

# Synchronous Rectifier Controller IC

## 1. Feature

- Built-in TrueWave™ real-time waveform tracking function
- CCM/CrM/DCM mode of switching power is supported
- High current ultra-fast totem pole output drive circuit
- Output peak drive current capability up to 1 A
- Extremely wide operating voltage range from 4.5 V to 40 V
- The 5 V can be powered directly or supplied by an auxiliary winding is supported
- Built-in high voltage isolation switch with BVDSS up to 120 V
- Build an ideal diode with Low RdsON MOSFET
- Meets energy efficiency such as CoC V5 and DoE VI
- Standby current can be as low as 0.2mA when no switching action
- Support switching power supply frequency up to 200 kHz
- Only one MOSFET switch is required for the extremely simple extra components
- SOT23-5 package form with a small footprint is available

## 2. Applications

- High efficiency USB Charger
- Multi-port USB Charger
- Low-voltage High-current Switching Power Supply

## 3. Description

LN5S03 is a high performance switching power supply secondary side synchronous rectification controller integrated circuit, which can easily construct a low voltage and high current switching power supply system that meets energy efficiency such as CoC V5 and DoE VI. It is the ideal ultra low on voltage drop rectifier device solution. A unique TrueWave™ real time waveform tracking function built-in on this chip, it can also support up to 200 kHz switching frequency application and various operating modes of switching power supplies such as CCM/CrM/DCM. The external Low RdsON MOSFET device can be automatically turned on or off fast at the edge of each waveform conversion of the switching power supply, Its extremely low turn-on voltage is used to achieve much lower conduction losses than Schottky diodes, the conversion efficiency of the system is greatly improved. The temperature of the rectifying device is greatly reduced, and the switching power supply application of low voltage and large current can be conveniently realized.

The high current totem pole drive output with voltage clamp can be used directly to drive external MOSFET devices. Peak current drive capability up to 1 A ensures fast turn-on/ turn-off of external high-current MOSFET devices for excellent conversion performance. The output voltage clamping function makes the gate safe and reliable even at high supply voltages.

The chip also has built-in high-voltage direct detection function, the detection isolation switch MOSFET BVDSS up to 120 V.

With a chip supply voltage range up to 40 V, the controller can be used directly in rectification applications with output voltages up to 20V, greatly expanding the usable range.

The highly integrated circuit design makes the peripheral circuit of the chip extremely simple. In applications where the 5 V output can be directly powered for the LN5S03, a complete switching power supply output synchronous rectification application can be constructed with only one MOSFET.

Now available in halogen-free SOT23-5 standard green package.

## 4. Functional Block Diagram

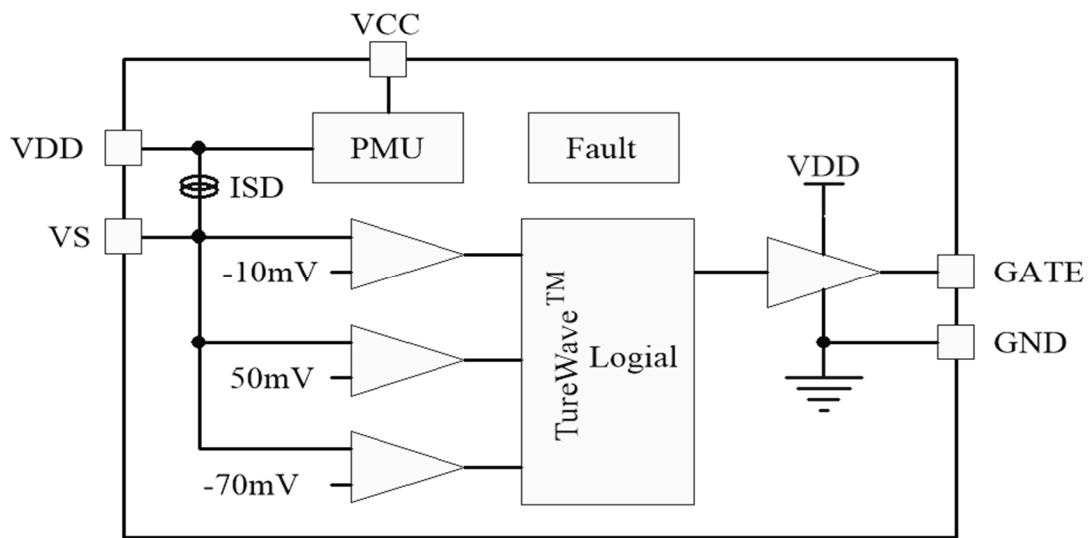


Fig1. Internal functional block diagram

## 5. Pin Definitions

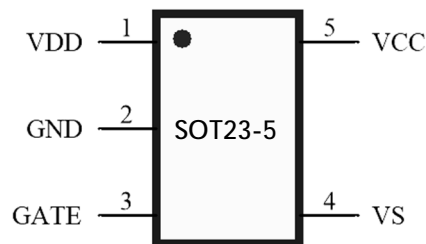


Fig2. Pin Definitions

## 6. Pin Function Description

PIN	Symbol	Function
1	VDD	Internal power supply pin, connect the decoupling capacitor
2	PGND	Ground pin connecting with external MOSFET source
3	GATE	Output drive pin, connecting external MOSFET gate
4	VS	Signal detection pin, connected to the external MOSFET drain
5	VCC	Power supply pin

## 7. Typical Simplified Schematic

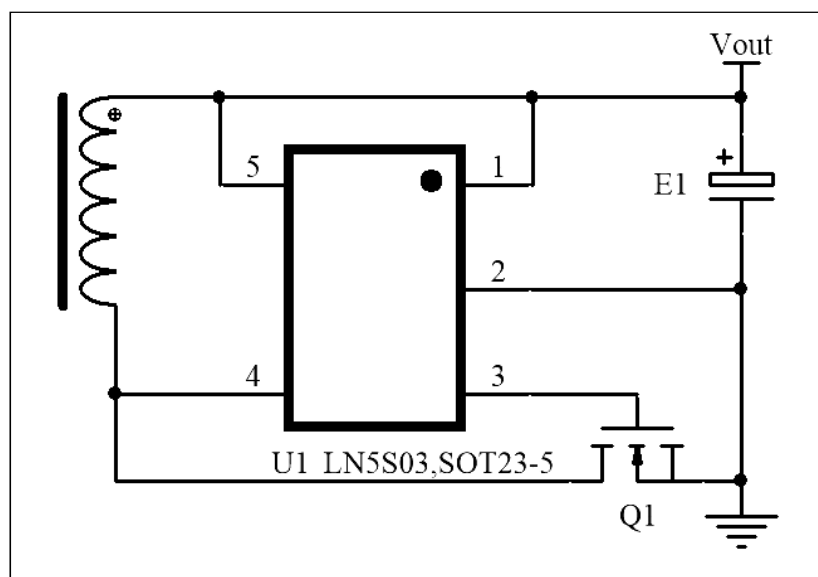


Fig3. Typical Simplified Schematic

## 8. Absolute Maximum Ratings \*

Parameter		Rating	Units
VS Pin Input Voltage		120**	V
VS Pin Input Current		+1 to -30	mA
VCC Pin Input Voltage		40***	V
Other Pins Input Voltage		-0.3 to 7***	V
PD Power Dissipation		250	mW
Min/Max Operating Junction Temperature T <sub>J</sub>		-40 to +150	°C
Min/Max Operating Ambient Temperature T <sub>a</sub>		-20 to +105	°C
Min/Max Storage Temperature T <sub>stg</sub>		-55 to +150	°C
R <sub>θj-a</sub>		350	°C/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 extended periods may affect device reliability.\*\* : with 1mA limit. \*\*\* : with 10mA limit. \*

## 9. Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Units
VCC	VCC Supply Voltage	4.5		40	V
VS	VS Peak Voltage			120	V
TA	Operating Ambient Temperature	-20		85	°C

## 10. Electrical Characteristics(Ta = 25°C, VDD=15V, if not otherwise noted)

### Power Supply Voltage (VCC Pin)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
VCC <sub>ON</sub>	VCC Start-up Voltage	VCC from 0V to 15V	-	4.3	-	V
VCC <sub>OFF</sub>	VCC Shut-down Voltage	VCC from 15V to 0V	-	4.0	-	V
VCC <sub>HYT</sub>	UVLO Hysteresis Voltage		-	0.3	-	V
I <sub>VCC</sub>	VCC Standby Current	GATE=OPEN,VS=0V	-	0.2	-	mA
I <sub>VCC2</sub>	VCC Operating Current	GATE=2nF,VS=50kHz	-	2	-	mA

### Internal Supply Voltage(VDD Pin)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
VDD <sub>RANGE</sub>	VDD Voltage Range	VCC=OPEN	4.0	-	7.5	V
VDD <sub>RATED</sub>	VDD Rated voltage	VCC=5-15V	4.5	7	7.5	V
I <sub>VDDQ</sub>	VDD Standby Current	VDD=5V,GATE=OPEN	-	100	-	uA
V <sub>DDUVP</sub>	VDD Undervoltage Protection Threshold	VDD from 7V to 0V	-	4	-	V
I <sub>VDDC</sub>	VDD Current Limit		-	30	-	mA

## Drive output (GATE Pin)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
$RD_{UP}$	Output High Side Switch Internal Resistance	$VCC = 15V, I_o = 100\text{ mA}$	-	2	-	$\Omega$
$RD_{DOWN}$	Output Low Side Switch Internal Resistance	$VCC = 15V, I_o = -100\text{ mA}$	-	1.5	-	$\Omega$
$V_{OL}$	Output Low Level	$VCC = 15V, I_o = -100\text{ mA}$	-	0.15	-	V
$V_{OH}$	Output High Level	$VCC = 15V, I_o = 100\text{ mA}$	-	6.5	7.5	V
$T_r$	Output Rise Time	$0 \rightarrow 4V, CL = 2nF$	-	20	-	nS
$T_f$	Output Falling Time	$4V \rightarrow 0V, CL = 2nF$	-	10	-	nS
$R_{GATE}$	Output Grounding Resistance		-	20	-	k $\Omega$

## Waveform sampling (VS Pin)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
$V_{VSBR}$	VS Withstand Voltage	$I_{VS}=10\mu A$	120	-	-	V
$I_{SD}$	VS Pull-up Current	$VS=0V$	-	50	-	$\mu A$
$VS_{THON}$	VS Turn-on Threshold Voltage	$RVS=0\Omega$	-	-70	-150	mV
$VS_{THOFF}$	VS Shut-down Threshold Voltage	$RVS=0\Omega$	-	-10	-	mV
$VS_{THONS}$	VS Reset Threshold Voltage	$RVS=0\Omega$	-	50	100	mV
$T_{HOLD}$	VS Blanking Hold Time		-	0.5	-	$\mu s$

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## 12. Application and Implementation

LN5S03 is a compact, high performance secondary side synchronous rectification control IC designed for energy efficient switching power converters. High compatibility can be used in various power modes such as CCM/CRM/DCM, allows systems with low voltage and high current output to easily meet the requirements of international energy efficiency standards such as CoC V5 and DoE VI.

### 12.1 VCC and VDD Supply

The LN5S03 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 7V) 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 1uF should be connected in parallel between the VDD pin and ground, as C1 shown in the figure below.

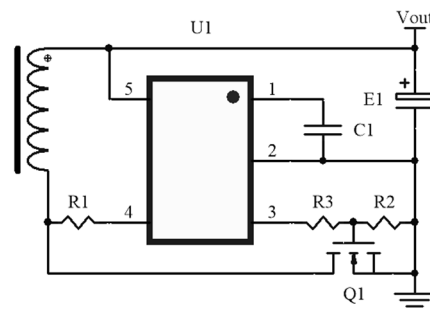


Fig4. VDD Decoupling Circuit

In applications where the output voltage is no greater than 7V and not less than 4.5V, 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.

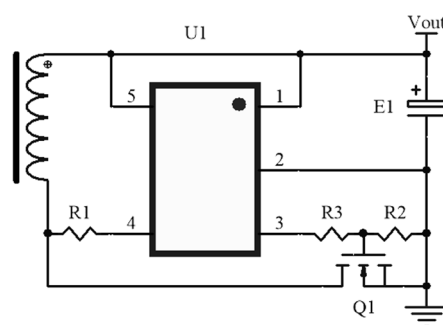
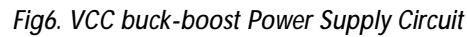


Fig5. VCC and VDD Parallel Supply Circuit

When the output voltage is lower than 4.5V during normal operation (for example, when the mobile phone charger charges the mobile phone in CV mode), should be powered separately at the VCC pin to meet the normal operating range of the chip. For example, through the forward flyback way to rectify a voltage directly from the MOS drain to power on the VCC pin, but keep the VCC voltage no more than 40V under the maximum input voltage. The current limiting resistor R0 is necessary and must be carefully adjusted, as shown in the figure below.

[illegible]

DS-01926-D-EN



The typical withstand voltage capability of the VS pin is 120V, so the voltage greater than 120V should not be applied at this pin on applications to avoid overvoltage damage.

### 12.3 GATE Output Driver

Built-in totem pole output driver on chip with the voltage clamp function at the same time. When the voltage of VCC is higher than 7.5V, the drive output voltage amplitude will be automatically limited to no more than 7.5V, which avoids the MOSFET gate overvoltage damage caused by the drive output voltage being too high.

Built-in driver circuit with drive capability up to  $\pm 1A$  peak current. The necessary resistor network should be connected in series between GATE terminal and MOSFET gate to reduce gate driving speed and optimize the index of EMI, while maintaining fast MOSFET switching speed and good synchronous rectification conversion efficiency. The optimized gate drive circuit is shown below.

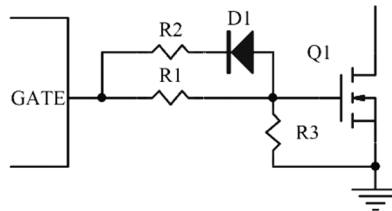


Fig9. Optimized Gate Drive Network

## 13. Layout Guidelines

### 13.1 Principles of high-frequency layout

A reasonable PCB layout should be maintained on applications to ensure that the chip-related connection pins have as short path as possible.

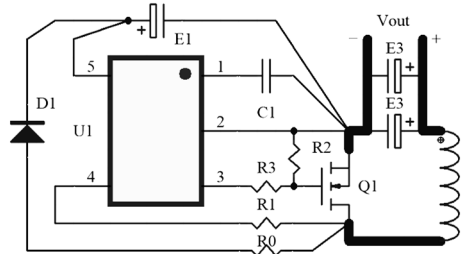


Fig10. PCB Layout Recommendation

### 13.2 Typical layout reference

An example of a typical PCB layout is shown below.

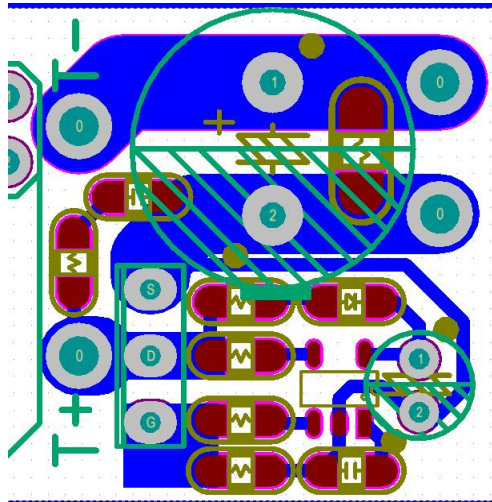
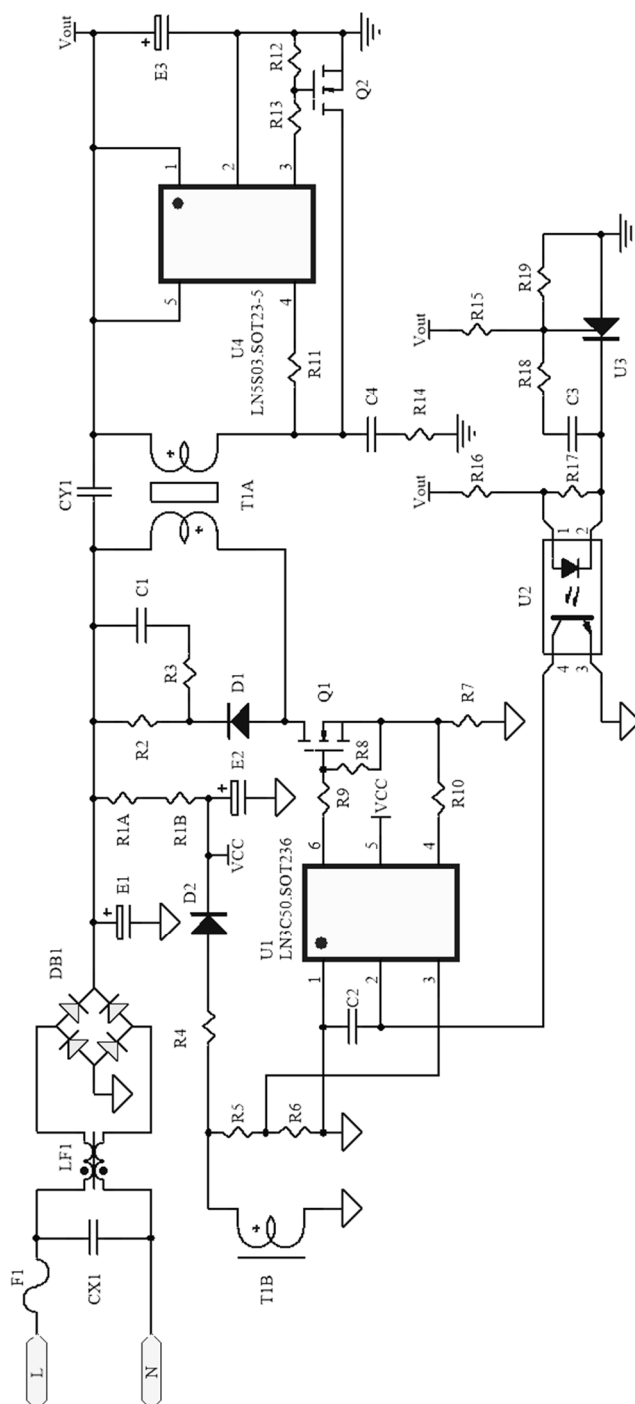


Fig11. PCB Layout Demonstration

#### 14. Typical Application Circuit Schematic1 ( input : 90~265Vac, VCC direct supply mode )



*Fig12. Typical Application Circuit Schematic*

Typical Application Circuit Schematic2 ( input : 90~265Vac,VCC buck-boost supply mode )

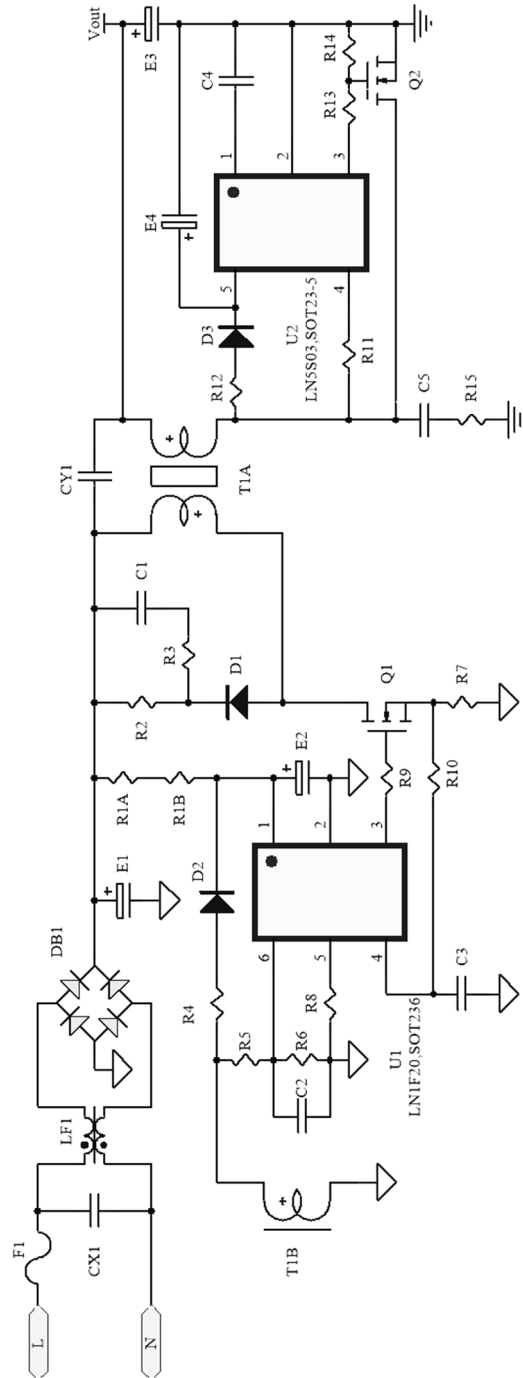
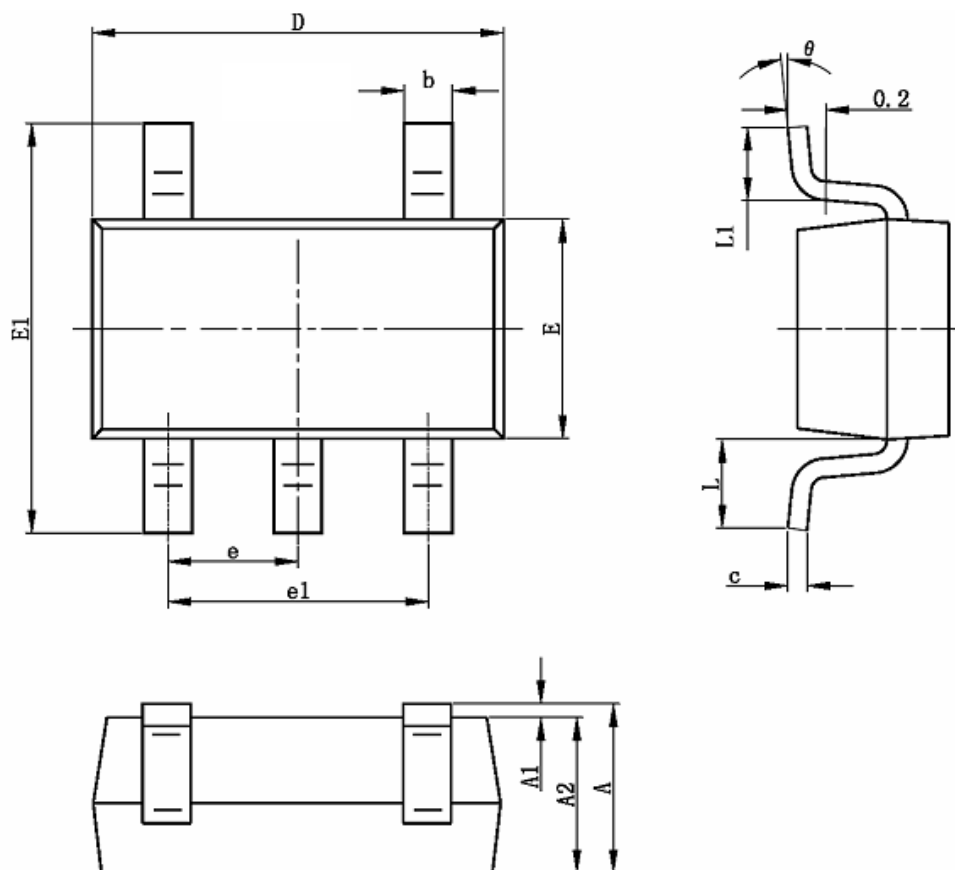


Fig13. Typical Application Circuit Schematic

## 15. Mechanical and Packaging

SOT23-5




Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.400	0.012	0.016
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950TYP		0.037TYP	
e1	1.800	2.000	0.071	0.079
L	0.700REF		0.028REF	
L1	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

Fig15. Mechanical Dimensional Drawings

## 16. Orderable Information

Type number	Green Standard	package	Quantity per Tube
LN5S03	halogen-free	SOT23-5	3000PCS/REEL

## 17. Important Notice

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