Application Report

LM5180 EMI Performance

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ABSTRACT

This application report presents the results of EMI testing on the LM5180-Q1 PSR isolated fly-back regulator. Although it is usually difficult to pass EMI testing on a fly-back, this document shows that with the proper EMI filter and shielding, the LM5180-Q1 easily passes the CISRP25 class 5 standard. Other members of the LM518x family can be found in Table 1-1.

Table 1-1. PSR Flyback DC/DC Converter Family

PSR Flyback Converter	Input Voltage Range	Peak Switch Current (TYP)	Maximum Load Current, V_{OUT} = 12 V, N_{PS} = 1		
			V_{IN} = 4.5 V	V_{IN} = 13.5 V	V_{IN} = 24 V
LM5181-Q1	4.5 V to 65 V	0.75 A	90 mA	180 mA	225 mA
LM5180-Q1	4.5 V to 65 V	1.5 A	180 mA	360 mA	450 mA
LM25180-Q1	4.5 V to 42 V	1.5 A	180 mA	360 mA	450 mA
LM25183-Q1	4.5 V to 42 V	2.5 A	300 mA	600 mA	750 mA
LM25184-Q1	4.5 V to 42 V	4.1 A	500 mA	1 A	1.25 A

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Trademarks

1 Detailed Descriptions

The following test conditions apply to the results found in this document:

- V_{IN} = 12 V and 24 V
- V_{OUT} = 5 V
- Output Current = 0.85A
- 2 layer PCB with 1oz copper
- PCB Dimensions = 1.4 inches x 2 inches (3.6 cm x 5.1 cm)
- CISPR 25 Class 5

The LM5180 EVM was modified as shown in Figure 1-1 and in Table 1-1. First, the 10 µH EMI filer inductance was changed to 4.7 µH. The smaller inductor has a higher self resonant frequency (SRF) and, therefore, less parasitic capacitance. The parasitic capacitance of the inductor will by-pass the high frequency noise around the inductor, thus reducing the effectiveness of the EMI filter. A high SRF is desired for an EMI filter inductance in order to maintain the low-pass characteristic to the highest possible frequency. An additional filter capacitor, C3a, is added to bring the filter cut-off frequency back to near the value obtained with the 10 µH inductance.

In every fly-back transformer, switching noise on the primary side is couple to the secondary by the inter-winding capacitance. Unless a dedicated path is provided for this current, it will flow through any extraneous path to get back to the primary side. This common mode current will flow in an unnecessarily long path back to the primary side and show up as increased EMI. C1 is used to connect the primary and secondary grounds, providing a controlled path for this current while maintaining the D.C. isolation of the secondary output. Selecting, or designing, a transformer with low inter-winding capacitance will also help to reduce this noise contribution. The copper shield shown in Figure 1-2 is also helpful by capturing and shunting any capacitive noise current from the transformer windings back to the primary ground.

Finally, the snubber circuit capacitors, C8 and C10, were increased in value to help damp the ringing that occurs between the parasitic capacitance at the SW node and the transformer inductance. Ringing will also occur on the secondary side when the output diode turns off. This ringing will affect both conducted and radiate EMI, and should be damped as much as possible without affecting the operation of the regulator or unduly reducing the system efficiency.

1.1 Test Schematic

The modified schematic shown in Figure 1-1, was used for all of the testing in this document. Modified components are shown in the red circles and in Table 1-1. The details of T1 and C3a are shown in Figure 1-2 and Figure 1-3. For more information, see the *LM5180-Q1 Single-Output EVM User's Guide*.

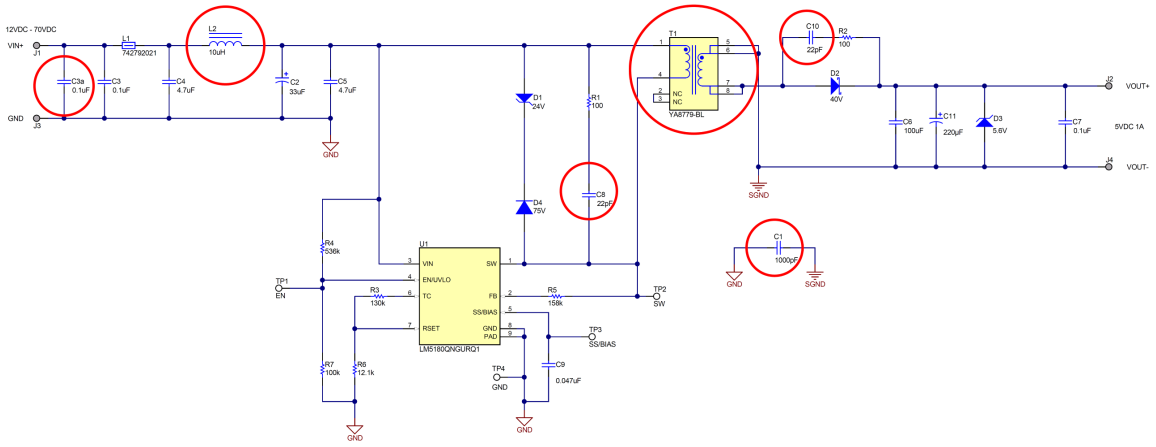

Figure 1-1. Modified EVM Schematic

Table 1-1. Changes to EVM

Reference	Modification
C3a	Added C3a; same value and location as C3; 0.1 µF
L2	Changed from 10 µH, Würth, 744042100 to 4.7 µH Würth, 744042004
C8, C10	Changed value of both capacitors from 22 pF to 100 pF
T1	Wrap transformer with copper shielding tape. Shield grounded at one point on primary side.
C1	Install C1. 1000 pF, 2kV, 1206, X7R

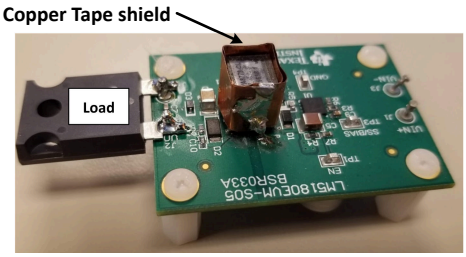

Figure 1-2. Copper Shielding of T1

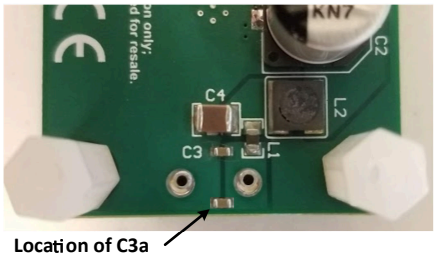

Figure 1-3. Location of C3a

1.2 PCB Layout

Details of the EVM PCB layout are found in Figure 1-4, Figure 1-5, and Figure 1-6.

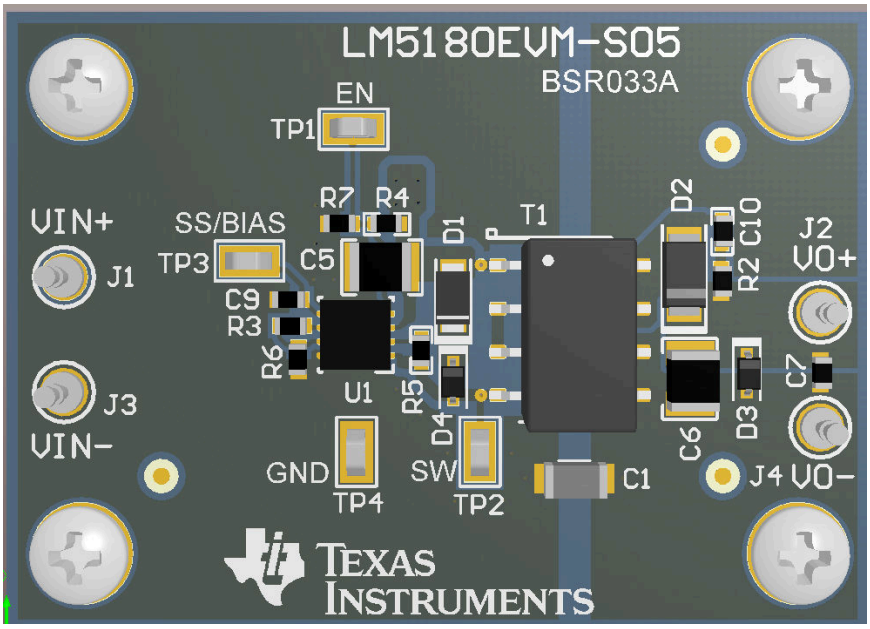

Figure 1-4. LM5180-SO5 EVM

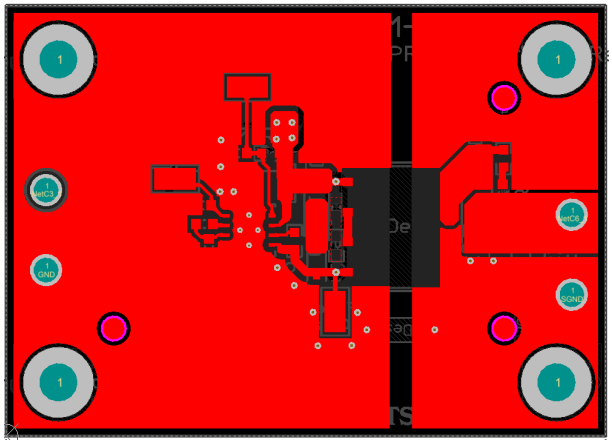

Figure 1-5. EVM Top Copper

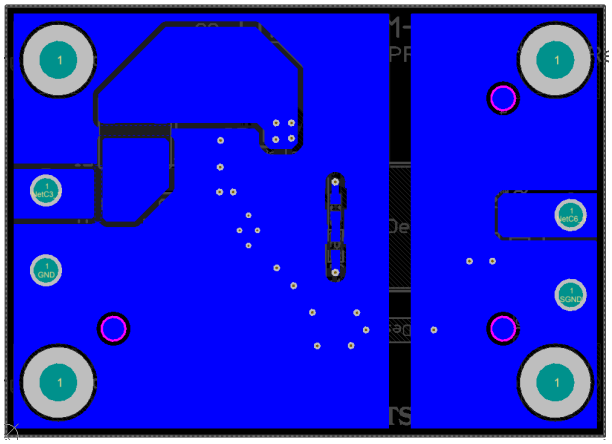

Figure 1-6. EVM Bottom Copper

2 CISPR 25 Class 5 Conducted Emissions Results

Unless otherwise specified, the following conditions apply: V_{OUT} = 5 V, I_{OUT} = 0.85 A.

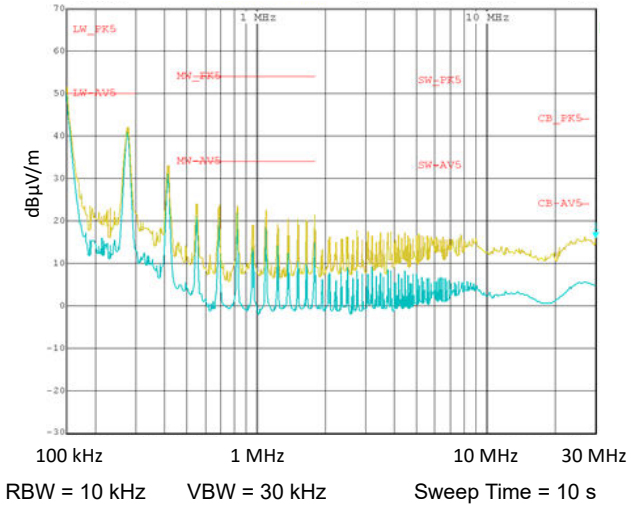

Figure 2-1. LF: V_{IN} = 12 V

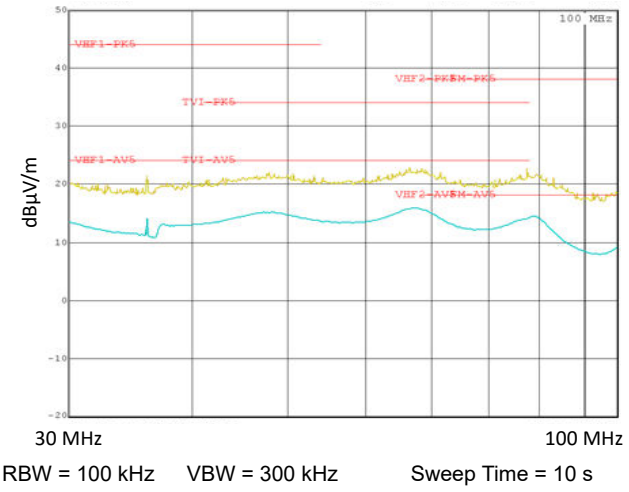

Figure 2-2. HF: V_{IN} = 12 V

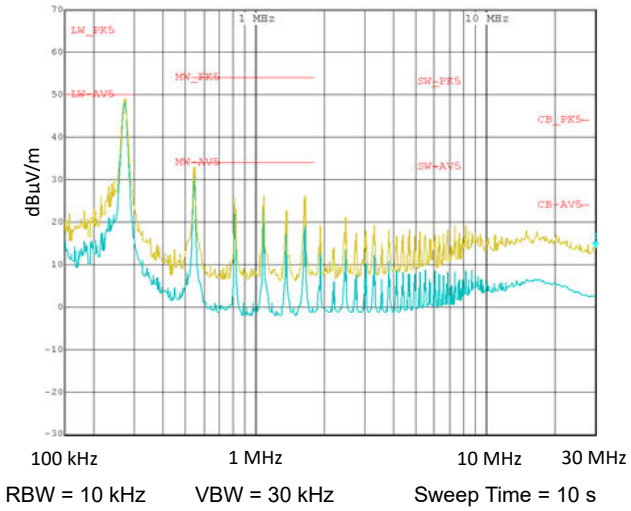

Figure 2-3. LF: V_{IN} = 24 V

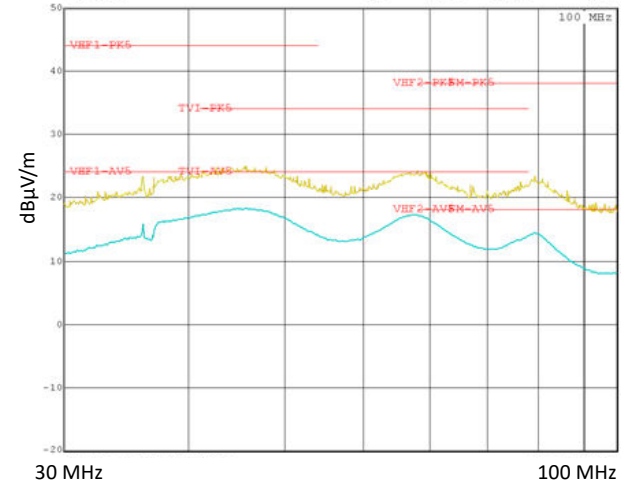

Figure 2-4. HF: V_{IN} = 24 V

3 References

- *LM5180-Q1 Single-Output EVM User's Guide*

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