FEATURES

- Available in fixed output voltages of 3.3V, 5V, 12V and an adjustable output version
- Adjustable version output voltage range is 1.2V to 37V
- Output load current up to 3A
- Input voltage rate up to 40V
- Operating with an internal oscillator frequency of 150kHz
- Simple application circuit, only requiring four peripheral components
- Excellent line and load regulation
- Output controlled through TTL level
- Typical standby current is 100µA
- Thermal shutdown and current limit protection
- Standard inductors optimized for use
- Available in TO-220 and TO-263 packages

PRODUCT APPEARANCE

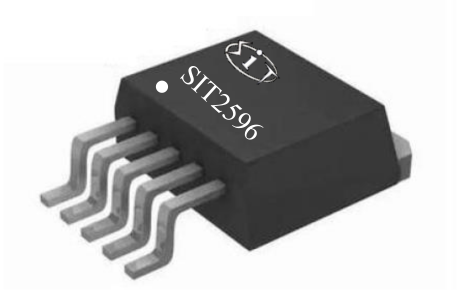


Fig 1 provides green, lead-free packaging

DESCRIPTION

SIT2596 is a step-down switching regulator chip. These devices are available in fixed output voltages of 3.3V, 5V,12V and an adjustable output version. The output voltage can also be adjusted according to needs, the voltage output range is 1.2V to 37V and the input voltage is up to 40V and the output current is up to 3A. It also has excellent linear adjustment rate and load adjustment rate.

The SIT2596 has an integrated frequency compensation and fixed frequency generator with a switching frequency of 150kHz, allowing the use of smaller filter elements compared to low-frequency switching chips. The fixed output voltage version requires only four peripheral components and can use common standard inductors, which optimizes the use of the SIT2596, greatly simplifies the design of the switching power supply circuit, and saves the cost and volume of the peripheral.

SIT2596 has current limiting protection and overtemperature protection. The output of the chip can be controlled by external logic level. External shutdown is included, featuring typically 100µA standby current. The SIT2596 is available in a standard 5-pin TO-220 package (DIP) and 5-pin TO-263 package (SMD).

PIN CONFIGURATION

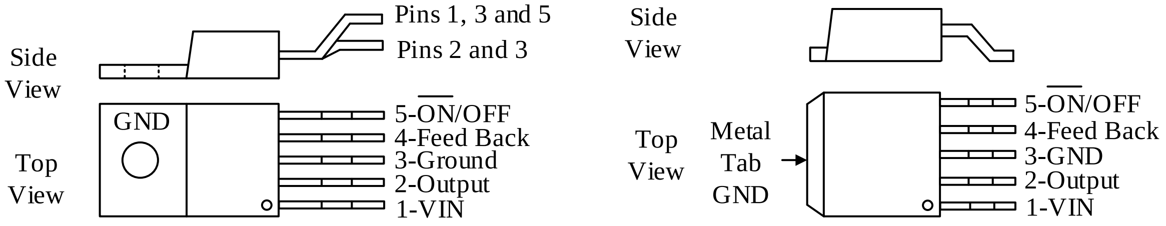


Fig 2 SIT2596 TO-220 and TO-263 packages pin configuration

PIN DESCRIPTION

SIT2596 pin description

PIN	SYMBOL	PIN DESCRIPTION
1	VIN	DC voltage input. The maximum value can reach 40V and the minimum value is 4.5V.
2	Output	Switching tube emitter open output. Inductor and the free-wheeling diode connected to this pin to form a step-down circuit, with the output up to 37V and the minimum 1.2V.
3	Ground	Ground connection.
4	Feed Back	Stabilized sample voltage input. The pin is generally connected to the output voltage, and the output voltage is monitored through the partial voltage network in the IC. When the output voltage increases or decreases, the pin voltage increases or decreases in proportion, compared with the internal reference voltage regulator value of 1.23V, the internal amplifier can automatically adjust the output duty ratio of the oscillator to decrease or increase the output voltage, so that the output voltage is stable at the rated value.
5	$\overline{\text{ON}}$/OFF	Enable control. Control the output voltage, When the pin is higher than 1.3V (maximum 25V), the internal switch tube is turned off and the output voltage is 0V. At this time, the input power current is 100μA and the power consumption is the lowest. When it is lower than 1.3V, the output voltage is rated. If the sub-closing function is not required, the $\overline{\text{ON}}$/OFF pin can be connected to GND or can be kept open.

BLOCK DIAGRAM

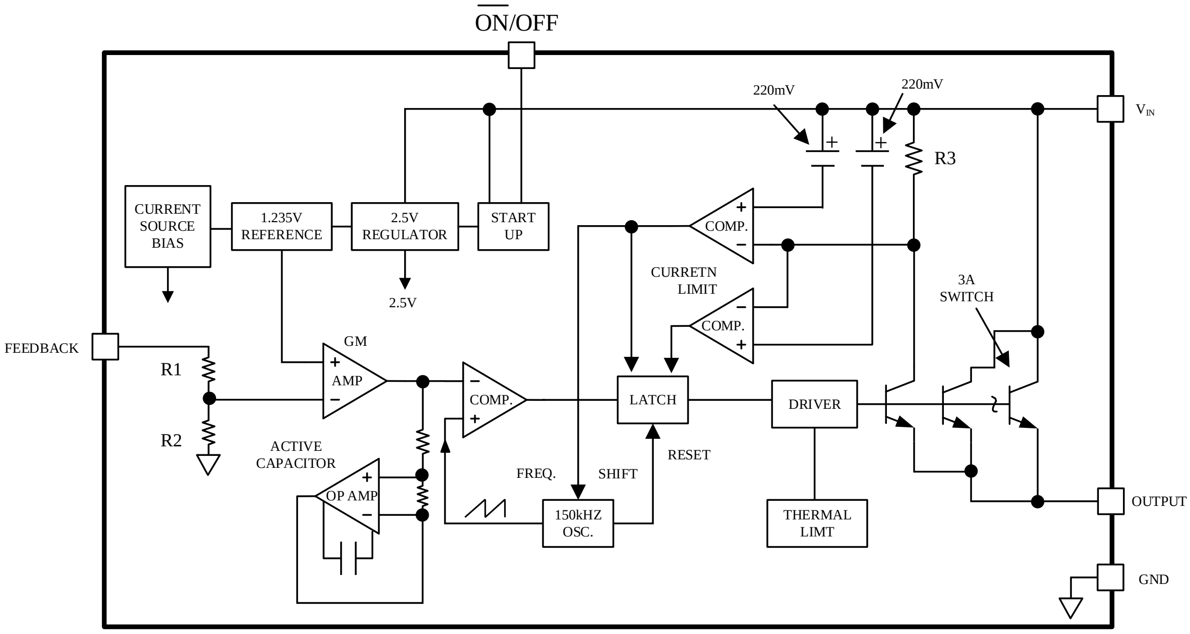


Fig 3 SIT2596 block diagram

FEATURE DESCRIPTION

1 Sketch

SIT2596 is a DC-to-DC step-down voltage regulator chip and features excellent switching efficiency. Requiring a minimum number of external components, these regulators are simple to use. It can be applied for electrical appliances, grid infrastructure, EPOS, home theater and other fields.

2 Typical application

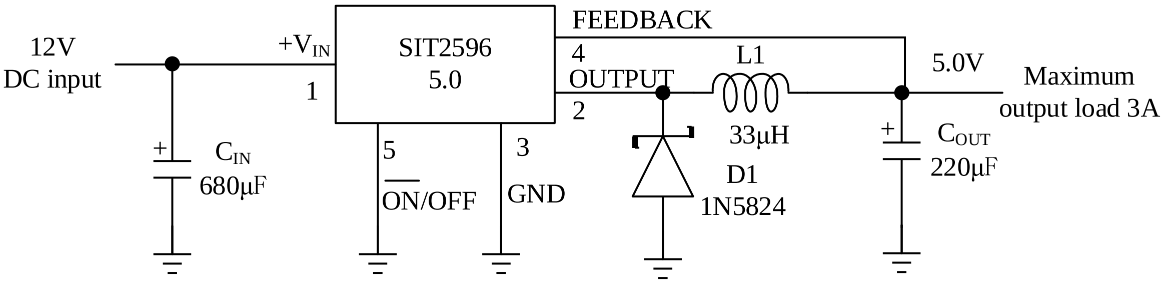


Fig 4 Fixed output voltage 5Vversion

3 Thermal shutdown protection

When $T_j \geq 150$°C, the chip will automatically turn off the internal switching transistors and stop output to protect the chip.

4 Current limit protection

5 Operating mode

Normal operating mode:

The chip will be in normal operation mode by connecting $\overline{\text{ON}}$/OFF pin to low level. Under this mode, the chip will provide the designed output voltage and current for the external application supply voltage.

Standby mode:

When $\overline{\text{ON}}$/OFF pin is connected to high level, the chip will be in standby mode. Under this mode, the output voltage is 0, the input supply current is 100µA and power consumption is lowest.

LIMITING VALUE

PARAMETER	SYMBOL	MIN	MAX	UNIT
Supply voltage	V_{IN}		45	V
$\overline{\text{ON}}$/OFF pin input voltage	$V_{\overline{ON}/OFF}$	-0.3	+25	V
Feed Back pin voltage	V_{FB}	-0.3	+25	V
Output voltage to ground	V_{OUT}		-1	V
Power Dissipation		Internally limited		V
Virtual junction temperature	T_j	-40	150	°C
Ambient temperature	T_{amb}	-40	125	°C
Storage temperature	T_{stg}	-65	150	°C

The maximum limit parameters mean that exceeding these values may cause irreversible damage to the device. Under these conditions, it is not conducive to the normal operation of the device. The continuous operation of the device at the maximum allowable rating may affect the reliability of the device. The reference point for all voltages is ground.

ESD

PARAMETER	VALUE	UNIT
ESD (HBM)	±2000	V

OPERATING CONDITION

Parameter	Min	Max	Unit
Supply voltage	4.5	40	V
Ambient temperature	-40	125	°C

THERMAL RESISTANCE DESCRIPTION

Parameter		**SIT2596**		**Unit**
		TO-263	**TO-220**	
		5 PINS	**5 PINS**	
$R_{\theta JA}$: Thermal resistance of chip junction to environment (Note 2, Note 3)	Note 4	—	50	°C/W
	Note 5	50	—	
	Note 6	30	—	
	Note 7	20	—	
$R_{\theta JC(top)}$: Thermal resistance of chip junction to package surface		2	2	°C/W

Note 1: More information on thermal resistance calculations, see the Semiconductor and IC Package Thermal Metering Application Report.

Note 2: The thermal impedance of the package is calculated according to JESD 51-7.

Note 3: Thermal resistance is simulated on a 4-layer JEDEC board.

Note 4: Ambient thermal resistance (without heat sink) refers to the value of SIT2596 in the TO-220 package welded vertically on a PCB covered with approximately 1 square inch copper foil and 1 ounce thick.

Note 5: The SIT2596 in the TO-263 package is vertically welded to the corresponding environmental thermal resistance on a single-sided PCB covered with approximately 0.5 square inches of copper foil and 1 ounce thick.

Note 6: The SIT2596 in the TO-263 package is vertically welded to the corresponding environmental thermal resistance on a single-sided PCB covered with approximately 2.5 square inches of copper foil and 1 ounce thick.

Note 7: The SIT2596 in the TO-263 package is vertically welded TO the corresponding ambient thermal resistance on a two-sided PCB covered with approximately 3 square inches of copper foil and 1 ounce thick, while the other side of the PCB is covered with approximately 16 square inches of copper foil.

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, $T_{amb} = 25°C$, V_{IN}=12V for the 3.3V, 5V and adjustable version and V_{IN}=24V for 12V version. I_{LOAD}=500mA.

Parameter	Symbol	Condition		Min	Typ	Max	Unit
Output voltage	V_{OUT}	SIT2596-33	$4.75V \le V_{IN} \le 40V$, $0.2A \le I_{LOAD} \le 3A$	3.20	3.3	3.40	V
		SIT2596-50	$7V \le V_{IN} \le 40V$, $0.2A \le I_{LOAD} \le 3A$	4.85	5.0	5.15	
		SIT2596-12	$15V \le V_{IN} \le 40V$, $0.2A \le I_{LOAD} \le 3A$	11.64	12.0	12.36	
Efficiency	η	SIT2596-33	$I_{LOAD} = 3A$		73		%
		SIT2596-50	$I_{LOAD} = 3A$		80		
		SIT2596-12	$V_{IN} = 25V$, $I_{LOAD} = 3A$		90		
		SIT2596-ADJ	$V_{OUT} = 3V$, $I_{LOAD} = 3A$		73		
Feedback voltage	V_{FB}	SIT2596-ADJ	$4.5V \le V_{IN} \le 40V$, $0.2A \le I_{LOAD} \le 3A$ $V_{OUT} = 3V$	1.193	1.230	1.267	V
Feedback bias current	I_D	SIT2596-ADJ; $V_{FB} = 1.3V$			15	50	nA
Oscillator frequency	f_O			127	150	173	kHz
Saturation voltage	V_{SAT}	$I_{OUT} = 3A$ (Note 1,2)			1.26	1.4	V
Max duty cycle (ON)	DC	(Note 2)			100		%
Min duty cycle (OFF)		(Note 3)			0		
Current limit	I_{CL}	Peak current (Note 1,2)		3.4	4.5	6.0	A
Output leakage current	I_L	Output =0V (Note 1, 3)				25	μA
		Output = -1V, $V_{IN} = 40V$			1	10	mA
Quiescent current	I_Q	(Note 3)			5	10	mA
Standby quiescent current	I_{STBY}	ON/OFF pin = 5V (OFF), $V_{IN} = 40V$			100	200	μA
$\overline{ON}$/OFF pin logic input threshold voltage					1.3		V
	V_{IH}	Low (regulator ON)				0.6	
	V_{IL}	High (regulator OFF)		2.0			
$\overline{ON}$/OFF pin input current	I_H	$V_{LOGIC} = 2.5V$ (regulator OFF)			5	15	μA
	I_L	$V_{LOGIC} = 0.5V$ (regulator ON)				5	

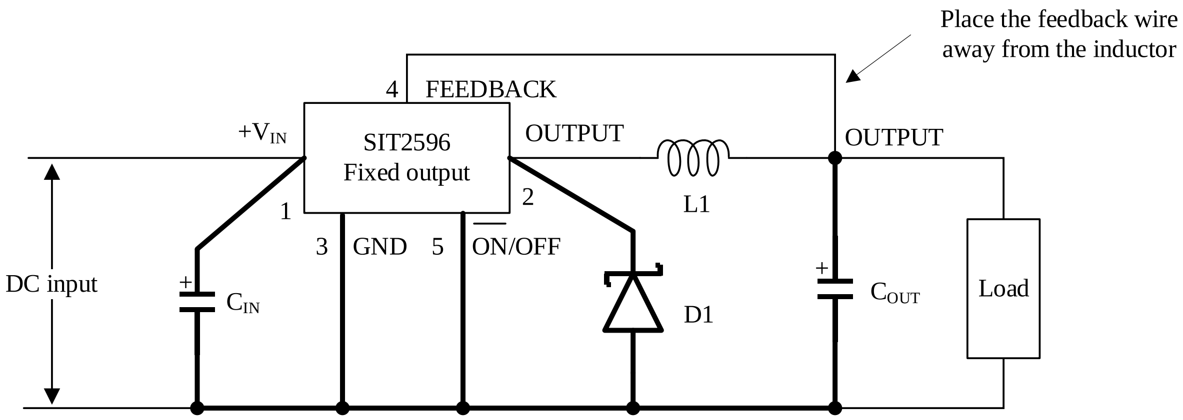
Note 1: No components connected to output pin.

Note 2: Feedback pin removed from output and connected to 0V to force the output transistor switch ON.

Note 3: Feedback pin removed from output and connected to 12V for the 3.3V, 5V and the ADJ version, and15V for 12V version. To force the output transistor switch OFF.

APPLICATION INFORMATION

1 Fixed output application circuit

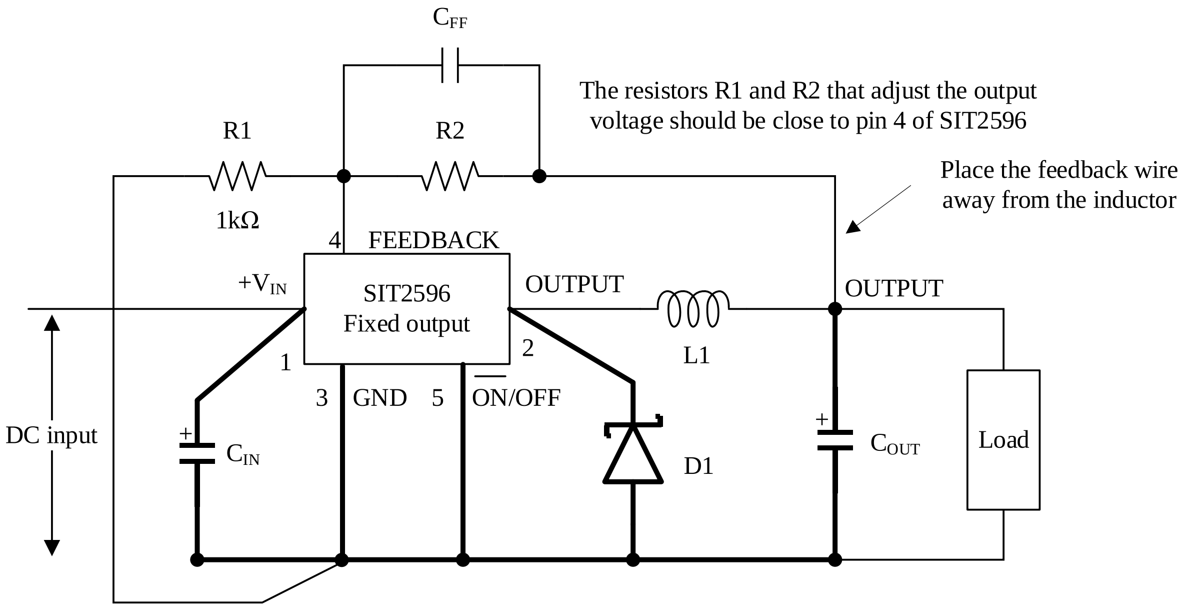


The bold line in the figure must be short, and it is best to shield the ground line

Fig 5 Fixed output voltage typical application

C_{IN}: 470µF/50V, C_{OUT}: 220µF/25V, D1: 5A/40V (eg. IN5825), L1: 68 µH, L38

2 Adjustable output application circuit



The bold line in the figure must be short, and it is best to shield the ground line

Fig 6 Adjustable output voltage typical application

The output voltage can be calculated by the following formula:

$$V_{OUT} = V_{REF}(1 + \frac{R_2}{R_1})$$

To ensure a stable output: $V_{REF} = 1.23$ V; $R_2 = R_1(\frac{V_{OUT}}{V_{REF}} - 1)$; R1 uses a resistance with a nominal resistance of 1kΩ and an accuracy of 1%. C_{IN}: 470μF/50V, C_{OUT}: 220μF/35V, D1: 5A/40V (eg. IN5825), L1: 68 μH, L38, R1: 1kΩ, 1%, C_{FF}: refer to the application information.

In the switching power supply circuit, the PCB layout is very important, the switching current is closely related to the loop inductance, and the transient voltage generated by this loop inductance often causes many problems. To make this induction minimum and the ground wire form a loop, the bold line shown in the figure should be printed wider on the PCB board and as short as possible. For best results, external components should be placed as close to the SIT2596 as possible, preferably shielded from the ground or grounded at a single point. It is best to use an inductor with a magnetic shield structure, if the inductor used is an open core, then it must be placed with great care. If the inductive flux and the sensitive feedback line intersect, the wiring of the chip's ground wire and the capacitor C_{OUT} at the output end may cause some problems. In a scheme where the output is adjustable, special attention must be paid to the position of the feedback resistance and its associated wiring. Physically, on the one hand, the resistance should be close to the chip, and on the other hand, the related wiring should be away from the inductor, which is even more important if the inductor used is an open core.

DESIGN STEPS AND EXAMPLES

Design steps of fixed output power supply

Design requirements: V_{OUT}=3.3 (or 5, or 12) V, $V_{IN\ (max)}$ is the maximum DC input voltage, $I_{LOAD\ (max)}$ is the maximum load current.

Steps:

1 Inductance selection (L1)

(1) To select the appropriate value of the inductor based on the data shown in Fig 7, Fig 8 and Fig 9 (corresponding to output voltages of 3.3V, 5V, and 12V, respectively), for all other output voltages, see the steps for the design of a regulator with an adjustable output.

(2) In Fig 7, Fig 8 and Fig 9, the value of the inductance is determined by the intersection of the maximum input voltage line and the maximum load current line. Each area corresponds to an inductance value and an inductance code (LXX).

(3) Select a suitable inductor from the product numbers listed by the four manufacturers in Table 3. Preferably use an inductor with a magnetic shield structure.

2 Output capacitance selection (C_{OUT})

(1) In most applications, the electrolytic capacitance value of the Low ESR is between 82μF and 820μF, while the tantalum capacitance value of the Low ESR is between 10μF and 470μF. The capacitor should be close to the IC, at the same time, the capacitor pin should be short, the connected copper wire should be short, and the capacitance value should not be greater than 820μF.

(2) To simplify the capacitor selection step, refer to the Capacitor Quick Selection shown in Table 1, which contains the different input voltages, output voltages, load currents, different inductors and output capacitors required for the best design.

(3) The voltage of the electrolytic capacitor should be at least 1.5 times the output voltage, and in order to obtain the output voltage with lower ripple, a capacitor with a higher voltage value is needed.

3 Free-wheeling diode selection (D1)

(1) The maximum current capacity of the free-wheeling diode should be at least 1.3 times the maximum load

current, if the design of the power supply to withstand continuous short-circuit output, the maximum current capacity of the free-wheeling diode should be equal to the limit output current of SIT2596. The worst case for a free-wheeling diode is overload or a short circuit in the output.

(2) The reverse voltage withstand of free-wheeling diode should be at least 1.25 times the maximum input voltage.

(3) The free-wheeling diode must be fast recovering and must be close to SIT2596. The pin of the diode must be short and the copper wire connected to it must be short. Because the required diode switching speed is fast and the forward voltage is reduced, the Schottky diode is preferred, and at the same time, its performance and efficiency are very good, especially in the case of low output voltage. The use of ultrafast recovery or high efficiency rectifier diodes also works well. The typical recovery time of ultrafine recovery diodes is 50ns or faster, and rectifier diodes like the IN5400 series are slow and usually not used.

4 Input capacitance selection (C_{IN})

In order to prevent large transient voltages at the input terminal, an aluminum electrolytic capacitor or tantalum capacitor with low equivalent resistance should be added between the input end and the ground as a bypass capacitor, which is close to the IC. In addition, the input capacitance ripple current must be at least half of the DC load current and make sure that this parameter of the selected capacitor cannot be less than half of the DC load current. The curve corresponding to the typical ripple current of several different aluminum electrolytic capacitors is shown in Fig11. For aluminum electrolytic capacitors, the voltage withstand value should be 1.5 times the maximum input voltage. It must be noted that if a tantalum capacitor is used, its voltage should be twice the input voltage, and it is recommended to use a capacitor that has been tested by the manufacturer for inrush current. Be especially careful when using a chip capacitor as an input bypass capacitor, as this can cause very serious noise at the input pin.

Example of fixed output power supply design

Design requirements: V_{OUT}=5V, $V_{IN(max)}$=12V, $I_{LOAD(max)}$=3A.

Steps:

1 Inductance selection (L1)

(1) Select the inductance when the output is 5V according to the inductance selection method shown in Fig 8.

(2) As can be seen from Fig 8, the inductance at the intersection of a horizontal line with a voltage of 12V and a vertical line with a current of 3A corresponds to 33μH, number is L40.

(3) The required inductor value is 33μH, and an inductor is selected from the four manufacturers' inductor serial numbers listed in the L40 row of Table 3 (common, SMD and DIP inductors are all available), and preferably use an inductor with a magnetic shield structure.

2 Output capacitance selection (C_{OUT})

(1) From the quick design device selection shown in Table 1, firstly, select the rows with an output voltage of 5V, then select the current line that is closest to the current required in your application in the load current column. In this case, select the current line 3A. In the maximum input voltage column, select the voltage line that is closest to the required input voltage for your application. In this case, select the voltage line 15V. On this line are the inductors and capacitors that work best.

(2) When the output voltage is 5V, the capacitor should withstand at least 7.5V or higher. However, even for low ESR series capacitors, an aluminum electrolytic capacitor of 220μF/10V will produce an equivalent impedance of about 225 mΩ, which produces a relatively high output ripple voltage at the output teminal. To reduce the ripple voltage to 1% or less of the output voltage, it is necessary to select a higher voltage (low

equivalent resistance) or a higher capacitance. A 16V or 25V capacitor can reduce the ripple voltage by almost half.

3 Free-wheeling diode selection (D1)

Refer to Table 4. In this example, the 5A/20V Schottky diode IN5823 can produce good results, and in the case of output short-circuit, will not overload.

4 Input capacitance selection (CIN)

Voltage resistance and ripple current of input capacitor are important parameters of input capacitor. If the input voltage is 12V, then the voltage of the aluminum electrolytic capacitor is greater than 18V (1.5×VIN), you can choose the next commonly used higher specification capacitor voltage value of 25V. The ripple current of the input capacitor in the power supply is about half of the current of the DC load. In this case, the load current is 3A, then the ripple current of the input capacitor is at least 1.5A, and the appropriate capacitor can be selected using the graph shown in Fig 11. In the graph, a voltage line with a voltage tolerance of 35V corresponds to a capacitance with a ripple current greater than 1.50A of 680µF, so we can select a capacitance of 680µF/35V. For designs that choose DIP components, an electrolytic capacitor of 680µF/35V is sufficient, and other types or manufacturers of capacitors can be used to provide sufficient ripple current. SMD tantalum capacitors can be selected for the design of the selected sticker element. But it is important to note that the surge current value of the capacitor must be tested. The surge current values of AVX's TPS series and VISHAY's 593D series devices were tested.

Condition			Inductor		Output capacitor			
					Electrolytic capacitor (DIP)		Tantalum capacitor (SMD)	
Output voltage (V)	load current (A)	maximum input voltage(V)	Inductance µH	Inductance number#	PANASONIC HFQ series (µF/V)	NICHICON PL series (µF/V)	AVX TPS series （µF/V）	VISHAY 595D series (µF/V)
3.3	3	5	22	L41	470/25	560/16	330/6.3	390/6.3
		7	22	L41	560/35	560/35	330/6.3	390/6.3
		10	22	L41	680/35	680/35	330/6.3	390/6.3
		40	33	L40	560/35	470/35	330/6.3	390/6.3
	2	6	22	L33	470/25	470/35	330/6.3	390/6.3
		10	33	L32	330/35	330/35	330/6.3	390/6.3
		40	47	L39	330/35	270/50	330/10	330/10
5	3	8	22	L41	470/25	560/16	220/10	330/10
		10	22	L41	560/25	560/25	220/10	330/10
		15	33	L40	330/35	330/35	220/10	330/10
		40	47	L39	330/35	270/35	220/10	330/10
	2	9	22	L33	470/25	560/16	220/10	330/10
		20	68	L38	180/35	180/35	100/10	270/10
		40	68	L38	180/35	180/35	100/10	270/10

Table 1 SIT2596 fixed output quick design device selection table

Design steps of adjustable output power supply

Design requirements: V_{OUT} is the adjustable output voltage, $V_{IN\ (max)}$ is the maximum DC input voltage, $I_{LOAD\ (max)}$ is the maximum load current, F= switching frequency.

Steps:

1 Calculation of output voltage (Use R1 and R2 in Fig 6)

The R1 and R2 resistances can be calculated by the following formula:

$V_{OUT} = V_{REF}(1+\frac{R_2}{R_1})$, V_{REF}=1.23V; Choose an appropriate resistance value for R1 between 240Ω and 1.5kΩ. The low resistance minimizes the noise tolerance of the sensitive feedback pin (a low temperature bleach resistor with an accuracy of 1% can be selected for the best stability over time).

$$R_2 = R_1(\frac{V_{OUT}}{V_{REF}} - 1)$$

2 Inductance selection (L1)

(1) The inductance voltage multiplied by microseconds can be calculated by the following formula：

$$E \bullet T = (V_{IN} - V_{OUT} - V_{SAT}) \bullet \frac{V_{OUT} + V_D}{V_{IN} - V_{SAT} + V_D} \bullet \frac{1000}{150kHz} (V \bullet \mu s)$$

Where V_{SAT} is the internal switching saturation voltage, V_{SAT}=1.16V, V_D is the diode positive voltage drop, VD=0.5V.

(2) The value of E·T is calculated by the previous formula, find a matching inductor serial number from the ordinate of Fig 7 and select a maximum load current on the horizontal coordinate.

(3) An inductance region is determined by the intersection of the E· T value and the maximum load current value, and each region is characterized by an inductance value and an inductance number (LXX).

(4) Choose an appropriate inductor from the four manufacturers' component numbers listed in Table 3 and preferably use an inductor with a magnetic shield structure.

3 Output capacitance selection (C_{OUT})

(1) In most applications, electrolytic capacitors or solid tantalum capacitors with low equivalent resistance (Low ESR) between 82μF and 820μF work best, with capacitors close to the IC, pins short, and connected copper wires short. Do not use a capacitor larger than 820μF.

(2) To simplify the capacitor selection step, refer to the Capacitor Quick Selection shown in Table 2, which contains the different output voltages and output capacitors required for the best design.

(3) The voltage of the capacitor should be at least 1.5 times the output voltage, and sometimes a higher voltage value is required to obtain a low ripple output voltage.

4 Selection of front feedback capacitance (C_{FF}, see Fig 6)

When the output voltage is greater than 10V, a compensation capacitor is required. The capacitor is typically between 100pF and 33nF, and is in parallel with the output voltage setting resistor R2. For high output voltages, low input-output voltages and/or output capacitors with low equivalent resistance, this capacitor can keep the output voltage stable, as with solid tantalum capacitors.

$$C_{FF} = \frac{1}{31 \times 10^3 \times R_2}$$

This capacitor can be a ceramic capacitor, plastic or mica capacitor, etc. (Because the Z5U/Y5V ceramic capacitor is unstable, it is recommended not to use this capacitor).

5 Free-wheeling diode selection (D1)

(1) The maximum current capacity of the free-wheeling diode must be at least 1.3 times the maximum load current, and if the power supply is designed to withstand a continuous short-circuit output, the maximum current capacity of the free-wheeling diode must be equal to the limit output current of the SIT2596. The worst case for a free-wheeling diode is overload or a short circuit in the output.

(2) The reverse voltage withstand of the free-wheeling diode should be at least 1.25 times the maximum input voltage.

(3) The free-wheeling diode must be fast recovering and must be close to SIT2596. The pin of the diode must be short and the copper wire connected to it must be short. Because the required diode switching speed is fast and the positive voltage is reduced, the Schottky diode is preferred, and its performance and efficiency are also very good, especially in the case of low output voltage. The use of ultrafast recovery or high-efficiency rectifier diodes also works well, but some of these devices with sudden shutdown properties may cause instability or electromagnetic induction problems. The typical recovery time for ultrafine recovery diodes is 50ns or faster, but the IN5400 series of rectifier diodes are slow and usually not used.

6 Input capacitance selection (C_{IN})

In order to prevent large transient voltages at the input, an aluminum electrolytic capacitor or tantalum capacitor with Low equivalent resistance (Low ESR) is added between the input and the ground as a bypass capacitor. The capacitor should be close to the IC. In addition, the ripple current of the input capacitor must be at least half of the DC load current. Make sure that this parameter of the selected capacitor cannot be less than half of the DC load current. The curve corresponding to the typical ripple current of several different aluminum electrolytic capacitors is shown in Fig 11. For aluminum electrolytic capacitors, the voltage should be 1.5 times the maximum input voltage and close to the IC. It is important to note that if tantalum capacitors are used, it is recommended to use capacitors that have been tested by the manufacturer for inrush current. Special care should be taken when using a dielectric fixed chip capacitor as an input bypass capacitor, as this can cause very serious noise at the input pin.

Adjustable output power supply design example

Design requirements: V_{OUT}=20V, $V_{IN(max)}$=28V, $I_{LOAD(max)}$=3A, F=switching frequency (fixed 150kHz)

Design steps:

1 Calculation of output voltage values (using R1 and R2 in Fig 6)

Select a 1kΩ resistor R1 with a precision of 1% to calculate R2:

$$R_2 = R_1\left(\frac{V_{OUT}}{V_{REF}} - 1\right) = 1k\left(\frac{20V}{1.23V} - 1\right)$$

R2=1k (16.26-1) =15.26kΩ, which is close to 15.4k with a precision of 1%, so take R2= 15.4kΩ.

2 Inductance selection (L1)

(1) The inductance voltage multiplied by microseconds can be calculated by the following formula E • T:

$$E \bullet T = (28 - 20 - 1.16) \bullet \frac{20 + 0.5}{28 - 1.16 + 0.5} \bullet \frac{1000}{150} (V \bullet \mu s)$$

$$E \bullet T = (6.84) \bullet \frac{20.5}{27.34} \bullet 6.67 (V \bullet \mu s) = 34.2 (V \bullet \mu s)$$

(2) E • T=34.2 (V • µs);

(3) $I_{LOAD(max)}$=3A;

(4) The inductance determined by the intersection of the horizontal line of Fig 10, 34 (V·µs) and the vertical line of 3A is 47µH and the inductance number is L39.

(5) As shown in Table 3, in the row where L39 is located, select an inductor device number, and preferably use an inductor with a magnetic shield structure.

3 Output capacitance selection (C_{OUT})

(1) From the quick design device selection shown in Table 2, firstly, select an output voltage column. In the output voltage column, select a voltage line that is closest to the voltage required in your application, in this case, a voltage line of 24V. Then, in the output capacitor section, choose one of the in-line electrolytic capacitors and surface mounted tantalum capacitors listed by four different manufacturers.

(2) When the output voltage is 20V, the capacitor should withstand at least 30V or higher. In this case, either a 35V or 50V capacitor can be used. If a low output ripple voltage is required, 50V can also be selected. As long as they are similar to those listed in the table, low ESR capacitors from other manufacturers can also be used.

4 Front feedback capacitor selection (C_{FF})

Table 2 includes feedforward capacitance values for different output voltages. In this case, a capacitance of 560pF is required.

5 Free-wheeling diode selection (D1)

Refer to Table 4. In this case, the 5A/40V Schottky diode IN5825 can produce good results, and, in the case of a short output, will not overload.

6 Input capacitance selection (C_{IN})

Voltage resistance and ripple current of input capacitor are important parameters of input capacitor. If the input voltage is 28V, then the voltage of the aluminum electrolytic capacitor is greater than 42V ($1.5\times V_{IN}$), then a 50V capacitor is to be used. The ripple current of the input capacitor of SIT2596 is about half of the current of the DC load. In this case, the load current is 3A. So, the ripple current of the input capacitor is at least 1.5 A. The suitable capacitor can be selected using the graph shown in Fig 11. In the graph, note that the 50V voltage line corresponds to A capacitance with a ripple current value greater than 1.50A, so we can select a capacitance of 680μF/50V or 470μF/50V. For designs that choose DIP components, an electrolytic capacitor of 680μF/50V is sufficient, and other types or manufacturers of capacitors can be used to provide sufficient ripple current. SMD tantalum capacitors can be selected for the design of the selected sticker element, but it is important to note that the surge current value of the capacitor must be tested. The surge current values of AVX's TPS series and VISHAY's 593D series devices were tested.

Output voltage (V)	DIP output capacitor			SMD output capacitor		
	PANASONIC HFQ series (μF/V)	NICHICON PL series (μF/V)	Forward feedback capacitance	AVX TPS series (μF/V)	VISHAY 595D series (μF/V)	Forward feedback capacitance
2	820/35	820/35	33nF	330/6.3	470/4	33 nF
4	560/35	470/35	10 nF	330/6.3	390/6.3	10 nF
6	470/25	470/25	3.3 nF	220/10	330/10	3.3 nF
9	330/25	330/25	1.5 nF	100/16	180/16	1.5 nF
12	330/25	330/25	1 nF	100/16	180/16	1 nF
15	220/35	220/35	680pF	68/20	120/20	680 pF
24	220/35	150/35	560 pF	33/25	33/25	220 pF
28	100/50	100/50	390 pF	10/35	15/50	220 pF

Table 2 Output capacitance and forward feedforward capacitance selection table

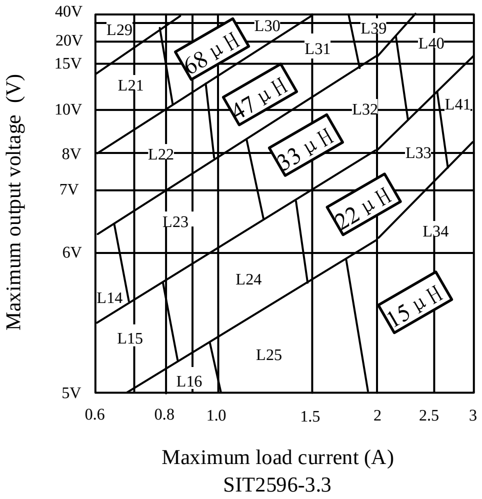


Fig 7

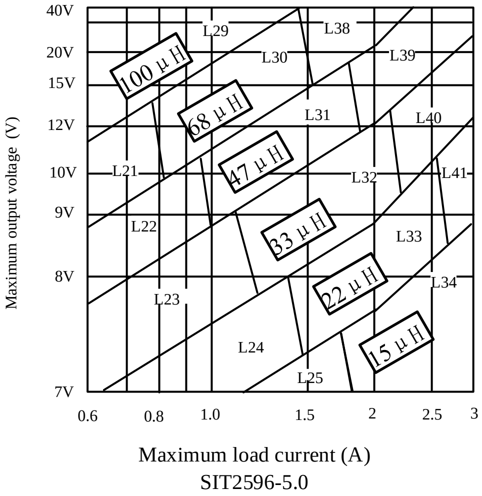


Fig 8

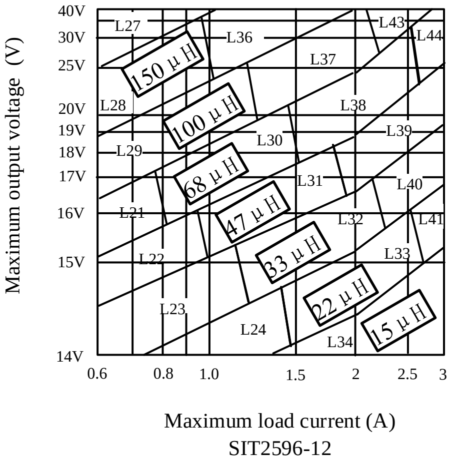


Fig 9

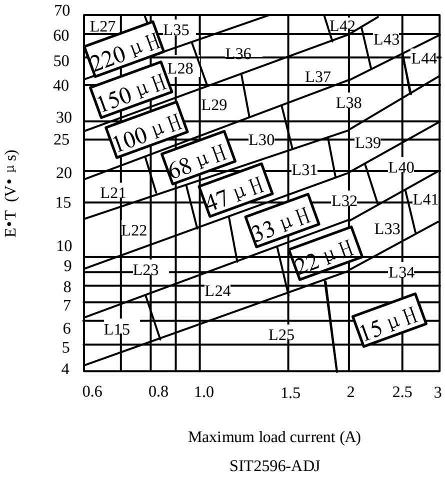


Fig 10

Number / Inductor (µH) / Current (A)	Schott		Renco		Pulse Engineering		Coilcraft
	DIP	SMD	DIP	SMD	DIP	SMD	SMD
L15/22/0.99	67148350	67148460	RL-1284-22-43	RL1500-22	PE-53815	PE-53815-S	DO3308-223
L21/68/0.99	67144070	67144450	RL-5471-5	RL1500-68	PE-53821	PE-53821-S	DO3316-683
L22/47/1.17	67144080	67144460	RL-5471-6	--	PE-53822	PE-53822-S	DO3316-473
L23/33/1.40	67144090	67144470	RL-5471-6	--	PE-53823	PE-53823-S	DO3316-333
L24/22/1.70	67148370	67148480	RL-1283-22-43	--	PE-53824	PE-53825-S	DO3316-223
L25/15/2.10	67148380	67148490	RL-1283-15-43	--	PE-53825	PE-53824-S	DO3316-153

Number / Inductor (μH) / Current (A)	Schott		Renco		Pulse Engineering		Coilcraft
	DIP	SMD	DIP	SMD	DIP	SMD	SMD
L26/330/0.80	67144100	67144480	RL-5471-1	--	PE-53826	PE-53826-S	DO5022P-334
L27/220/1.00	67144110	67144490	RL-5471-2	--	PE-53827	PE-53827-S	DO5022P-224
L28/150/1.20	67144120	67144500	RL-5471-3	--	PE-53828	PE-53828-S	DO5022P-154
L29/100/1.47	67144130	67144510	RL-5471-4	--	PE-53829	PE-53829-S	DO5022P-104
L30/68/1.78	67144140	67144520	RL-5471-5	--	PE-53830	PE-53830-S	DO5022P-683
L31/47/2.20	67144150	67144530	RL-5471-6	--	PE-53831	PE-53831-S	DO5022P-473
L32/33/2.50	67144160	67144540	RL-5471-7	--	PE-53932	PE-53832-S	DO5022P-333
L33/22/3.10	67144390	67144500	RL-1283-22-43	--	PE-53933	PE-53833-S	DO5022P-223
L34/15/3.40	67144400	67144790	RL-1283-15-43	--	PE-53934	PE-53834-S	DO5022P-153
L35/220/1.70	67144170	--	RL-5473-1	---	PE-53935	PE-53835-S	--
L36/150/2.10	67144180	--	RL-5473-4	--	PE-54036	PE-53836-S	--
L37/100/2.50	67144190	--	RL-5472-1	--	PE-54037	PE-53837-S	--
L38/68/3.10	67144200	--	RL-5472-2	--	PE-54038	PE-53838-S	--
L39/47/3.50	67144210	--	RL-5472-3	--	PE-54039	PE-53839-S	--
L40/33/3.5	67144220	67148290	RL-5472-4	---	PE-54040	PE-53840-S	--
L41/22/3.50	67144230	67148300	RL-5472-5	--	PE-54041	PE-53841-S	--
L42/150/2.70	67144410	--	RL-5473-4	--	PE-54042	PE-53842-S	--
L43/100/3.4	67144240	--	RL-5473-2	--	PE-54043		--
L44/68/3.40	67144250	--	RL-5473-3	--	PE-54044		--

Table 3 Product models of inductor manufacturers

VR	Output current 3A				Output current 4A to 6A			
	DIP		SMD		DIP		SMD	
	Schottky	UFRD	Schottky	UFRD	Schottky	UFRD	Schottky	UFRD
20V		The lowest voltage of all such diodes is 50V MURS320 30WF10	IN5820	The lowest voltage of all such diodes is 50V MUR320		The lowest voltage of all such diodes is 50V MURS620 50WF10	SR502	The lowest voltage of all such diodes is 50V MUR620 HER601
	SK32		SR302				IN5823	
			MBR320				SB520	
30V	30WQ03		IN5821					
	SK33		MBR330		50WQ03		SR503	
			31DQ03				IN5824	
40V			IN5822				SB530	
	SK34		SR304		50WQ04		SR504	
	MBRS340		MBR340				IN5825	
	30WQ04		31DQ04				SB540	
50V or	SK35		SR305					

VR	Output current 3A				Output current 4A to 6A			
	DIP		SMD		DIP		SMD	
	Schottky	UFRD	Schottky	UFRD	Schottky	UFRD	Schottky	UFRD
higher	MBRS360		MBR350		50WQ05		SB550	
	30WQ05		31DQ05				50SQ080	

Table 4 Diode selection table

APPLICATION ANNOUNCEMENTS

1 Input capacitance (C_{IN})

This is an aluminum electrolytic capacitor or tantalum capacitor bypass capacitor with a Low equivalent resistance (Low ESR) added between the input and the ground. And it must be close to SIT2596 by a short wire. This capacitor prevents excessive transient voltages at the input and provides the SIT2596 with a transient current each time the SIT2596 switches.

For input capacitors, the most important parameters are voltage resistance and ripple current (root mean square value). Due to the relatively high ripple current flowing through the input capacitor of the switching chip (SIT2596), the input capacitor is selected based on the ripple current rather than the capacitance value or withstand voltage value.

The ripple current range of the capacitor can be regarded as the power range of the capacitor, that is, the power generated by the ripple current flowing through the equivalent resistance inside the capacitor and the temperature of the capacitor rises. The ripple current of a capacitor is determined by the current value required to generate heat that raises the internal temperature by 10°C above the ambient temperature (105°C), and the ability of the capacitor to dissipate heat into the surrounding environment will determine the maximum current at which the capacitor can safely operate. For a given capacitance value, in volume, a high-voltage electrolytic capacitor is larger than a low-voltage electrolytic capacitor, which helps to dissipate more heat into the surrounding environment, and its ripple current range is also larger.

Making the electrolytic capacitor work at higher than the ripple current shortens its working life, and the high temperature will accelerate the evaporation of the capacitor electrolyte, and eventually lead to the damage of the capacitor.

When selecting capacitors, refer to the maximum ripple current (root mean square value) on the data sheet provided by the manufacturer. When the maximum ambient temperature is 40°C, it is generally necessary to select a capacitor with a maximum ripple current (root mean square value) of 0.5 times the current of the DC load. When the ambient temperature reaches 70°C, it is best to select a capacitor with a maximum ripple current of 0.75 times the DC load. The capacitor voltage value is at least 1.25 times higher than the maximum input voltage, and sometimes in order to meet the needs of ripple current, a capacitor with a higher voltage value is often selected. Fig 11 shows the relationship between the voltage withstand value of the electrolytic capacitor, the capacitance value, and the ripple current. These curves include the Nicholas PL series electrolytic capacitors with low equivalent impedance and high stability required for design applications related to switching power supplies. Other capacitor manufacturers also provide similar capacitors, but it is generally necessary to check its capacitance data sheet when using. ‘Standard’ electrolytic capacitors generally have high equivalent impedance, low ripple current, and short life.

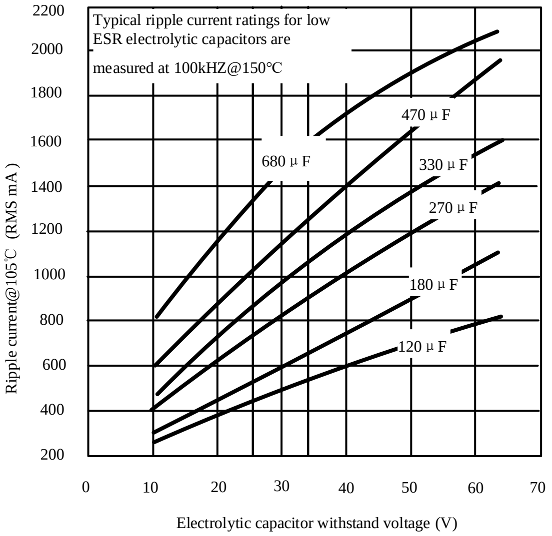


Fig 11 The relationship between electrolytic capacitor withstand voltage value, capacitance value and root mean square current

Due to its small size and good performance, the SMD tantalum capacitor is generally used as an input bypass capacitor, but there are several points that must be prevented in advance. When the surge current is exceeded, a small part of the solid tantalum capacitor will be broken down. Several capacitor manufacturers do inrush current checks on all their products to minimize this potential problem. If a higher starting current is required, it is necessary to add some resistance or inductance before the tantalum capacitor, or choose a capacitor with a high voltage value. For aluminum electrolytic capacitors, the ripple current is preferably as large as the load current.

2 Forward feedback capacitance (C_{FF})

When the output voltage is greater than 10V or the equivalent resistance of the output capacitor is very small, a feedforward capacitor C_{FF} should be added, as shown in Fig 6. This capacitor is used to compensate the feedback loop and increase the phase margin to improve the stability of the loop. For the choice of C_{FF}, please refer to the relevant design steps.

3 Output capacitance (C_{OUT})

This capacitor is used to filter the output and improve the stability of the loop. In the design of switching regulators, electrolytic capacitors or solid tantalum capacitors with LOW impedance or low equivalent resistance (LOW ESR) must be used. When selecting the output capacitance, several important parameters are:

(1) Equivalent series resistance (ESR) at 100kHz;
(2) Maximum ripple current;
(3) Withstand voltage value;
(4) Nominal capacity.

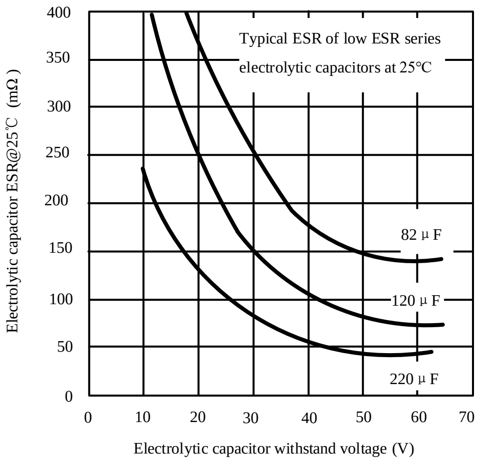


Fig12 The relationship between the ESR of the electrolytic capacitor and the withstand voltage

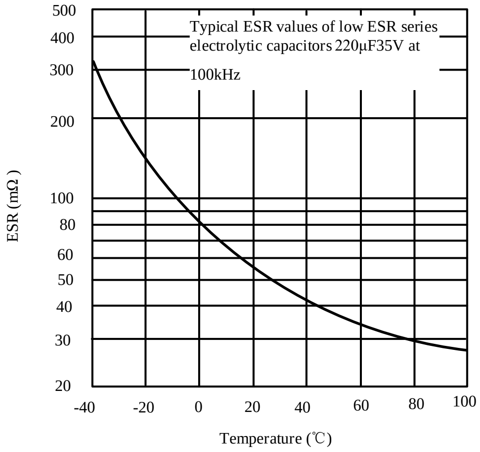


Fig 13 The relationship between the ESR electrolytic capacitor and temperature

Equivalent resistance (ESR) is the most important parameter. The equivalent resistance value of the output capacitance has an upper limit and a lower limit. If the ripple voltage of the output voltage is small, the equivalent resistance value of the output capacitance is expected to be smaller. This value is determined by the permissible maximum ripple voltage, generally 1% to 2% of the output voltage. However, if the equivalent resistance value of the output capacitor is too small, it is possible to make the feedback loop unstable, and eventually cause the output to oscillate. Using the capacitors listed in the table or similar capacitors will solve this problem.

The equivalent resistance value of the aluminum electrolytic capacitor is related to its capacitance value and voltage withstand value. In many cases, the equivalent resistance of the electrolytic capacitor is small if the voltage withstand value is low (see Fig 12). Generally, when the output ripple voltage is small and the equivalent impedance is low, the electrolytic capacitor with high voltage withstand value should be selected. In the design of many different switching power supplies, only three or four capacitance values or several different voltage withstand values of the output capacitor can meet the design requirements. At temperatures below -25°C, it is recommended not to use electrolytic capacitors, because the equivalent resistance value of electrolytic capacitors increases sharply at low temperatures (see Fig 13). Since solid tantalum capacitors have good equivalent resistance at temperatures below -25°C, it is recommended to use solid tantalum capacitors at temperatures below -25°C.

4 Freewheel diode

In SIT2596 applications, a freewheel diode is required to provide a path for inductive current (when the switch is closed). This must be a fast diode close to SIT2596, with short pins and short connected wires.

Because the Schottky diode switch is fast and has a small positive voltage drop, it performs well in use, especially in applications with low output voltage (5V or lower). Ultrafast recovery or high efficiency rectifier diodes also perform well in use. However, it may cause instability or EMI problems during sudden shutdown. Ultrafast recovery diodes typically have reverse recovery times of 50ns or less. Rectifiers (such as the 1N5400 series) are too slow to be used.

5 Inductance

All switching power supplies have two basic modes of operation: continuous mode and discontinuous mode, the difference between the two modes is the difference in the current flowing through the inductor, either continuously, or after a certain period of time in a switching cycle becomes 0. Each mode of operation has different characteristics that can affect power performance and demand. When the load current is small, most switch designs will operate in discontinuous mode.

SIT2596 can be used in both continuous mode and discontinuous mode.

Continuous operation mode:

In most cases, people prefer to use continuous mode, which can provide greater output power, while the peak switching current, inductor current, diode current and output ripple voltage are small. However, this requires a larger inductor to maintain the continuity of the current flowing through the inductor, especially if the output load current is small or the input voltage is high.

To simplify the process of selecting inductors, refer to Fig 7 to Fig 10. This assumes that the power supply operates in continuous mode and that the peak-to-peak value of the ripple current of the inductor is a percentage of the designed maximum output current. The percentage of the peak-to-peak value of this inductive ripple current is not fixed, it can change with different load currents. As shown in Fig 14.

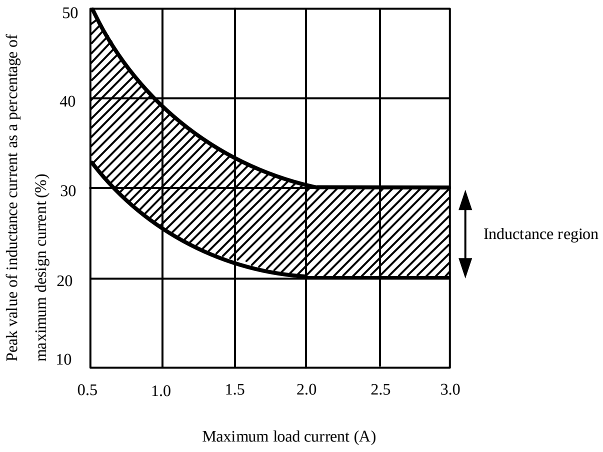


Fig 14

By allowing the percentage of the inductor ripple current to be increased at a low load current, the value and size of the inductor can be kept relatively low.

When operating in continuous mode, the inductive current waveform varies from triangular to sawtooth (as determined by the input voltage), and the average value of the current waveform is equal to the output DC load current.

There are different types of inductors, such as basin core, ring core, E core, bobbin core, etc., and different core materials, such as ferrite and iron powder. The cheapest is composed of a coaxial spool, a rod core, and a wire wound around a ferrite spool. This structure makes the inductor inexpensive, but because the magnetic flux is not fully contained within the core, it generates more electromagnetic interference (EMl). This magnetic flux can induce voltage into nearby printed circuit routes, causing problems with switching power supply operation and nearby sensitive circuits, and giving incorrect oscilloscope readings due to the induced voltage in the oscilloscope probe.

When multiple switching regulators are located on the same PCB, the open core can cause interference between two or more regulator circuits, especially at large currents. In these cases, ring or E-type inductors (closed magnetic structures) should be used.

Exceeding the maximum current rating of the inductor may cause the inductor to overheat due to copper wire loss, or the core may become saturated. If the inductance begins to saturate, the amount of inductance decreases rapidly, and the inductance is equivalent to the resistance (the DC resistance of the winding), which causes the switching current to rise rapidly, forcing the switch into the cycle-by-cycle current limit, thereby reducing the DC output load current. This can also cause the inductor or SIT2596 to overheat. Different inductor types have different saturation characteristics, so this should be considered when choosing an inductor.

Discontinuous operation mode:

The inductance selection described above is only suitable for continuous operation mode, and for applications with low current or/and high input voltage, discontinuous mode is the better choice. In this case, the required inductance size is smaller, and the inductance value only needs to be 1/2 to 1/3 of the continuous mode, in the discontinuous mode, the peak switching current and inductive current will be higher, but in this low load current (1A or less), the maximum switching current is still less than the limit switching current. The voltage waveform of the discontinuous operation mode is very different from that of the continuous operation mode, and there is a weak sinusoidal noise on the output pin waveform, but this is normal for the discontinuous operation mode and is not caused by the instability of the feedback loop. In discontinuous operation mode, there is a period of time when neither the switching tube nor the diode is working and the inductor current drops to 0. During this period, a small amount of energy flows between the inductor and the switching tube/diode, while noise is caused by the parasitic capacitance. Normally, this is not a problem unless the amplification is large enough to make it exceed the input voltage. Even then, there’s only a very low energy loss. Different inductance types or different core materials will cause different levels of noise, the inductance of the ferrite core, because its core loss is very small, so caused a lot of noise, and the core loss of the core inductance caused by the noise is very small. If necessary, some RC network (in parallel with the inductor) can be given to the inductor to suppress the noise.

6 Output ripple voltage and transient voltage

The output voltage of a switching power supply operating in continuous mode may contain some sawtooth voltage at the switching frequency, and some short burrs at the peak of the sawtooth wave.

The output ripple voltage is caused by the ripple current of the inductor and the equivalent resistance of the capacitor, and the typical output ripple voltage can range from 0.5% to 3% of the output voltage. To obtain a small ripple voltage, the equivalent resistance of the output capacitor must be small, however, when using an output capacitor with a very small equivalent resistance, it is important to note that this may affect the stability of the feedback loop and eventually lead to oscillation problems at the output. If you want the output ripple voltage to be very small (less than 20mV), a post-ripple filter is recommended, and the typical value of the required inductance is 1μH to 5μH. Output filter capacitors with low equivalent impedance are also required to ensure good dynamic load response and ripple suppression.

Voltage burrs are caused by the fast switching of the output switching tube and diode, the parasitic inductance of the output filter capacitor, and the wires associated with it. To reduce these voltage burrs, it is necessary to use a special capacitor suitable for switching power supplies, at the same time, its pin must be short. Loop inductors, distributed capacitors, and oscilloscope probes used to measure transient voltages all cause burrs. When the power supply is operating in continuous mode, the inductive current waveform changes from triangular to sawtooth wave (as determined by the input voltage). For a given input and output voltage, the peak-to-peak value of the inductance current waveform is a constant, as the load current increases or decreases, the current sawtooth wave will also rise or fall, the average value of the current waveform is equal to the DC load current value. If the load current is low enough, the trough of the current sawtooth wave becomes zero, and the switching power supply can be converted between continuous and discontinuous.

In the design of a switching power supply, knowing the peak-to-peak value of the inductance ripple current (ΔI_{IND}) will facilitate the determination of other parameters in the circuit, such as the peak current of the inductor or switching tube, the minimum load current of the circuit before being converted to a discontinuous mode, the output ripple voltage, and the equivalent impedance of the output capacitance. Using Fig 7 to Fig 10 and Table 3 to select inductance values, the peak-to-peak values of inductance ripple current can be calculated immediately. Fig 15 shows the range of peak-to-peak values of inductance ripple current that can be determined by different load currents.

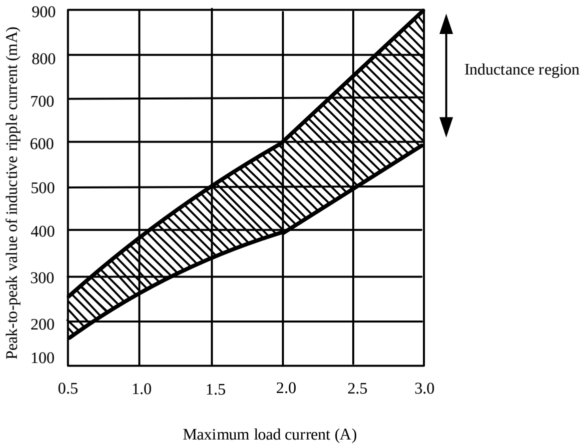


Fig 15 Relation curve between peak-to-peak value of inductance ripple current and load current

The graph also shows the peak-to-peak value change of the inductance ripple current when the inductance region changes from the bottom edge to the top edge, with the top edge representing a high input voltage and the bottom edge representing a low input voltage. These graphs are correct only in continuous operation mode and can only be used to select inductance values.

Consider the following example: V_{OUT}=5V, $I_{LOAD\,(max)}$=2.5A, V_{IN}=12V (varies between 10V and 16V).

The intersection of the vertical line of 2.5A and the horizontal line of 12V in Fig 8 is almost halfway between the top and bottom edge of the 33μH inductance region, where the 33μH inductance peak current is a percentage of the maximum load current. Refer to Fig 15. The peak-to-peak value of the inductance ripple current corresponding to the middle of the inductance region through which the 2.5A current line passes is about 620 mA.

When the input voltage increases to 16V, the intersection point reaches the top edge of the inductance region, and the corresponding peak-to-peak value of the inductance ripple current (ΔI_{IND}) also increases. Refer to Fig 15, it can be seen that when the load current is 2.5A and the input voltage is 12V, the corresponding peak-to-peak value of the inductance ripple current is 620 mA. When the input voltage is 16V, the corresponding peak-to-peak value of the inductance ripple current is 740 mA. When the input voltage is 10V, the corresponding peak-to-peak value of the inductor ripple current is 500 mA. Once the peak-to-peak value of the inductive ripple current is known, other parameters of the switched regulator circuit can be calculated using the following formula.

(1) Peak current of inductors and switching tubes

$$I_{PP} = \left(I_{LOAD} + \frac{\Delta I_{IND}}{2}\right) = \left(2.5A + \frac{0.62}{2}\right) = 2.81A$$

(2) The minimum load current before the circuit operating mode becomes discontinuous

$$I_{LOAD(MIN)} = \frac{\Delta I_{IND}}{2} = \frac{0.62}{2} = 0.31A$$

(3) Output ripple voltage

$$V_{PP} = (\Delta I_{IND}) \times (\text{output electrolytic capacitance ESR}) = 0.62\ A \times 0.1\ \Omega = 62\ mV$$

Output electrolytic capacitance ESR (equivalent series resistance)

$$ESR = \frac{\text{Output ripple voltage}}{\text{Output ripple current}} = \frac{0.062V}{0.62A} = 0.1\Omega$$

7 Open inductance

Another possible source of increased output ripple voltage or unstable operation is open inductance. The magnetic flux line of a ferrite spool or rod inductor flows through air from one end of the spool to the other. These flux lines will induce voltage in any wire or PCB copper wire within the inductive magnetic field. The strength of the magnetic field, the orientation and position of the PCB copper wire in the magnetic field, and the distance between the copper wire and the inductor determine the amount of voltage generated in the copper wire. Another way to observe this inductive coupling is to consider the PCB copper wire as a turn (secondary) of the transformer, dominated by inductive windings, copper wires located near the open inductor may generate millivolt level induced voltage, which can cause stability problems or high output ripple voltage problems.

If an unstable condition is found and an open inductor is used, the position of the inductor relative to other PCB tracks may be the problem. To determine if this is the problem, temporarily lift the inductor a few centimeters off the circuit board and then check how the circuit works. If the circuit is working properly, the problem is caused by the magnetic flux from the open inductor. Replacing a shielded inductor or E-type inductor will correct the problem or rearrange the PCB layout. The distance between the inductor and the IC ground wire, feedback wire or positive and negative lines of the output capacitor should be increased as much as possible.

Sometimes, placing the wire directly under the spool inductor has a good effect, provided it is right in the center of the inductor (because the induced voltages cancel each other out). However, if the trajectory is off-center in one direction or the other, problems can arise. If there is a magnetic flux problem, even the direction of the inductance winding will have an effect on some circuits.

8 Heat dissipation

The SIT2596 is available in two package, 5-pin TO-220 (T) and 5-pin TO-263 (S).

In general, the TO-220 (T) package requires a heat sink. The size of the heat sink is determined by the input voltage, output voltage, load current and ambient temperature. As is shown in Fig 16, the curve that the temperature of SIT2596 is higher than the ambient temperature when the load current is 3A and the input voltage and output voltage are different. These data were measured when the SIT2596 was used as a switching power supply at an ambient temperature of 25°C. These rising data of temperature are approximate, and there are many factors that can affect these temperatures, the higher the ambient temperature, the more heat needs to be dissipated.

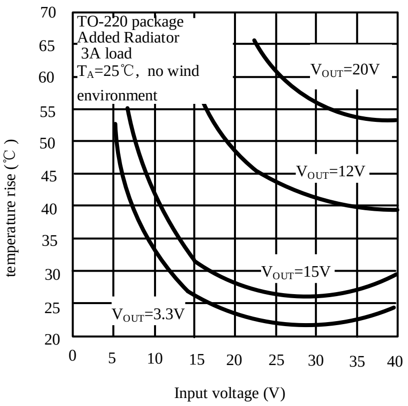


Fig 16

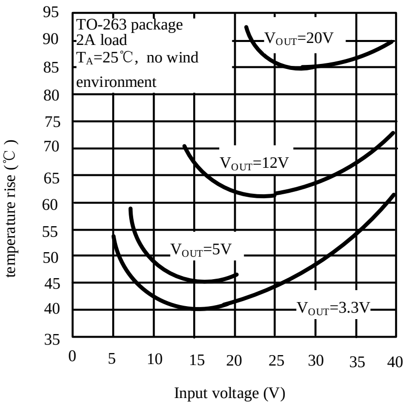
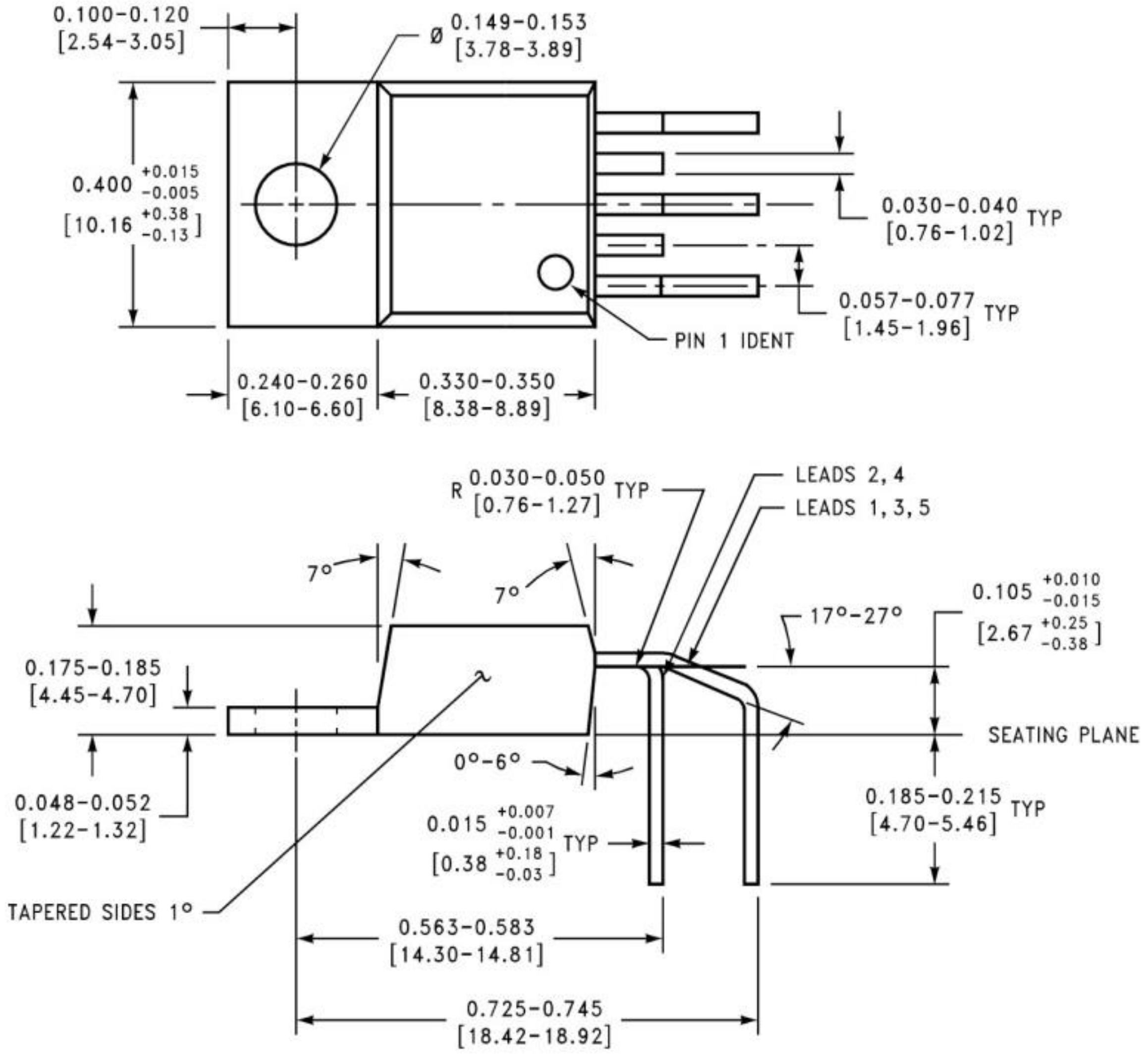


Fig 17

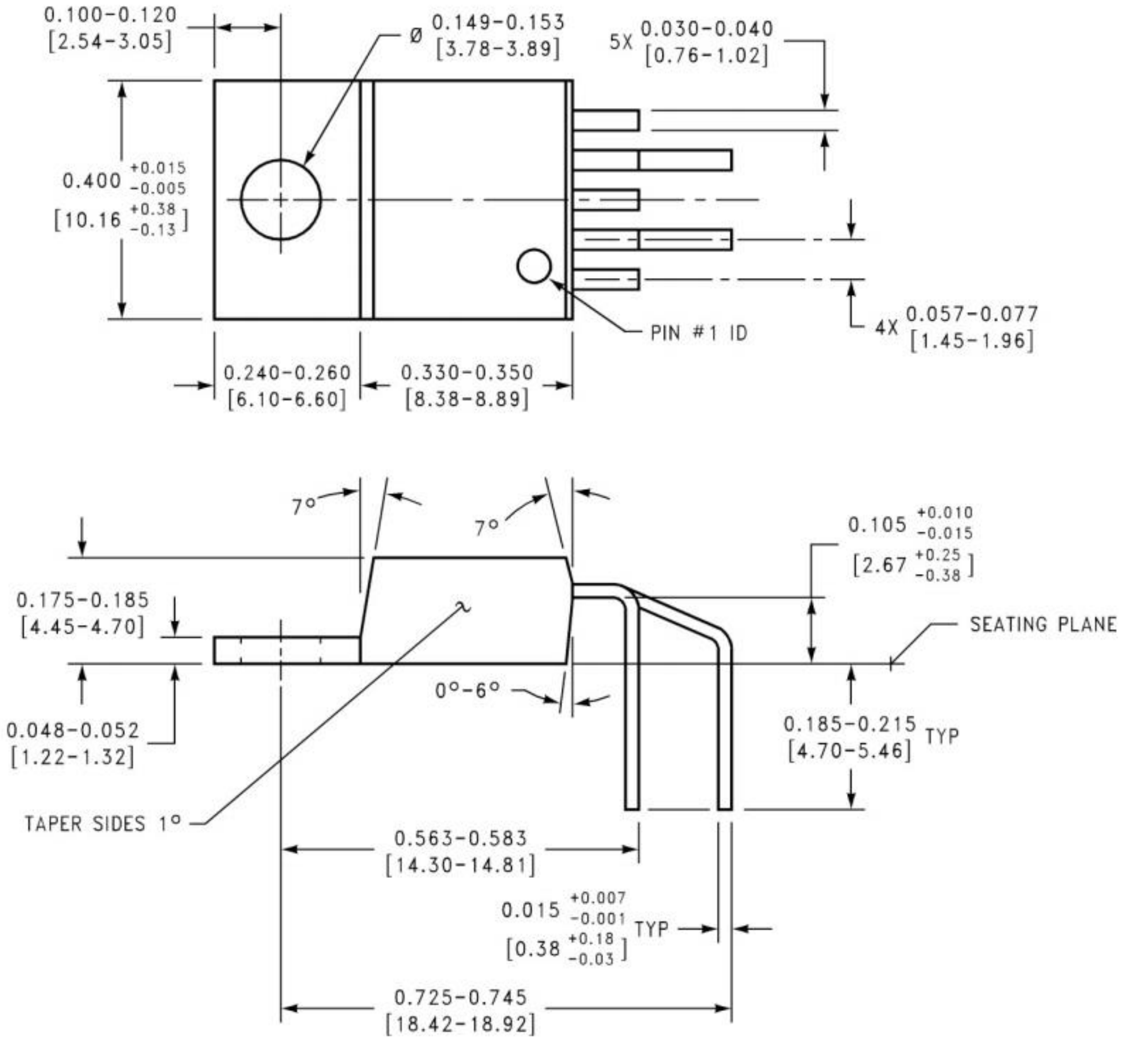
SIT2596 in the TO-263 (S) package is a surface mount component to be soldered onto a PCB board. Copper and PCB boards contribute to the heat dissipation of this package device and other heat dissipation elements, such as absorbing diodes and inductors. Solder the PCB of this package with at least 0.4 square inches of copper-covered area, more copper-covered area will improve the thermal characteristics, but when the area is greater than 6 square inches, the improvement in heat dissipation is small, if further improvement in heat dissipation is needed. It is recommended to use multiple PCB boards with large copper coating areas or in the case of ventilation. Fig 17 shows the temperature of SIT2596 in TO-263 package that is higher than the ambient temperature under the load current of 2A and different input and output voltages.

TO-220-5 DIMENSIONS

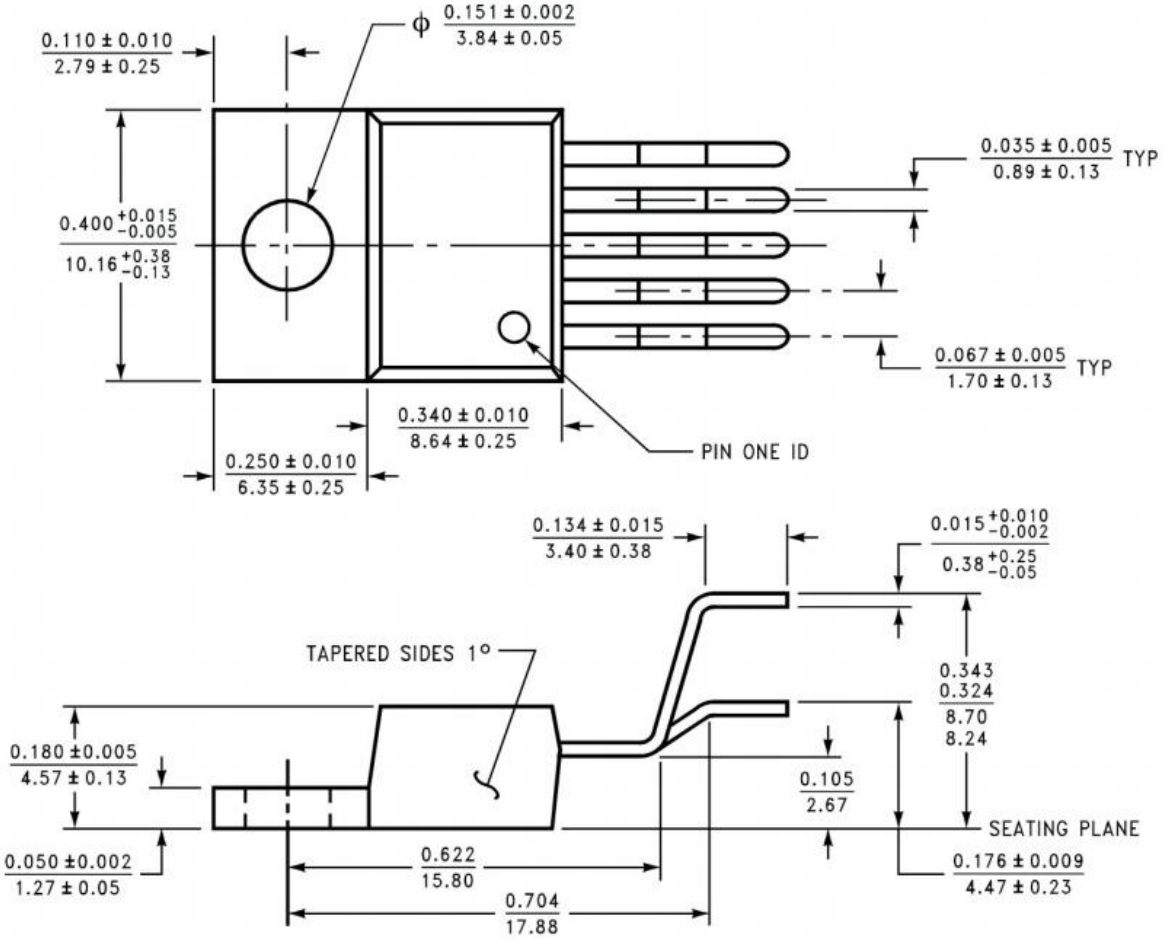
TO-220-5-1 package size



TO-220-5-2 package size

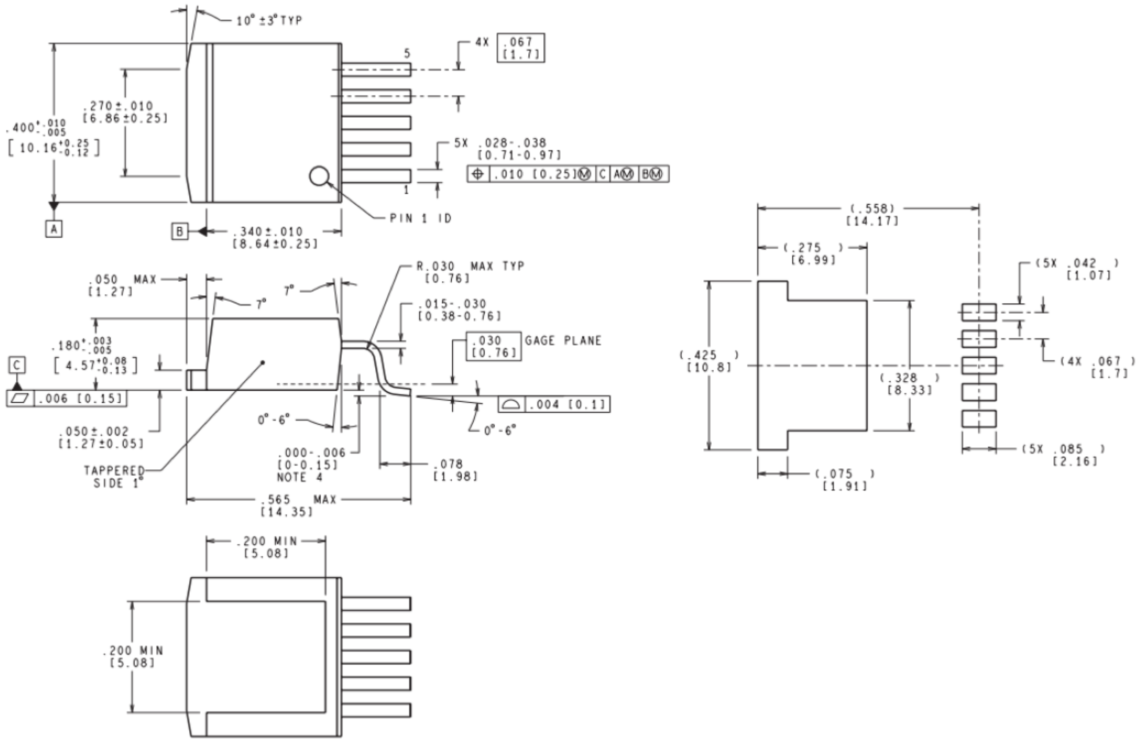


TO-220-5-3 package size



TO-220-5 DIMENSIONS

TO-263-5 package size



BOTTOM SIDE OF PACKAGE

ORDERING INFORMATION

TYPE NUMBER	TEMPERATURE	PACKAGE
SIT2596S-5.0	-40℃~125℃	TO263-5
SIT2596T-5.0	-40℃~125℃	TO220-5
SIT2596S-3.3	-40℃~125℃	TO263-5
SIT2596T-3.3	-40℃~125℃	TO220-5
SIT2596S-12	-40℃~125℃	TO263-5
SIT2596T-12	-40℃~125℃	TO220-5
SIT2596S-ADJ	-40℃~125℃	TO263-5
SIT2596T-ADJ	-40℃~125℃	TO220-5

Important statement

SIT reserves the right to change the above-mentioned information without prior notice.

REVISION HISTORY

Version number	Data sheet status	Revision date
V1.0~V1.1	Product datasheet.	June 2023