SY22603A

Adaptive LED Current Filter For LED Lighting

General Description

The SY22603A is an adaptive linear current regulator that is designed to eliminate low frequency current ripple. It is intended for LED lighting applications, particularly those with single-stage LED drivers. The device acts as a ripple current filter for the LED load. It operates using adaptive control and requires a minimal number of external components.

The part can deliver up to 1.2A output current over a wide output voltage range from 20V to 65V. It uses a proprietary scheme to reduce the power loss and increase the overall efficiency. Multiple devices can operate in parallel to support higher LED current.

The SY22603A provides reliable open/short-LED and over temperature protections.

The SY22603A is available in a compact TO252-3 package.

Features

- Current Filter for Single-Stage LED Driver to Eliminate Current Ripple
- 20V to 65V Output Voltage Range
- Operating Current: 91μA (typ.)
- 0.25A to 1.2A Output Current Range
- Proprietary Scheme for Low Power Loss (2.5% or less)
- Open-LED and Short-LED Protections
- Over temperature Protection
- RoHS-Compliant and Halogen-Free
- Compact Package: TO252-3

Applications

- LED lighting

Typical Application

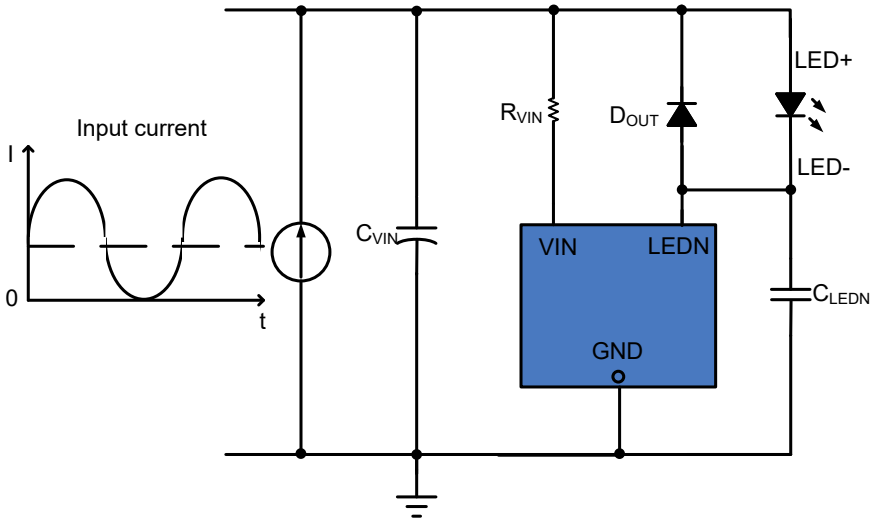


Figure 1. Schematic Diagram

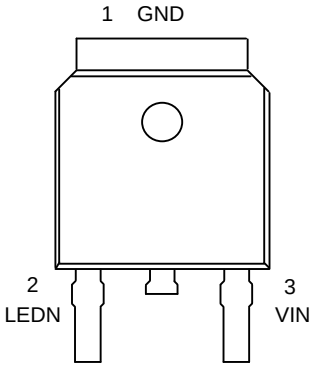
Ordering Information

SY22603□(□□)□
- Temperature Code
- Package Code
- Optional Spec Code

Ordering Part Number	Package Type	Top Mark
SY22603AJAC	TO252-3 RoHS-Compliant and Halogen-Free	**BUAxyz**

x = year code, y = week code, z = lot number code

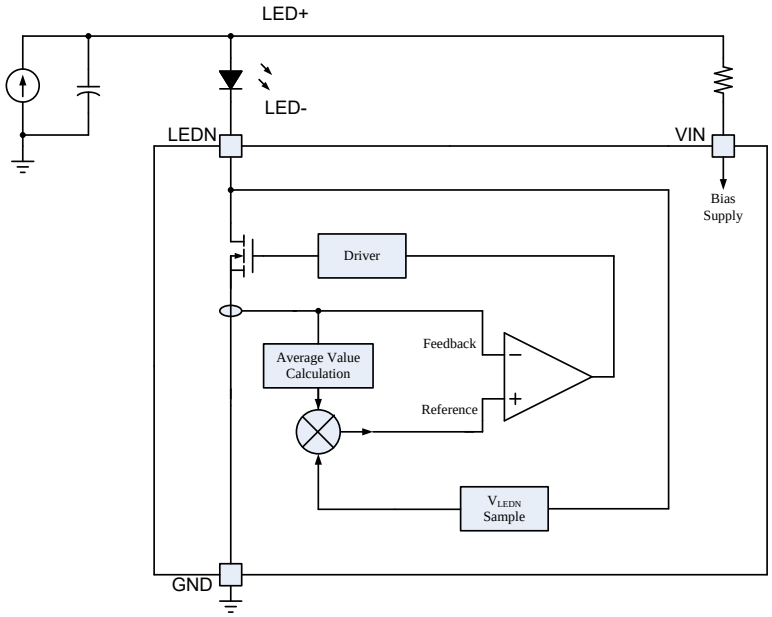
Pinout (top view)



Pin Description

Pin Number	Pin Name	Pin Description
1	GND	Ground pin
2	LEDN	Cathode of LED string
3	VIN	Power supply

Block Diagram



Absolute Maximum Ratings

Parameter (Note 1)	Min	Max	Unit
VIN	-0.3	60	V
LEDN	-0.3	65	
Lead Temperature (Soldering, 10s)		260	°C
Junction Temperature, Operating	-40	150	
Storage Temperature	-65	150	

Thermal Information

Parameter (Note 2)	Typ	Unit
θ_{JA} Junction-to-Ambient Thermal Resistance	50	°C/W
θ_{JC} Junction-to-Case Thermal Resistance	4.5	
P_D Power Dissipation T_A = 25°C	2.5	W

Recommended Operating Conditions

Parameter	Min	Max	Unit
VIN	20	60	V
LEDN	-0.3	65	V

Electrical Characteristics

(V_{IN} = 2.4V, T_A = 25°C unless otherwise specified.)

Parameter		Symbol	Test Conditions	Min	Typ	Max	Unit
Power Supply	V_{IN} Minimum Operating Voltage	V_{VIN_MIN}			20		V
	V_{IN} Maximum Operating Voltage	V_{VIN_MAX}			60		V
	V_{IN} Turn-On Threshold	V_{VIN_ON}		2.9	3.4	4.1	V
	V_{IN} Turn-Off Threshold	V_{VIN_OFF}		2.7	3.2	3.9	V
	V_{IN} Operating Current	I_{VIN}		70	91	120	μA
LEDN Current	LEDN Minimum Operating Current	I_{LEDN_MIN}			250		mA
	LEDN Maximum Operating Current	I_{LEDN_MAX}			1200		mA
LEDN Voltage	High Voltage Protection	V_{LEDN_HV}		4.3	4.85	5.3	V
	Overvoltage Protection	V_{LEDN_OV}		12.3	14	15.7	V
BV		V_{BV}	V_{IN} = GND = 0V, LEDN = 250μA				
Thermal	Shutdown Temperature 1	T_{SD1}	$V_{LEDN} < V_{LEDN\_OV}$		150		˚C
	Shutdown Temperature 2	T_{SD2}	$V_{LEDN} > V_{LEDN\_OV}$		100		˚C
	Hysteresis Temperature	T_{HYS}			20		˚C

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.

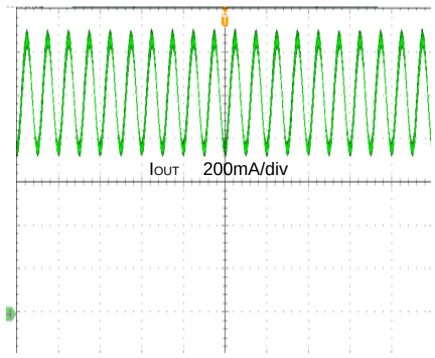
Note 2: θ_{JA} is measured in the natural convection at T_A = 25°C on a low effective single layer thermal conductivity test board of JEDEC 51-3 thermal measurement standard. Test condition: Device mounted on 2” x 2” FR-4 substrate PCB, 2oz copper, with minimum recommended pad on top layer and thermal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

Typical Performance Characteristics

(V_{IN} = 40V, T_A = 25°C unless otherwise specified)

Without SY22603A

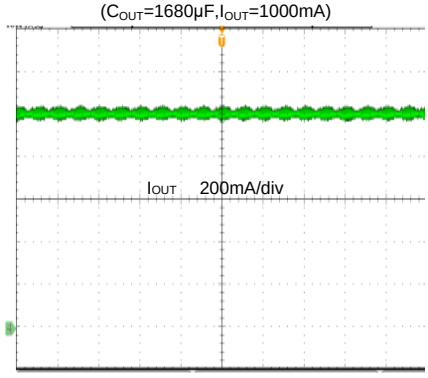
(C_{OUT}=1680μF,I_{OUT}=1000mA)



Time (20ms/div)

With SY22603A

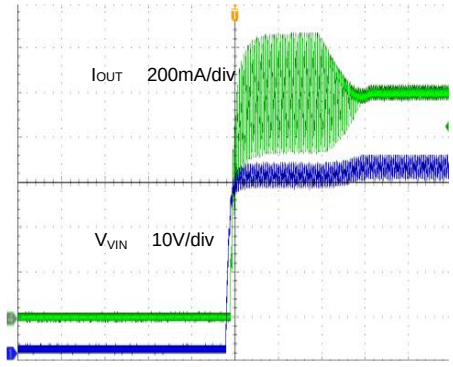
(C_{OUT}=1680μF,I_{OUT}=1000mA)



Time (20ms/div)

Startup

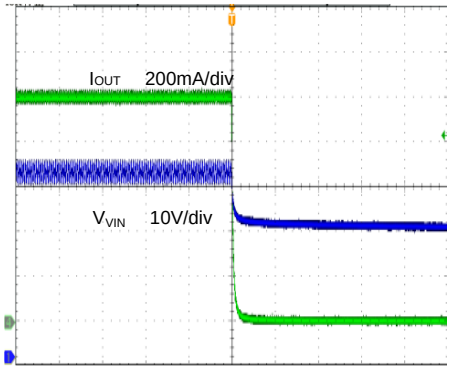
(C_{OUT}=1680μF,I_{OUT}=1000mA)



Time (200ms/div)

Shutdown

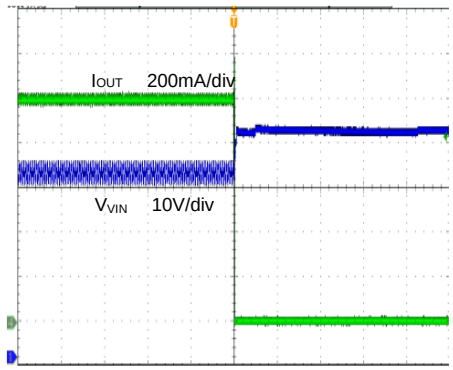
(C_{OUT}=1680μF,I_{OUT}=1000mA)



Time (200ms/div)

Open LED Protection

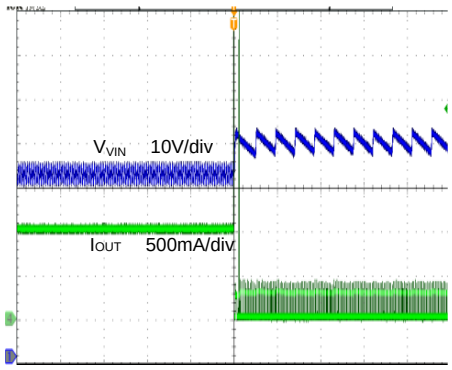
(C_{OUT}=1680μF,I_{OUT}=1000mA)



Time (200ms/div)

Short LED Protection

(C_{OUT}=1680μF,I_{OUT}=1000mA)



Time (200ms/div)

General Information

The SY22603A is an adaptive linear current regulator that is designed to eliminate low frequency current ripple going through an external load. It is intended for LED lighting applications, particularly single-stage LED drivers. The device acts as a ripple current filter for the load.

The device can deliver up to 1.2A output current over a wide output voltage range from 20V to 65V. It uses a proprietary scheme to reduce the power loss and increase efficiency. Multiple parts can be operated in parallel for applications requiring higher LED current.

Reliable open/short-LED protection (OLP/SLP) and overtemperature protection (OTP) are provided for ensuring reliable operation.

Startup

The SY22603A begins operation when V_{VIN} exceeds V_{VIN_ON}. There is an initial blanking time in which the current filter function is suppressed to allow the internal average current reference to start. After startup, the LED current ripple is gradually suppressed.

Shutdown

When V_{VIN} falls below V_{VIN_OFF}, the LEDN pin becomes high impedance with respect to the GND reference.

Steady-State Operation

The LED current is sampled and processed inside the device. The average LED current value is taken as the reference to regulate the instantaneous current. V_{LEDN} is sensed simultaneously and kept low to reduce power loss. If the input/output experience transient voltages that causes V_{LEDN} to be higher than V_{LEDN_HV}, the LED current ripple suppression will be reduced to enable V_{LEDN} fall quickly until V_{LEDN} is lower than V_{LEDN_HV}. Therefore, the normal operating voltage for V_{LEDN} will be lower than V_{LEDN_HV}.

Input Capacitor C_{VIN}

The power loss on the chip is related to the input capacitor C_{VIN}. A larger C_{VIN} value reduces the power loss.

The input capacitor C_{VIN} are designed by rules below:

(a) Select an input capacitor C_{VIN}, making sure that the voltage on LEDN pin is lower than V_{LEDN_HV}.

(b) Select C_{VIN} to obtain an optimal power loss P_{LEDN_LOSS} and ensure that the power loss and the chip power dissipation are acceptable.

$$P_{LEDN\_LOSS} = V_{LEDN\_AVG} * I_{LED}$$

(c) If the C_{VIN} is not large enough to ensure that the power loss and thermal dissipation are acceptable, increase C_{VIN} and go back to step (b) and reiterate until conditions are met.

Note: The recommended input capacitor C_{VIN} value is dependent on the output current and PCB heat dissipation conditions. The relation between the LED current, P_{LOSS_LEDN} and C_{VIN} is shown in Table 1.

Table 1. Input Capacitor C_{VIN} Value

I_{LED} (mA)	C_{VIN} (µF)	V_{LEDN_AVG} (V)	P_{LEDN_LOSS} (mW)
250	220	1.92	481
250	330	1.32	331
400	440	1.64	654
400	880	0.91	364
600	880	1.37	820
600	1320	1.01	603
800	1320	1.34	1071
800	1980	1.01	814
1000	1980	1.27	1272
1000	2470	1.113	1113

Open LED and Recovery

When a LED is open, LED current and V_{LEDN} both naturally drop to zero, and the current filter function will shut down. When the LED is reconnected, the LED current is sensed and the device will resume normal operation.

Short LED and Recovery

When an LED is shorted, V_{LEDN} is pulled high. If V_{LEDN} is higher than V_{LEDN_OV}, the LED current will be limited and the thermal shutdown threshold is reduced to T_{SD2}.

When the output short is removed, V_{LEDN} is pulled down. If V_{LEDN} is lower than V_{LEDN_OV}, the LED current limit is disabled and the thermal shutdown threshold is changed back to T_{SD1}.

When the LED output is shorted, the external diode D_{OUT} is used to avoid LEDN overshoot, typically caused by the parasitic inductance of the output wiring.

Safety Test

The external D_{OUT}, R_{VIN} and C_{LEDN} are used to protect the VIN/LEDN pins from overvoltage, especially for the ESD and Hi-Pot tests. The recommended values are D_{OUT}= 1N4148 or BAV21W (Fast recovery diode), R_{VIN} = 20KΩ and C_{LEDN} = 100nF.

Parallel Operation Application

Multiple SY22603A devices can operate in parallel to support higher LED current, as shown in Figure 2.

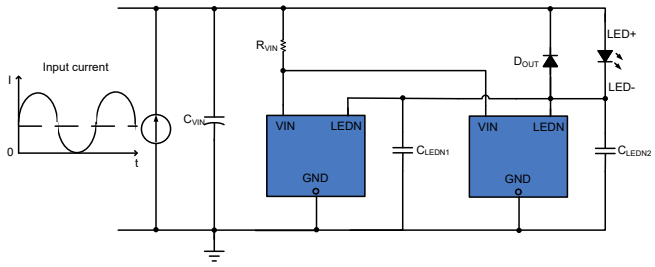


Figure 2. Parallel Circuit

Layout

To achieve optimal design, follow these PCB layout considerations:

- C_{LEDN} must be close to the pins LEDN and GND to protect the LEDN pin from overvoltage.
- The PCB copper area associated with GND pin and LEDN pin must be maximized to enhance heat dissipation.
- C_{VIN} must be placed close to IC, D_{OUT} must be placed close to LEDN pin and C_{VIN} to reduce the impact of parasitic inductance on the circuit.

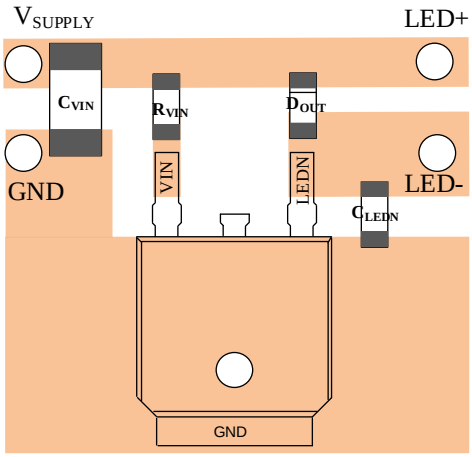
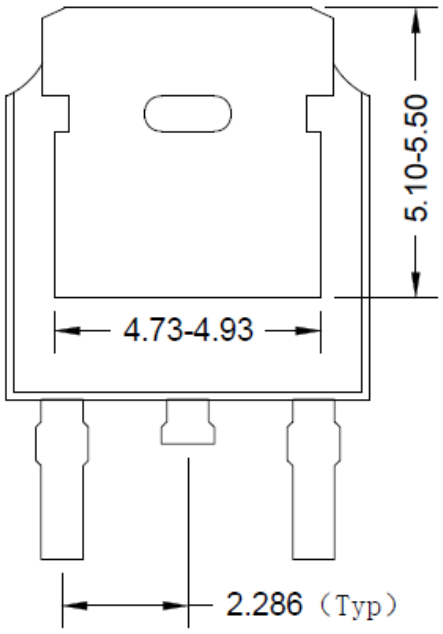
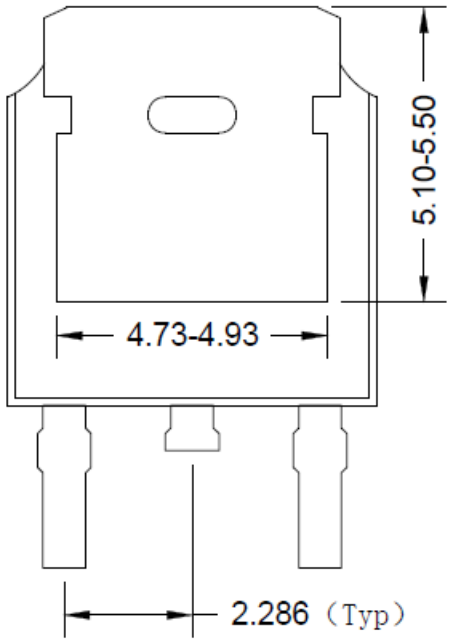


Figure 3. Recommend PCB Layout

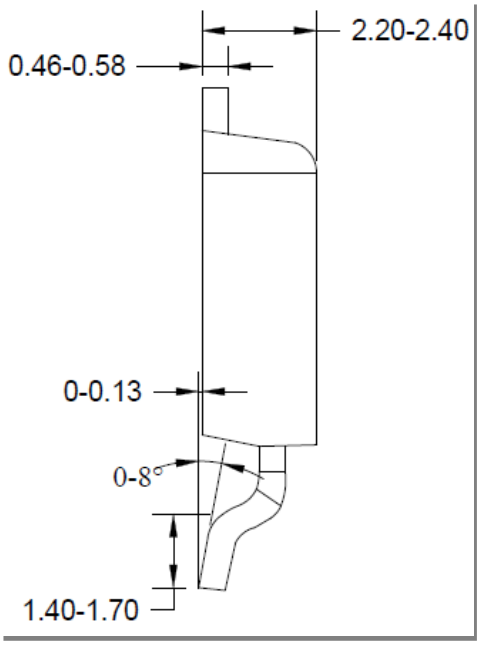
TO252-3 Package Outline Drawing



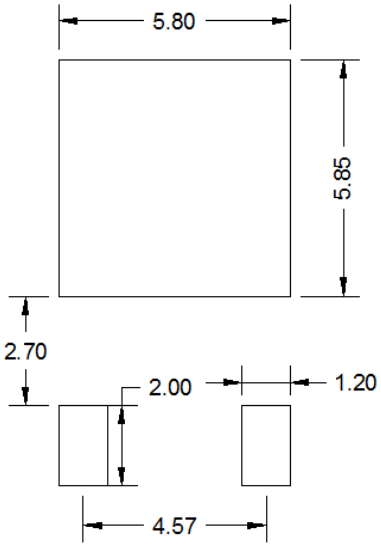
Top view



Bottom view



Side view

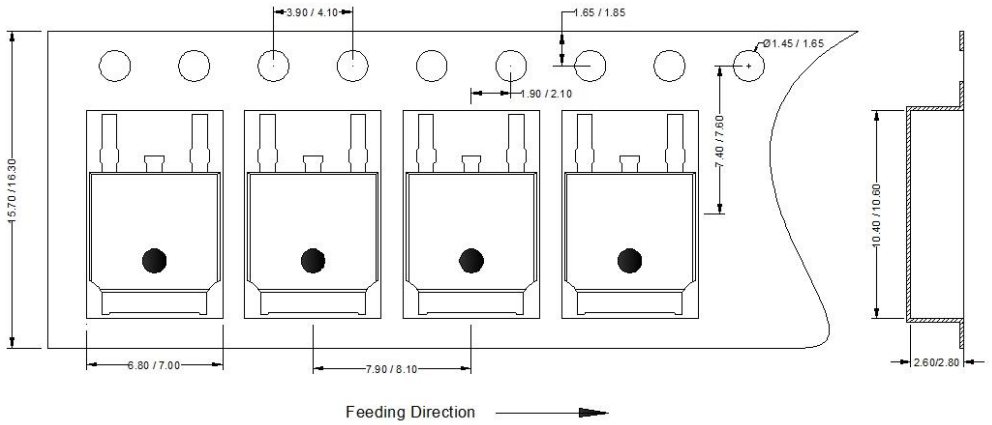


Recommended pad layout (reference only)

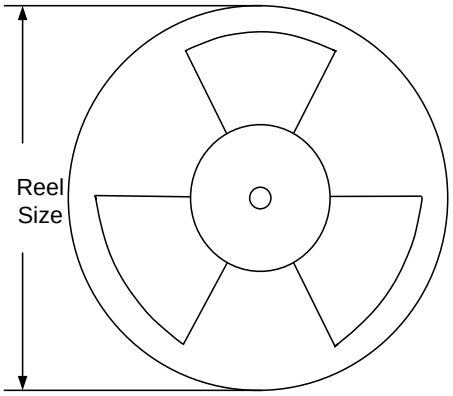
Note: *All dimensions are in millimeters and exclude mold flash and metal burr.*

Taping and Reel Specification

TO252-3 taping orientation



Carrier tape and reel specification for packages



Package type	Tape width (mm)	Pocket pitch(mm)	Reel size (Inch)	Trailer length(mm)	Leader length (mm)	Qty per reel (pcs)
TO-252-3	16	1.1	13"	400	400	2500

Others: NA

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