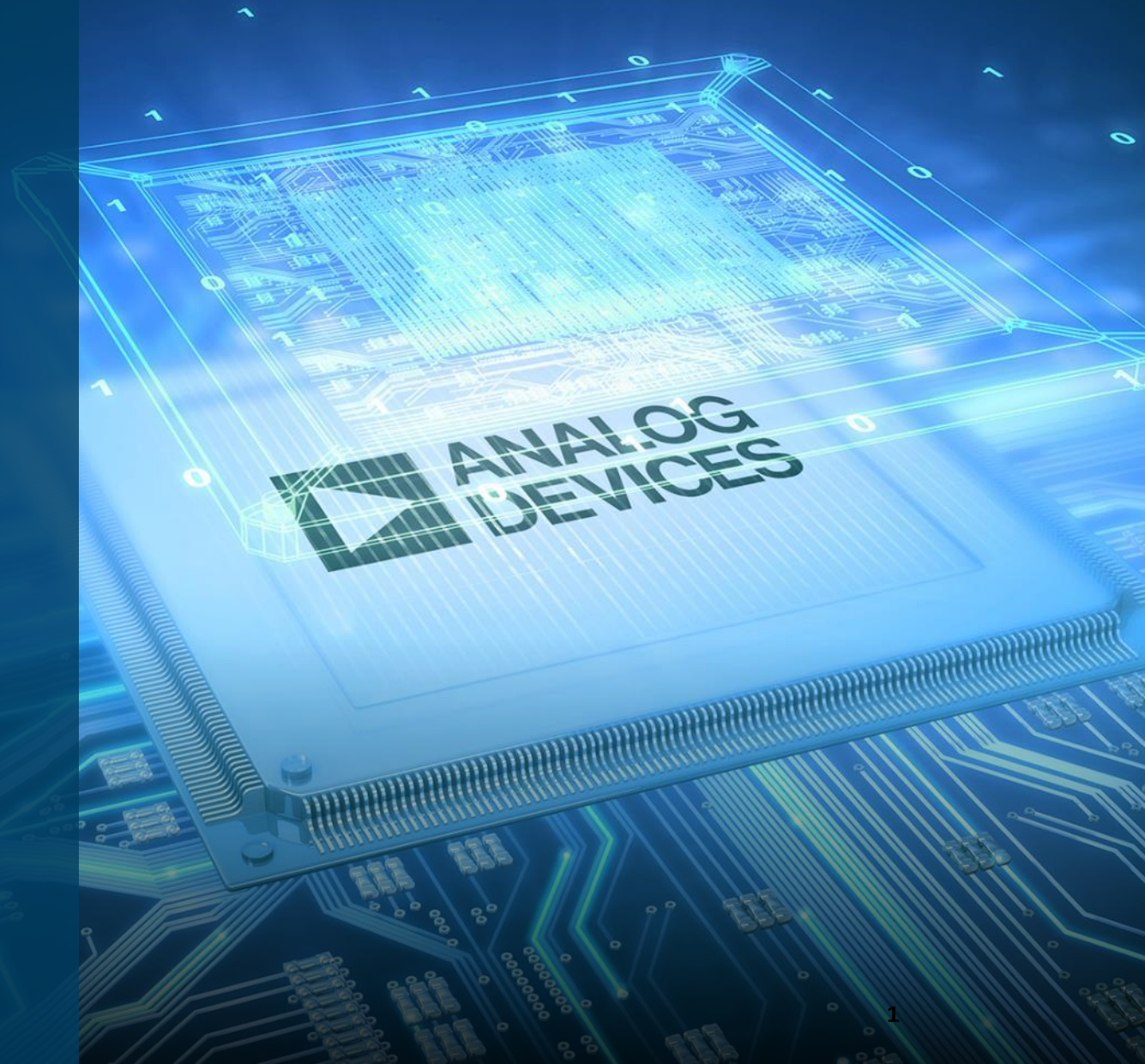


Silent Switcher Technology

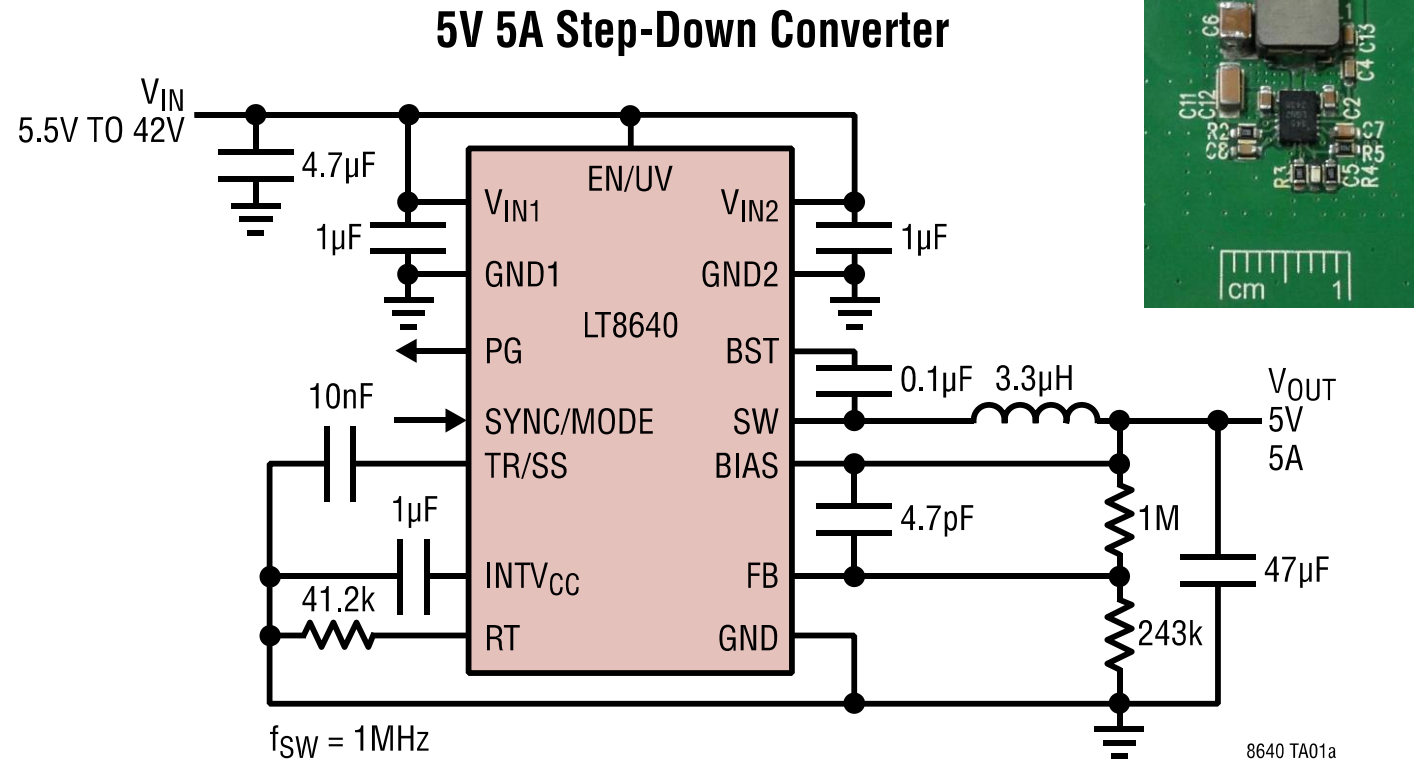
TONY ARMSTRONG



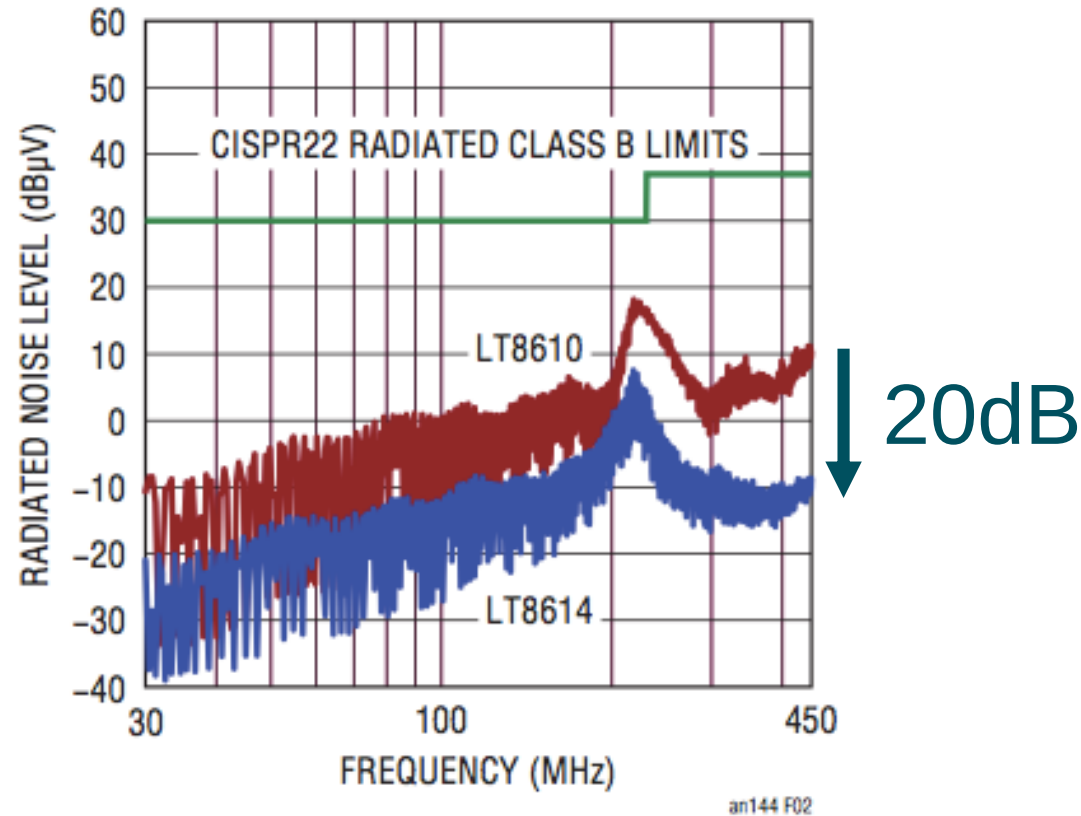
What High Performance Step-Down Regulators Need

- ▶ Wide Input Range: 3V to 42V and higher
 - Reliable operation from 12V automotive battery
- ▶ High Efficiency: > 90%
 - Low power loss, operates at high ambient temperature
- ▶ Low Quiescent Current: ~2uA
 - Long standby operation
- ▶ Low Output Ripple & Low EMI:
 - Your system works
 - Pass verification first try
- ▶ High Frequency
 - Small circuit size, above AM band

Silent Switcher



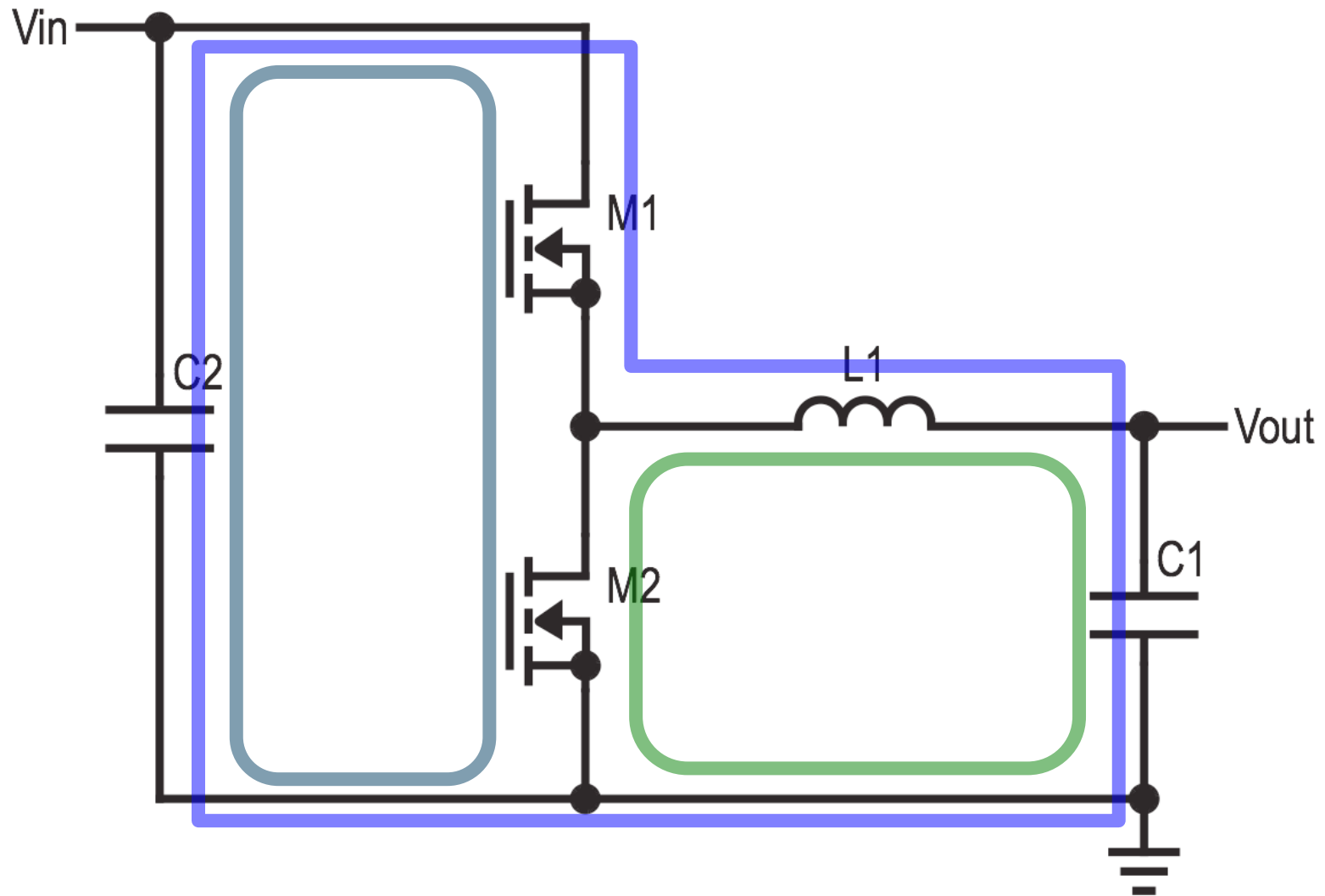
20dB EMI Improvement - No compromise In Efficiency and Size



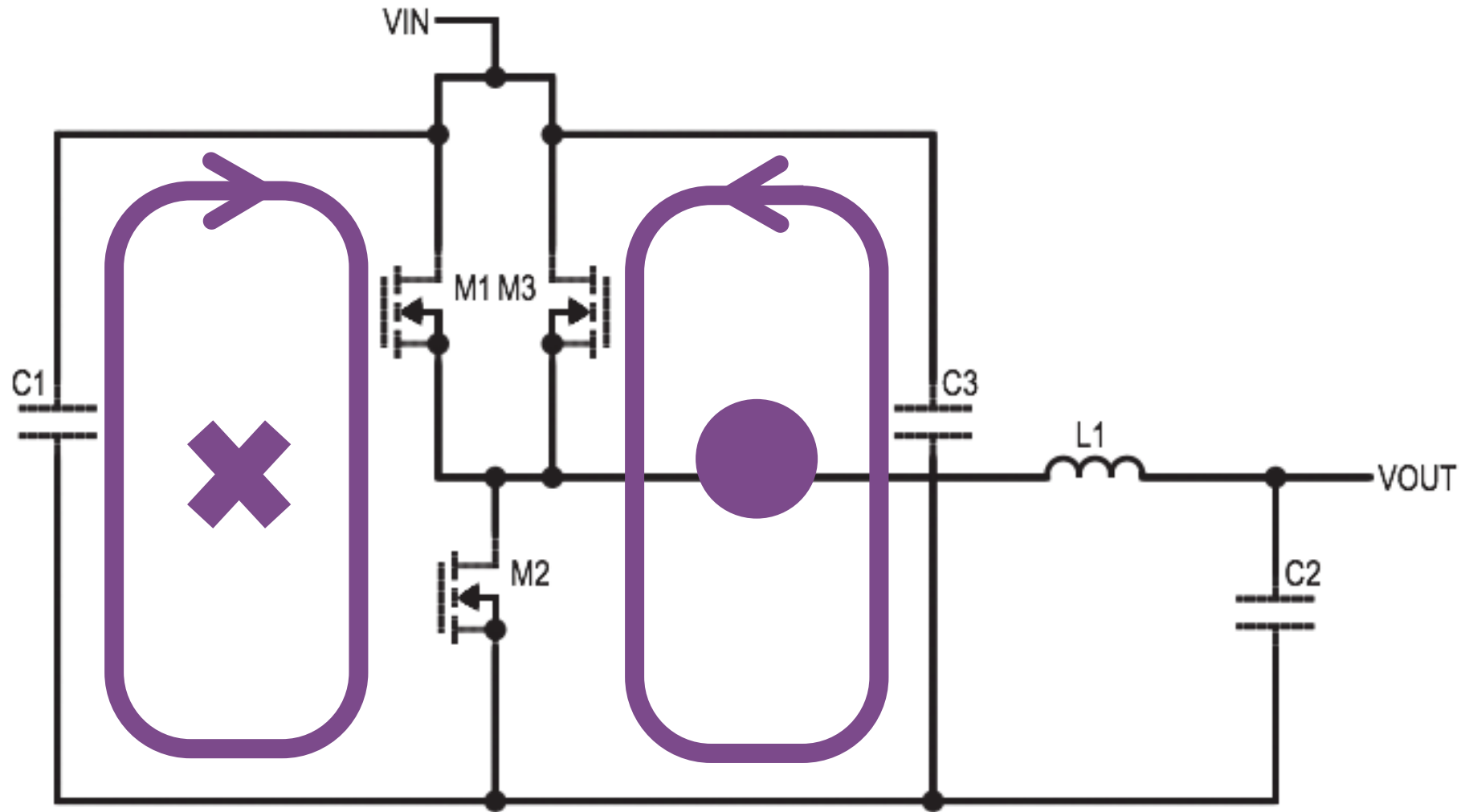
**Figure 2. LT8610 and LT8614 700kHz 14V to 3.3V 2A
Radiated EMI in GTEM Corrected for OATS**

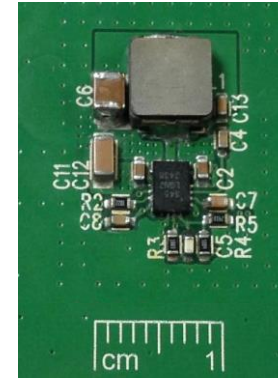
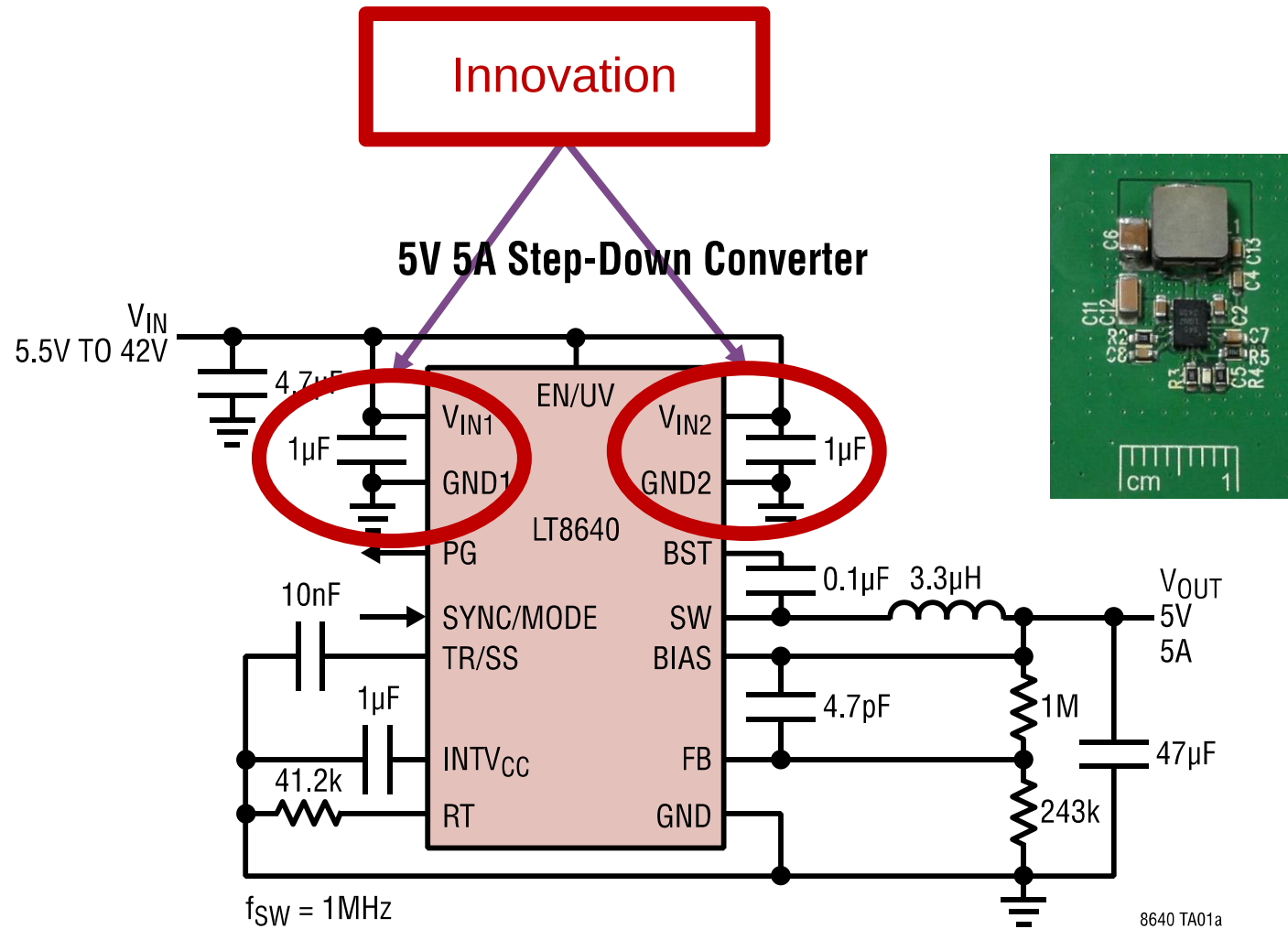
How? – Innovation!

Buck Hot Loops



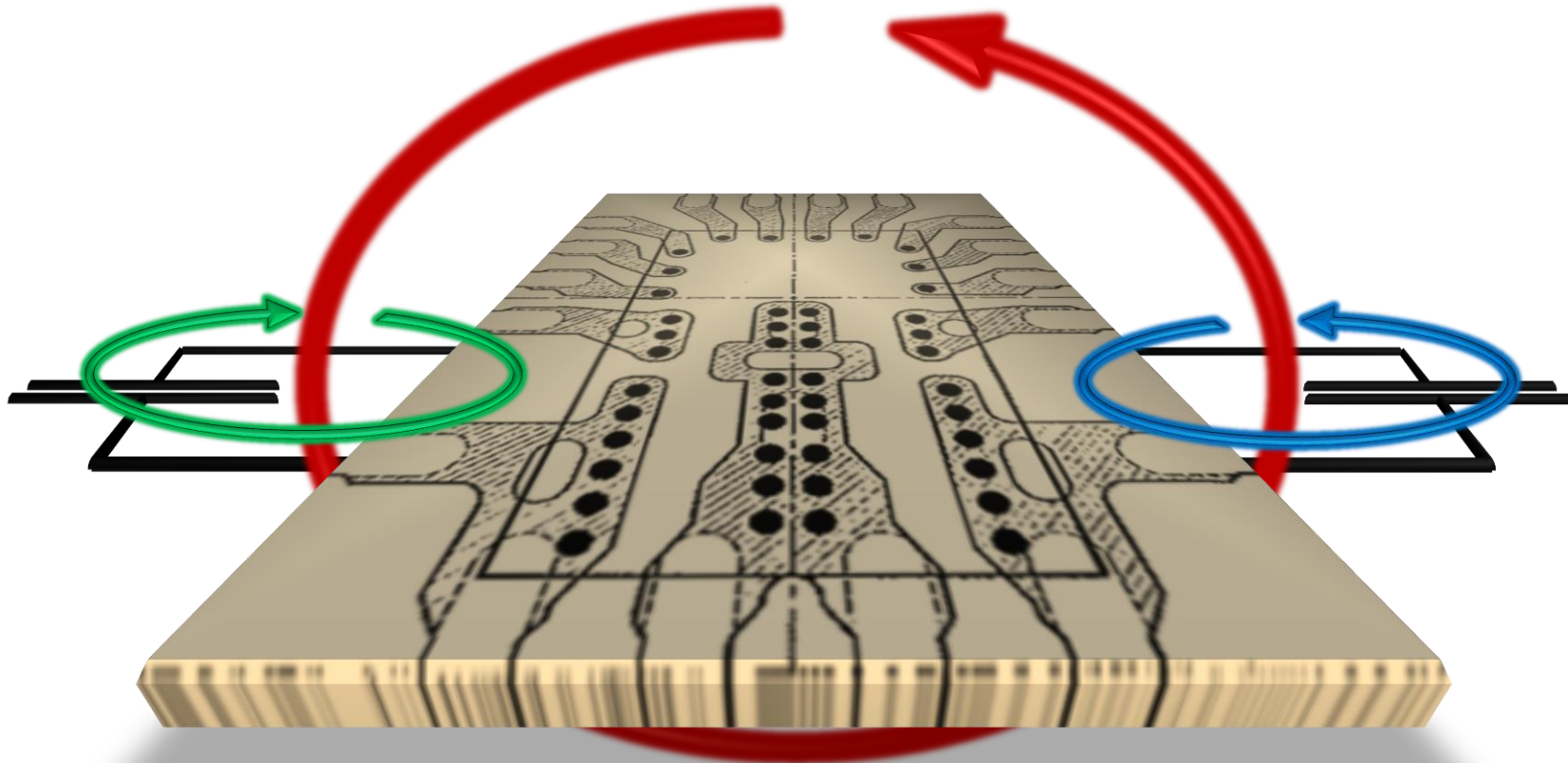
Silent switcher – magnetic field cancellation





Coupled Hot Loops

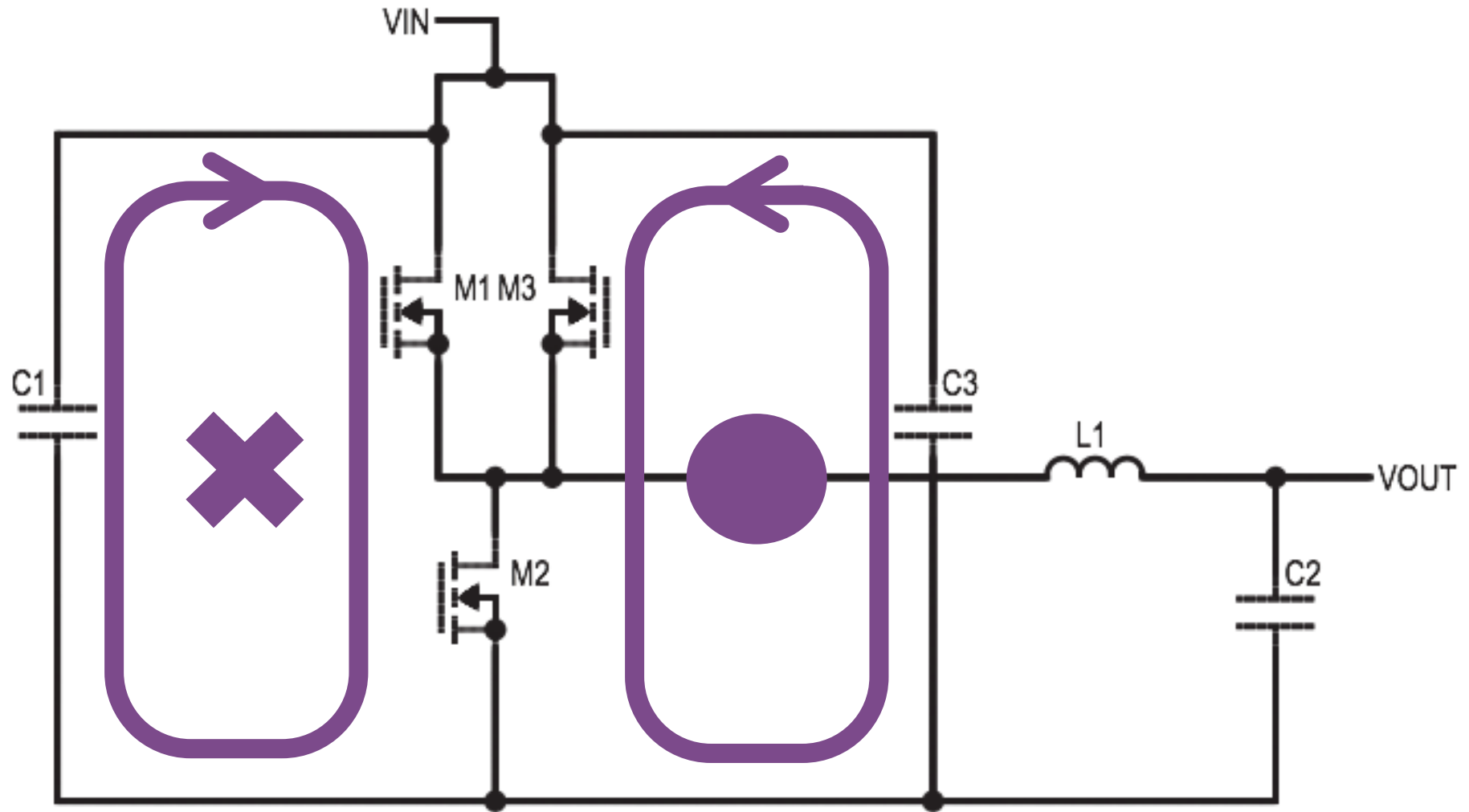
Confined Magnetic Field = Low EMI



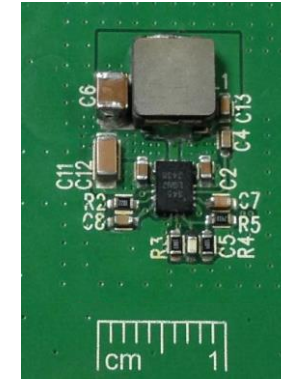
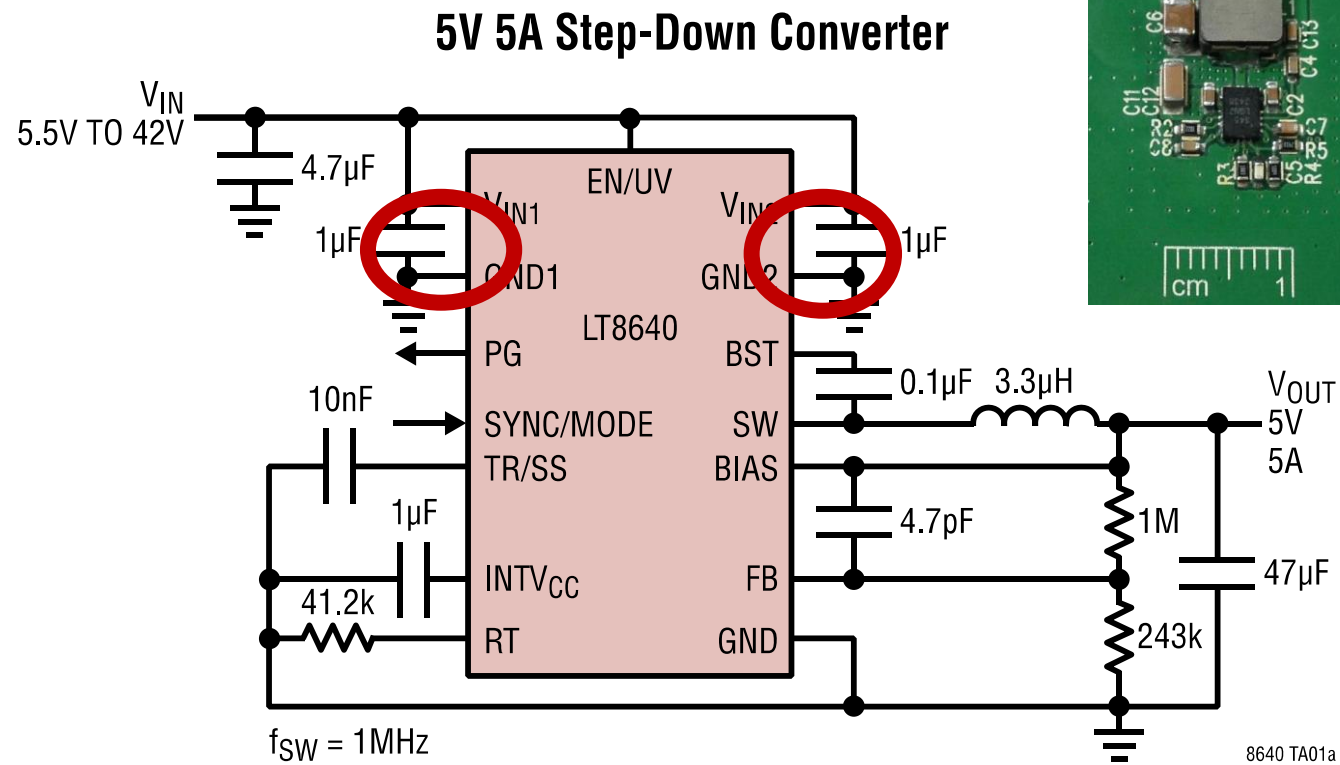
-LT8614-

More Innovation!

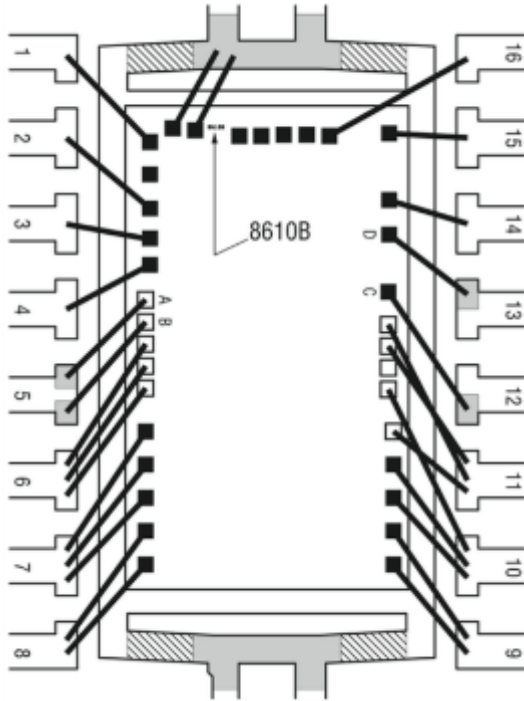
Hot Loops



Make Hot Loops smaller !

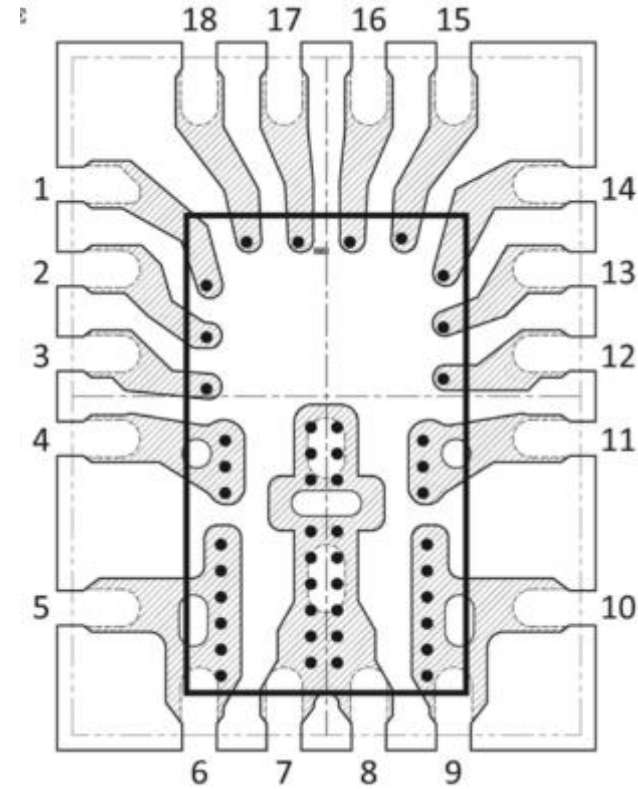


Compare LT8610 package to LT8640 package



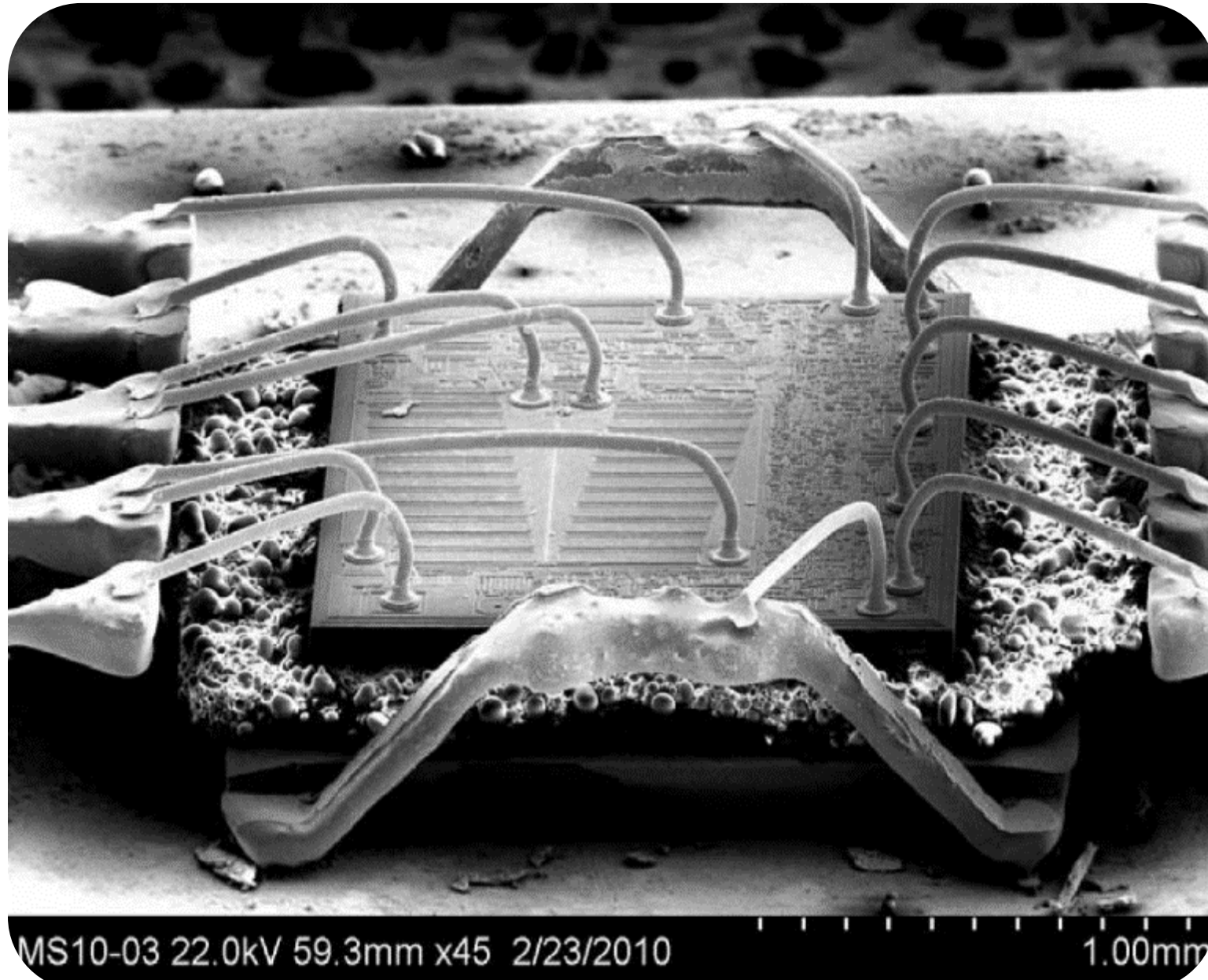
LT8610
MSOP-16E
Body 3 x 4 mm

Die size is identical,
But....

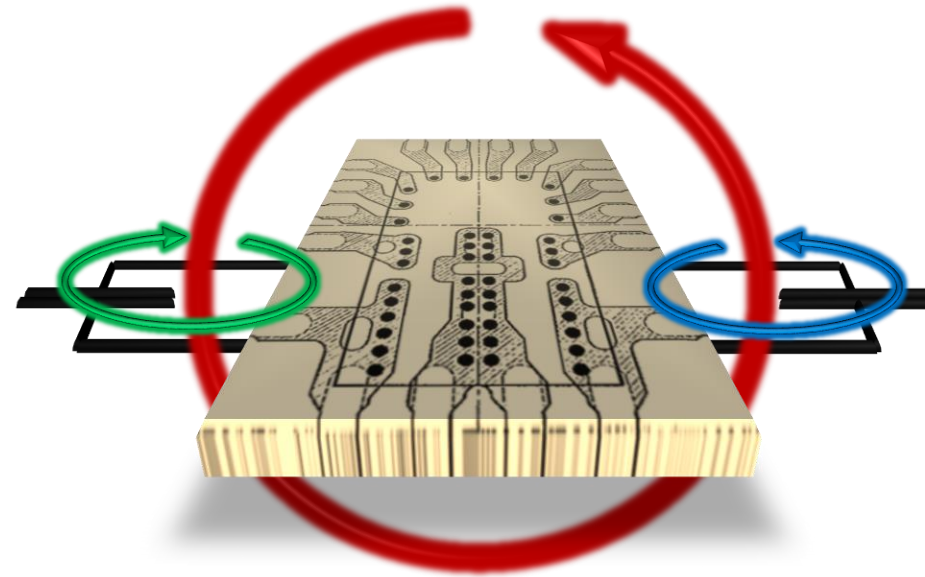
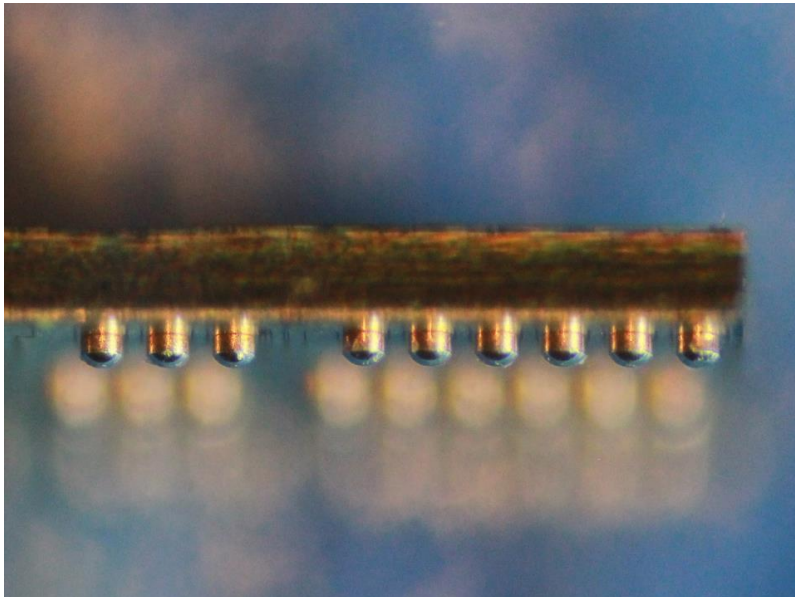
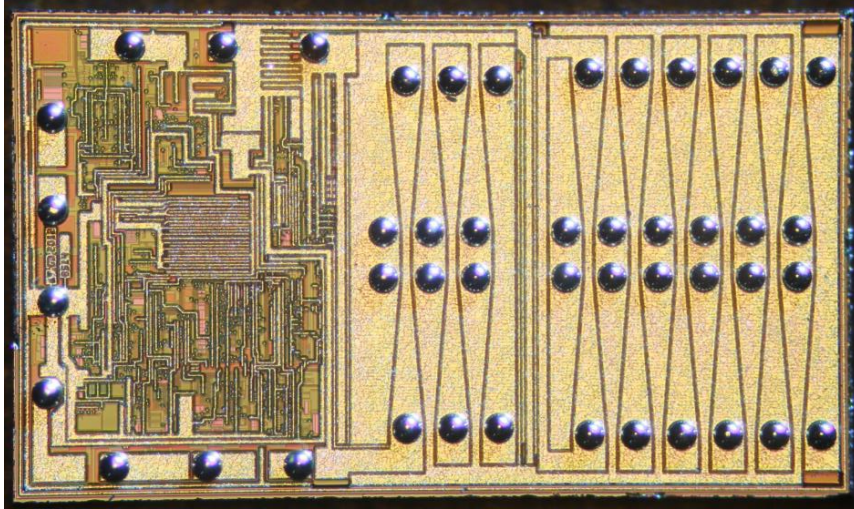


LT8640
QFN
Body 3 x 4 mm

Wire bond part (LT8609, disassembled)

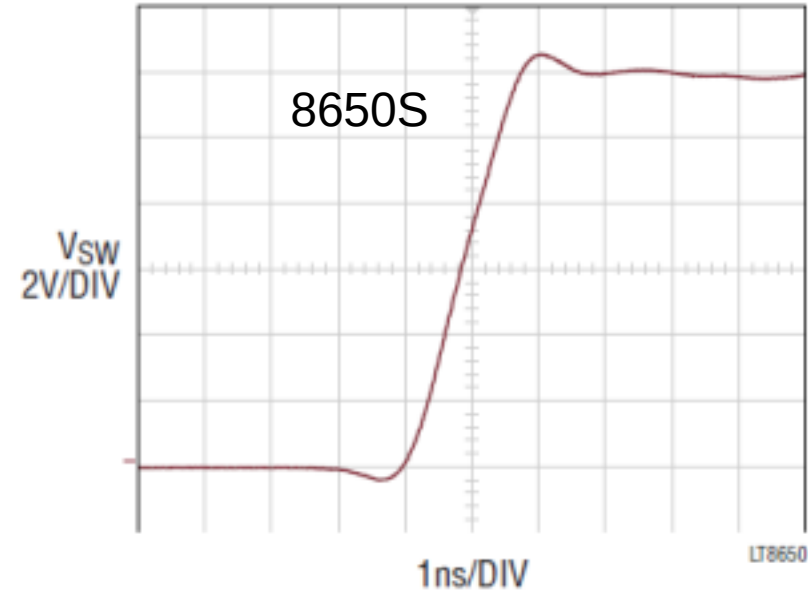
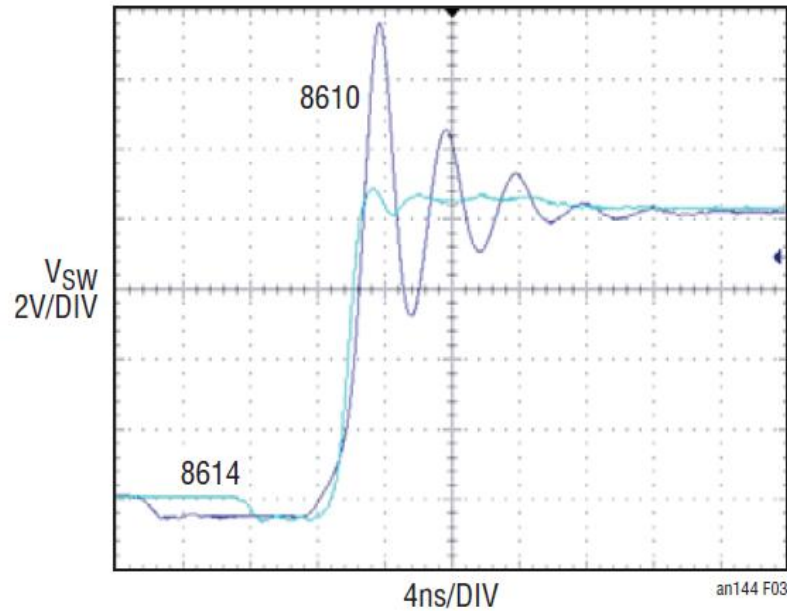


Copper pillars and Flip Chip



-LT8614-

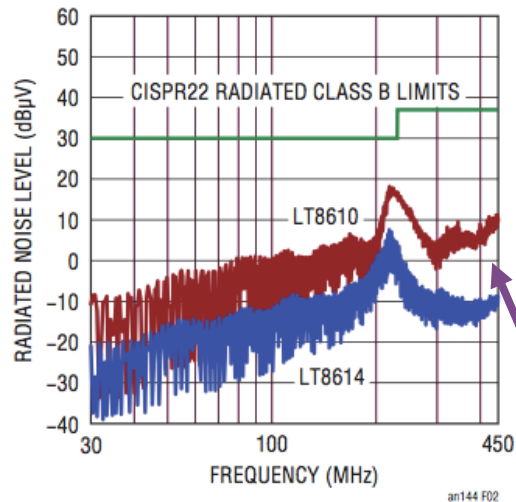
Silent Switcher Eliminates Switch Ringing



- ▶ Better EMI
- ▶ Lower Voltage Stress
- ▶ Higher Efficiency

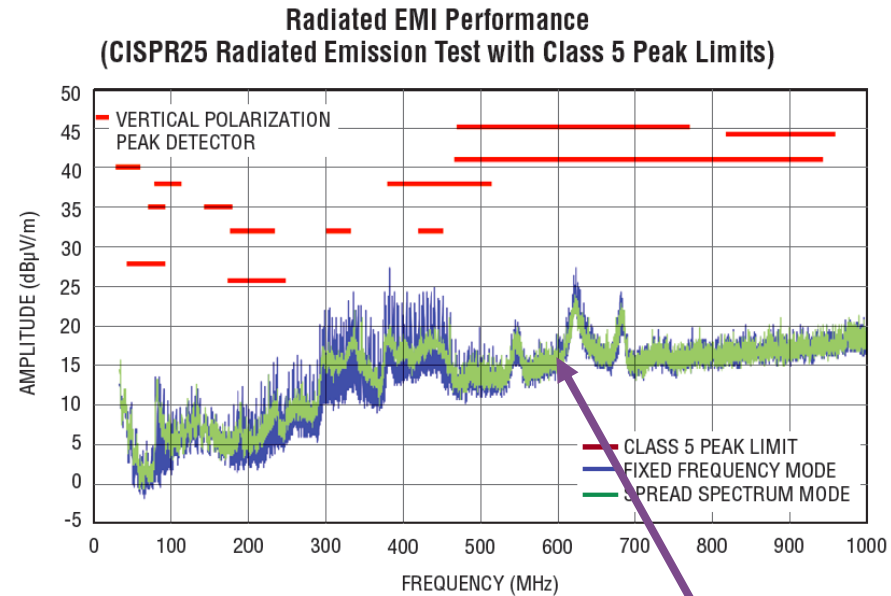
Silent Switcher: LT8614 & LT8640

The Figure 2 measurements were taken in an anechoic chamber 12V in 3.3V out at 2A with a fixed switching frequency of 700kHz.



**Figure 2. LT8610 and LT8614 700kHz 14V to 3.3V 2A
Radiated EMI in GTEM Corrected for OATS**

LT8614
Silent Switcher provides
20dB improvement

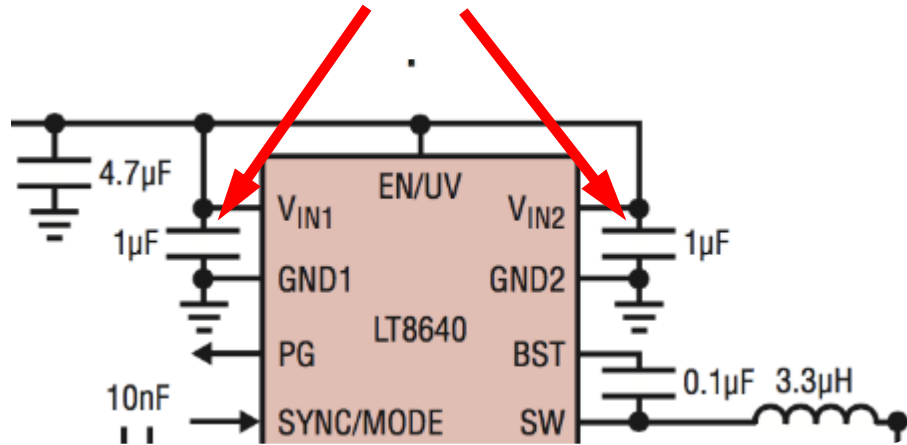


LT8640 adds spread
spectrum

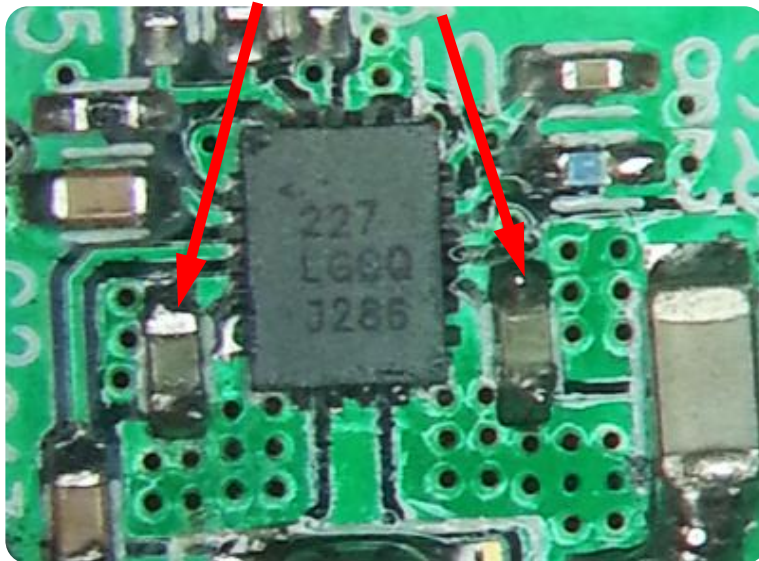
More Innovation & Smaller Hot Loops

Most Customer circuit layouts are poor - More often than you would think!

Schematic



Our Demoboard



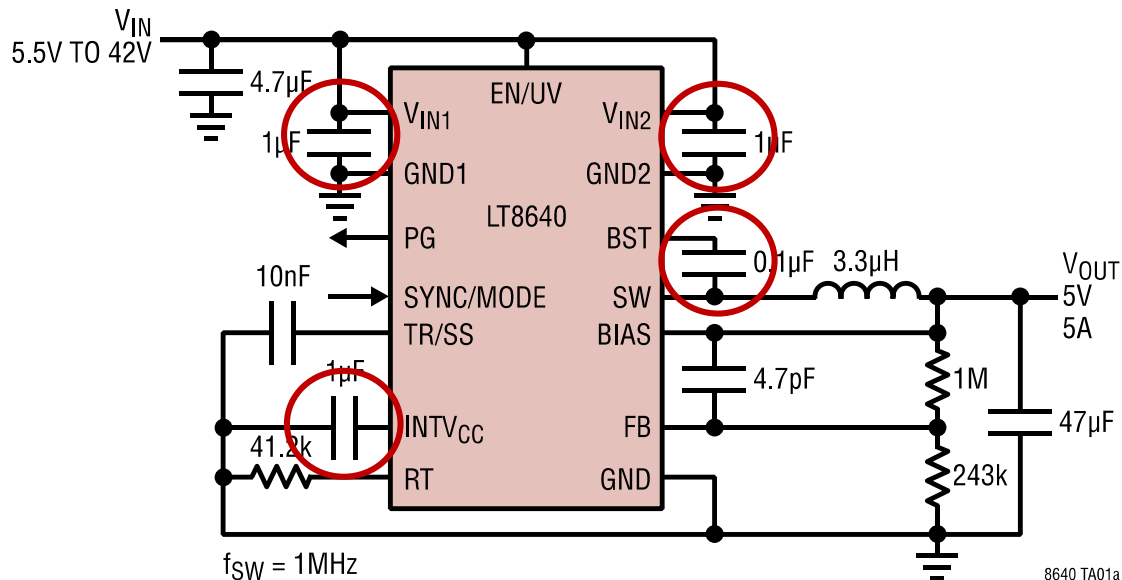
The Customers Board!?



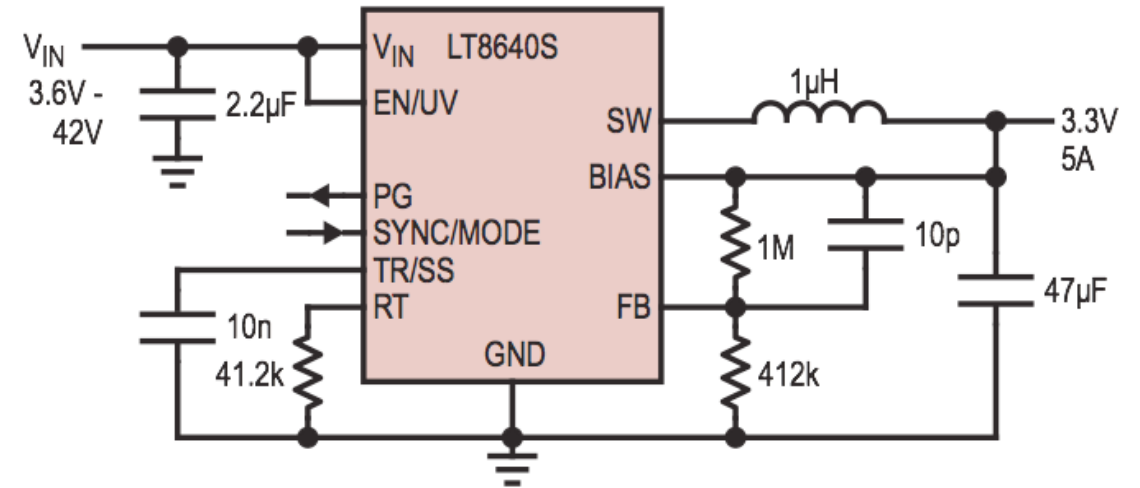
Silent Switcher 2 to the rescue:

- ▶ Lower EMI
- ▶ Higher Integration
- ▶ Higher Efficiency

5V 5A Step-Down Converter



Capacitors External

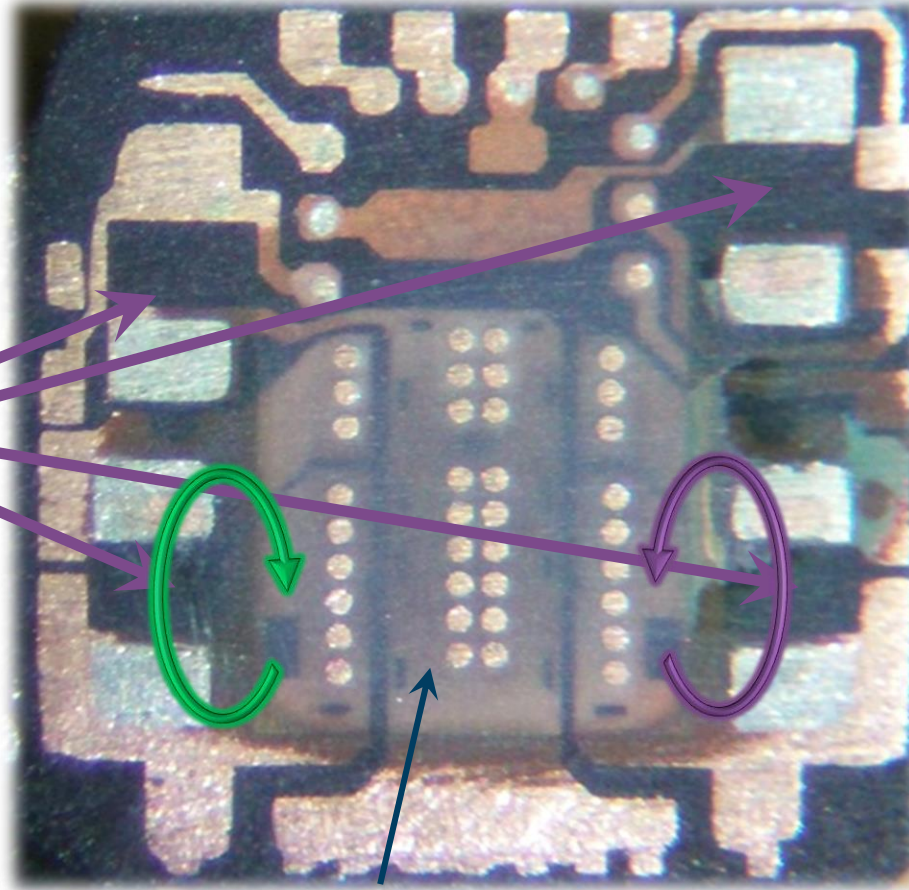


Capacitors Internal

“S” suffix = Silent Switcher 2

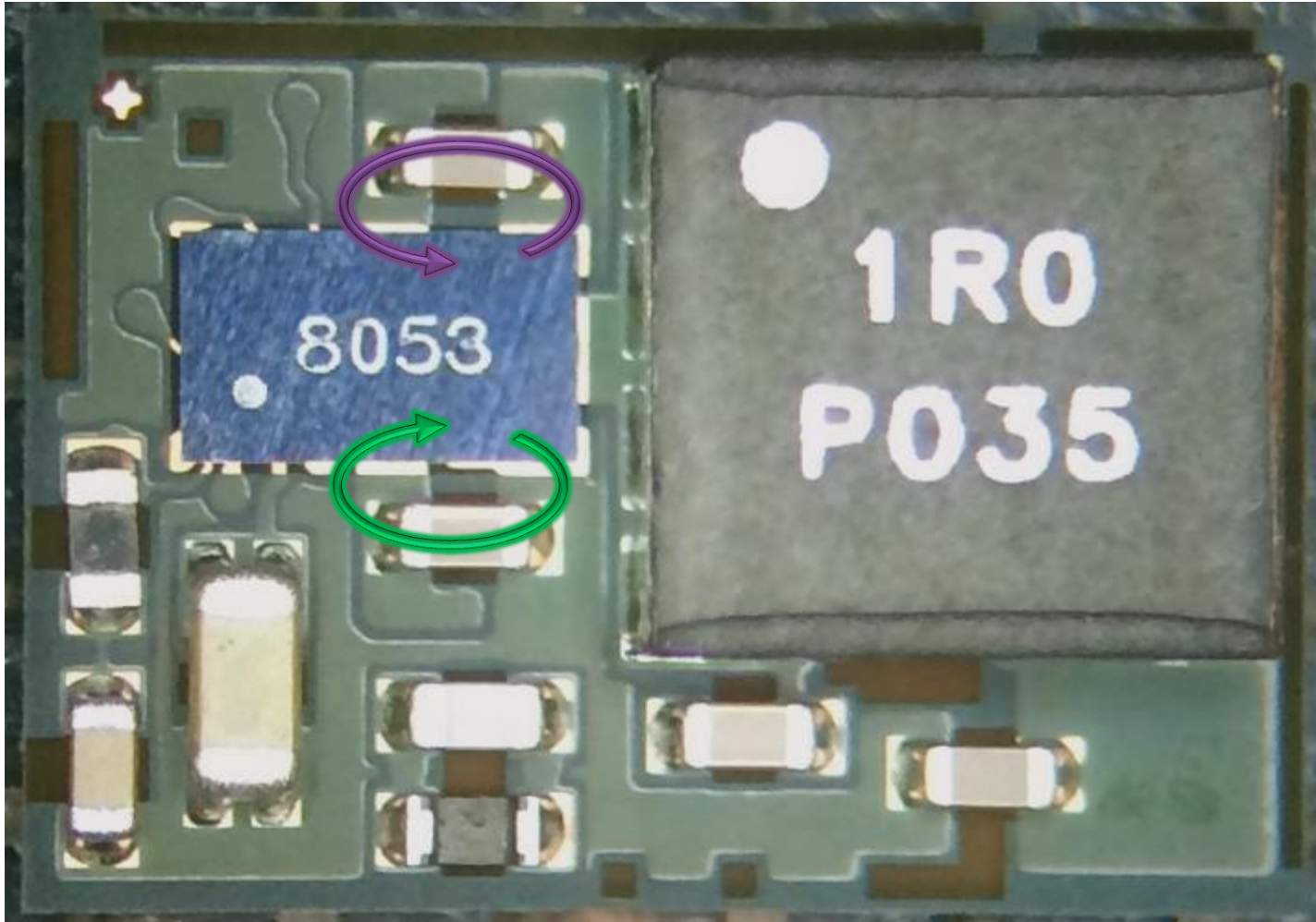
Silent Switcher 2: LT8640S

Four
Internal
Capacitors

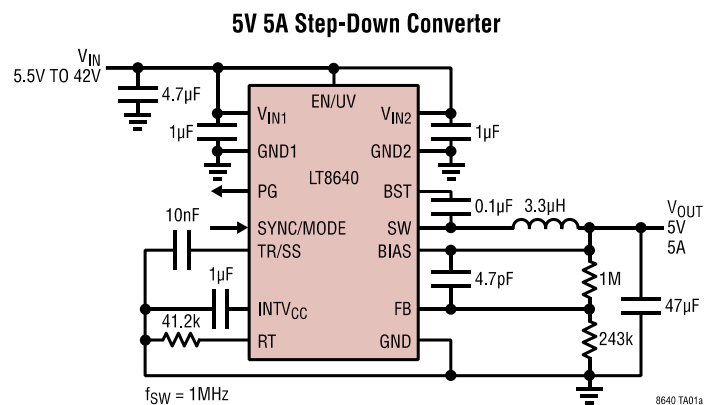
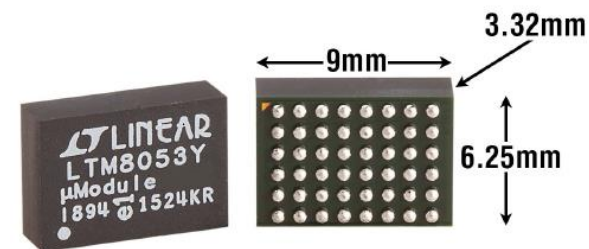
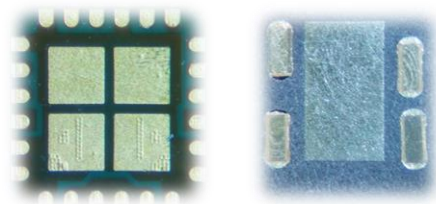
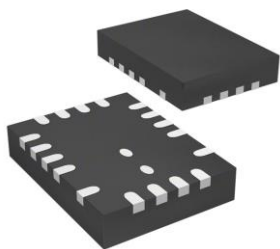


Even More Integration

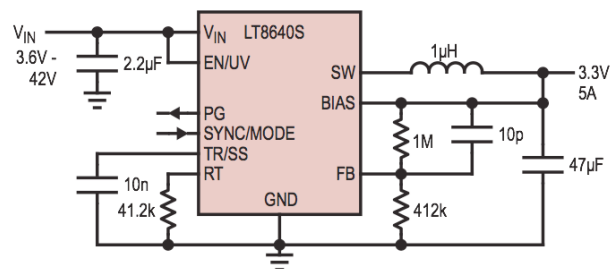
Micro Module hot loop



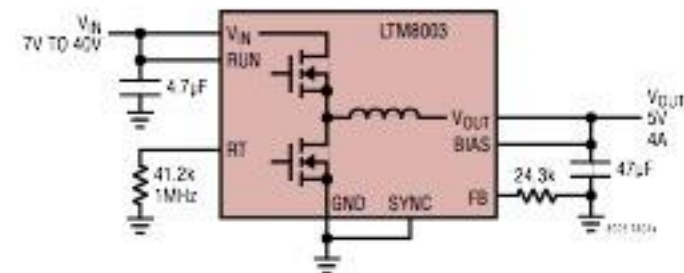
LT8640 integration options: IC / +C_{IN} / +C_{IN} +L



Capacitors External

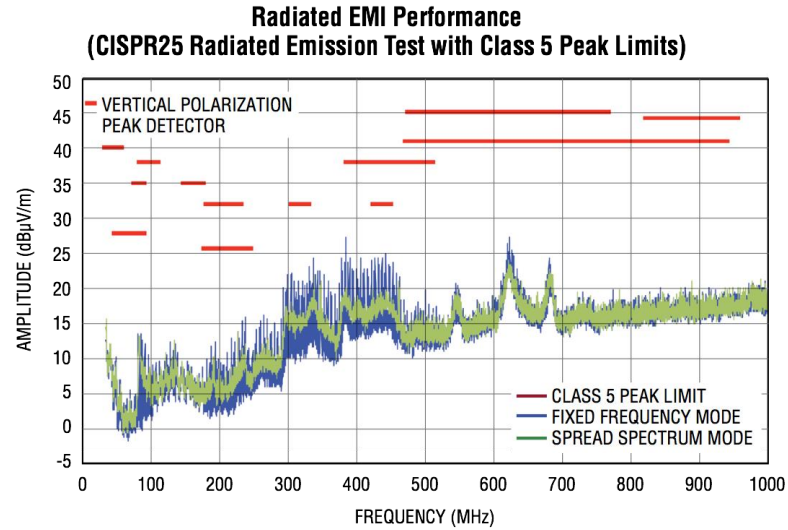


Capacitors Internal

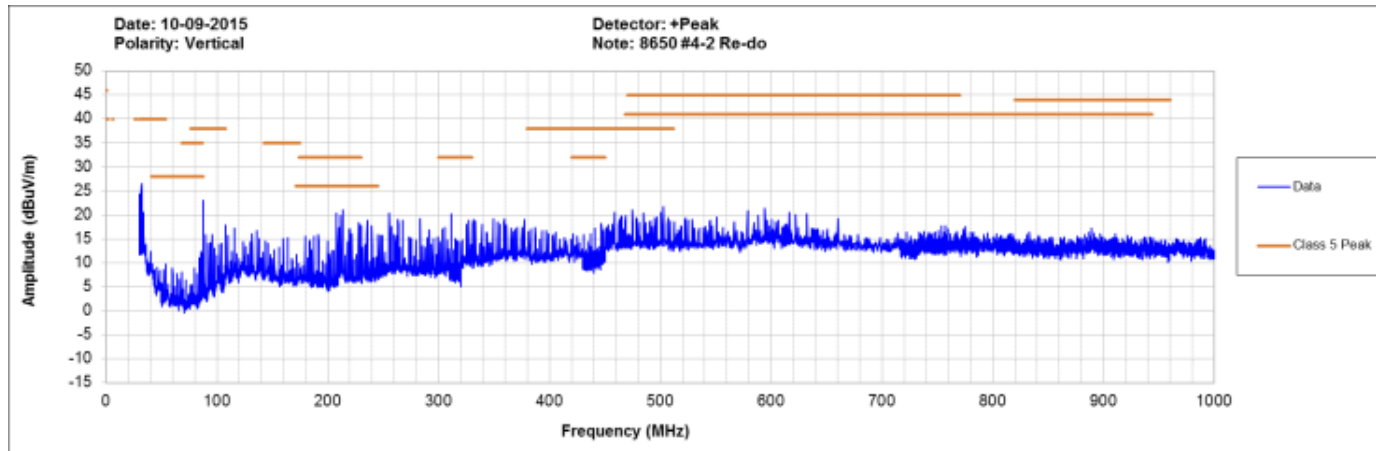


All Intergrated

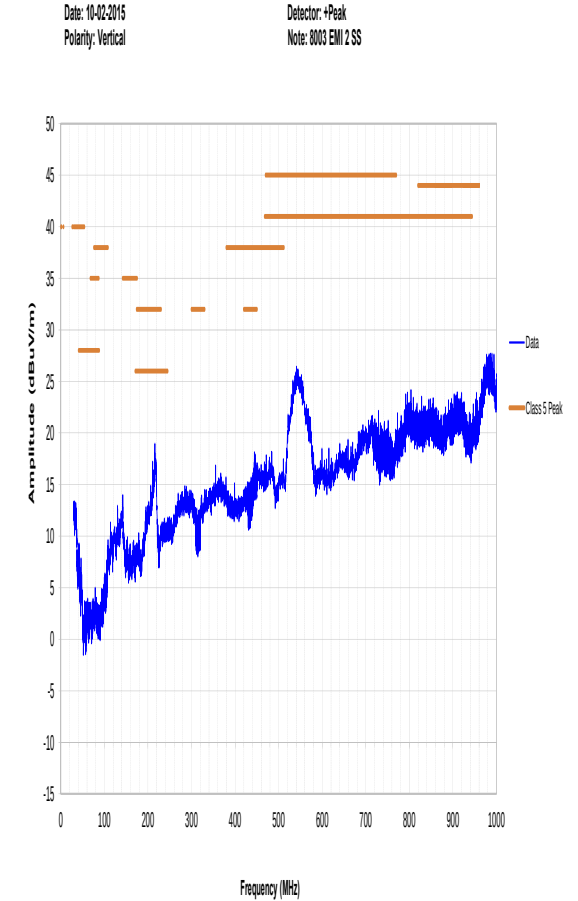
LT8640 / LT8640S / LTM8003 EMI Performance



LT8640



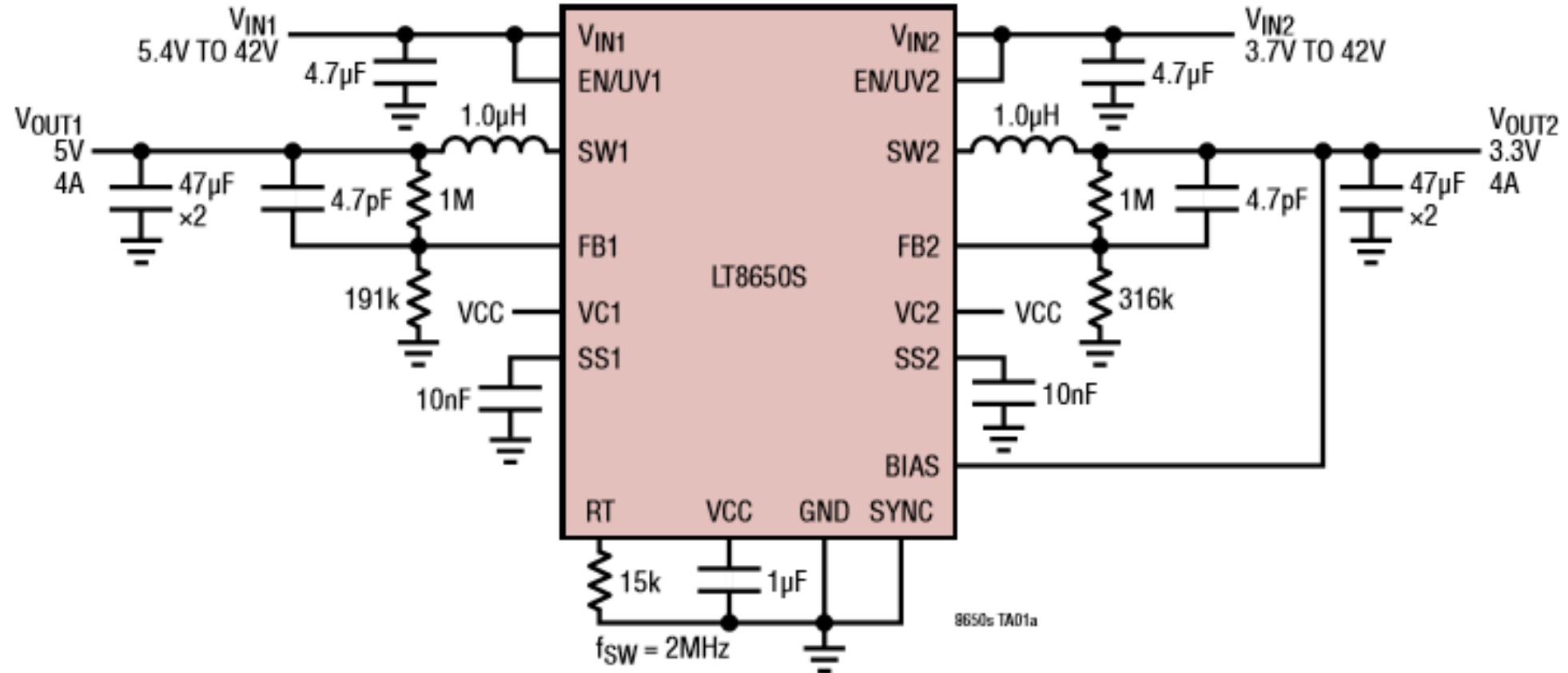
LT8640S



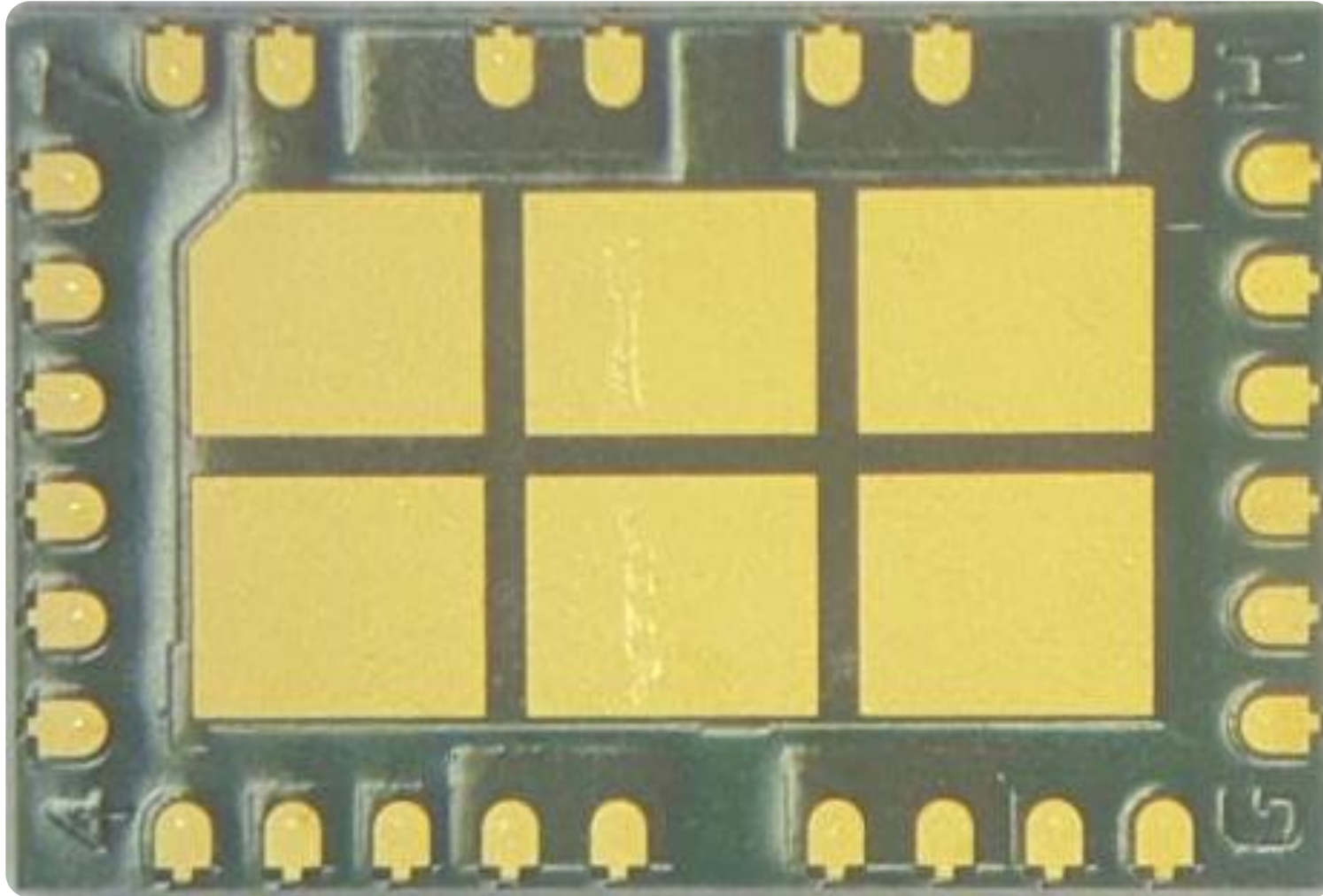
LTM8003

Silent Switcher 2: Dual 5A Synchronous Step-Down

5V/4A, 3.3V/4A 2MHz Step-Down Converter

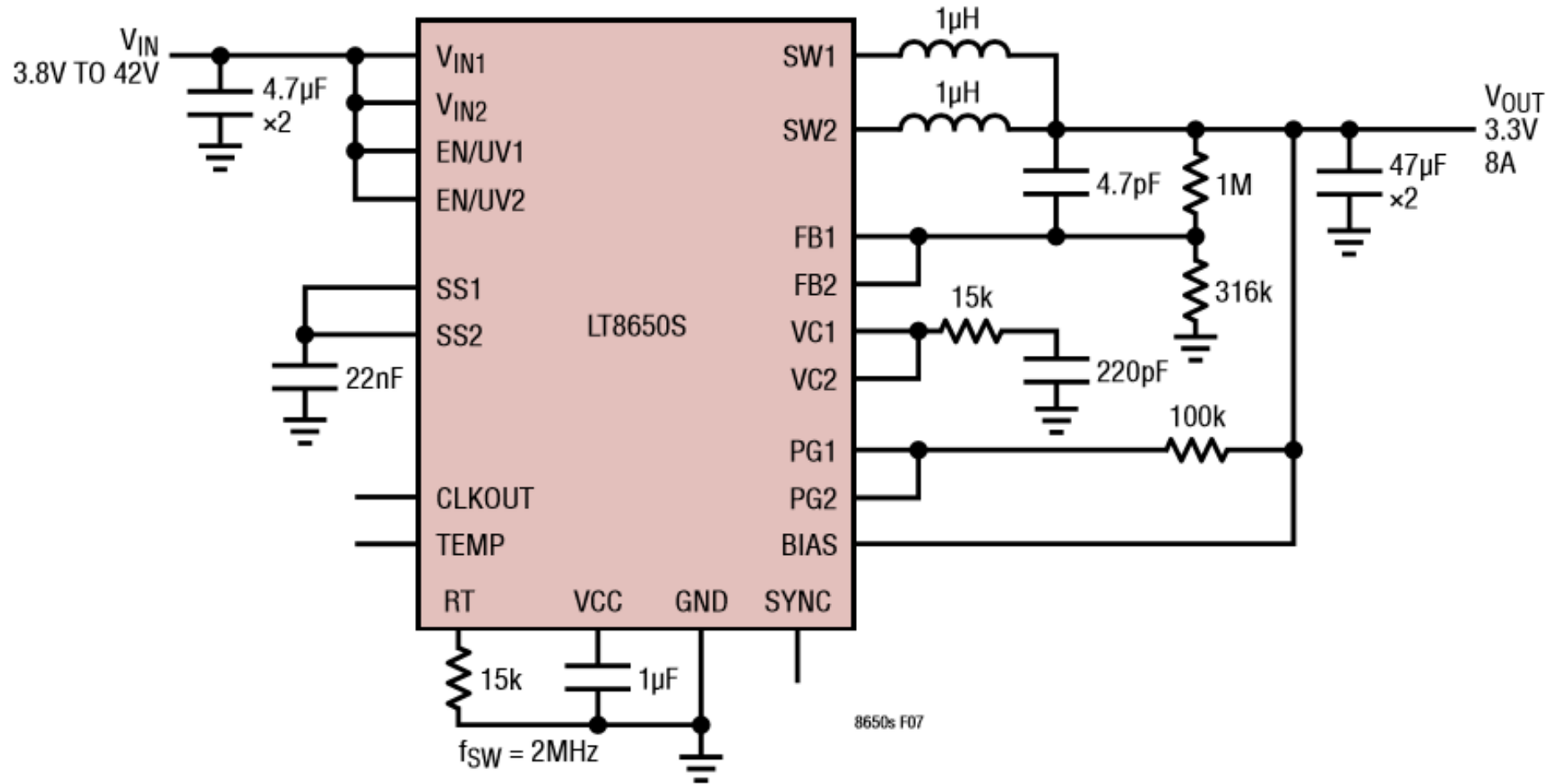


Excellent Thermal Performance:



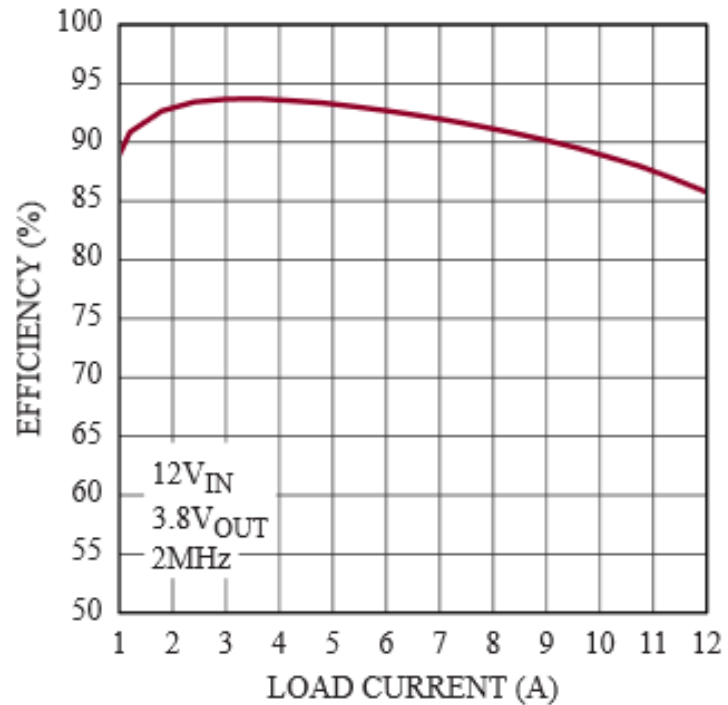
- Large exposed pad for good PCB layout
- Low junction-to-case thermal resistance

LT8650S 2-Phase Application



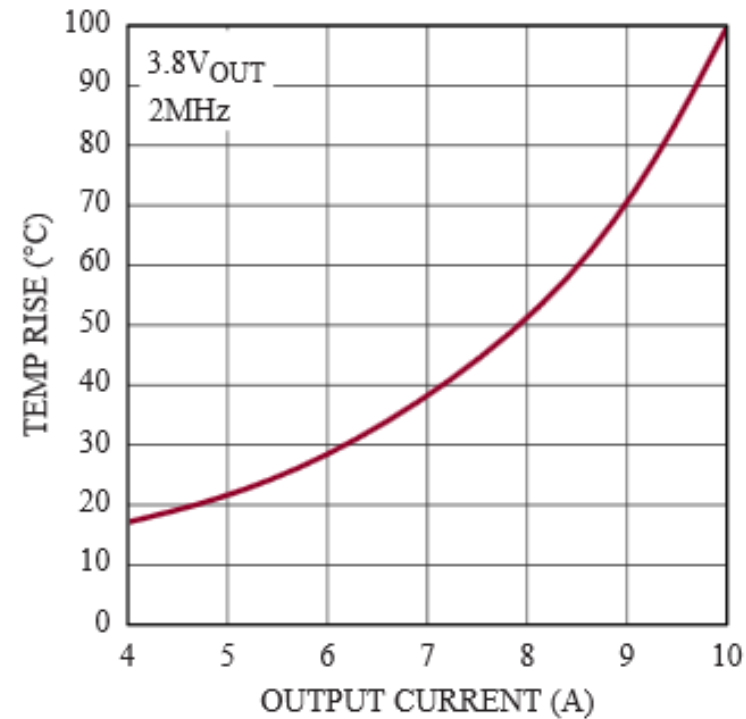
LT8650S 2-Phase Application Efficiency & Temp Rise Curves

LT8650 Efficiency for Parallel App



LT8650 G07

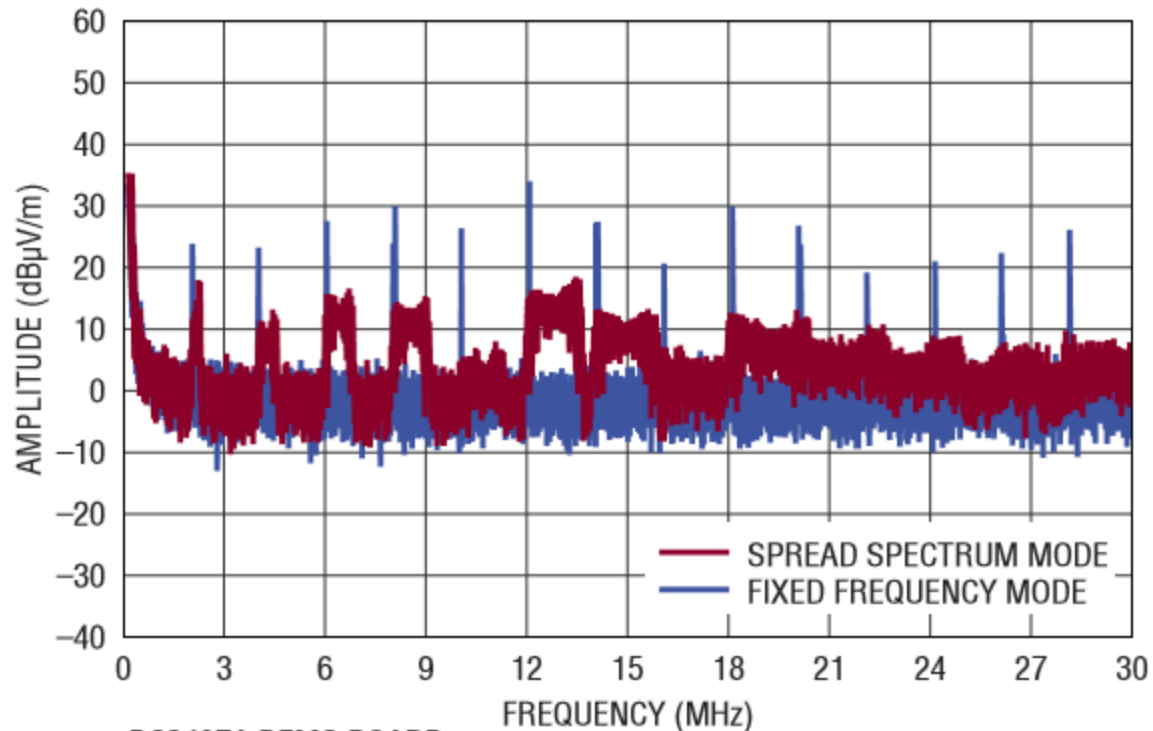
LT8650 Temp Rise for Parallel App



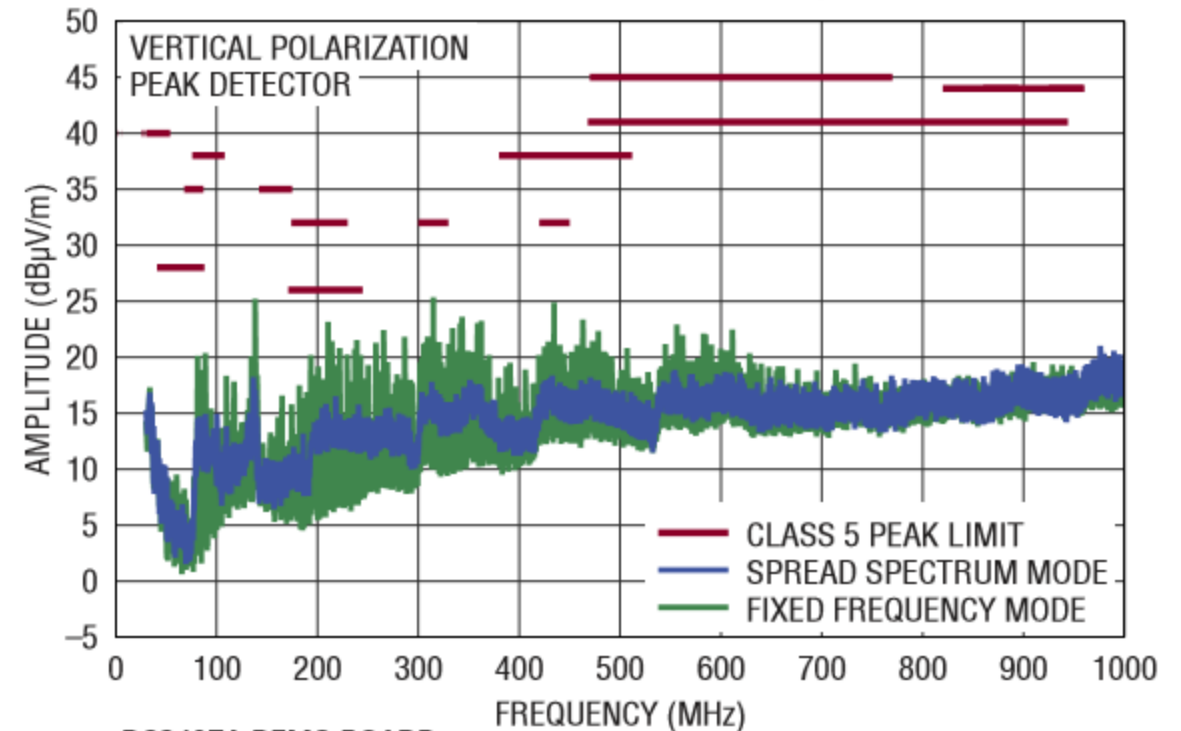
LT8650 G90

LT8650S EMI Performance

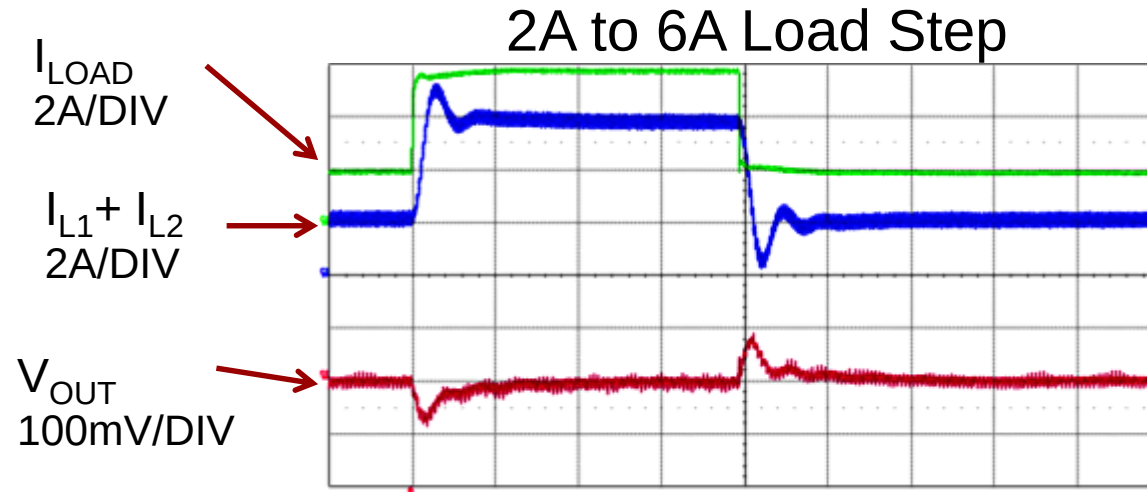
Conducted EMI Performance



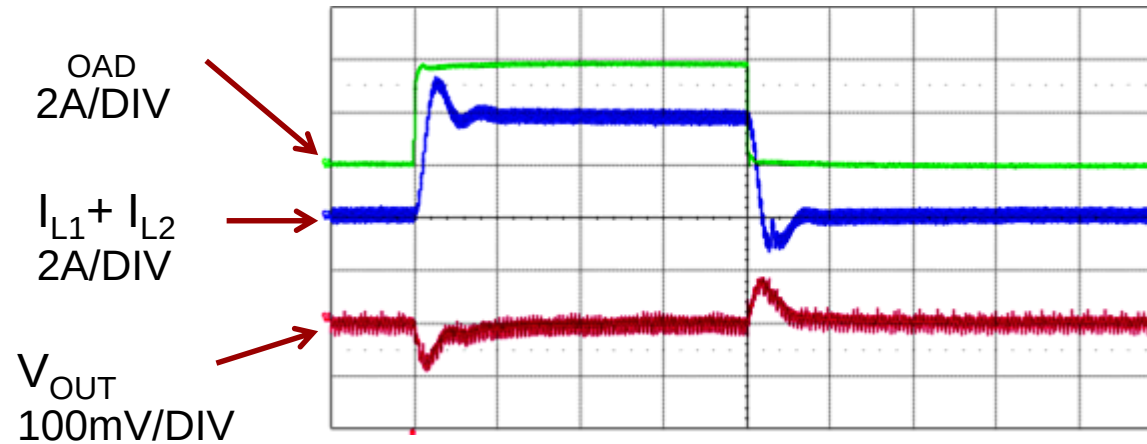
Radiated EMI Performance (CISPR25 Radiated Emission Test with Class 5 Peak Limits)



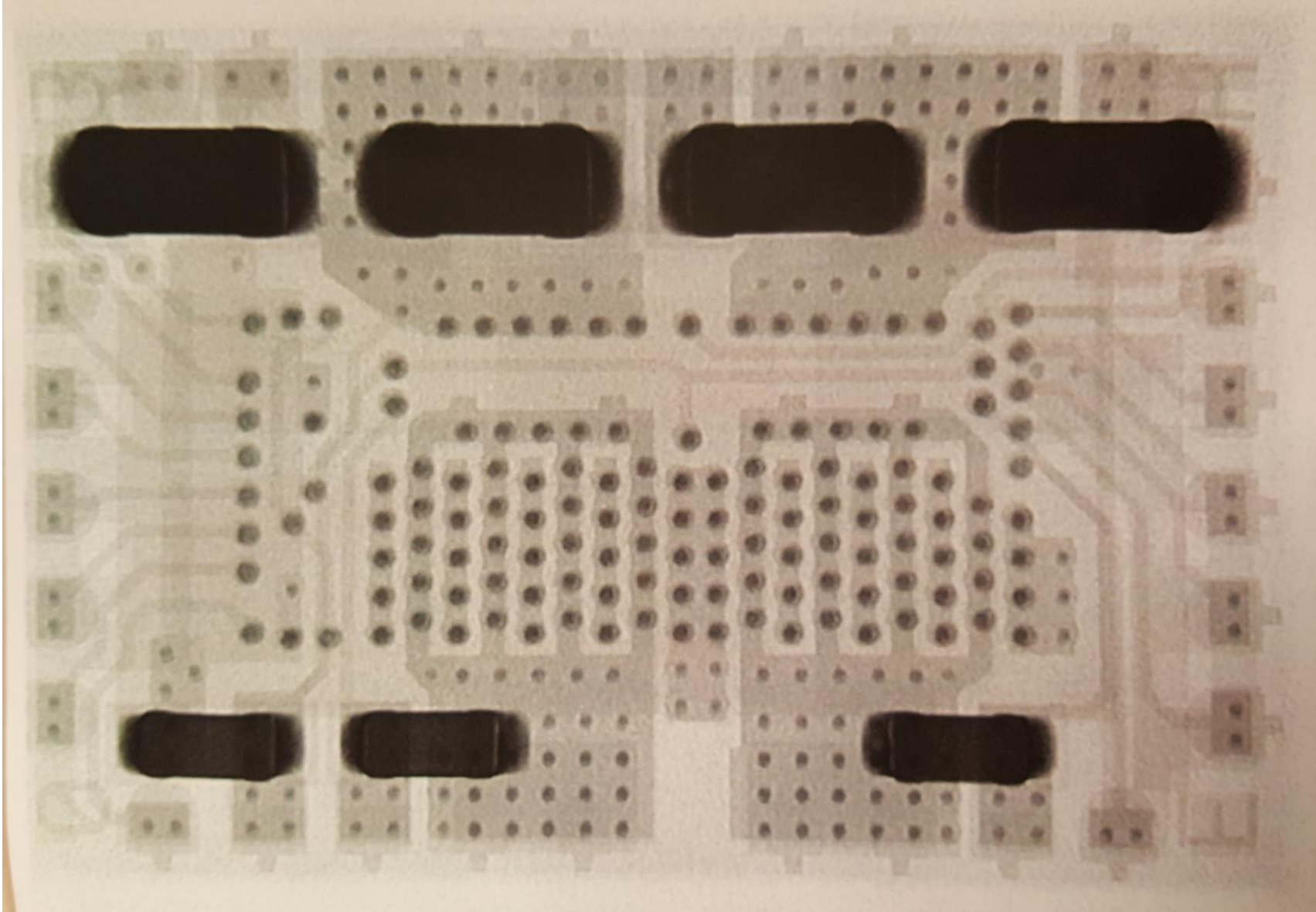
LT8650S 2-Phase Application Transient Response



$$C_{OUT} = 47\mu F \times 2$$
$$\Delta V_{OUT} < 90 \text{ mV}$$

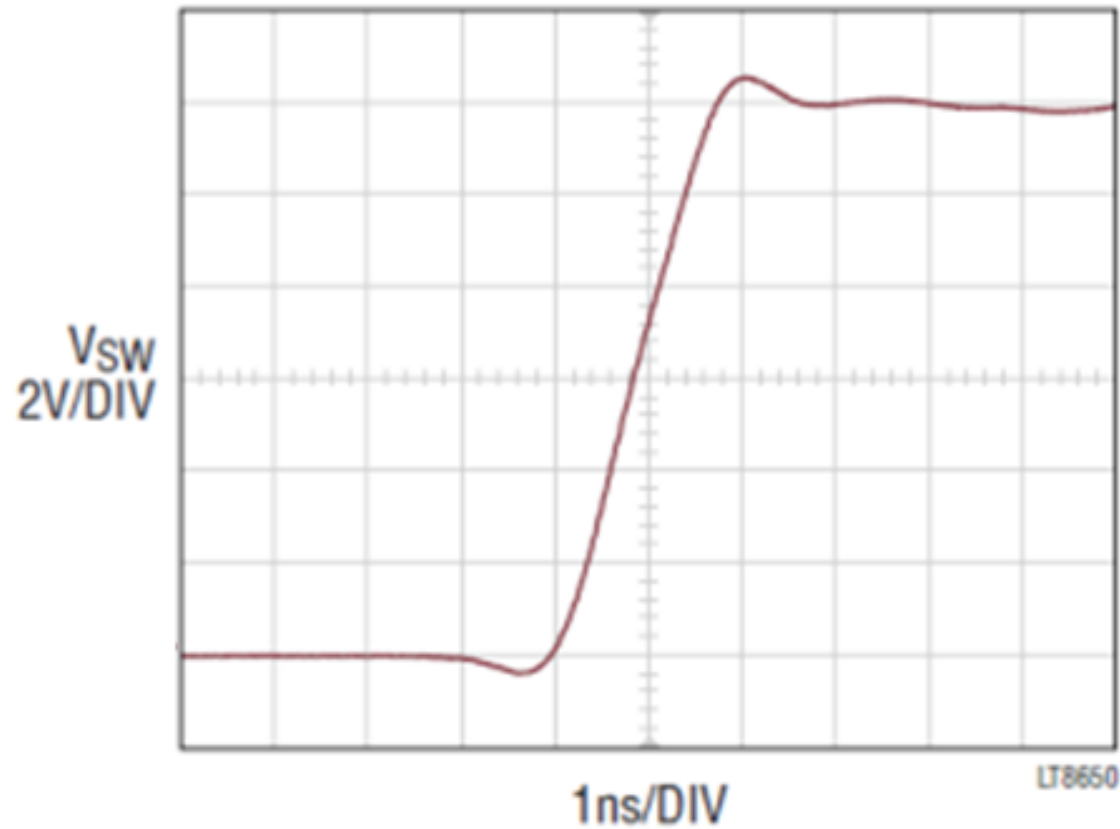


LT8650S: Internal View

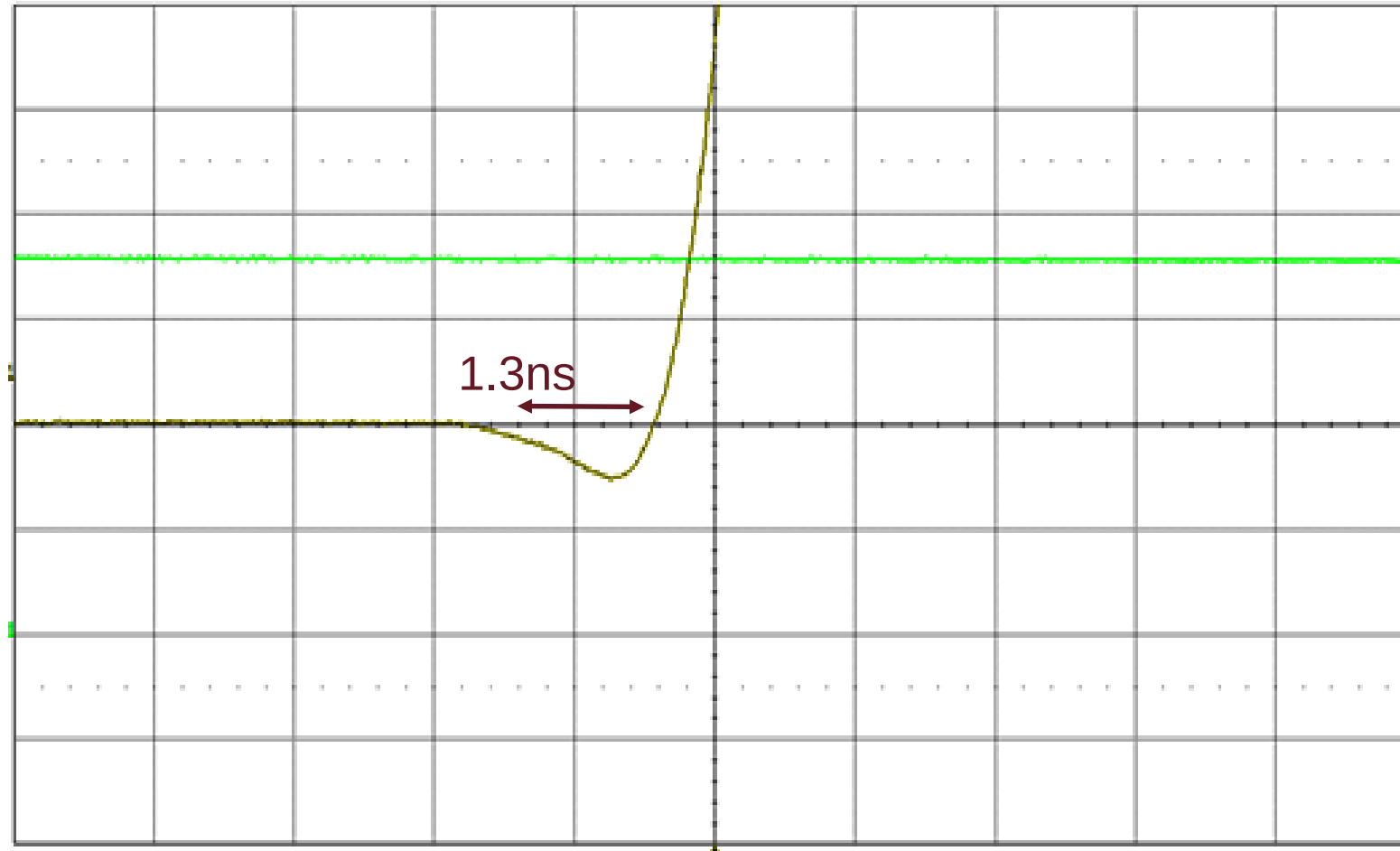


LT8650S High Efficiency:

- Low switching losses due to clean & fast edge
- Low switch resistance



LT8650S Dead Time



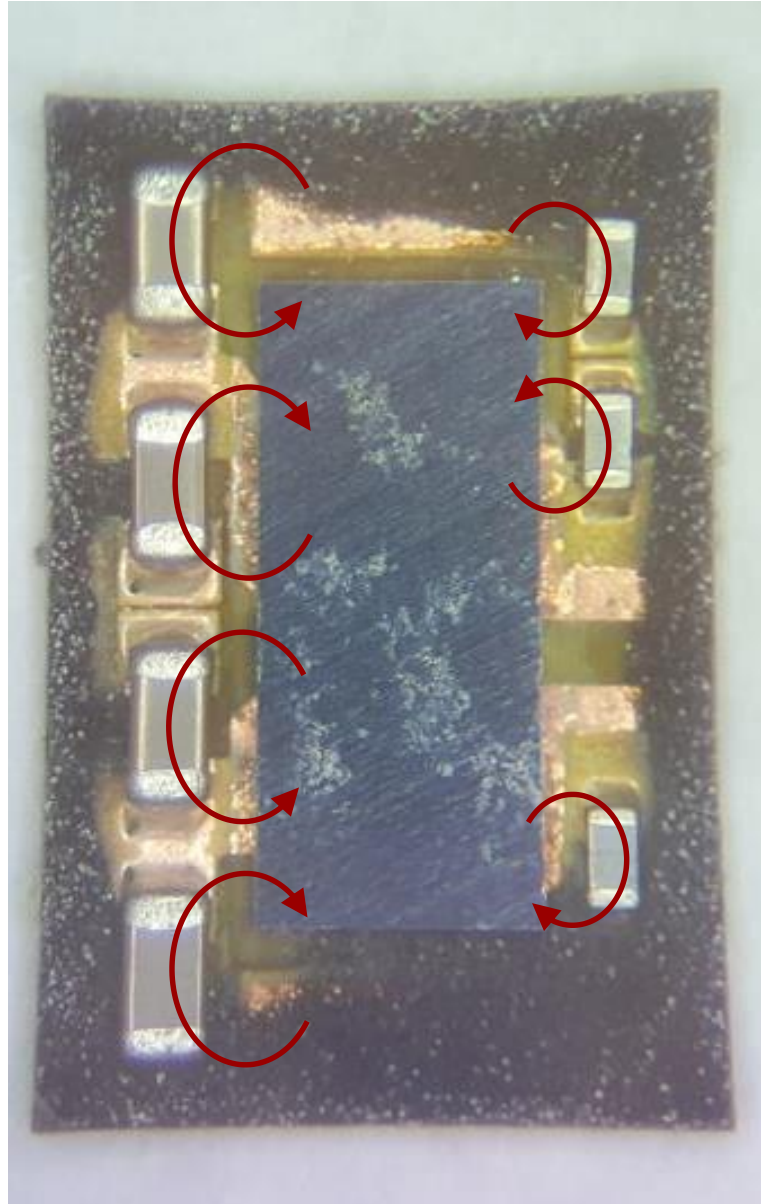
4A Load
300mV Vsw Dip

LT8650S Hot Loops

**All Hot Loops
Inside Part!**

V_{IN1} Silent
Switcher

V_{IN2} Silent
Switcher



VCC Driver Loop

BST1 Driver Loop

BST2 Driver Loop

LT86xx Single Output Regulators

Part	max Vin (V)	Output (A)	Size	Notes
LT8606	42	0.35	2x2mm, MS10	
LT8630	100	0.6	FE20	
LT8607	42	0.75	2x2mm, MS10	
LT8631	100	1	FE20	
<i>LT8619</i>	<i>60</i>	<i>1.2</i>	<i>3x3mm, MS16</i>	
LT8608	42	1.5	2x2mm, MS10	
LT8620	65	2	MS16	
<i>LT8632</i>	<i>80</i>	<i>2</i>	<i>MS16</i>	
LT8609	42	2.5	MS10	
LT8610	42	3.5	MS16	
LT8611	42	3.5	3x5mm	Programmable output current
LT8641	65	3.5	3x4mm	Silent Switcher
LT8614	42	4	3x4mm	Silent Switcher
LT8640	42	5	3x4mm	Silent Switcher
LT8612/3	42	6	3x6mm	Programmable output current

LT86xx Multiple Output Regulators

Part	Max Vin (V)	Output (A)	Size	Notes
LT8601	42	2.5,1.5,1.8	6x6mm	
LT8602	42	2.5,1.5,1.8,1.8	6x6mm	
LT8602	42	2.5,1.5,1.8,1.8	7x7mm	LQFP leaded package
<i>LT8603</i>	42	2.5,1.5,1.8, boost	6x6mm	Includes boost controller
LT8616	42	2.5,1.5	3x6mm TSSOP 28	
<i>LT8650S</i>	42	4,4	4x6mm	Silent Switcher 2
<i>LT8652S</i>	18	7.5,7.5	4x7mm	Silent Switcher 2
<i>LT8653S</i>	42	2,2	3x4mm	Silent Switcher 2
<i>LT8626</i>	65	2,1	3x6mm TSSOP 28	