Development of Non-Isolated Flyback Power Supply IC STR5A300 Series

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Abstract

This report describes the development of a power supply IC designed for low-capacity power sources used in white goods such as air conditioners, washing machines, and air purifiers, as well as smart meters. For these applications, cost reduction and space-saving in the power system are critical requirements, and further miniaturization is expected in the future. The newly developed IC integrates a high-voltage (900V) power MOSFET and an internal error amplifier, targeting non-isolated power supply applications. This report outlines the key features of the IC, compares circuit topologies, and presents the characteristics of a power board equipped with the IC.

1. Introduction

In recent years, energy conservation has become increasingly important to reduce the consumption of energy resources. It is also expected to contribute to the reduction of CO_2 emissions, a major factor in global warming. In Japan, energy efficiency standards based on the Top Runner Program have been introduced for designated equipment such as household appliances and automobiles. Manufacturers are required to produce and supply products that comply with these standards. For residential air conditioners, new standards will be applied starting in fiscal year 2027, requiring compliance with even stricter regulations(1).

Under these circumstances, semiconductor products such as power supply ICs are expected to play a significant role in energy conservation. For low-capacity power supplies, the flyback topology is widely used due to its ease of design. In isolated types, feedback signals from the output side are typically controlled via a voltage detection circuit and a photocoupler(2). However, in white goods such as air conditioners, where the enclosure is already insulated, the power system may not require isolation, allowing for a non-isolated configuration. In non-isolated systems, the omission of the photocoupler—a component with limited lifespan—offers advantages such as improved reliability and quality.

In this development, a non-isolated power supply IC was created featuring a high-voltage (900V) power MOSFET and a flyback topology optimized for high efficiency under light load conditions.

2. Product Overview

Figures 1 and 2 show the external appearance and application circuit examples of the STR5A300 series. Tables 1 and 2 present the product lineup and pin functions.

This series is characterized by high efficiency across the full load range and low power consumption of 25mW or less under no-load conditions. The power MOSFET lineup includes high-voltage 900V models, designed to ensure robustness even in regions with unstable power supply conditions.

The package options include DIP (Dual In-line Package) for through-hole mounting and SMD (Surface Mount Device) for surface mounting, both commonly used in flyback power supply ICs.

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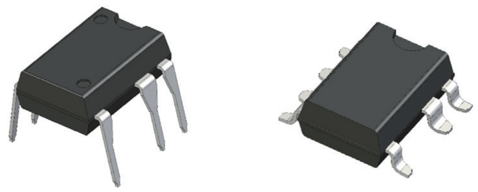
Table 1. Product Lineup

Line up	$f_{OSC(AVG)}$ typ.	V_{DSS} min.	$R_{DS(ON)}$ max.	P_{OUT} (230V/Wide)
STR5A361	100kHz /130kHz	700V	3.95Ω	35W/23.5W
STR5A369			6.0Ω	30W/19.5W
STR5A342		900V	3.0Ω	37.5W/26W
STR5A349			6.5Ω	30W/19.5W



DIP type SMD type

Figure 1. External Appearance

Table 2. Pin Functions

Pin Number	Pin Name	Description
1	S/OCP	Power MOSFET source / Overcurrent protection (OCP) signal input
2	BR	Input voltage sensing input
3	GND	Ground
4	FB	Feedback input for constant voltage control
5	VCC	Logic power supply input / overvoltage protection (OVP) signal input
6	—	(Pin removed)
7	D/ST	Power MOSFET drain / Startup current input
8		

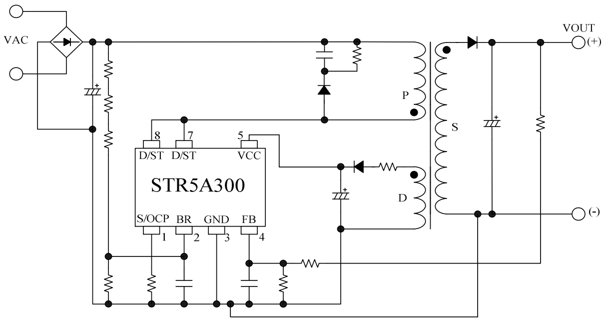


Figure 2. Application Circuit Example

3. Power Supply Configuration for Isolation

Figure 3 illustrates the feedback configuration of conventional isolated products, while Figure 4 shows the feedback configuration of the newly developed non-isolated STR5A300 series.

In conventional isolated types, feedback signals from the output side are transmitted to the internal control circuit of the IC via a voltage detection circuit and a photocoupler.

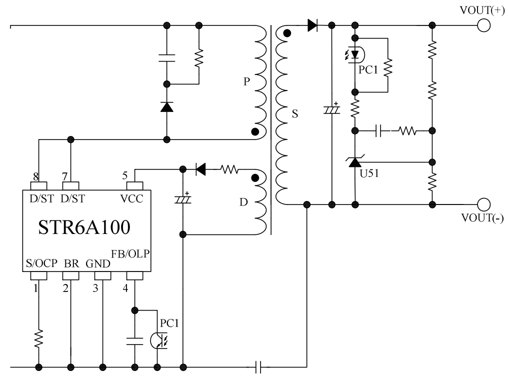


Figure 3. Isolated Type (Conventional Product)

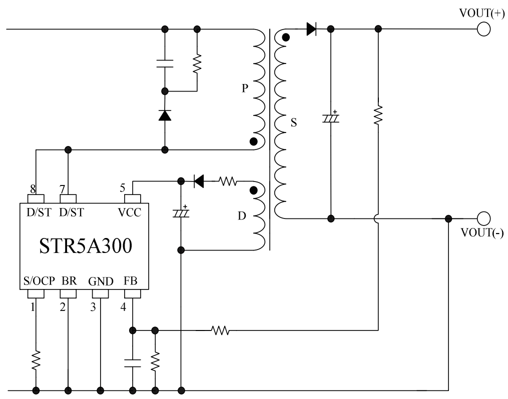


Figure 4. Non-Isolated Type (Developed Product)

In contrast, the newly developed non-isolated type integrates an error amplifier within the IC's internal control circuit, eliminating the need for peripheral components such as shunt regulators and photocouplers that were previously required.

This results in a reduction of five components, enabling miniaturization and cost reduction of the power system in applications where non-isolated configurations are feasible.

4. Functions and Features

4.1 Step Drive Control

Figure 5 illustrates the operation of step drive control, and Figures 6 and 7 show waveforms during startup with and without step drive control.

When the power MOSFET turns on, a surge voltage is generated across the secondary-side rectifier diode D51 due to recovery current and inductive components.

The rectifier diode must be selected with a voltage rating that accounts for this surge voltage.

Using Sanken's proprietary step drive control technology, the gate rise time of the built-in power MOSFET is optimally controlled within the IC according to load conditions.

This suppresses the slope of the recovery current during turn-on and reduces surge voltage.

As shown in Table 3, step drive control allows the VRM voltage rating of the rectifier diode to be set lower than conventional values, enabling cost reduction and improved circuit efficiency through lower forward voltage (VF).

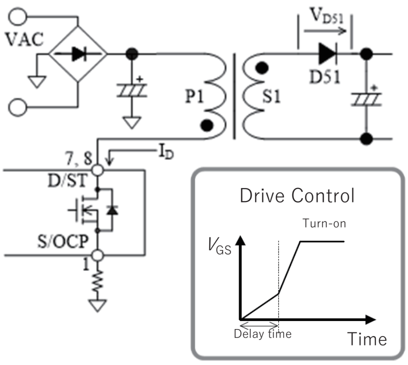


Figure 5. Operation of Step Drive Control

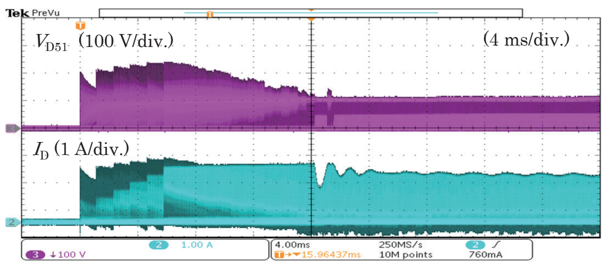


Figure 6 Startup Waveforms without Step Drive Control (V_{OUT} = 24V)

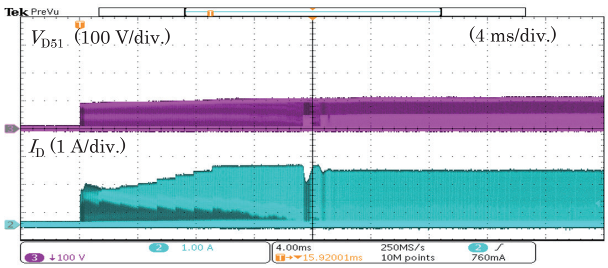


Figure 7. Startup Waveforms with Step Drive Control (V_{OUT} = 24V)

Table 3. VRM Voltage Rating of Rectifier Diodes (Reference Values)

Output Voltage	without Step Drive Control	with Step Drive Control
5V	100V	60V
12V	200V	120V
15V	200V	120V
24V	400V	200V

Step drive control is effective under transient conditions and disabled during steady-state operation. The drive speed is switched between transient and steady-state conditions to optimize switching speed. As a result, power loss in the power MOSFET is reduced and high efficiency of the power supply is achieved across the entire operating range.

4.2 Input Voltage Sensing Function

The input voltage sensing function is designed to ensure safe operation even in regions with unstable power supply conditions. It includes an AC input overvoltage protection function (HVP) that activates when the input voltage is high, and a brown-in/brown-out function (BR_IN/BR_OUT) that activates under abnormal low input voltage conditions. Both functions are configured on the same pin.

By continuously monitoring the input voltage, the IC can instantly suppress damage to the power MOSFET caused by overvoltage and prevent overheating due to prolonged low input voltage.

Figure 8 shows the relationship between the BR pin voltage and switching current. The input voltage sensing function detects the input voltage via the BR pin and controls switching operation based on the BR pin voltage to transition to appropriate protection modes.

If the input voltage sensing function is not used, it can be disabled by connecting the BR pin to GND to fix the potential.

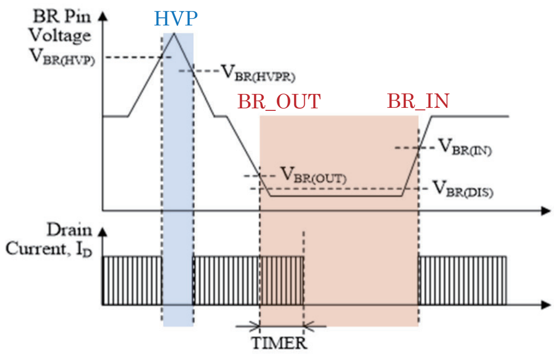


Figure 8. BR Pin Voltage and Switching Current

4.3 Low Power Consumption and High Efficiency Across Full Load

Measured values for the STR5A361 model (oscillation frequency: 100kHz) are reported. Figure 9 shows the evaluation board used for efficiency measurement.

The no-load power consumption is 25mW (AC230V), equivalent to that of conventional isolated products, achieving low power consumption.

Although the non-isolated STR5A300 series integrates an error amplifier into the control IC, resulting in increased circuit scale, a review of the circuit configuration has enabled the control chip size to remain equivalent to that of conventional products.

As shown in **Figures 10**, **11**, and **12**, the IC automatically switches its operating mode according to the load current: Burst Oscillation Mode, Green Mode (25kHz–100kHz), and Normal Operation (100kHz).

When the load decreases to standby conditions, the IC transitions from Green Mode to Burst Oscillation Mode. In Green Mode, switching frequency is reduced, and in Burst Oscillation Mode, switching operation is temporarily halted, both contributing to reduced switching losses and improved conversion efficiency.

Figure 13 shows the output power and load regulation characteristics, confirming favorable load regulation.

Figure 14 presents the efficiency characteristics under full load. Through optimized oscillation frequency control and drive circuitry, high efficiency of approximately 88–89% was achieved in the output power range of 5W to 23W.

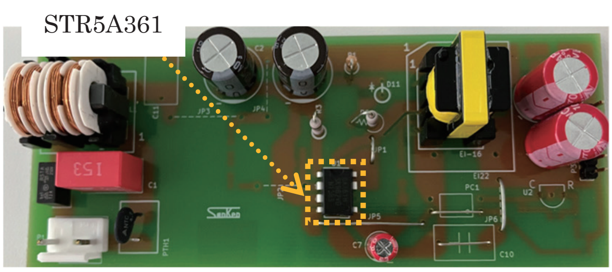


Figure 9. External View of Evaluation Board

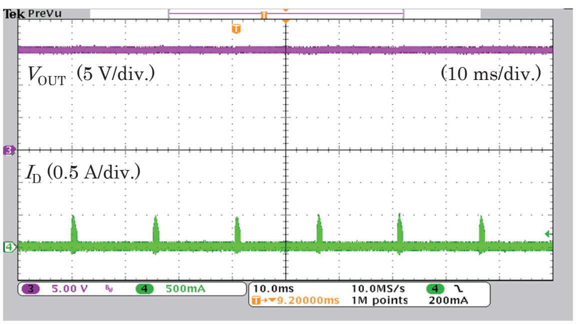


Figure 10. Burst oscillation mode

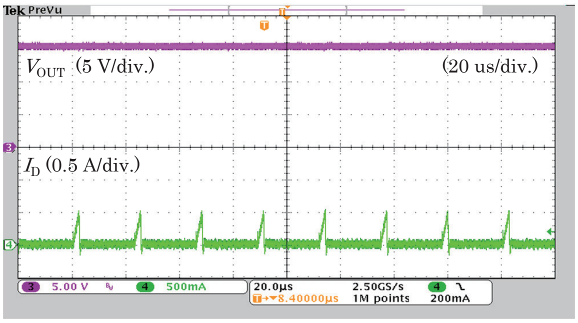


Figure 11. Green Mode

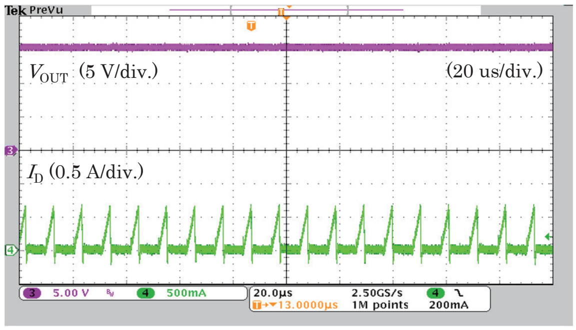


Figure 12. Normal Operation

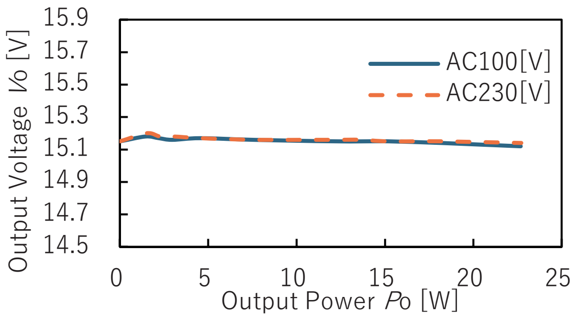


Figure 13. Load Regulation Characteristics

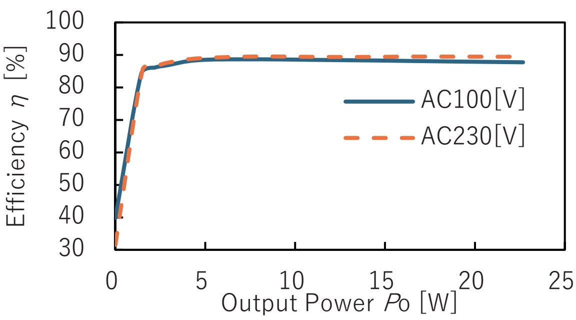


Figure 14. Efficiency Characteristics

5. Conclusion

A non-isolated flyback power supply IC, the STR5A300 series, has been developed for use in non-isolated power supply systems.

By integrating an error amplifier, five peripheral components were eliminated, enabling miniaturization and cost reduction of the power system.

Step drive control and oscillation frequency control have achieved low power consumption and high efficiency across the full load range.

Additionally, the incorporation of high-voltage power MOSFETs and input voltage sensing functions ensures safe operation even in regions with unstable power supply conditions.

Future product development will continue to address diverse power supply requirements and contribute to energy conservation.

References

(1) Agency for Natural Resources and Energy, “New Energy Efficiency Standards for Residential Air Conditioners Established,” Ministry of Economy, Trade and Industry, 2022. URL: https://www.meti.go.jp/press/2022/05/20220531003/20220531003.html (Accessed: September 18, 2025)

(2) Hayakawa, A. and Tabata, T.: “Sanken Technical Report,” 2014, Vol. 46, pp. 33–36.