EMI optimized Fly-buck design

TI number: PMP11052 Rev A

V_{IN}: 20V-75V (95V transient)
V_{OUT1}: 10V (nominal)
V_{OUT2} (isolated): 9.5V (nominal)
Total Load Current (I_{OUT1}+I_{OUT2}): 300mA

Test Results

1 Circuit Description

A buck converter has high di/dt current flow in only the VIN-loop (Figure 1). The Fly-buck converter has high di/dt current flow in VIN-loop, COUT1-loop, and COUT2 loop (Figure 2). Therefore, all the loops in a Fly-buck converter must be minimized for quieter operation.
This reference design demonstrates the improvement in EMI performance in a Fly-buck design with optimized layout for all high di/dt loops shown in Figure 2 and compares it with another layout which is laid out just like a buck converter with only the VIN-loop optimized.
The LM34927 fly-buck is used as an example. The optimization applies to all Fly-buck design including LM34927/6/5 and LM5017/8/9, and LM25017/8/9.

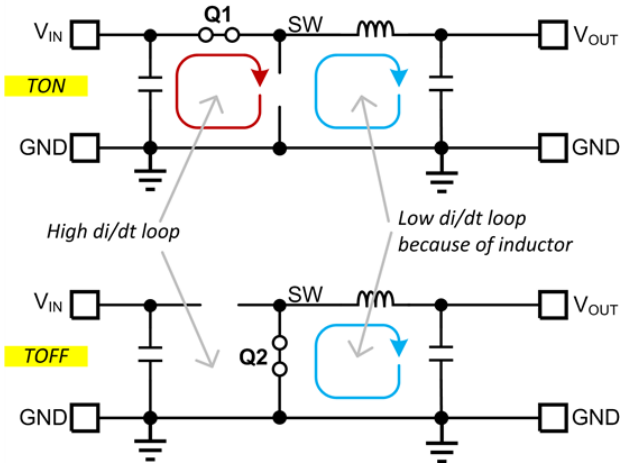


Figure 1. Current flow in a buck converter. Only the input loop (red) has discontinuous current flow.

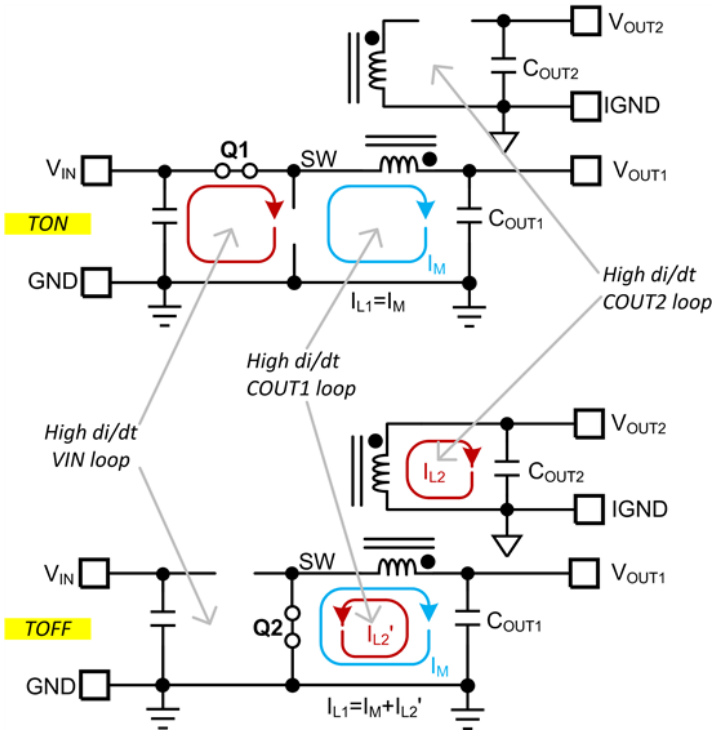
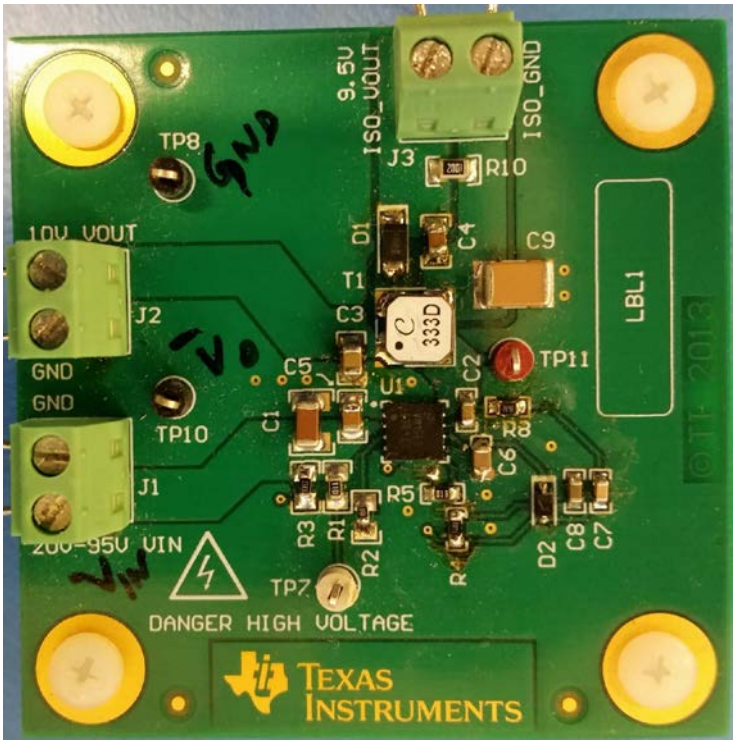
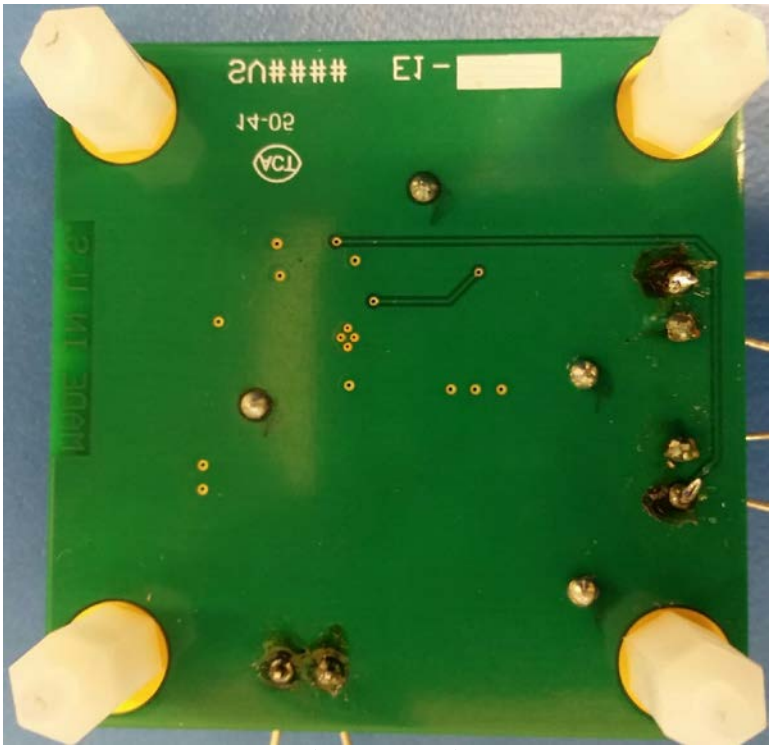


Figure 2. Current flow in a Fly-buck converter. Both the input and output loops have discontinuous current flow.

2 Photos

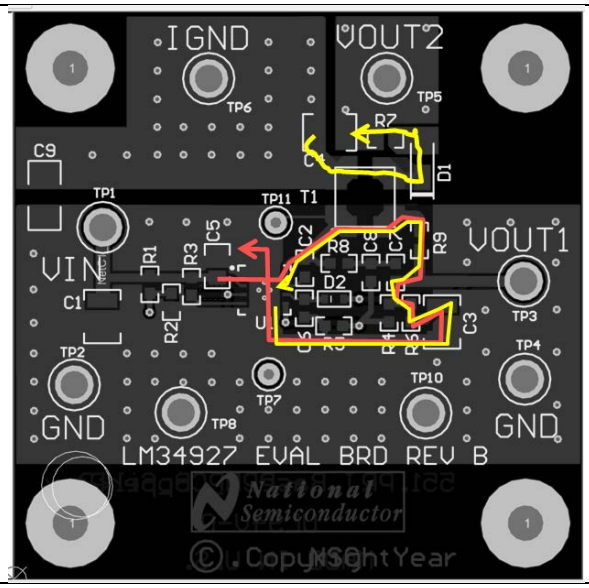


(Top view)

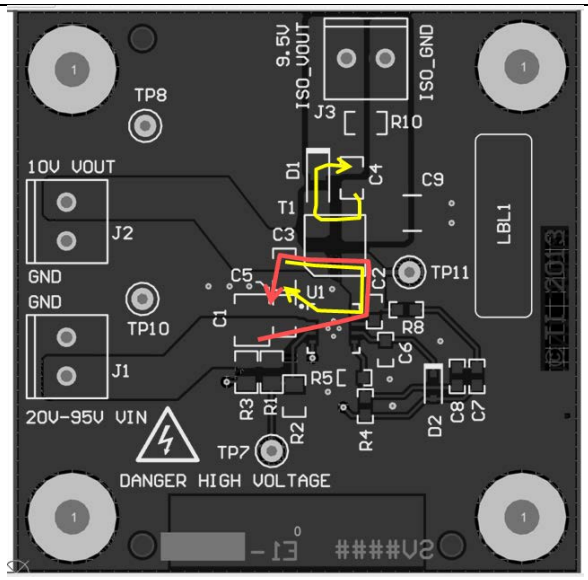


(Bottom view)

3 Comparison with un-optimized layout



Unoptimized Fly-buck layout (only input loop minimized)

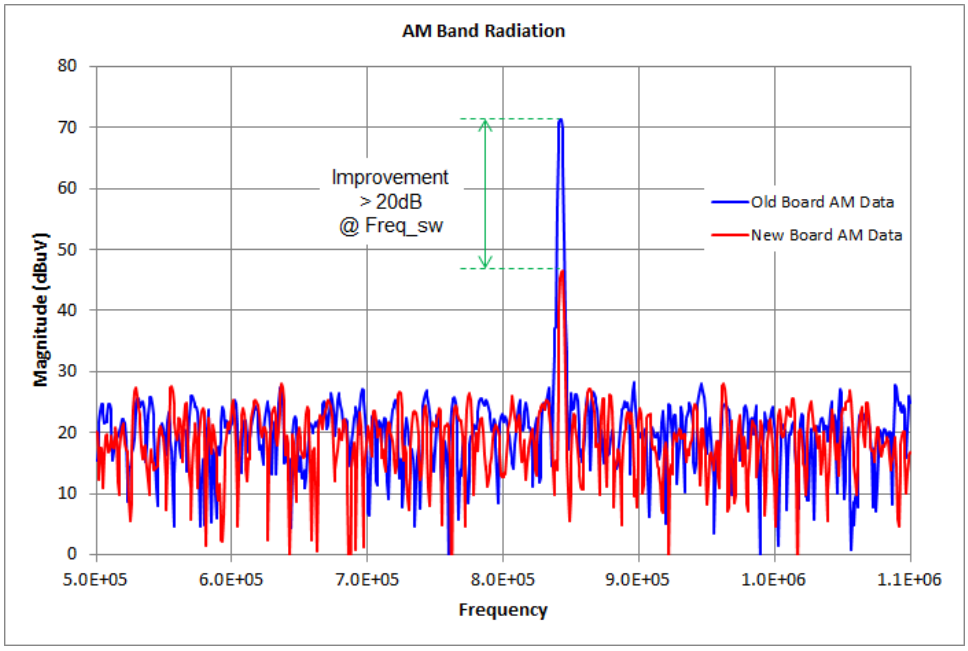


Optimized Fly-buck layout (all di/dt loops minimized)

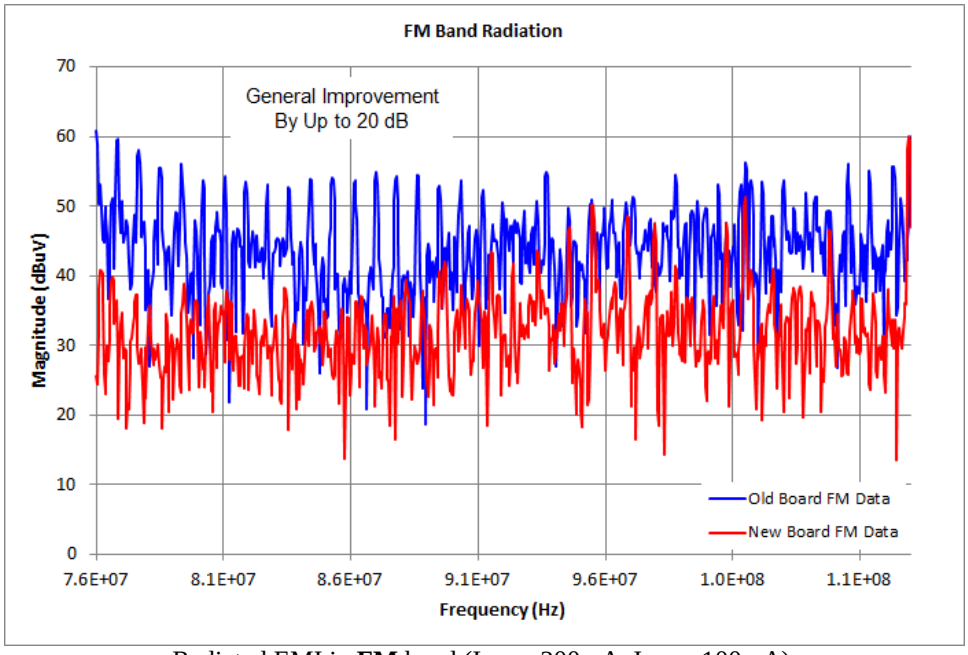
4 Test Setup

- Radiated emission was read with a wire hook antenna that encloses the entire circuit board.
- Conducted Emission was read following the CISPR-25 recommendation. A LISN was used for conducted emission testing.
- Frequency sweeps were limited to two frequency bands, owing to the instrument limitations. One was partial AM band, the other partial FM band.

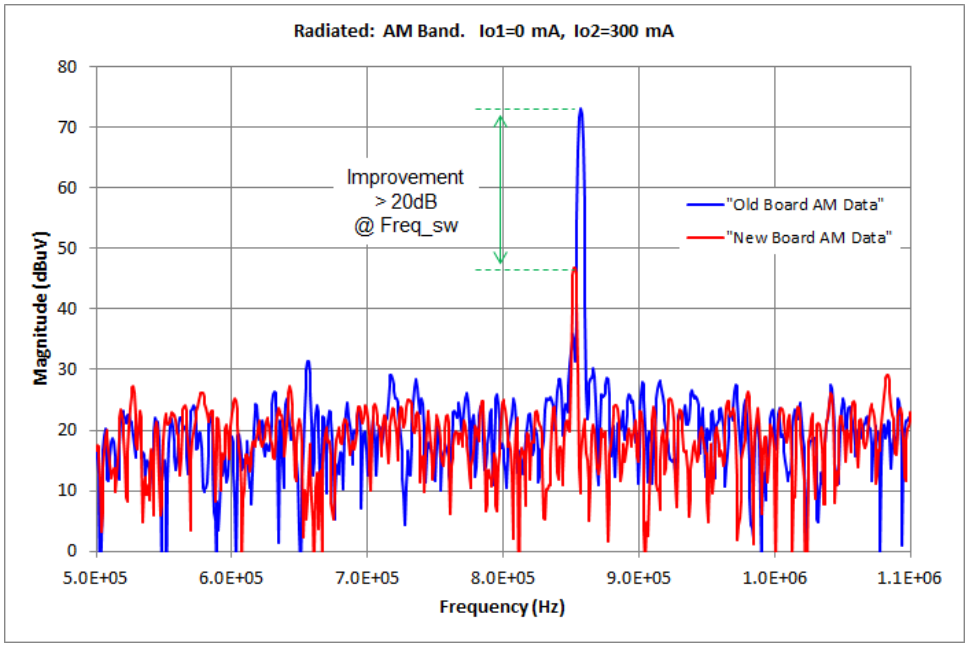
5 Test Data (Radiated EMI in AM and FM bands)



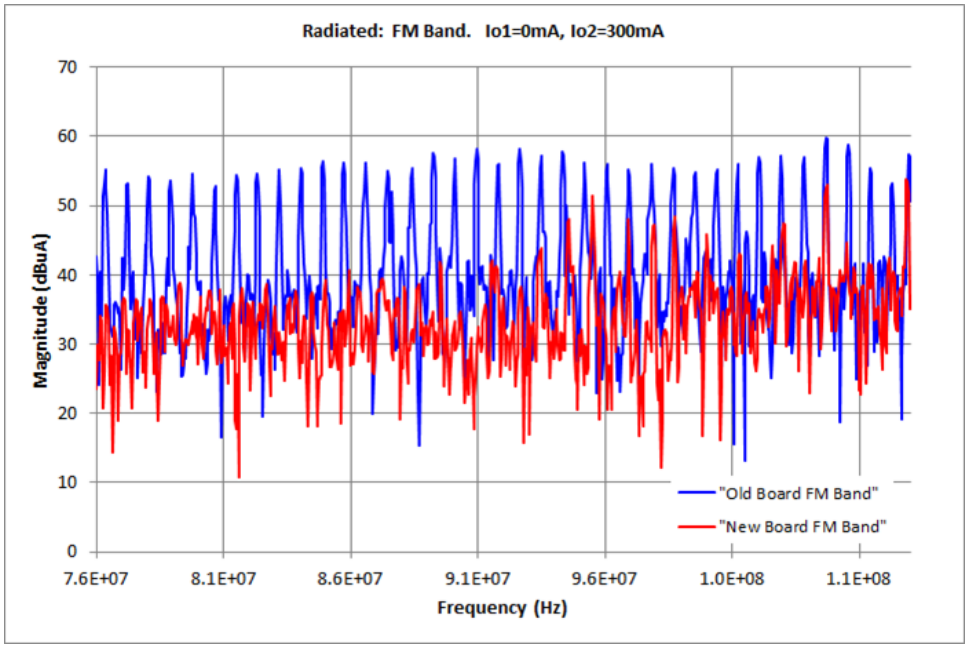
Radiated EMI in **AM** band (I_{OUT1}=200mA, I_{OUT2}=100mA).
(blue trace: old board layout with only the input loop optimized
red trace: new board layout with all di/dt loops optimized)



Radiated EMI in **FM** band (I_{OUT1}=200mA, I_{OUT2}=100mA).
(blue trace: old board layout with only the input loop optimized
red trace: new board layout with all di/dt loops optimized)



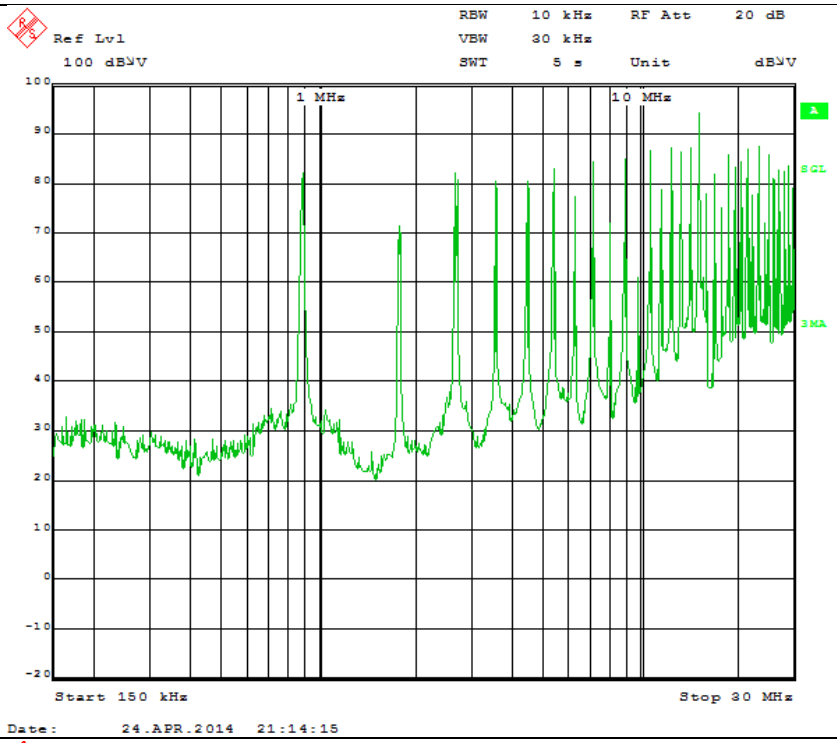
Radiated EMI in **AM** band (I_{OUT1}=0, I_{OUT2}=300mA).
(blue trace: old board layout with only the input loop optimized
red trace: new board layout with all di/dt loops optimized)



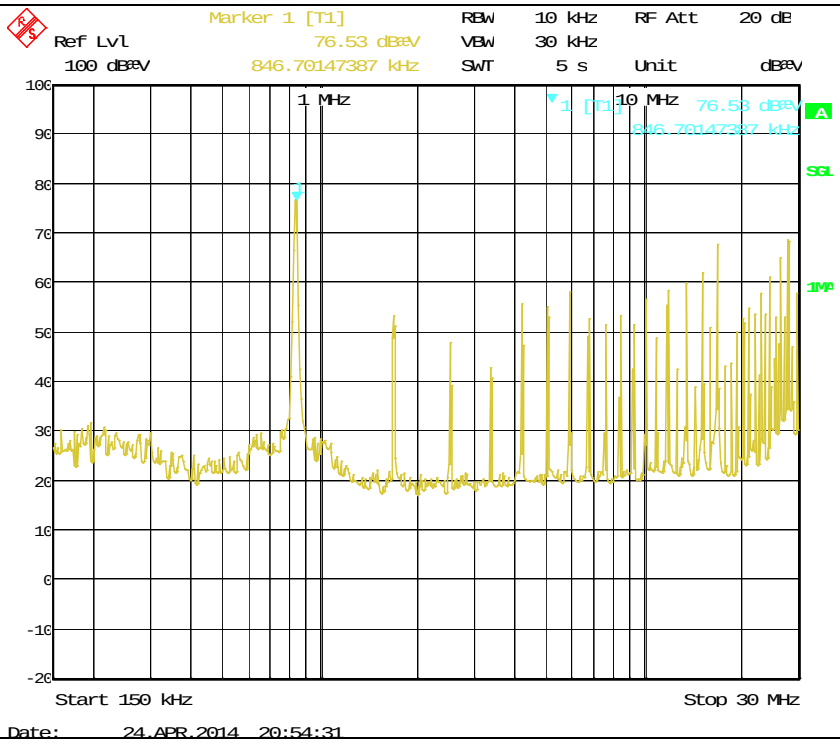
Radiated EMI in **FM** band (I_{OUT1}=0, I_{OUT2}=300mA).
(blue trace: old board layout with only the input loop optimized
red trace: new board layout with all di/dt loops optimized)

6 Test Data (Conducted EMI in AM and FM bands)

Old layout



Optimized layout



Conducted EMI in **150 kHz – 30 MHz** (Vin=20V, I_{OUT1}=0, I_{OUT2}=300mA).
(top: old board layout with only the input loop optimized
bottom: new board layout with all di/dt loops optimized)
The test setup follows the CISPR25 standard, LISN and ground plane (peak detection used).

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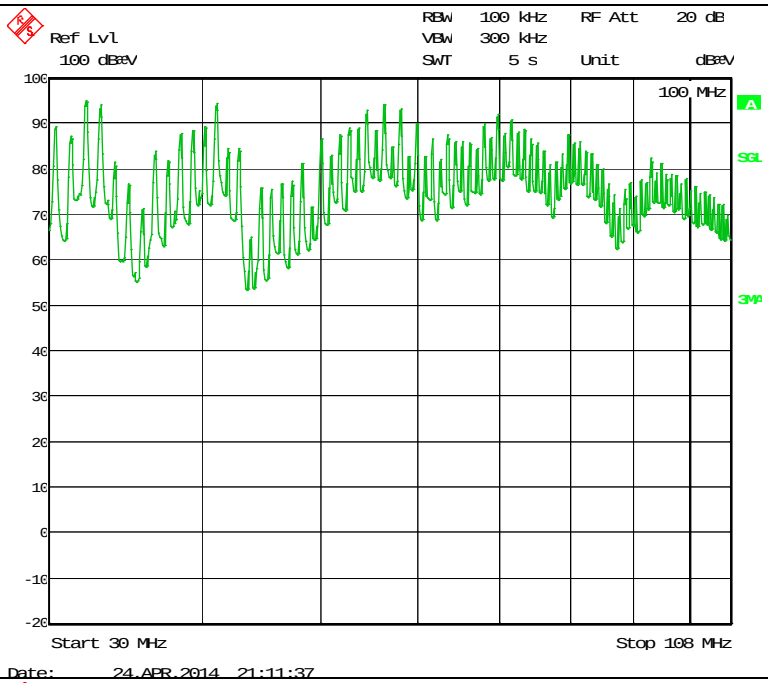
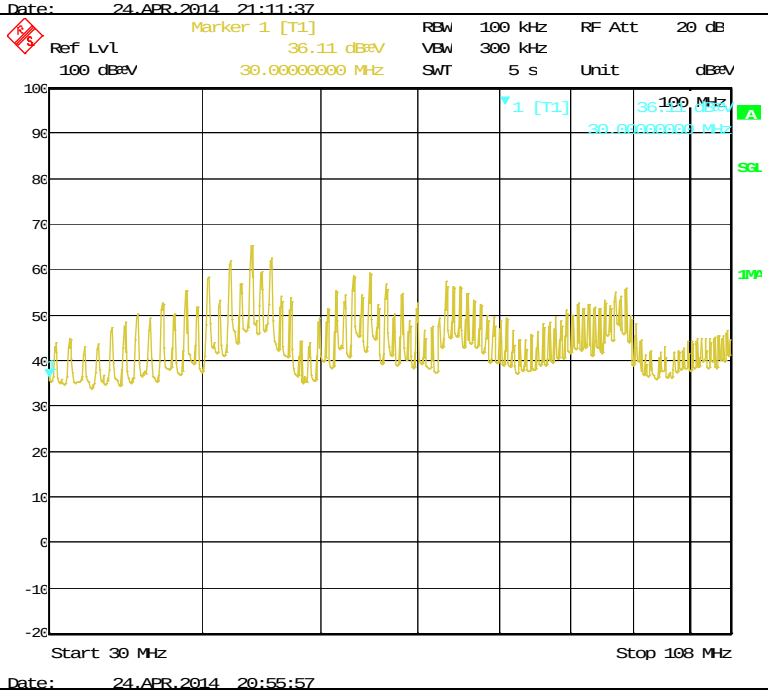
Old layout	
Optimized layout	

Conducted EMI in **30 MHz – 108 MHz** (Vin=20V, I_{OUT1}=0, I_{OUT2}=300mA).
(top: old board layout with only the input loop optimized
bottom: new board layout with all di/dt loops optimized)
The test setup follows the CISPR25 standard, LISN and ground plane (peak detection used).

7 Conclusions

- The improvements in layout to minimize the areas of all di/dt loops in a Fly-buck converter resulted in significantly reduced EMI. Significant improvement is observed at the switching frequency.
- The improvements in layout to minimize the areas of all di/dt loops had significant impact on the conducted EMI in FM band.

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