Synchronous·Rectifier·Power·Switch IC

1. Feature

- Built-in TrueWave™ real-time waveform tracking function
- Suitable for 5~12 V ultra-wide range synchronous rectification
- CCM/CrM/DCM mode of switching power is supported
- Built-in NMOSFET BVdss up to 65 V
- Built-in NMOSFET RdsON down to 8 mΩ
  - LN5S200 : 20 mΩ typ
  - LN5S20 : 15 mΩ typ
  - LN5S20A : 10 mΩ typ
  - LN5S20B : 8 mΩ typ
- 3~6 % higher than conventional diode rectification efficiency
- Extremely wide operating voltage range from 4 V to 40 V
- Powered by simple positive flyback rectification
- The 5V can be powered directly or supplied by an auxiliary winding is supported
- Standby current can be as low as 0.2 mA when no switching action
- Support switching power supply frequency up to 120 kHz
- Simple peripheral does not require any external components in the simplest application
- Standard SOP8 package with reasonable footprint is available

2. Applications

- 5~12 V / 1.5~4A Charger
- High efficiency adapter

3. Description

The LN5S20x is a high performance switching power supply secondary side synchronous rectification power switcher IC with built-in MOSFET. It is easy to build a fast-charging switching power supply system with a 5~12 V voltage range and 1.5~4A current level that meets energy efficiency such as CoC V5 and DoE VI. It is an ideal diode rectifier solution with excellent performance. The chip features a unique TrueWave™ full-time waveform tracking technology that supports switching frequency up to 120 kHz and supports various switching power supply operating modes such as CCM/CrM/DCM, which automatically turn on or off the internal Low RdsON MOSFET device quickly on the edge of each waveform conversion of the switching power supply, using its extremely low turn-on voltage drop to achieve much lower conduction loss than a Schottky diode, greatly improving the conversion efficiency of the system and greatly reducing the temperature of the rectifying device. It can easily realize low-voltage and high-current switching power supply applications with extremely high conversion efficiency.

The chip has an NMOSFET synchronous rectification power switch with a BVdss up to 65V and a very low internal resistance. Typical RdsON is as low as 8 mΩ, which provides up to 4 A current output capability, excellent conversion performance and greatly improved conversion efficiency.

The chip also has built-in high-voltage direct detection technology, detecting terminal BVdss up to 65 V, with a supply voltage range of up to 40 V, so that the controller can directly use the positive flyback energy obtained from the transformer terminal to supply power, resulting in better on-resistance performance and allowing the output voltage to drop to very low values in a simple manner.

The highly integrated circuit design makes the peripheral circuit of the chip extremely simple. In a 5 V / 9 V /12 V fast charge and 12V 1A/2A/3A adaptor application, only one capacitor can be used to build a complete synchronous rectification application.

SOP8 package that meets RoHs requirements is available.

4. Functional Block Diagram

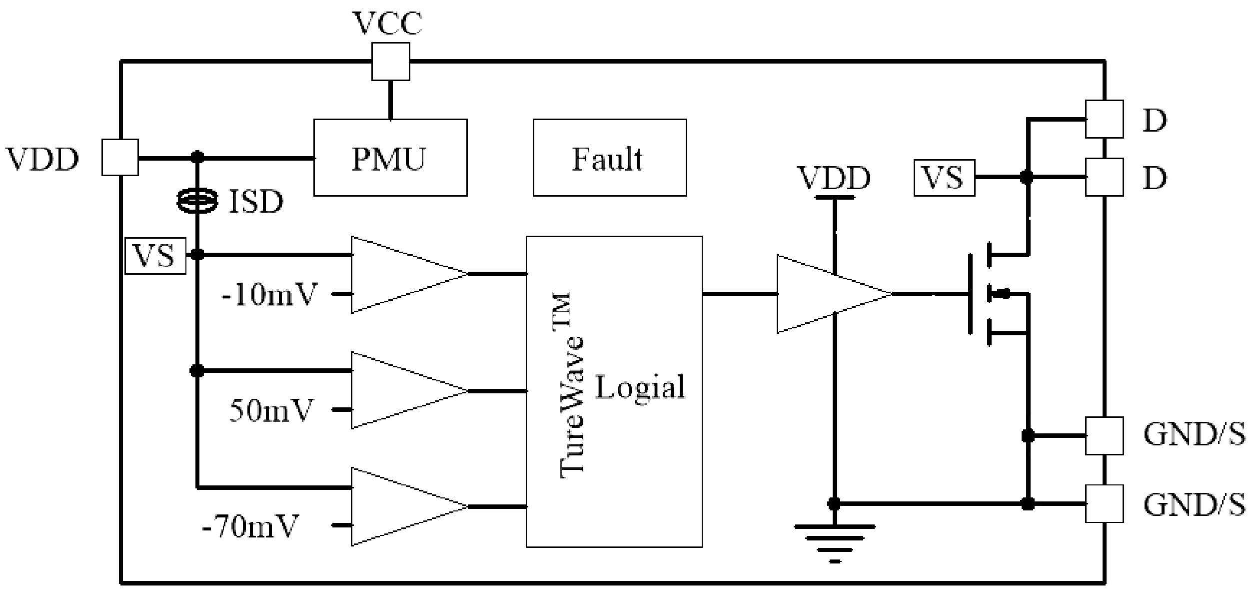

Fig1. Internal functional block diagram

5. Pin Definitions

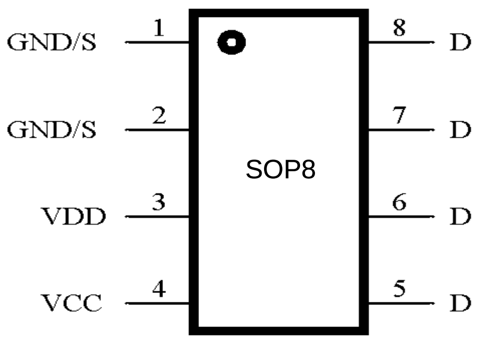

Fig2. Pin Definitions

6. Pin Function Description

PIN	Symbol	Function
1,2	GND/S	Ground pin, internal MOSFET Source pin
3	VDD	Internal power supply pin, connect to decoupling capacitor
4	VCC	Power supply pin
5,6,7,8	D	Switch pin, internal MOSFET Drain pin

7. Typical Simplified Schematic

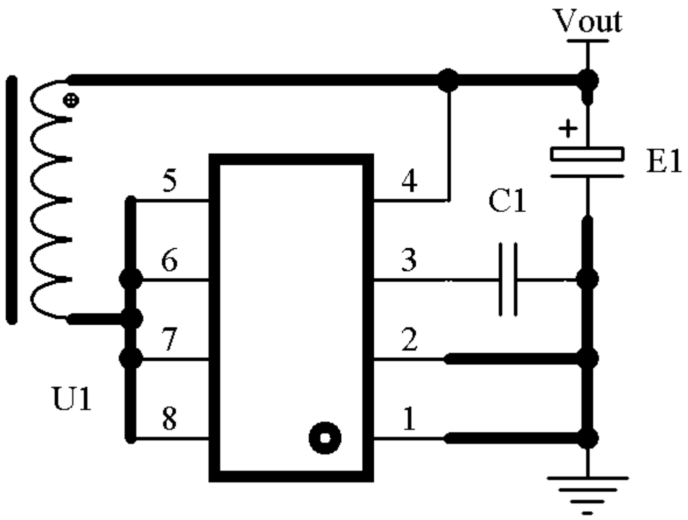

Fig3. Typical Simplified Schematic

8. Absolute Maximum Ratings *

Parameter		Rating	Units
D Pin Input Voltage		65	V
D Pin Input Current		+25 to -1**	mA
VCC Pin Input Voltage		40	V
Other Pin Input Voltage		-0.3 to 7	V
PD		1000	mW
Min/Max TJ		-40 to 150	℃
Min/Max Tstg		-55 to 150	℃
Rθj-a		90	℃/W
ESD	HBM	2500	V
	MM	250	V

Note*: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute maximum-rated conditions for ex tended periods may affect device reliability.** : Only allow width is 1ms pulse and period is 1s.

9. Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Units
VCC	VCC Supply Voltage	4.5		40	V
V_{DS}	Peak Drain Voltage			60	V
T_{AMP}	Operating Ambient Temperature	-20		105	℃

10. Electrical Characteristics(Ta = 25℃, VCC=12V, if not otherwise noted)

VCC Section

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
VCC_{ON}	VCC Start-up Voltage	VCC from 0 V to 12 V	-	4.3	-	V
VCC_{OFF}	VCC Shut-down Voltage	VCC from 12 V to 0 V	-	4.0	-	V
VCC_{HYT}	UVLO Hysteresis Voltage		-	0.3	-	V
I_{VCC}	VCC Standby Current	VCC=5 V, VS=0 V	-	0.2	-	mA
I_{VCC2}	VCC Operating Current	VCC=5 V, VS=50 kHz	-	4	-	mA

VDD Section

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
VDD_{RANGE}	VDD Voltage Range	VCC=OPEN	4.0	-	7.5	V
VDD_{RATED}	VDD Rated voltage	VCC=5-12 V	4.5	6.5	7.5	V
I_{VDDQ}	VDD Standby Current	VDD=5 V, GATE=OPEN	-	100	-	uA
V_{DDUVP}	VDD Under-voltage Protection Threshold	VDD from 7 V to 0 V	-	4	-	V
I_{VDDC}	VDD Current Limit		-	30	-	mA

D Section

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
V_{BSS}	Power Switch Withstand Voltage	ID=100uA	65	75	-	V
$R_{DS}ON$	Power Switch Internal Resistance	LN5S200, VCC=12 V	-	20	-	mΩ
		LN5S20, VCC=12 V	-	15	-	mΩ
		LN5S20A, VCC=12 V	-	10	-	mΩ
		LN5S20B, VCC=12 V	-	8	-	mΩ
T_r	Output Rise Time	D=0->30 V, IO=2 A	-	20	-	nS
T_f	Output fall Time	D=30 V->0 V, IO=2 A	-	50	-	nS

VS Section

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
I_{SD}	VS Pull-up Current	VS=0 V	-	50	-	uA
VS_{THON}	VS Turn-on Threshold Voltage		-	-70	-150	mV
VS_{THOFF}	VS Shut-down Threshold Voltage		-	-10	-	mV
VS_{THONS}	VS Reset Threshold Voltage		-	50	100	mV
T_{HOLD}	VS Blanking Hold Time		-	1.5	-	us

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12. Application and Implementation

The LN5S20x is a high performance secondary side synchronous rectification control IC with built-in 65 V 8~20 mΩ MOSFET designed for energy efficient switching power converters. High compatibility is available in various power modes such as CCM/CrM/DCM. The international energy efficiency standards such as CoC V5 and DoE VI can be easily satisfied in a fast charging source systems with 5~12 V 1.5~4 A output.

12.1 VCC and VDD Supply

The LN5S20x internal power management unit starts operating after VCC pin is powered up, generates the various reference voltage and current signals required, and outputs a stable voltage (typically 6.5 V) on the VDD pin for internal circuitry. The power supply decoupling of VDD is done outside the chip. Usually, only need a non-polar capacitor of not less than 1 uF should be connected in parallel between the VDD pin and ground, as C1 shown in the figure below.

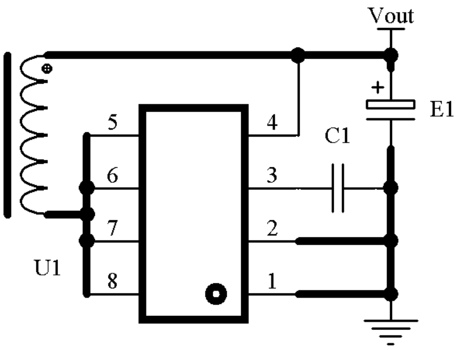


Fig4. VDD decoupling circuit

In applications where the output voltage is no greater than 6.5 V and not less than 4.5 V, the VCC pin and the VDD pin of the chip can be directly connected together to supply powered by the output directly. No need additional decoupling capacitors are required at this time, as shown in the figure below.

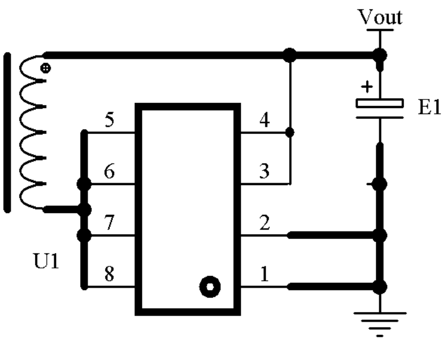


Fig5. VCC and VDD Parallel Supply Circuit

When the output voltage is lower than 4.5 V during normal operation (for example, when the mobile phone charger is loaded in CV mode), should be powered separately at the VCC pin to meet the normal operating range of the chip. An easy way to do this is to use a positive flyback power supply that rectifies a voltage directly from the MOS drain to the VCC terminal, but keep the VCC voltage no more than 40 V under the maximum input voltage. The current limiting resistor R1 is necessary and must be carefully adjusted (the resistance may be 200 Ω), as shown in the figure below.

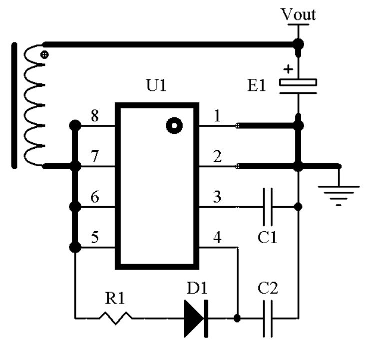


Fig6. VCC buck-boost Power Supply Circuit

When the output voltage may be lower than 4.5 V but the method on the above is unable to get the maximum VCC voltage below 40 V, a separate winding group can be used to supply power to the chip. In this case, the entire synchronous rectification system can be connected to the positive or ground terminal of transformer. As shown in the figure below.

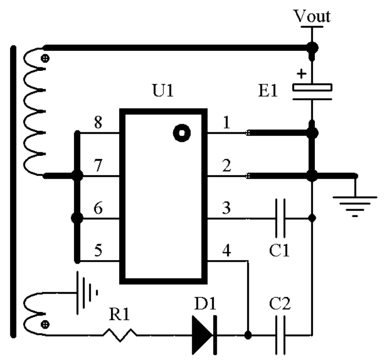


Fig7. VCC Auxiliary Winding Connection Method（Ground Connection）

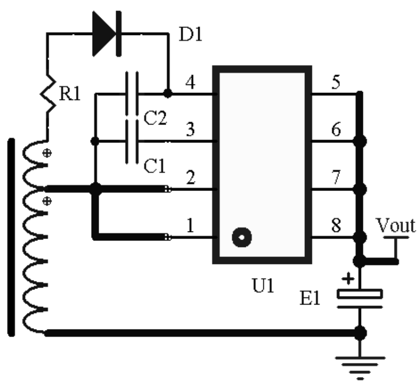


Fig8. VCC Auxiliary Winding Connection Method（Positive Connection）

In comparison, the advantage of the entire synchronous rectification system be connecting to the positive end is that the transformer requires only three taps, but the EMI may be affected by a larger dynamic end area. Conversely, the method of connected to ground has a smaller dynamic end area but the transformer will require four taps.

12.2 Switch Drain and Source Output

The LN5S20x has a built-in 65 V withstand voltage MOSFET with an internal resistance as low as 8~20 mΩ. Its drain is pulled out from the pin 5/6/7/8 to the outside of the chip, and the source is taken out from the pin 1/2 to the outside of the chip. The pins of 5/6/7/8 and 1/2 are the main heat dissipation channels of the chip. In the application, the pins of 5/6/7/8 and 1/2 should be well connected to the external copper foil, and a sufficient area of copper foil should be tinned if necessary to enhance heat dissipation and keep the chip temperature within a reasonable range.

At any time should also ensure that the voltage from the D terminal to the ground does not exceed the rated withstand voltage, so as to avoid the chip being damage caused by overvoltage; the S terminal is connected to the GND terminal internally. It is better to keep the GND/S terminal and the output capacitor or transformer loop as the minimum.

13. Layout Guidelines

13.1 Principles of high-frequency layout

Appropriate PCB layout should be maintained in the application to ensure that the chip-related connection pins have the shortest possible path. In particular, the pin D of the chip should be connected to the transformer terminal or capacitor for the shortest connection. The S terminal should be connected to the output capacitor negative terminal or transformer terminal for the shortest connection. As shown below.

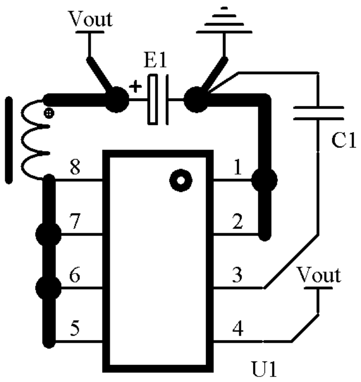


Fig9. Typical current loop diagram

13.2 Typical layout reference

An example of a typical PCB layout is shown below.

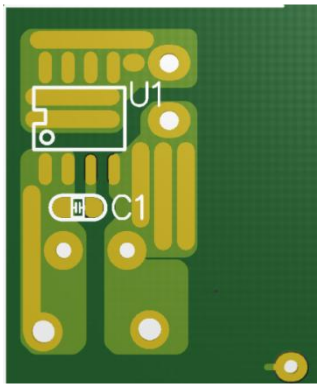


Fig10. Typical layout reference (bottom view)

14. Typical Application Circuit Schematic (input：90~265 Vac)

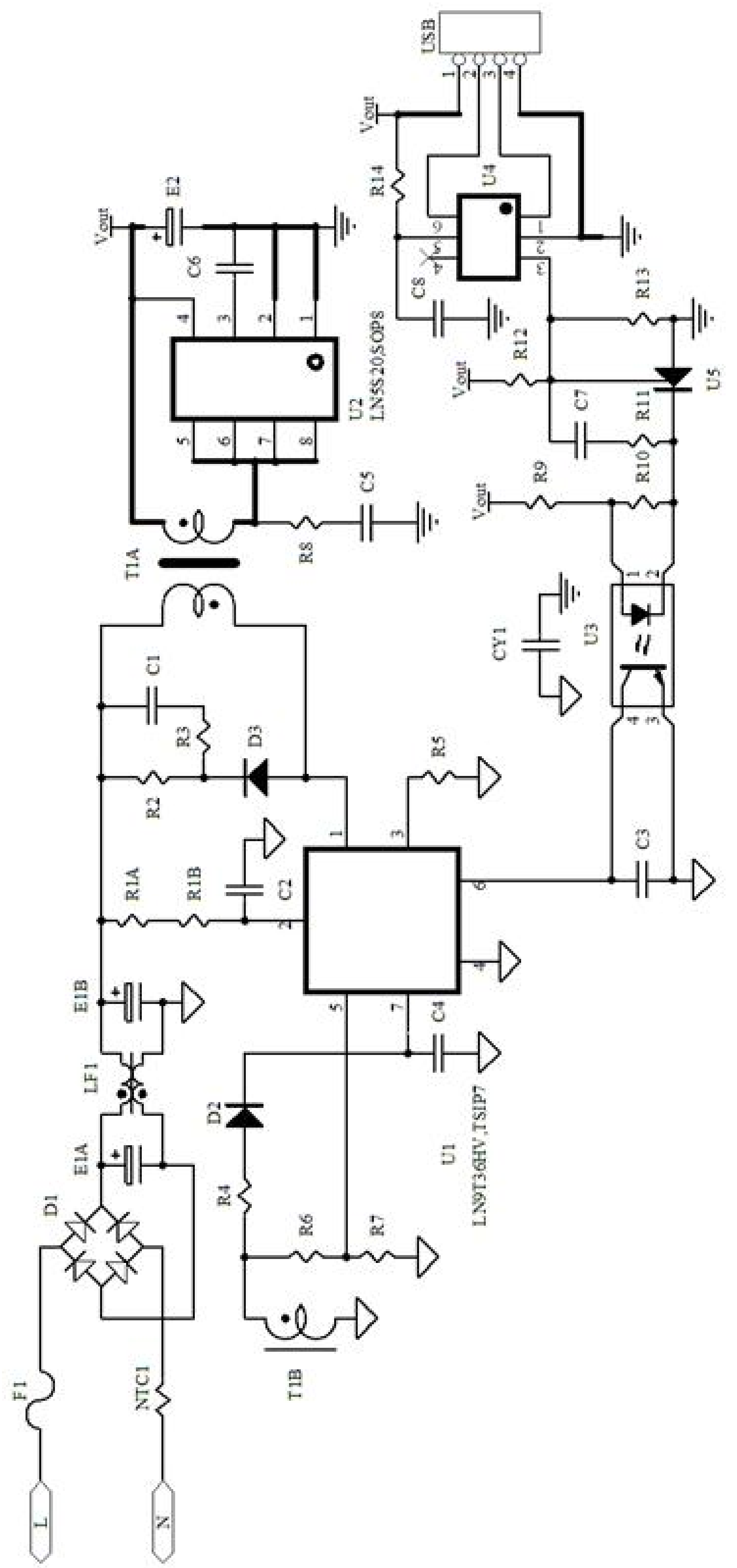
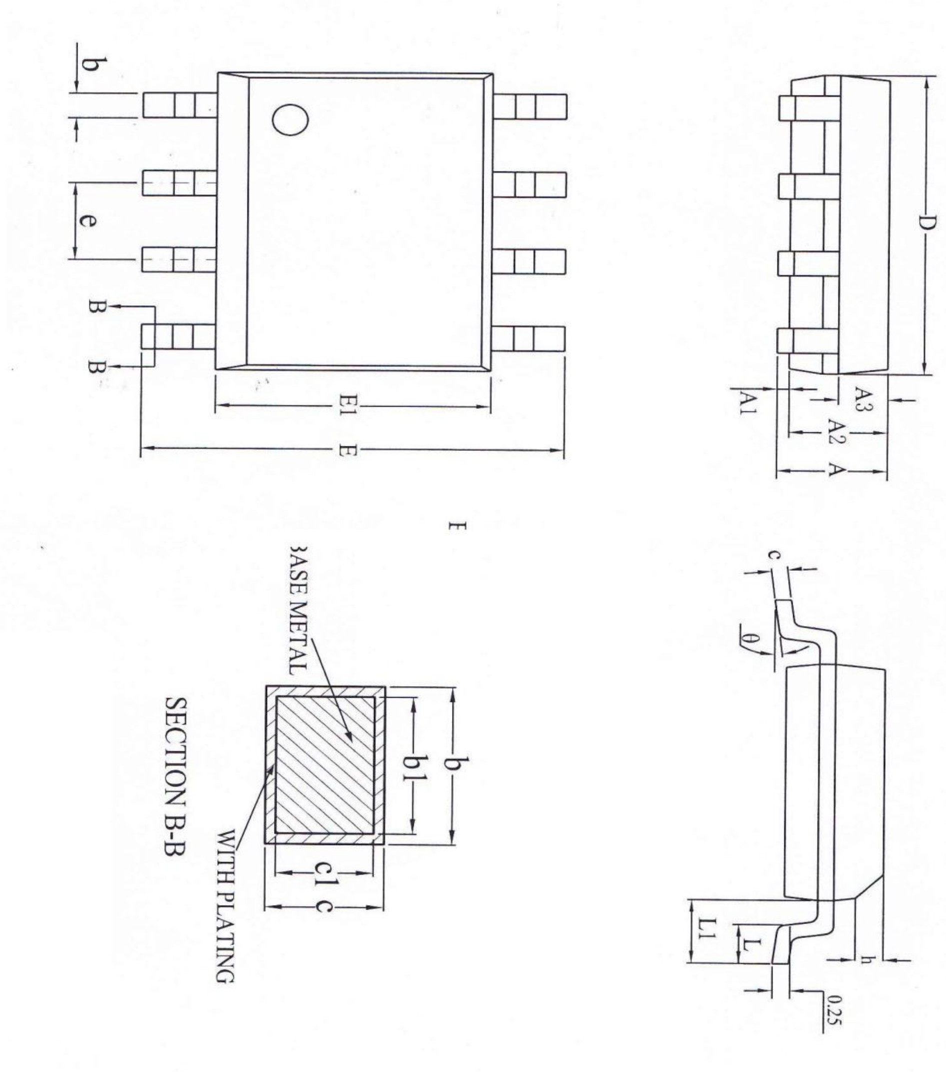


Fig11. Typical Application Circuit Schematic

15. Mechanical and Packaging

SOP8



SYMBOL	MILLIMETER MIN	MILLIMETER NOM	MILLIMETER MAX
A	—	—	1.75
A1	0.10	—	0.225
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	—	0.47
b1	0.38	0.41	0.44
c	0.20	—	0.24
c1	0.19	0.20	0.21
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27BSC		
h	0.25	—	0.50
L	0.50	—	0.80
L1	1.05REF		
θ	0	—	8°

Fig12. Mechanical Dimensional Drawings

16. Orderable Information

Type number	RdsON	Green Standard	package	Quantity per Tube
LN5S200	20 mΩ	halogen-free	SOP8	100 PCS/TUBE
LN5S20	15 mΩ	halogen-free	SOP8	100 PCS/TUBE
LN5S20A	10 mΩ	halogen-free	SOP8	100 PCS/TUBE
LN5S20B	8 mΩ	halogen-free	SOP8	100 PCS/TUBE

17. Important Notice

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