

Secondary regulation
Synchronous rectification controllers

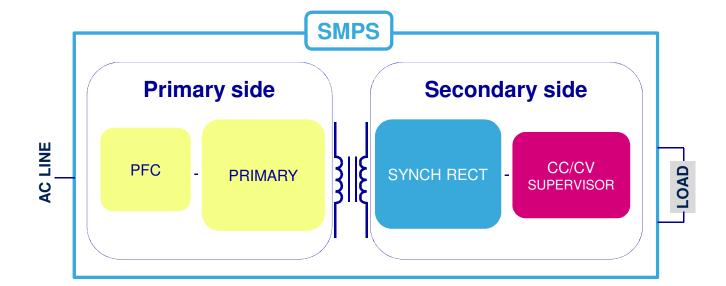




Contents

Synchronous rectification

- Functionality and applications
- ST's sync. rect. ICs topologies and offer







Synchronous rectification ICs

Function

 Drive power MOSFETs that replace the rectification diodes at the SMPS secondary side

Target

 Increase SMPS efficiency especially in low-outputvoltage and high-current power supplies

Topologies

 Different SR controllers topologies according to the type of primary-side converters

Features

 SR ICs allow space saving, cost reduction, reliability and performance improvement with respect to discrete solutions





SR – topologies & IC portfolio







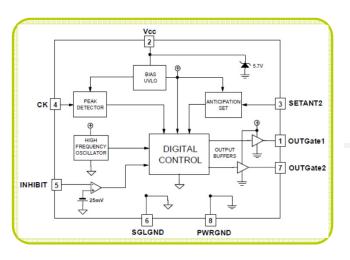






STSR30 – SR x Flyback

Features



STSR30

- Vcc = 4 5.5 V
- Operating freq. = 20 500 kHz
- Icc (no load) = 3.2 mA, with (DISABLE = 0) 15 μA
- Output peak current (typ): 1.5 A
- Inhibit blanking time: 700 ns
- Smart turn-off anticipation timing to avoid short circuit between primary and secondary sides
- Automatic turn-off for duty cycles less than 14%
- Disable pin allows turning off the device during no-load conditions
- Operates in DCM, CCM and QR configurations
- SO8

Application note

- AN2432

EVALSTSR30-60W: 60 W AC-DC adapter with synchronous rectification using L6668 and STSR30



Application requirements

• High current, medium power

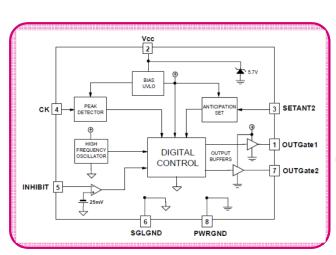
Application target

High current adapter





STSR2P/STSR2PM - SR x Forward



STSR2

Features

- Vcc = 4.5 5.5 V
- Operating freq. = 20 750 kHz
- Icc (no load) = 3 mA
- Output peak current (typ): source 2 A, sink 3.5 A
- Smart turn-off anticipation timing preventing secondary side shootthrough conditions
- Operation independent from the forward magnetic reset technique
- STSR2P automatically turns off the outputs when duty-cycle < 13%
- STSR2PM works even at very low duty-cycle values
- Operates in DCM
- SO8

Application note

- AN1645

STSR2P/STSR2PM simplifies implementation of synchronous rectifiers in forward converters

Application requirements



Medium power, low output voltage, high current

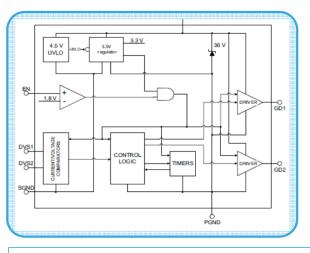
Application target

- High-current forward converters for servers
- Low-output-voltage DC/DC forward modules



SRK2000 & SRK2000A - SR x LLC resonant

Features



SRK2000 SRK2000A

- Vcc = 4.5 32 V
- Operating freq. up to 500 kHz
- Iq (typ) 250 μA
- Protection against current reversal
- Safe management of load transient, light load and startup conditions
- Optimized state-machine control algorithm
- Automatic sleep mode at light loads
- Dual gate driver for N-channel MOSFETs with 1 A source and 3.5 A sink drive current
- Programmable UVLO with hysteresis
- SO8
- SRK2000A is P2P with SRK2000 and both feature the same electrical parameters
- SRK2000A features matched turn-off thresholds offering a more balanced current in the two MOS
- EVL400W-ADP/ATX 12V 400W SMPS for Adapter, Desktop and AIO using L4984D, L6699 and SRK2000A

Application requirements



• Space shrunk, slim form factor, high efficiency smaller heat sink

Application target

- AIO PCs, PCs, ATXs, servers
- LCD TVs, console games, Industrial SMPSs
- Adapters above 90 W







SRK2000 / SRK2000A Key principles of operation



Switching mode

- Turn-on SR MOSFET after body diode starts conducting and turn-off when current approaches zero
- Drain sensing optimization to take into account parasitic elements effects on MOSFET turn-off and turn-on

Control logic with 3 state-machines

- Two state-machines for the two drivers, operating synchronously
- One state-machine for power states management: switching, sleep, idle modes

Sleep mode at light loads

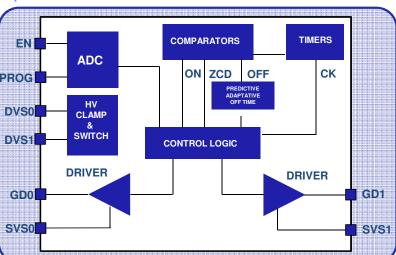
- Enter when primary side stops switching or when SR conduction time is <40% of SR switching cycle
- Exit when conduction time of body diode is >60% of SR switching cycle
- After entering/exiting sleep mode, timing is ignored for 128/256 switching cycles



Features



SRK2001 / SRK2001L Adaptive SR x LLC resonant



SRK20001

• Vcc = 4.5 - 32 V

Operating freq. up to 500 kHz

Iq (typ) 50 μA

Dual gate driver for N-channel MOSFETs

5 V / 10 V driving options

Auto-compensation of parasitic inductance

High voltage drain-to-source Kelvin sensing for each MOSFET

Improved ZCD turn-off

Turn-on logic with adaptive masking time

Adaptive turn-off logic

 Improved control logic algorithms to avoid SR MOSFET conduction time jitter @ low current

SO10

Adaptive control algorithms for parasitic inductance self compensation → Maximum MOSFETs conduction & High efficiency in all load conditions



Flexibility in SR MOSFET selection

→ SRK2001 and SRK2001L compatible with standard and logic-level MOSFETs





SRK2001 Key principles of operation



SR MOSFET driving

- MOSFET are switched on and off depending on the evolution of their drain-source voltages
- Proper driving is achieved through adaptive turn-on and turn-off control algorithms, by directly sensing the drain-source voltage V_{DS} of either MOSFET

Control logic and operating mode configurations

- The logic that controls the driving of the two MOSFETs is based on two state machines working in parallel in interlocked way
- A third state machine manages the transitions from normal to sleep mode and vice versa

Sleep modes

• EN and PROG pins allow to configure automatic sleep operating modes by selecting D_{OFF} and D_{ON} conduction duty cycles with the R_{EN} and R_{PG} values setting

Automatic sleep mode enabled

• Sleep mode is entered when MOSFET conduction duty cycle becomes lower than D_{OFF} for 512 consecutive clock cycles. As load increases, system exits sleep mode when the MOSFET body diode conduction duty cycle exceeds D_{ON}



Automatic sleep mode disabled

 Automatic sleep mode is disabled with R_{EN} open and D_{ON} conduction duty cycle is selected among the values available in the internal lookup table. When half-bridge converter switching activity stop is detected, SRK2001 enters low consumption state



SRK2001 reference designs



Name	Description	Application notes
STEVAL-ISA170V1	12 V, 150 W EuP Lot 6 resonant converter based on SRK2001, L6699 and L6563H	AN4677
STEVAL-ISA165V1	Plug-in board with SRK2001 and 40 V MOSFETs in TO220 package	AN4674
STEVAL-ISA166V1	Plug-in board with SRK2001 and 60 V MOSFETs in TO220 package	AN4674
STEVAL-ISA167V1	Plug-in board with SRK2001 and 60 V MOSFETs in PowerFLAT™ package	AN4674
STEVAL-ISA168V1	Plug-in board with SRK2001 and 40 V MOSFETs in PowerFLAT™ package	AN4674
STEVAL-ISA169V1	Plug-in with SRK2001L and 40 V MOSFETs in PowerFLAT™ package	AN4674





SRK2001 Reference design performance

150W-12V evaluation board STEVAL-ISA170V1 [L6563H + L6699 + SRK2001]

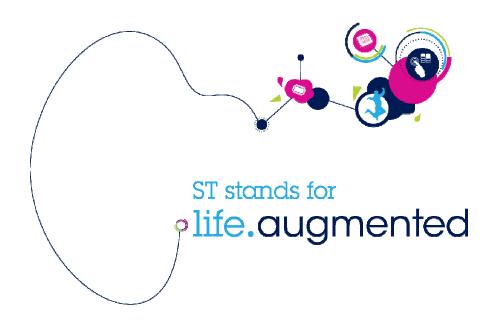
- Application target: AIO power supply, high power adapter
- No-load mains consumption: < 0.15 W at 230 Vac, according to European CoC ver. 5 Tier 2 requirements
- Avg. efficiency: > 91% at 115 Vac, according to ENERGY STAR® 6.1
- Light load efficiency: according to EuP Lot 6 Tier 2 requirements
- Full load efficiency: 90.96% @ 115 Vac and 93.16% @ 230 Vac
- EMI: according to EN55022-Class-B
- Safety: according to EN60950







Thank you!





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