DT0084
Design tip

Application of SRK2001 in higher output voltage circuits with external sensing MOSFETs

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Main components	
SRK2001 SRK2001A	Adaptive synchronous rectification controller for LLC resonant converter

Purpose and benefits

Purpose of this design tip is to show an implementation of SRK2001 with external high voltage signal MOSFETs on the DVS1 and DVS2 sensing pins. The proposed circuit allows extending the applicability of SRK2001 in converters with higher output voltages (for example 48V converters), where the AMR of the sensing pins DVS1,2 would not be enough.

Description

In LLC resonant converter applications with higher output voltages (for example 48V output converters), where the AMR of SRK2001 DVS1,2 pin voltage may be not enough to withstand the voltage excursion across SR MOSFET drain-source, external sensing MOSFETs can be used as shown in ***Figure 1*** below.

The two sensing MOSFETs have the drain terminal connected to the corresponding SR MOSFET drain terminal and the source terminal connected to the resistor in series to the respective DVS pin of SRK2001.

Each sensing MOSFET starts turning on when the voltage across the corresponding SR MOSFET drain decreases below the level ($V_{CC} – V_{F\_bd} - V_{TH}$) and is completely turned on when the drain voltage drops to zero (V_{TH} is the gate threshold voltage level of the sensing MOSFET). Then, when the SR MOSFET drain voltage (after the rectified current has reached zero) starts increasing causing the V_{GS} of the sensing MOSFET to decrease, this last starts turning off and, when the SR MOSFET drain increases above the level ($V_{CC} - V_{F\_bd} - V_{TH}$), it is definitely turned off, with its body diode reverse biased. Thus, the voltage of SRK2001 DVS1,2 pins remains clamped at V_{CC} voltage level (specifically to $V_{CC} + V_F$), as shown in ***Figure 2***. Waveforms in ***Figure 3*** show also that, during SR MOSFET conduction (ON period), the signals across SR MOSFETs drain-source are almost equal to the signals across DVS1,2 pins, with a negligible delay (few nanoseconds). Therefore, the external sensing MOSFETs added to the circuit do not affect the overall circuit operation (neither the turn-on delay, nor any premature turn-off).

Figure 1. Circuit diagram

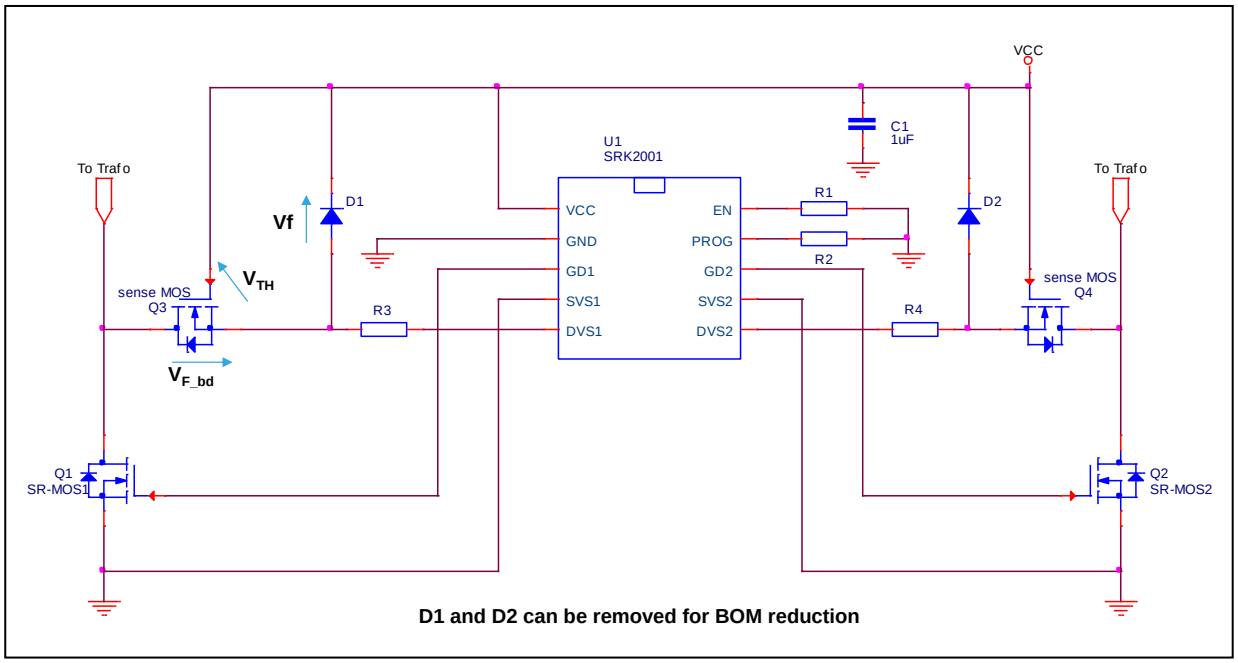


Figure 2. SR MOSFET drain voltage and DVS pin voltage waveforms

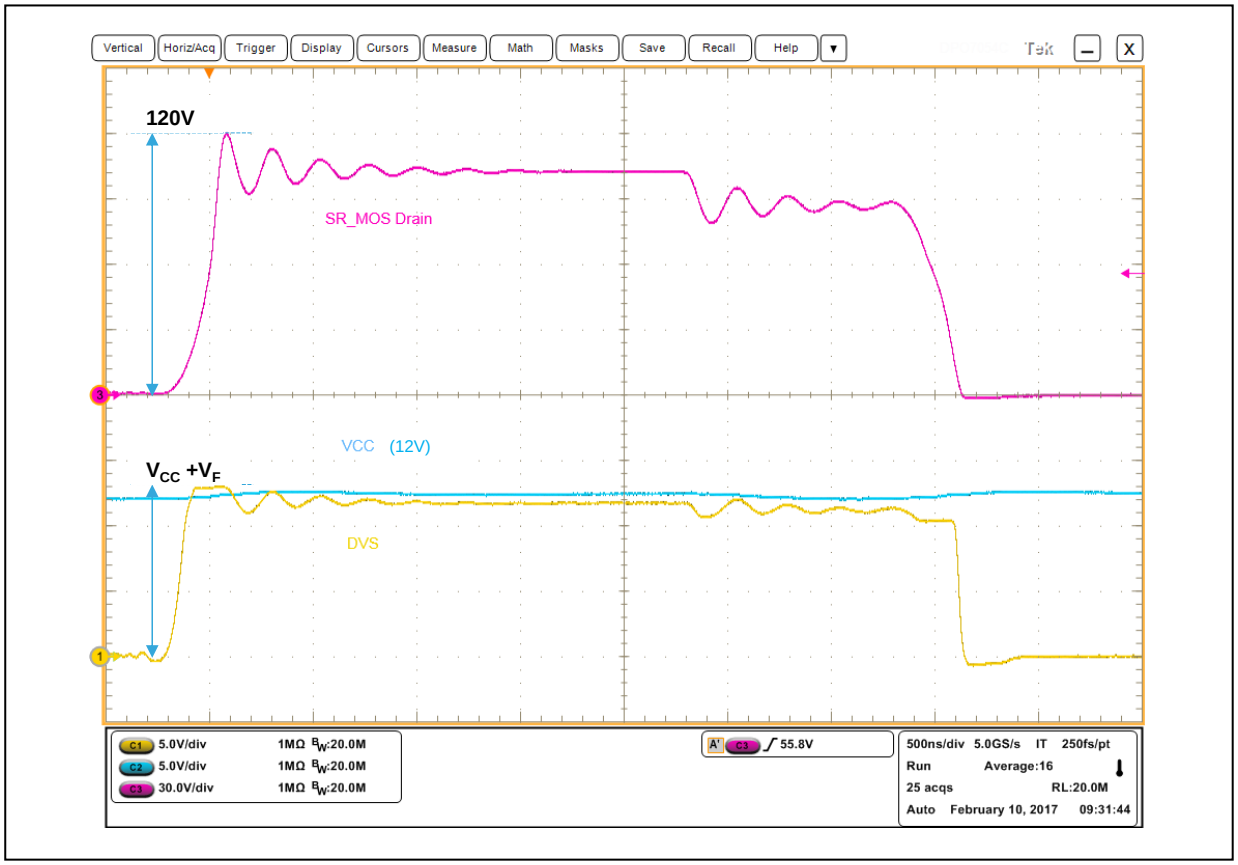
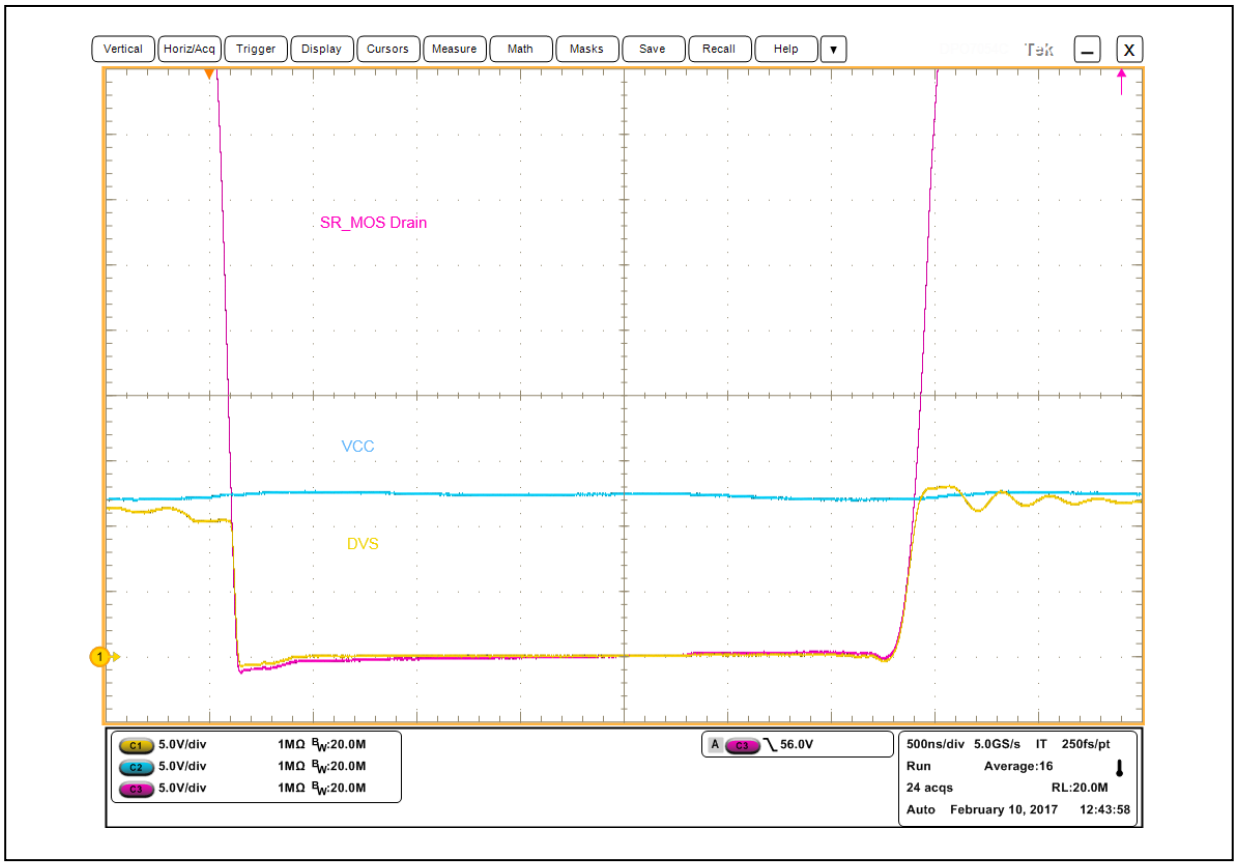


Figure 3. SR MOSFET drain voltage and DVS pin voltage waveforms (details during ON)



In practice, the two sensing MOSFETs have to withstand the difference between the SR MOSFET drain voltage and the VCC pin voltage and need to be chosen accordingly; therefore we can roughly select the sensing MOSFET with the same voltage rating of the power SR MOSFET. For example, in the case of a 48V output voltage converter, with a 150V rated SR MOSFET, a sensing MOSFET of 150V can be selected as well.

The supply voltage V_{CC} cannot be the converter output voltage (e.g. 48V), since SRK2001 supply pin has an internal clamp at 33V (min). Furthermore, the maximum gate-source voltage rating of the external sensing MOSFETs (generally ±20V) also fixes a limit to V_{CC} voltage. Therefore, it is advisable to provide the circuit with an external V_{CC} supply voltage of about 12V, in order to minimize also the driving losses and consequently the power dissipated inside SRK2001. This +12V supply should be normally available in this kind of applications or at least it should be easily obtainable from the converter output itself.

In order to reduce BOM (and solution cost), the two diodes D1 and D2 can be removed. This will lead to a certain increase of the clamp voltage on DVS1,2 pin (in the order of 10V), due to the current injection from the sense MOSFET drain-source capacitance C_{DS}, like shown in ***Figure 4*** and ***Figure 5***.

Resistors in series to DVS1,2 pins of at least 100 ohm are required to limit dynamic current injection in any condition (see SRK2001 datasheet), also in DVS sensing without external MOSFETs.

Figure 4. DVS pin clamped voltage waveforms without diodes D1 and D2

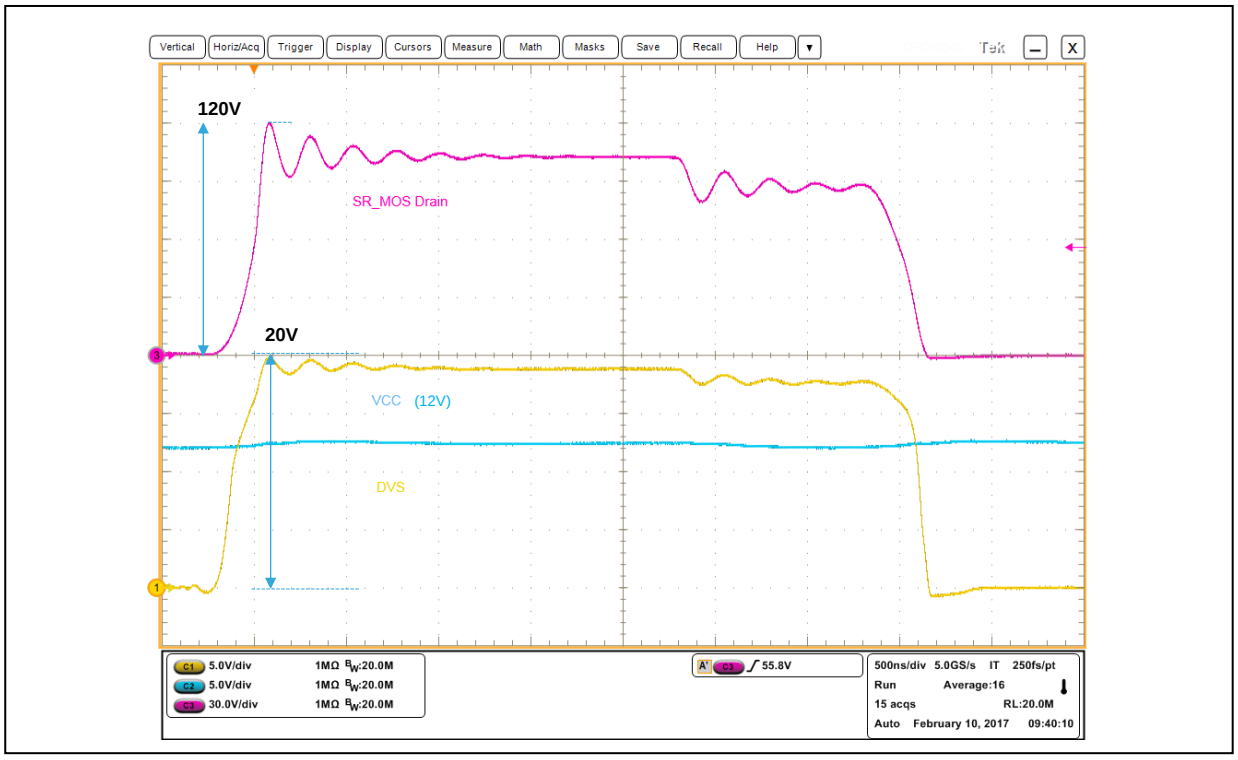
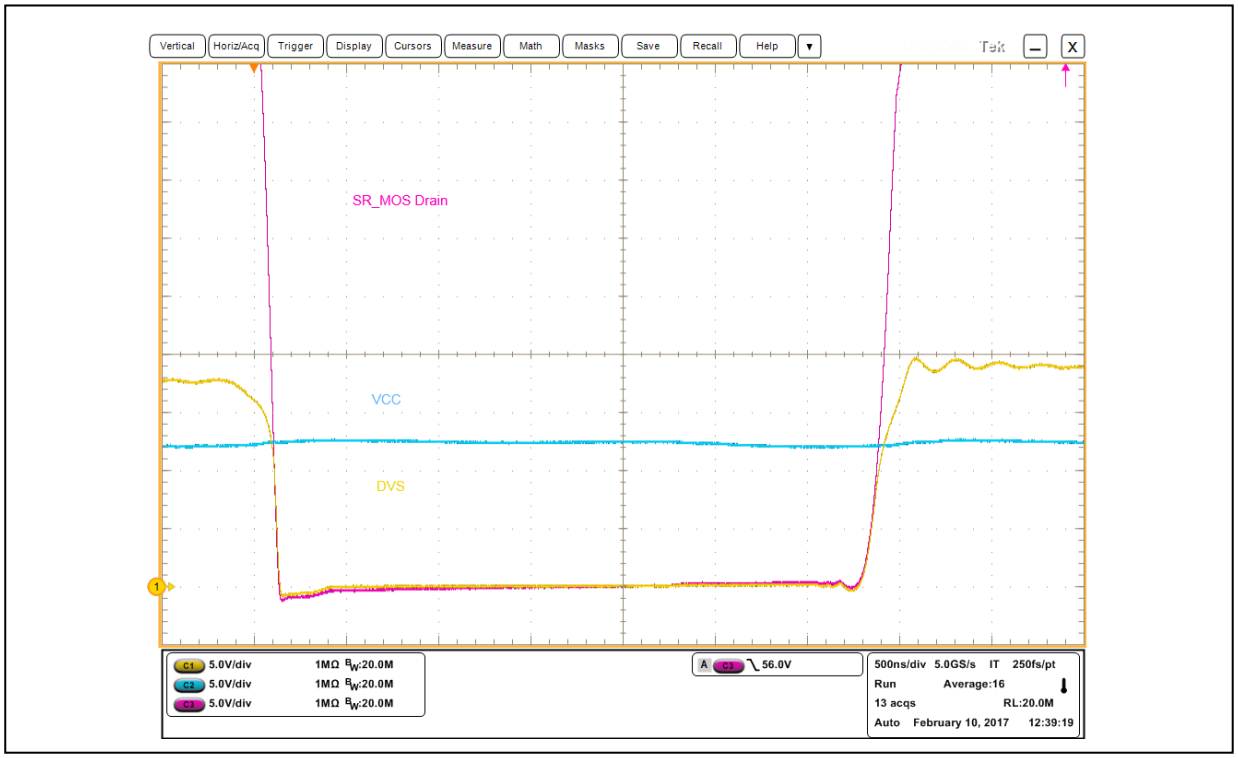


Figure 5. DVS pin clamped voltage waveforms without D1 and D2 (details during ON)



Support material

Related design support material
EVL-SRK2001-HVS – Evaluation board: SRK2001 adaptive synchronous rectification controller for LLC resonant converter with high voltage external sensing MOSFETs
Documentation
Application note, AN4674, “SRK2001 adaptive synchronous rectification controller for LLC resonant converter evaluation board family”

Revision history

Date	Version	Changes
16-May-2017	1	Initial release

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