# SY59012

**High Efficiency Linear AC/DC Driver With Integrated 500V MOSFET**

## General Description

The SY59012 is a linear AC/DC driver with integrated 500V MOSFET. Constant current control leads to good line regulation and load regulation. The patented technique is used to achieve high efficiency and high power factor. Multi-chip in parallel is available for higher output current application. The compact package and less peripheral components make it available for small structure lamps application.

## Features

- Integrated 500V MOSFET
- Power factor >0.5 or >0.7
- Up to 88% High efficiency
- ±3% output current precision
- No magnetic solution
- Excellent EMC performance
- Adjustable thermal fold back
- Compact package: SO8

## Ordering Information

SY59012 □(□□)□

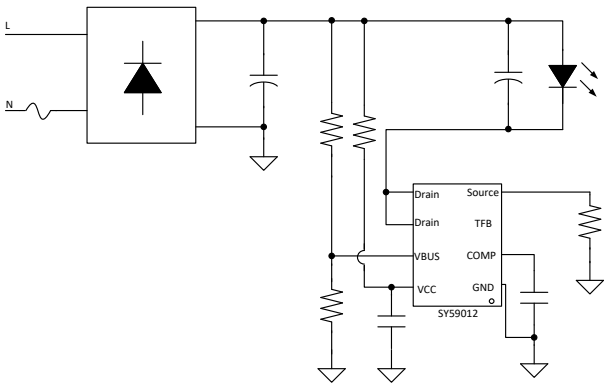
- Temperature Code
- Package Code
- Optional Spec Code

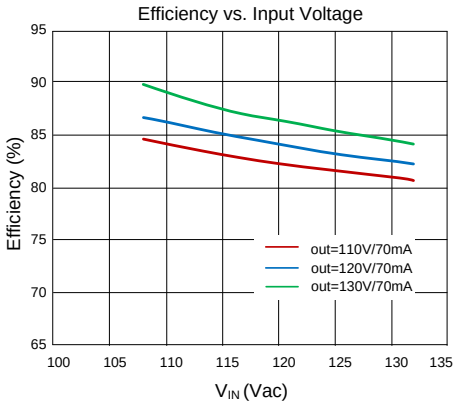
| Ordering Number | Package type | Note |
|---|---|---|
| SY59012FAC | SO8 | ---- |

## Applications

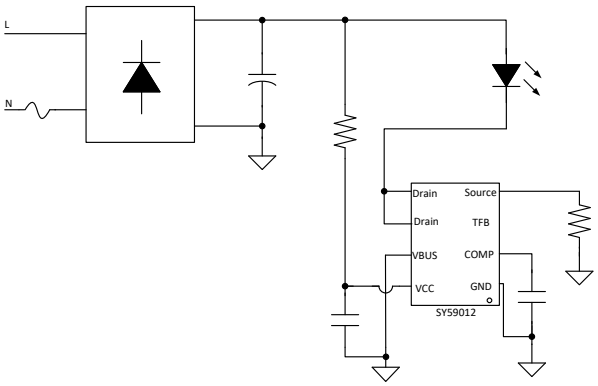
- LED Lighting

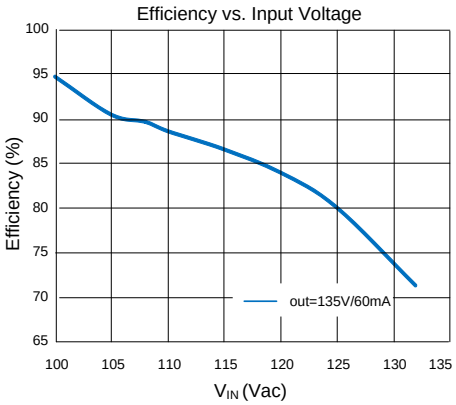
## Typical Applications




(a)With $V_{BUS}$ compensation

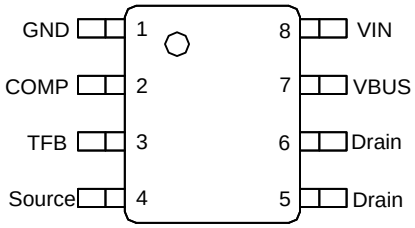



(b)Without $V_{BUS}$ compensation

**Fig. 1 Schematic Diagram and Efficiency Vs Input Voltage**

## Pinout (top view)




**(SO8)**

**Top Mark: BJQ*xyz* (**device code: BJQ, ***x=year code, y=week code, z= lot number code***)

| Pin | Name | Description |
|---|---|---|
| 1 | GND | Ground PIN. |
| 2 | COMP | Compensation PIN, connect a cap to GND. |
| 3 | TFB | Adjust thermal fold back by changing the resistor between TFB and GND |
| 4 | Source | Source PIN of integrated MOSFET. |
| 5,6 | Drain | Drain PIN of integrated MOSFET. |
| 7 | VBUS | Sense BUS voltage, and compensate to COMP. |
| 8 | VIN | IC power supply PIN |

## Block Diagram

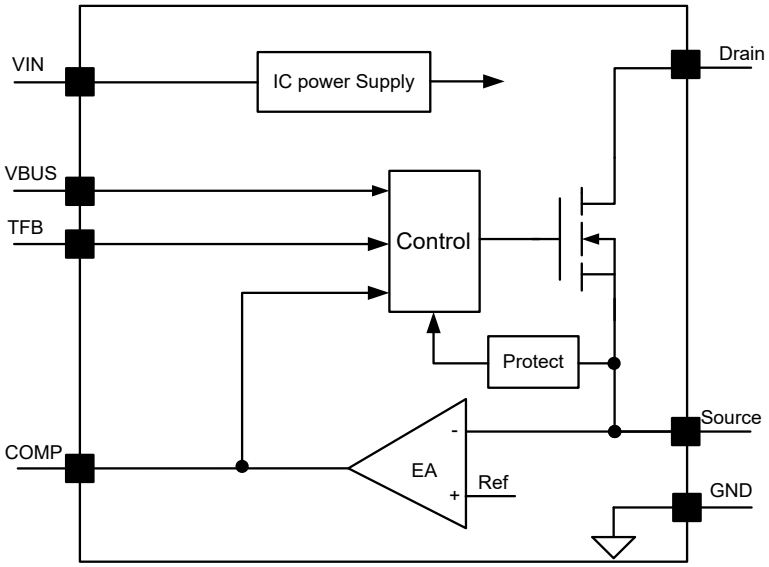



**Fig.2 Block Diagram**

## Absolute Maximum Ratings (Note 1)

Drain---------- -0.3V to 500V
Supply Current $I_{VIN}$ ---------- 1.0mA
VIN---------- -0.3V to 18V
VBUS---------- -0.3V to VIN+0.3V
COMP, TFB, Source---------- -0.3V to 3.6V
Power Dissipation, @ $T_A$ = 25°C SO8 ---------- 1.1W
Package Thermal Resistance (Note 2)
SO8,$\theta_{JA}$---------- 88°C/W
SO8,$\theta_{JC}$ ---------- 45°C/W
Temperature Range ---------- -40°C to 150°C
Lead Temperature (Soldering, 10 sec.) ---------- 260°C
Storage Temperature Range ---------- -65°C to 150°C

## Recommended Operating Conditions (Note 3)

VIN---------- 9V~15.5V
Absolute maximum range---------- -40°C to 150°C

# Electrical Characteristics

($V_{IN}$ = 12V (Note 3), $T_A$ = 25°C unless otherwise specified)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Power Supply Section | | | | | | |
| VIN turn-on threshold | $V_{VIN\_ON}$ | | 12.7 | 14 | 15.5 | V |
| VIN turn-off threshold | $V_{VIN\_OFF}$ | | 6.3 | 7.5 | 8.3 | V |
| Start up Current | $I_{ST}$ | $V_{VIN}<V_{VIN\_OFF}$ | | 30 | | μA |
| Quiescent Current | $I_Q$ | | | 210 | | μA |
| Internal reference voltage | $V_{REF}$ | | 194 | 200 | 206 | mV |
| Protection current limit voltage of Source PIN | $V_{S\_EX}$ | | 2 | 2.3 | 2.6 | V |
| BV of integrated MOSFET | $V_{DRAIN}$ | | 500 | | | V |
| Thermal Section | | | | | | |
| Thermal Fold-back Temperature | $T_{FB}$ | $R_{TFB}$=0 | | 110 | | ℃ |
| | | $R_{TFB}$=10k | | 120 | | ℃ |
| | | $R_{TFB}\geqslant$100k | | 155 | | ℃ |

**Note 1**: Stresses beyond the "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 in the operational sections of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**Note 2**: $\theta_{JA}$ is measured in the natural convection at $T_A$ = 25°C on a low effective single layer thermal conductivity test board of JEDEC 51-3 thermal measurement standard. Test condition: Device mounted on 2" x 2" FR-4 substrate PCB, 2oz copper, with minimum recommended pad on top layer and thermal vias to bottom layer ground plane.

**Note 3**: Increase VIN pin voltage gradually higher than $V_{VIN,ON}$ voltage then turn down to 12V.

.

# Operation

The SY59012 is a linear AC/DC driver targeting at LED lighting applications.

It integrates a MOSFET with 500V breakdown voltage to decrease external component.

With the constant current control, SY59012 can achieve good line regulation and load regulation.

The patented technology is used to compensate the output current. With this method the SY59012 can use a small capacitance after rectifier bridge, and the high efficiency and high PF>0.7 are achieved.

SY59012 provides reliable protections such as short circuit protection (SCP), over current protection (OCP), open LED protection (OLP), over temperature protection (Thermal fold-back), etc.

SY59012 is available with SO8 package.

# Applications Information

**Start Up**

After AC supply or DC BUS is powered on, the capacitor $C_{VIN}$ across VIN and GND pin is charged up by BUS voltage through a start up resistor $R_{ST}$. Once $V_{VIN}$ exceeds $V_{VIN\_ON}$, IC start to work, Q1 will take the extra current from VIN pin, so the voltage of $V_{VIN}$ is kept at $V_{VIN\_ON}$.

The startup procedure is shown in Fig.3.

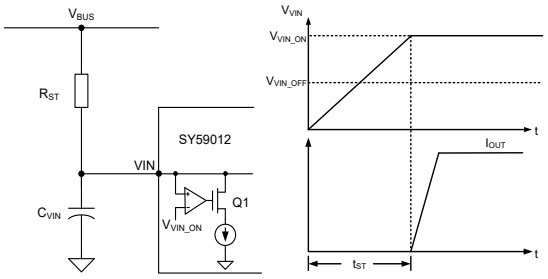



**Fig.3 Start up**

The start up resistor $R_{ST}$ and $C_{VIN}$ are designed by rules below:

**(a**) Preset start-up resistor $R_{ST}$, make sure that the current through $R_{ST}$ is larger than $I_Q$, but the current should less than $I_{VIN\_MAX}$ to prevent internal FET damaging.

$$\frac{V_{BUS}}{I_{VIN\_MAX}} < R_{ST} < \frac{V_{BUS}}{I_Q}$$

Where $V_{BUS}$ is the BUS line voltage.

**(b)** Select $C_{VIN}$ to obtain an ideal start up time $t_{ST,}$ and ensure the low $V_{VIN}$ ripple .

$$C_{VIN} = \frac{(\frac{V_{BUS}}{R_{ST}} - I_{ST}) \times t_{ST}}{V_{VIN\_ON}}$$

**Shut Down**

After AC supply or DC BUS is powered off, the energy stored in the BUS capacitor will be discharged. When $V_{VIN}$ is below $V_{VIN\_OFF}$, the IC will stop working and $V_{COMP}$ will be discharged to zero.

**Special Design for Current Compensation**

To have a better efficiency, special design is integrated into SY59012.

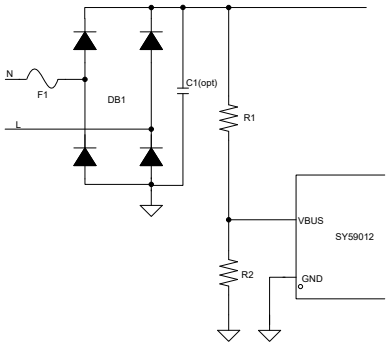



**Fig.4 The patented technology of compensation**

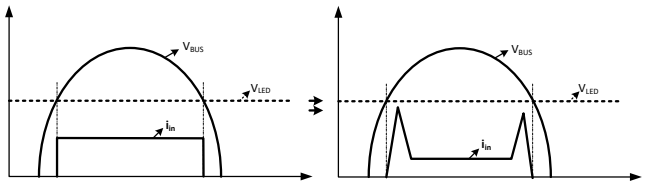



**Fig.5 Shape of current compensation**

With the traditional LDO, when $V_{BUS}$>$V_{LED}$, $i_{LED}$ is constant. The loss power is high when $V_{BUS}$ is higher than $V_{LED.}$ The SY59012 adopt the compensation from BUS voltage. When $V_{BUS}$ is close to $V_{LED}$, increase input current, and when around peak $V_{BUS}$, decrease input current. The total output current is constant by closed loop. In this way, the C1 is not necessary or just a small CBB.

**Constant-Current Control**

The output current $I_{OUT}$ can be represented by

$$I_{OUT} = \frac{V_{REF}}{R_S}$$

Where $V_{REF}$ is the internal reference voltage; $R_S$ is the current sense resistor.

With the constant-current control, the SY59012 has a good line regulation and load regulation.

**Thermal Fold-back Function (TFB)**

The thermal fold-back temperature can be adjusted by $R_{TFB}$. The thermal fold-back point is increasing with the decreasing of $R_{TFB}$. When $T_j$ reaches the point, the $V_{COMP}$ will be pulled down and output current drops.

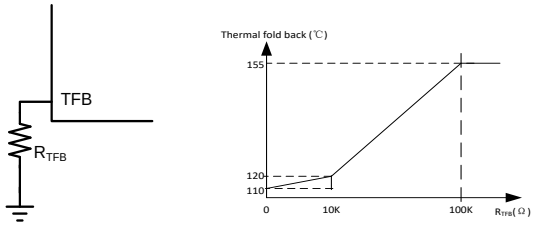



**Fig.6 Thermal fold-back circuit and curve**

**Single fault design**

When LED is short, there will be a high overshoot current on sense resistor, if IC detect $V_S$ is higher than $V_{S\_EX}$, MOSFET is turned off, COMP will be discharge to zero and $V_{VIN}$ drops to $V_{VIN\_OFF}$.

# External Component Design Guide

**VIN Resistor and Capacitor**

Recommended a 470nF ceramic capacitor between VIN and GND;
If input AC voltage is 90~132Vac, recommended $R_{ST}$ 470k Ω;
If input AC voltage is 176~264Vac, recommended $R_{ST}$ 680k Ω;

**Sense Resistor**

$$R_S = \frac{V_{REF}}{I_{OUT}}$$

Where $V_{REF}$ is the internal reference voltage, $I_{OUT}$ is average output current.

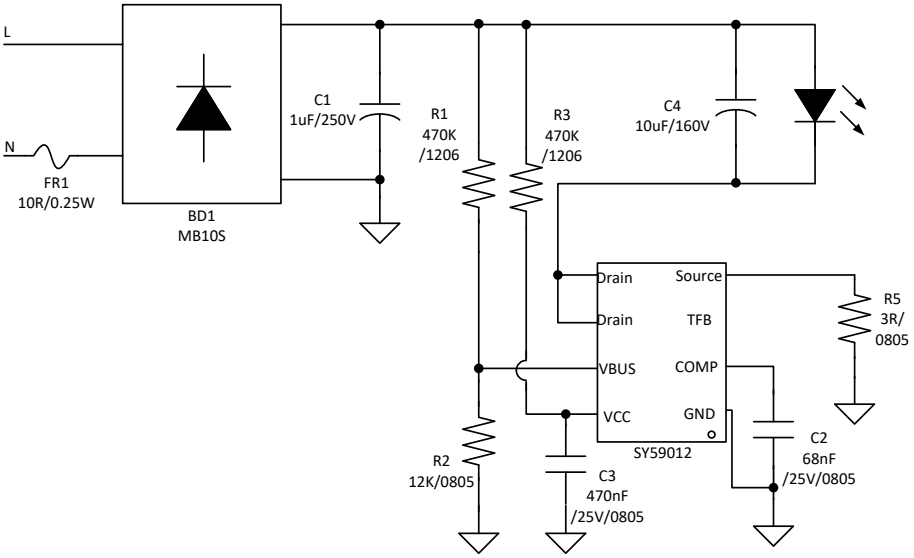
**$V_{BUS}$ Compensation Resistor**

The compensation coefficient is obtained from $V_{BUS}$. Set $R_{\_BUS\_UP}$ =510k Ω and adjust $R_{\_BUS\_DOWN}$ based on PF requirement. If without $V_{BUS}$ compensation, connect BUS PIN to GND.

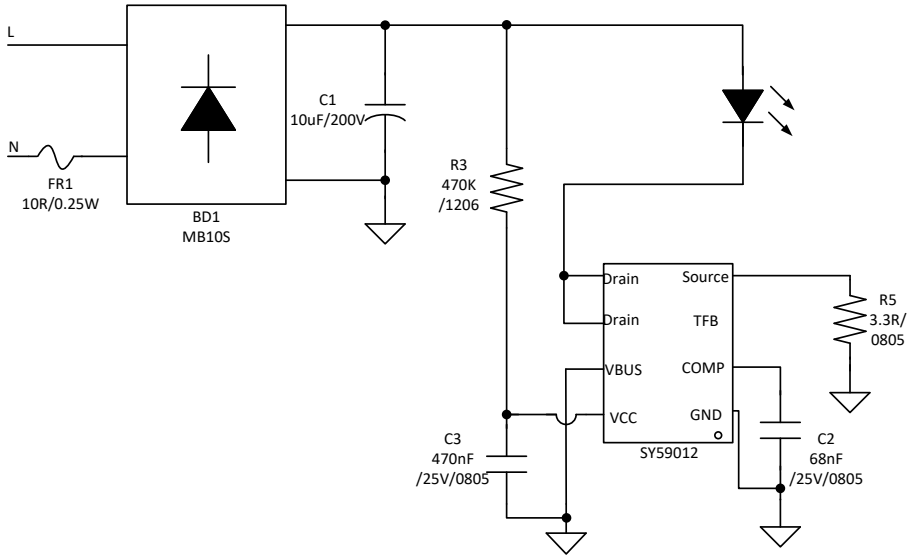
**COMP Capacitor**

Recommended a 47~100nF ceramic capacitor between COMP and GND;

# Typical Application



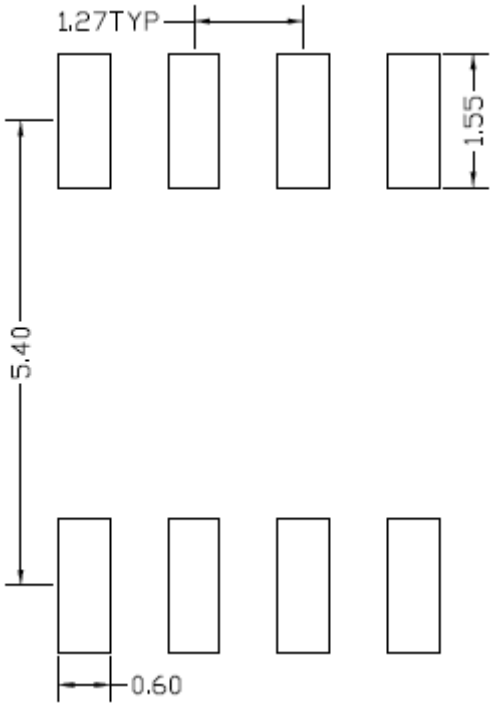

(a) With $V_{BUS}$ compensation @ 100-132Vac Input, 126V/66.7mA Output



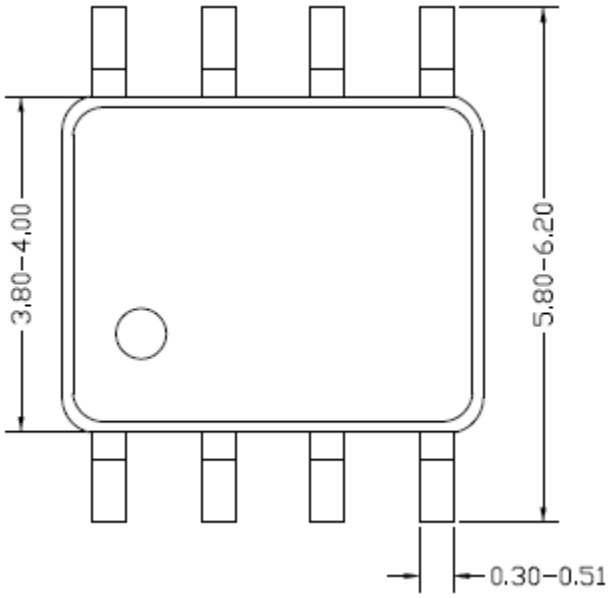

(b) Without $V_{BUS}$ compensation @ 100-132Vac Input, 135V/60mA Output

**Fig.7 Typical Application Circuit**

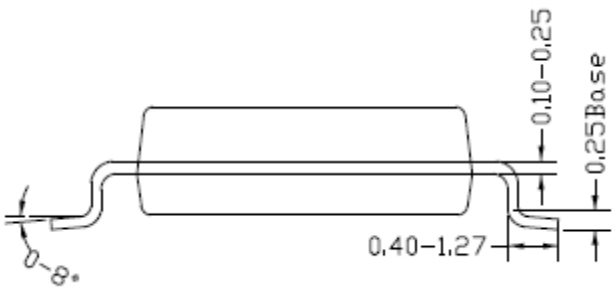
# SO8 Package outline & PCB layout design



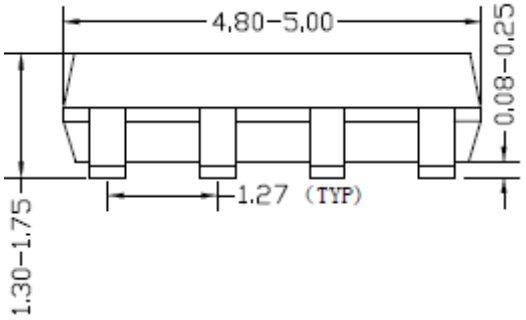

**Recommended Pad Layout**
**(Reference only)**




**Top view**




**Side view**

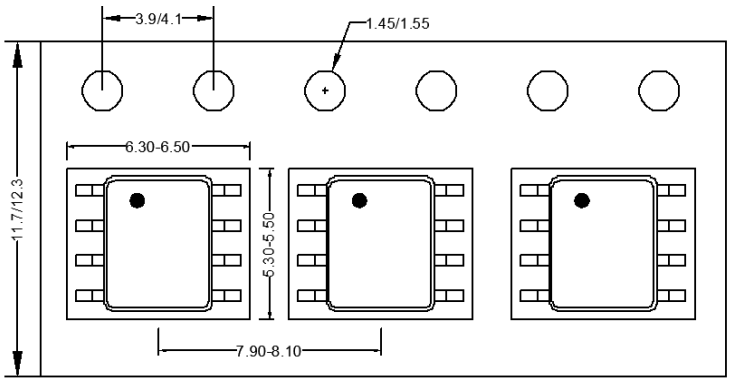



**Front view**

**Notes:** **All dimension in millimeter and exclude mold flash & metal burr.**

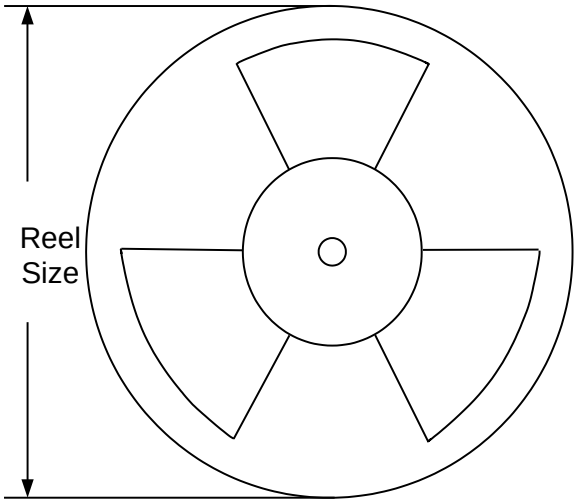
# Taping & Reel Specification

## 1. Taping orientation for packages（SO8）




**Feeding direction** ⟶

## 2. Carrier Tape & Reel specification for packages




| Package type | Tape width (mm) | Pocket pitch(mm) | Reel size (Inch) | Trailer length(mm) | Leader length (mm) | Qty per reel |
|---|---|---|---|---|---|---|
| SO8 | 12 | 8 | 13" | 400 | 400 | 2500 |

## IMPORTANT NOTICE

1. **Right to make changes.** Silergy and its subsidiaries (hereafter Silergy) reserve the right to change any information published in this document, including but not limited to circuitry, specification and/or product design, manufacturing or descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products are sold subject to Silergy's standard terms and conditions of sale.

**2. Applications.** Application examples that are described herein for any of these products are for illustrative purposes only. Silergy makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification. Buyers are responsible for the design and operation of their applications and products using Silergy products. Silergy or its subsidiaries assume no liability for any application assistance or designs of customer products. It is customer's sole responsibility to determine whether the Silergy product is suitable and fit for the customer's applications and products planned. To minimize the risks associated with customer's products and applications, customer should provide adequate design and operating safeguards. Customer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Silergy assumes no liability related to any default, damage, costs or problem in the customer's applications or products, or the application or use by customer's third-party buyers. Customer will fully indemnify Silergy, its subsidiaries, and their representatives against any damages arising out of the use of any Silergy components in safety-critical applications. It is also buyers' sole responsibility to warrant and guarantee that any intellectual property rights of a third party are not infringed upon when integrating Silergy products into any application. Silergy assumes no responsibility for any said applications or for any use of any circuitry other than circuitry entirely embodied in a Silergy product.

3. **Limited warranty and liability.** Information furnished by Silergy in this document is believed to be accurate and reliable. However, Silergy makes no representation or warranty, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. In no event shall Silergy be liable for any indirect, incidental, punitive, special or consequential damages, including but not limited to lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges, whether or not such damages are based on tort or negligence, warranty, breach of contract or any other legal theory. Notwithstanding any damages that customer might incur for any reason whatsoever, Silergy' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the Standard Terms and Conditions of Sale of Silergy.

4. **Suitability for use.** Customer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of Silergy components in its applications, notwithstanding any applications-related information or support that may be provided by Silergy. Silergy products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an Silergy product can reasonably be expected to result in personal injury, death or severe property or environmental damage. Silergy assumes no liability for inclusion and/or use of Silergy products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

5. **Terms and conditions of commercial sale**. Silergy products are sold subject to the standard terms and conditions of commercial sale, as published at http://www.silergy.com/stdterms, unless otherwise agreed in a valid written individual agreement specifically agreed to in writing by an authorized officer of Silergy. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. Silergy hereby expressly objects to and denies the application of any customer's general terms and conditions with regard to the purchase of Silergy products by the customer.

6. **No offer to sell or license**. Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights. Silergy makes no representation or warranty that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right. Information published by Silergy regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from Silergy under the patents or other intellectual property of Silergy.

For more information, please visit: www.silergy.com