



Working Together for a Greener Society

Future of Power Electronics and the Earth



LLC Current-resonant Off-line Switching Controller

SSC3S937



## ■ Description

The SSC3S937 is a controller for LLC current resonant switching power supplies, incorporating a floating drive circuit for a high-side power MOSFET. The IC includes useful functions such as standby function, automatic dead time adjustment, and capacitive mode detection. The IC achieves high efficiency, low noise and high cost-effective power supply systems with few external components.

## ■ Package

SOP18



## ■ Applications

Switching power supplies for electronic devices of  $\leq 500$  W such as:

- Digital Appliances (e.g., Television)
- Office Automation (OA) Equipment (e.g., Server, Multifunction Printer)
- Industrial Apparatus
- Communication Facilities

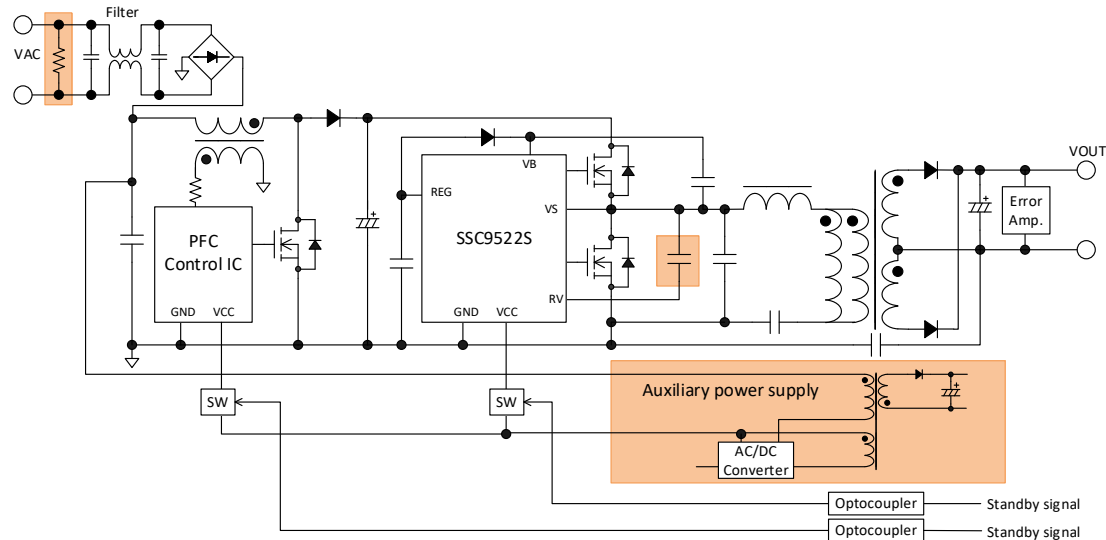


# Product Features

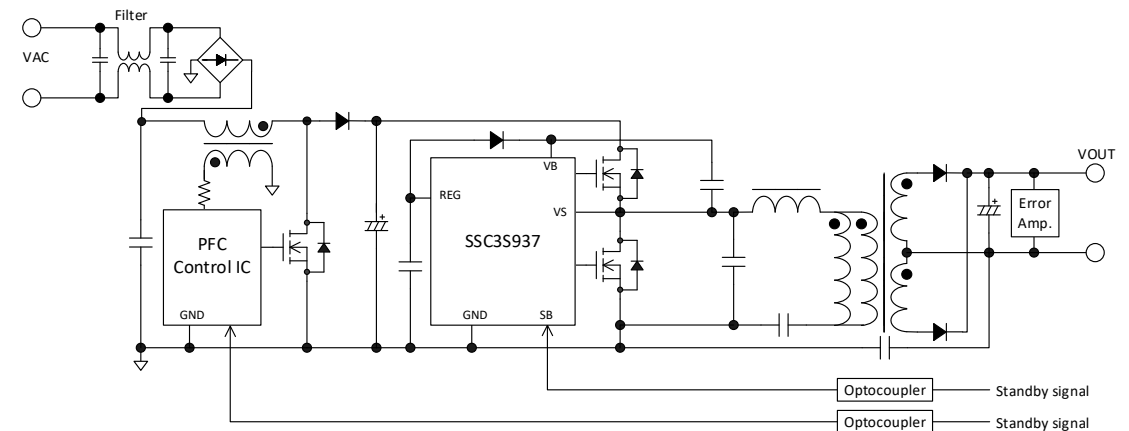
The SSC3S937 achieves high efficiency and few external components count.

- Higher efficiency at light load: No discharge resistor required by **X-capacitor discharge (AC input mode)**
- Standby function : No auxiliary power supply required
- Built-in capacitor for dead time detection: No high voltage capacitor required
- **Realizing the power boost for output current** : Larger range of normal operation by larger overcurrent protection range

## ■ Conventional



## ■ SSC3S937



Requires no X-capacitor discharge resistors, high voltage capacitors, and auxiliary power supply circuit. This results in a downsized circuit with few components!

## ■ Features

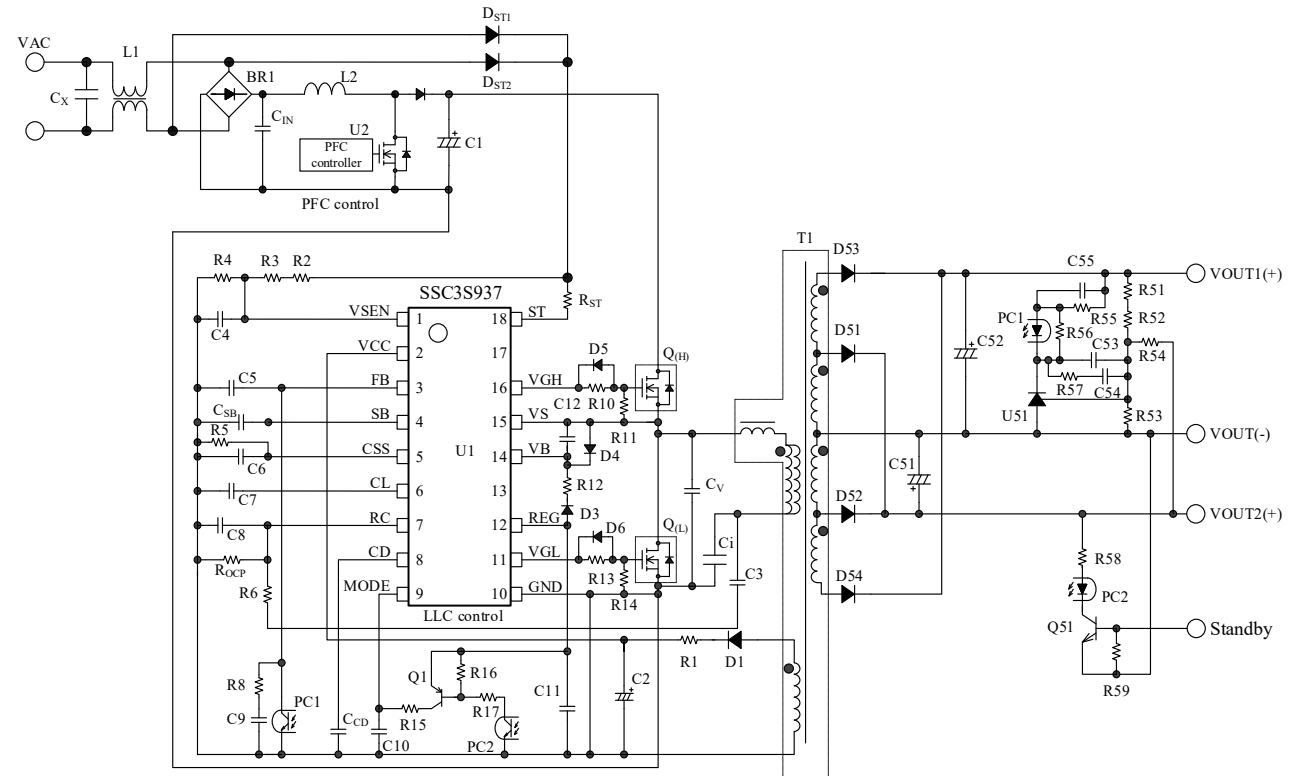
- Standby Mode Change Function by External Signal
  - Output Power at Light Load:  $P_O = 150 \text{ mW}$  ( $P_{IN} = 0.27 \text{ W}$ )
  - Burst Operation in Standby Mode
  - Soft-on/Soft-off Function: Reduces Audible Noise
- Soft-start Function
- Capacitive Mode Detection Function
- Reset Detection Function
- Automatic Dead Time Adjustment Function
- Built-in Startup Circuit
- X-capacitor Discharge Function (AC Input Mode)
- Input Capacitor Discharge Function (DC Input Mode)
- Protections
  - Input Voltage Protection
    - Input Overvoltage Protection (HVP): Auto-restart
    - Input Undervoltage Protection (UVP): Auto-restart
  - High-side Driver UVLO: Auto-restart
  - Overcurrent Protection (OCP): Pulse-by-pulse
  - Overload Protection (OLP): Auto-restart
  - VCC Pin Overvoltage Protection (OVP): Auto-restart
  - REG Pin Overvoltage Protection (REG\_OVP): Auto-restart
  - Thermal Shutdown (TSD): Auto-restart

## ■ Package

SOP18



## ■ Typical Application (AC Input Mode)



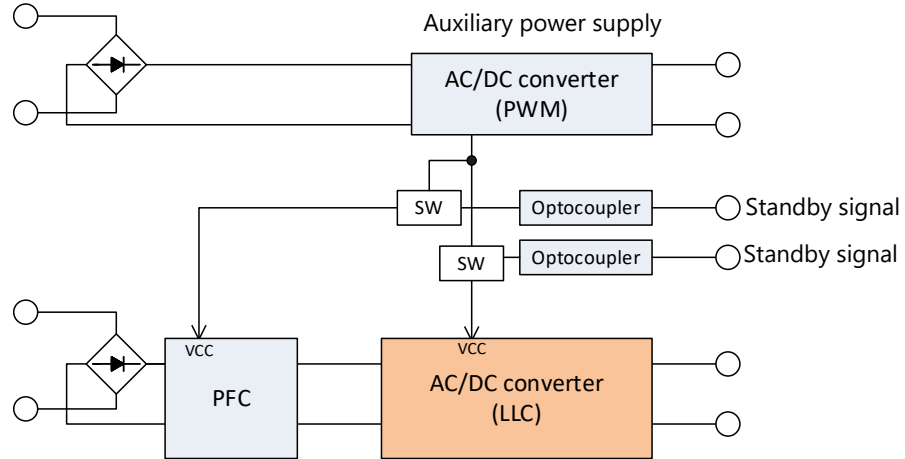
# LLC Current-resonant Power Supply ICs: Guideline

LLC type power supply ICs are available in two types: an external auxiliary power supply type and a built-in type. You can select the optimal IC for your application.

## Type 1: External Auxiliary Power Supply

◆ To minimize standby power ( $P_{IN} \leq 30 \text{ mW}$ )

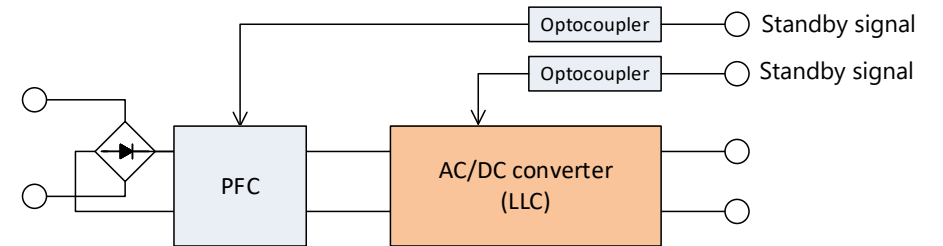
- SSC3S931
- SSC3S932



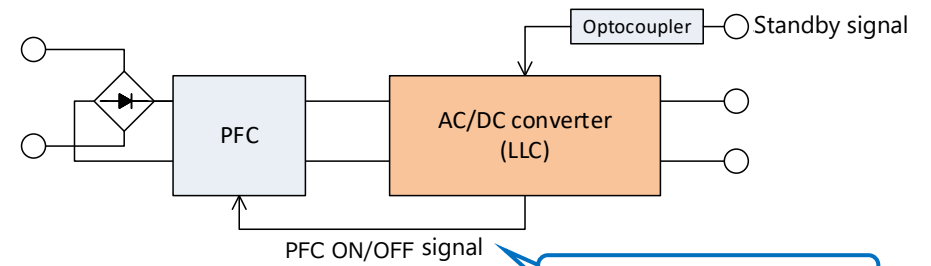
## Type 2: Built-in Standby Function

◆ To minimize the number of external components

- SSC3S90x
- SSC3S927L
- SSC3S910
- SSC3S937



- SSC3S921
- SSC3S927



Our LLC controllers provide safe resonant operation with standard functions including standby mode, capacitive mode detection, and automatic dead time adjustment, and have various protections.

\* With input compensation function

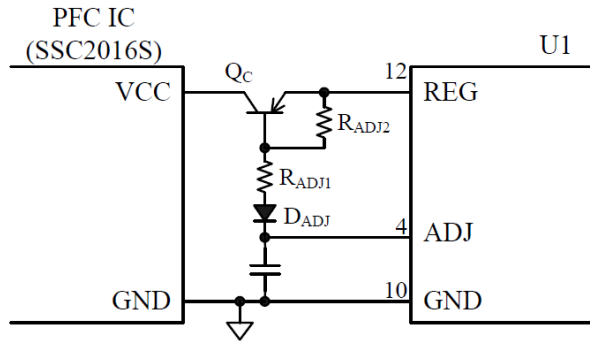
Part Number	V <sub>ST</sub> (Min.)	f <sub>MIN</sub> (Typ.)	f <sub>MAX</sub> (Typ.)	I <sub>FB(MAX)</sub> (Typ.)	Standby Function	PFC On/Off Function	X-capacitor Discharge Function	Input Capacitor Discharge Function	Input Voltage Protection (HVP)	OVP TSD	V <sub>CC(OVP)</sub> (Min.)	OLP	OCP
<a href="#">SSC3S901</a>	600 V	32 kHz	300 kHz	-195 μA	✓	—	—	✓	—	Auto-restart	29.5 V	Auto-restart*	Pulse-by-pulse
<a href="#">SSC3S902</a>	600 V	32 kHz	300 kHz	-195 μA	✓	—	—	✓	—	Latch	29.5 V	Latch*	Pulse-by-pulse
<a href="#">SSC3S910</a>	600 V	32 kHz	300 kHz	-195 μA	✓	—	—	✓	—	Auto-restart	30.0 V	Auto-restart*	Pulse-by-pulse
<a href="#">SSC3S921</a>	600 V	31.5 kHz	300 kHz	-195 μA	✓	✓	—	✓	—	Auto-restart	30.0 V	Auto-restart	Pulse-by-pulse
<a href="#">SSC3S927</a>	600 V	31.5 kHz	300 kHz	-195 μA	✓	✓	✓	—	✓	Auto-restart	30.0 V	Auto-restart	Pulse-by-pulse
<a href="#">SSC3S927L</a>	600 V	31.5 kHz	300 kHz	-195 μA	✓	—	✓	—	✓	Auto-restart	30.0 V	Auto-restart	Pulse-by-pulse
<a href="#">SSC3S937</a>	600 V	31.5 kHz	300 kHz	-195 μA	✓	—	✓	✓	✓	Auto-restart	30.0 V	Auto-restart	Pulse-by-pulse
<a href="#">SSC3S931</a>	—	31.5 kHz	300 kHz	-1600 μA	External	—	—	—	✓	Latch	30.0 V	Latch	Pulse-by-pulse
<a href="#">SSC3S932</a>	—	31.5 kHz	300 kHz	-1600 μA	External	—	—	—	✓	Latch/ Auto-restart	30.0 V	Latch/ Auto-restart	Pulse-by-pulse

# LLC Current-resonant Power Supply ICs: Functions

## 1. PFC On/Off Function

Powers on/off the PFC control IC (recommended: SSC2016S) in synchronization with the standby operation. Allows circuits to consist of fewer external components.

- ✓ Decreases the power consumption at light load or during standby



## 2. Standby Function

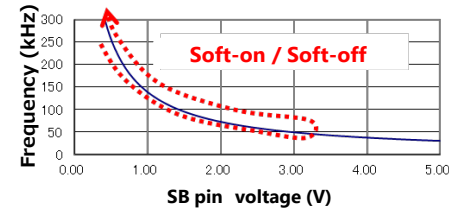
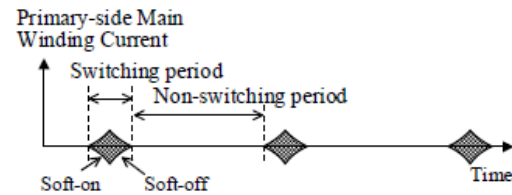
Performs the burst oscillation during the standby operation.

- ✓ Decreases the switching loss at light load

The soft-on/soft-off function prevents drain currents from varying steeply during the burst oscillation.

Controls switching frequencies with the SB pin voltage during the burst oscillation.

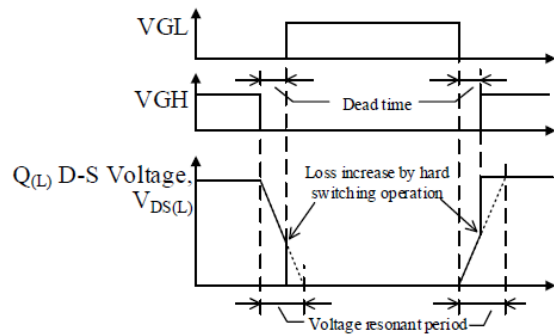
- ✓ Minimizes audible transformer noise



## 3. Automatic Dead Time Adjustment Function

Detects a voltage-resonant period to automatically control the zero voltage switching (ZVS) operations of the high- and low-side power MOSFETs.

- ✓ Requires no dead time adjustment



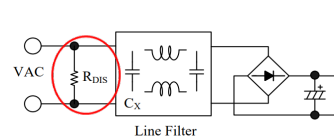
Waveforms at ZVS Failure

## 4. X-capacitor Discharge Function

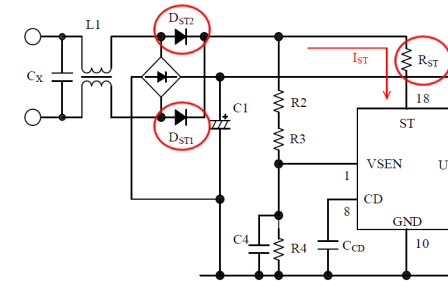
Requires no discharge resistor  $R_{DIS}$  (IEC62368-1 compliant).

A typical line filter configuration needs  $R_{DIS}$  that is connected to an X-capacitor,  $C_x$  in parallel and is always power-consuming.

- ✓ Increases circuit efficiencies



Typical Line Filter Circuit



$R_{DIS}$  removed;  $D_{ST1}$ ,  $D_{ST2}$ ,  $R_{ST}$  connected to the ST pin.

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