (typ)
<b>TSI 40-1210</b>	5/12	+4.5 ~ 13.6	<b>+3.3</b>	+1.0 ~ 3.3	<b>12 max. (*1)</b>	90	40	93
<b>TSI 40-1211</b>	12	+8.0 ~ 13.6 (*2)	<b>+5.0</b>	+5.0 ~ 6.0	<b>8 max. (*1)</b>	60	60	95

(\*1) Input Voltage will become max output by air cooling method (natural or compulsory air cooling). Please refer to thermal derating graph.

(\*2) When the voltage between the converter's output pin is 5.3V or below, operating is capable from input +7V. But only at input between +7~+8V, max output current at 7A.

#### Specification

Standard Output	When it is open between 11pin,12pin, output voltage will be set at +3.3V or +5V. (The accuracy of output V setting is ±4% max.)	
Adjustable Output V Range	Output Voltage is adjustable according to the range above.	
Line Reg.		
Load Reg.	8mV/typ. (For 0~100% of Load Reg., at Rating Input.)	
Temp. Reg.		
Ripple & Noise	Refer Table 1 (Rating Input, Rating output, Room Temp.).Measurements Frequency Band Width 20MHz)	
Efficiency	93%~95% (Rating Input/ Output, Room Temp., Refer Table 1.	
Over-Current Protection	Operates at 105% or more Rating Load Current, auto recovery type. Avoid long time of short-circuit condition.	
Over-Voltage Protection	None	
Standby Current	TSI 40-1210	3mAmax. (Vin=5.5V), 6mAmax.(Vin=13.6V)
	TSI 40-1211	100 µAmax.
Remote ON/OFF	Between 1pin(ON/OFF),2pin(S.GND.[Open: Output ON, Short: Output OFF (Refer to application)])	
Remote Sensing	TSI 40-1210	The voltage between the converter's output pin .voltage between 7-8pin] and sensing voltage difference [voltage between 6-9pin] is 10% of sensing voltage (0.1V~0.3V) or below. (*1)
	TSI 40-1211	The voltage between the converter's output pin .voltage between 7-8pin] and sensing voltage
MTBF	900,000Hr min. (EIAJ RCR-9102)	
Switching Frequency	220KHz typ. (TSI 040-1210), 270KHz typ. (TSI 40-1211)	
Operating Temp. Range		
Storage Temp. Range	Storage Temp. -20°C~+85°C	
Humidity Range	95%R.Hmax.	
Cooling Condition	Output current will change by the input voltage. Refer to the thermal derating graph.	
Vibrations	5~10Hz Every amplitude 10mm (3directions, each for 1hour), 10~55Hz acceleration 2G (3directions, each for 1hour.	
Shock	Acceleration 20G .3directions, 3times each.,	
Weight	14g typ.	
External dimensions	W=24.9 L=50.0 H=10.0 typ (mm) (For detail dimensions refer the outline.)	

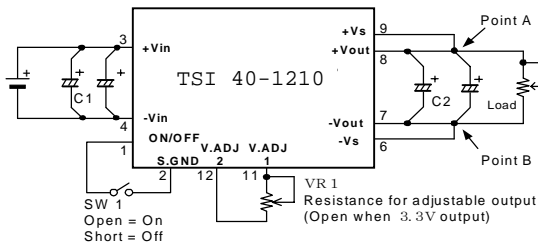
(\*1) When input is +5.5V or below and voltage between output pin is 3.40V~3.63V, mass output current will be 11A.

(\*2) When the voltage between converter's output pin is 5.3V or more, max output current will be 7A.

.The above specification will be provided at rating value, when there is no specified condition described.



### Standard Connection Circuit Diagram



### Additional Capacitor

- C1 selection  
Add 2 or more C1=68 μF or more, ESR=34 mOhm or below in parallel.  
Recommended Capacitor: 20SP68M (Sanyo)×2pcs,  
or 20SH100M (Sanyo)×2pcs
- C2 selection  
{When Output Voltage is 1.7V or more}  
Add 2 or more C2=220 μF or more, ESR=28 mOhm or below in parallel.  
Recommended Capacitor: 6SP220M (Sanyo)×2pcs,  
or 10SH220M (Sanyo)×2pcs  
  
{When Output Voltage is below 1.7V}  
Add 3 or more C2=330 μF or more, ESR=25 mOhm or below in parallel.  
Recommended Capacitor: 4SP330M (Sanyo)×3pcs,  
or 6SH330M (Sanyo)×3pcs

ESR Frequency of the above additional capacitor: 100KHz~300KHz

Note 1. This product can be effected by contacting resistor, so do not use a connector, and solder directly to the print board.

Note 2. For C1, C2 approximate the converter's pin as much as possible, and wire with a bold pattern.

Approximate (+) and (-) to make the loop not big.

Note 3. Connect +Vs pin and -Vs pin to the capacitor closer to the load side.

This pin is a remote sensing pin so do not keep it open.

### Remote Sensing

+Vs pin and -Vs pin are remote sensing pins.

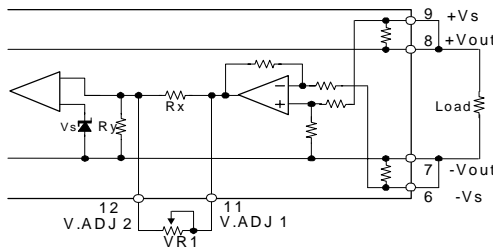
The connecting point of sensing line and output line will be the output setting voltage. (Between A-B of above figure)

By this function, the voltage drop at the output line can be corrected.

As much as A point and B point gets closer to the load side, Vout (voltage between 7-8pin) will become higher than the output setting voltage.

### Adjusting Output Voltage

Output voltage is adjustable in the range of 1.0~3.3V by connecting a resistor between V.ADJ1 pin (11Pin) and V.ADJ2 pin (12Pin). Resistance value is as the figure mentioned.



Resistance values when adjusting output voltage (Equation 1)

$$VR1 = \frac{R_x \times R_y \left( \frac{V_o}{1.1} - 0.8 \right)}{R_x \times V_s - R_y \left( \frac{V_o}{1.1} - 0.8 \right)}$$

Vo= Requested output V

Rx=22.56k ohm

Ry=8.2k ohm

Vs=0.8V

Note 1. When adjusting output voltage

Start initial energizing after checking that the adjustable resistor's lug is in the direction of low voltage.

Note 2. Recommend fixed resistor when mass production.

Note 3. Wire between V.ADJ1-V.ADJ2 pin short as much as possible.

Note 4. Without a resistor between V.ADJ1-V.ADJ2 pin, rating output voltage will be +3.3V.

## Remote ON/OFF Control

### - ON/OFF Function

By using this ON/OFF control function, the output can be ON/OFF controlled without intermitting input.

This is an effective function when composing a power supply system sequence. And this can also be used as a power standby function for saving power control.

### - Not using ON/OFF Function

To not use the ON/OFF function, keep ON/OFF pin open.

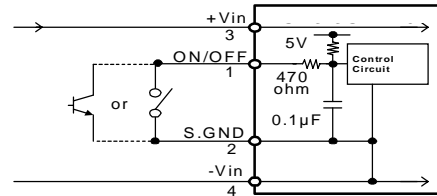
### - Method of ON/OFF Control

Between ON/OFF pin (1Pin) and S.GND (2Pin)

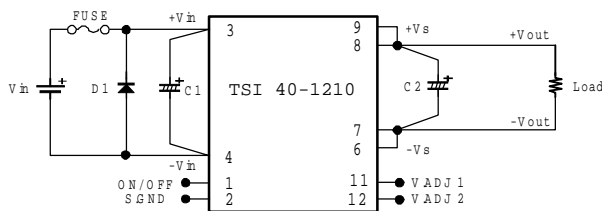
Open (Max. 6V) will be generated Output=ON

Short (0~0.5V 500μA max.) Output=OFF

Max. Rating Voltage of ON/OFF pin (1Pin): -0.3V~+6V



## Reverse Input Voltage Protection



This product is a non-isolated type DC-DC converter. If you connect the input voltage reversed by mistake, it will be damaged.

If there is a possibility of reverse connection, please add a protection as the left figure.

The left figure is an example using fuse and diode.

## Over-Voltage Protection

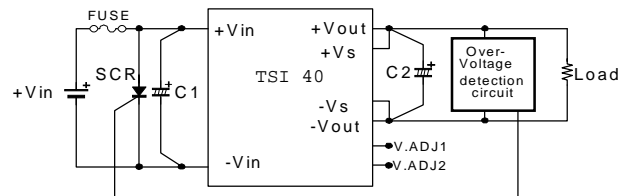
TSI-40 series does not have a built-in over-voltage protection.

If the switching element in this converter is damaged in short mode input voltage +Vin will be output as is.

However, to prepare for damage at over-voltage mode, we recommend to add a circuit to intercept the supplying power circuit.

### Note:

When it is damaged at over-voltage mode, ON/OFF control does not operate.

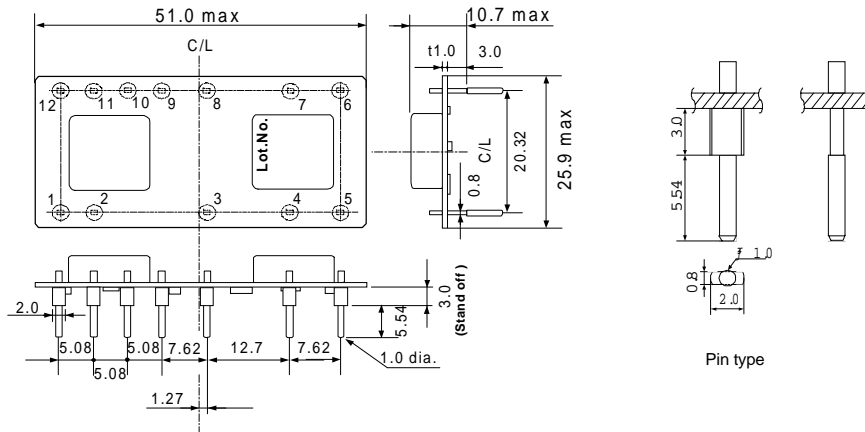


## Soldering Conditions

Solder under the following conditions.

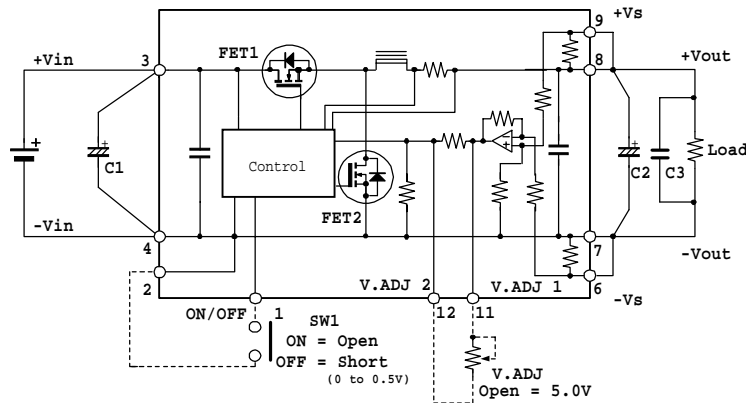
- |                        |             |               |
|------------------------|-------------|---------------|
| 1. With soldering iron | 340°C~360°C | within 5sec.  |
| 2. With soldering dip  | 240°C~260°C | within 10sec. |

### Outline

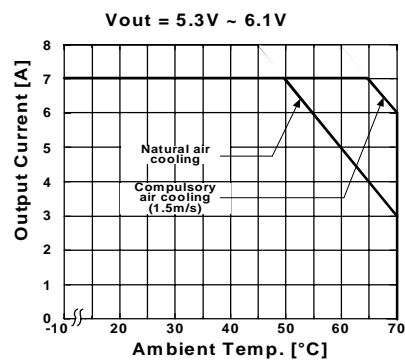
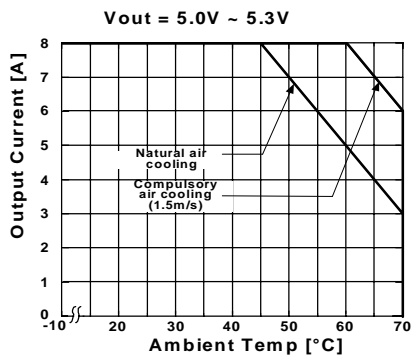


pin	Function
1	ON/OFF
2	S.GND
3	+Vin
4	-Vin
5	NC
6	-Vs
7	-Vout
8	+Vout
9	+Vs
10	NC
11	V.ADJ 1
12	V.ADJ 2

### Block Diagram

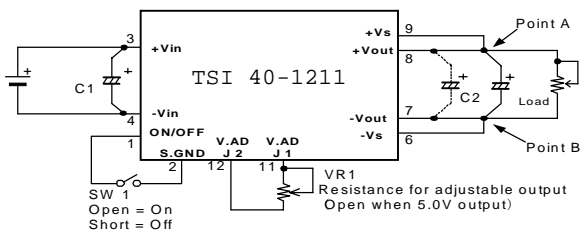


### Thermal Derating



Vout: Voltage between output pin (voltage between 7-8pin)

### Standard Connection Circuit Diagram



### Additional Capacitor

Add 1 or more C1=68  $\mu$ F or more, ESR=34 mOhm or below.  
Recommended Capacitor: 20SP68M (Sanyo)x1pcs,  
or 20SH100M (Sanyo)x1pcs

Add 1 or more C2=150  $\mu$ F or more, ESR=30 mOhm or below.  
Recommended Capacitor: 10SP180M (Sanyo)x1pcs,  
or 10SH220M (Sanyo)x1pcs

ESR Frequency of the additional capacitor: 100KHz-300KHz

Note 1. This product can be effected by contacting resistor, so do not use a connector, and solder directly to the print board.

Note 2. For C1, C2 approximate the converter's pin as much as possible, and wire with a bold pattern.

Approximate (+) and (-) to make the loop not big.

Note 3. Connect +Vs pin and -Vs pin to the capacitor closer to the load side.

This pin is a remote sensing pin so do not keep it open.

### Remote Sensing

+Vs pin and -Vs pin are remote sensing pins.

The connecting point of sensing line and output line will be the output setting voltage. (Between A-B of above figure)

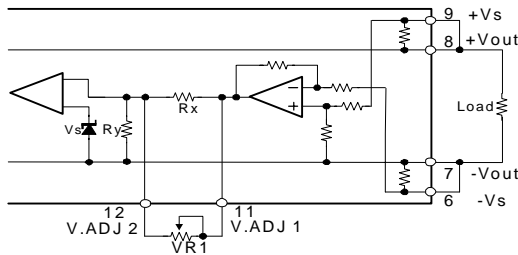
By this function, the voltage drop at the output line can be corrected.

As much as A point and B point gets closer to the load side, Vout (voltage between 7-8pin) will become higher than the output setting voltage.

### Output Voltage Adjustment

Output voltage is adjustable in the range of 5.0-6.0V by connecting a resistor between V.ADJ1pin (11Pin) and V.ADJ2 pin (12Pin).

Resistance value is as the figure mentioned.



Resistance figures when adjusting  
output voltage (Equation 2)

$$VR1 = \frac{0.8 \times R_x \times R_y}{\frac{13}{22} \times V_o \times R_y - 0.8 (R_x + R_y)}$$

Vo=Requested output Voltage  
Rx=22.1k ohm  
Ry=8.2kohm  
Vs=0.8V

Note 1. Be sure not to make the Vout (voltage between 7-8pin) over 6.1V.

Note 2. When adjusting output voltage

Start initial energizing after checking that the adjustable resistor's lug is in the direction of low voltage.

Note 3. Recommend fixed resistor when mass production.

Note 4. Wire between V.ADJ1-V.ADJ2 pin short as much as possible.

Note 5. Without a resistor between V.ADJ1-V.ADJ2 pin, rating output voltage will be +5.0V.