



The Future of Analog IC Technology®

# EV24971DN-00A

## 3A, 50V, 100kHz Step-Down Converter with Programmable Output Current Limit Evaluation Board

### DESCRIPTION

The EV24971DN-00A is an evaluation board for the MP24971. The MP24971 is a monolithic step-down switch mode converter with a programmable output current limit. It achieves 1.5A continuous output current over a wide input supply range with excellent load and line regulation. An internal 2~4ms soft start prevents inrush current at turning on. And it is capable of providing output line drop compensation.

MP24971 achieves low EMI signature with well controlled switching edges.

Fault condition protection includes hiccup current limit and short circuit protection, output over voltage protection and thermal shutdown.

The MP24971 requires a minimum number of readily available standard external components.

### ELECTRICAL SPECIFICATIONS

Parameter	Symbol	Value	Units
Input Voltage	V <sub>IN</sub>	8 - 50	V
Output Voltage	V <sub>OUT</sub>	5	V
Output Current Limit	I <sub>OUT-L</sub>	1.5	A
Output OVP	V <sub>OVP</sub>	6	V

### FEATURES

- Wide 8V to 50V Operating Input Range
- Programmable up to 1.5A Output Current
- Output Over Voltage Protection
- Internal 4ms Soft Start
- Stable with Low ESR Output Ceramic Capacitors
- Fixed 100kHz Frequency
- Low EMI Signature
- Thermal Shutdown
- Output Line Drop Compensation
- Hiccup Circuit Limit and Short Circuit Protection

### APPLICATIONS

- USB Power Supplies
- Automotive Cigarette Lighter Adapters
- Power Supply for Linear Chargers

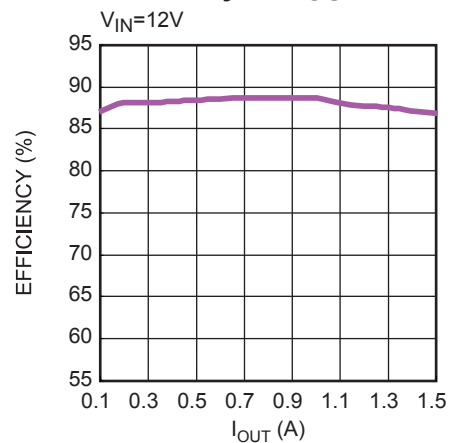
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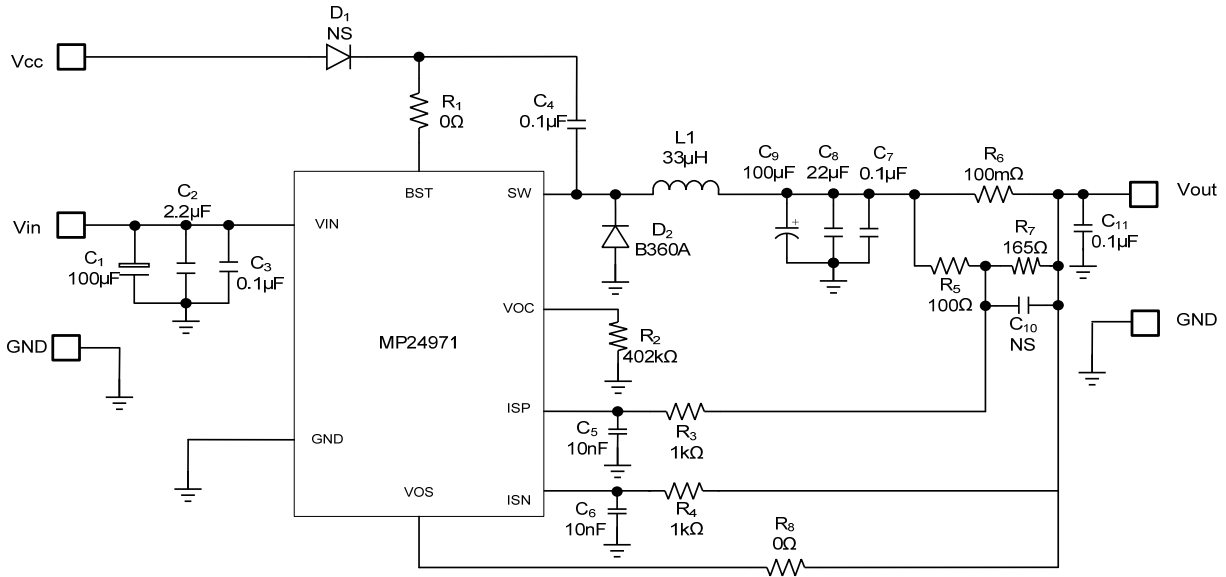
## EV24971DN-00A EVALUATION BOARD



Board Number	MPS IC Number
EV24971DN-00A	MP24971

### Efficiency vs. I<sub>OUT</sub>



**EVALUATION BOARD SCHEMATIC**

**EV24971DN-00A BILL OF MATERIALS**

Qty	RefDes	Value	Description	Package	Manufacturer	Manufacturer P/N
1	C1	100µF	Electronic Cap.,100V	DIP	JiangHai	CD287-100V100
1	C2	2.2µF	Ceramic Cap., 100V, X7R	1210	Murata	GRM32ER72A225K
1	C3	0.1µF	Ceramic Cap., 100V, X7R	0603	Murata	GRM188R72A104KA35D
3	C4,C7, C11	0.1µF	Ceramic Cap., 50V, X7R	0603	Murata	GRM21BR71H104KA01L
2	C5,C6	10nF	Ceramic Cap., 50V, X7R	0603	Murata	GRM188R71H103KA01D
1	C8	22µF	Ceramic Cap., 16V, X5R	1210	Murata	C3225X5R1C226M
1	C9	100µF	Electronic Cap.,16V	SMD	JiangHai	VZ1-16V100
0	C10	NS	Do Not Stuff			
0	D1	NS	Do Not Stuff			
1	D2	B360A	Schottky Diode,3A,60V	SMA	Diodes	B360A
1	L1	33µH	Inductor, 5.5A/45mΩ	SMD	Würth	7447709330
2	R1,R8	0Ω	Film Res., 5%	0603	Yageo	RC0603JR-070RL
1	R2	402kΩ	Film Res.,1%	0603	Yageo	RC0603FR-07402KL
2	R3,R4	1kΩ	Film Res., 1%	0603	Royalohm	0603F1001T5E
1	R5	100Ω	Film Res.,1%	0603	Yageo	RC0603FR-07100RL
1	R6	100mΩ	Sense Res., 1%	2512	CYNTEC	RL-3264-9-R100-FN
1	R7	165Ω	Film Res.,1%	0603	Yageo	RC0603FR-07165RL
1	U1		DC-DC Converter	SOIC8	MPS	MP24971DN

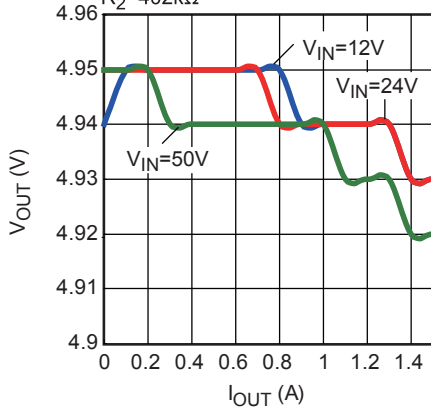
### EVB TEST RESULTS

Performance waveforms are tested on the evaluation board.

C1=100μF, C2=2.2μF, C8=22μF, C9=100μF, L=33μH, R<sub>SENSE</sub>=100mΩ, R5=100Ω, R7=165Ω, T<sub>A</sub>=25°C, unless otherwise noted.

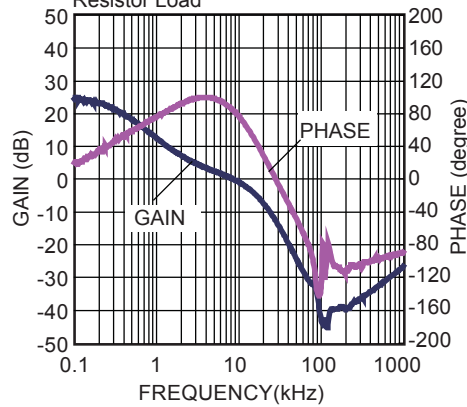
#### Output Line Drop Compensation

R<sub>SENSE</sub>=100mΩ, R<sub>TRACE</sub>=225mΩ  
R<sub>2</sub>=402kΩ



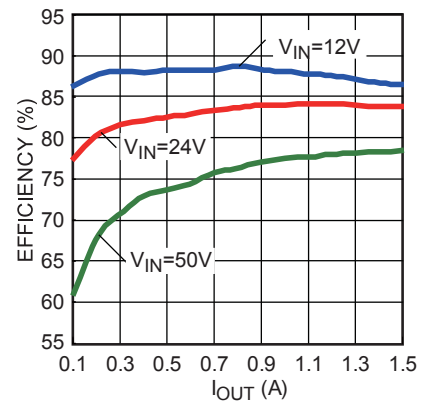
#### Loop Gain with Phase Margin

V<sub>IN</sub>=12V, V<sub>OUT</sub>=5V, I<sub>OUT</sub>=1.5A  
Resistor Load



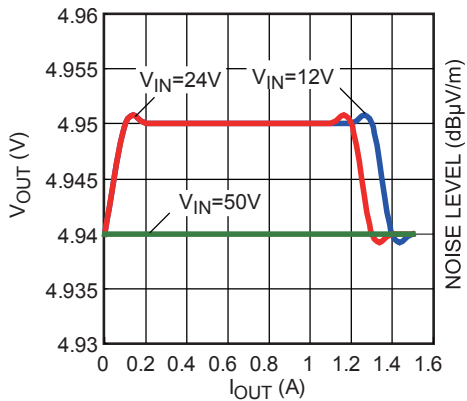
#### Efficiency vs. Output Current

V<sub>OUT</sub>=5V



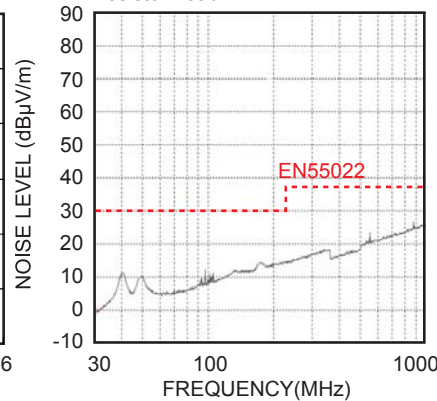
#### Load Regulation

Connect ISP, ISN to GND



#### EMI Radiation

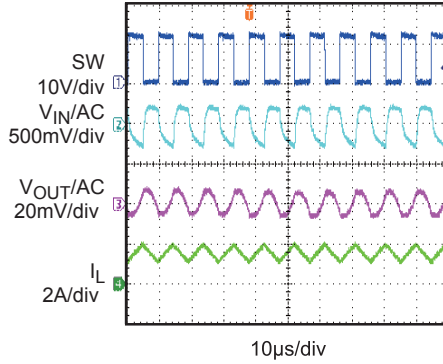
V<sub>IN</sub>=12V, V<sub>OUT</sub>=5V, I<sub>OUT</sub>=1.5A  
Resistor Load

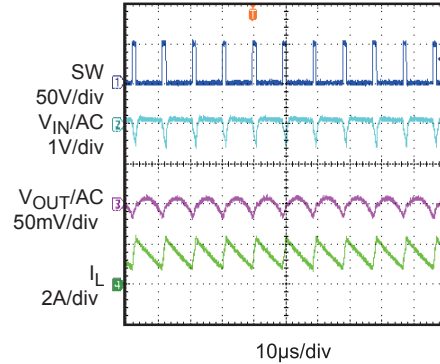


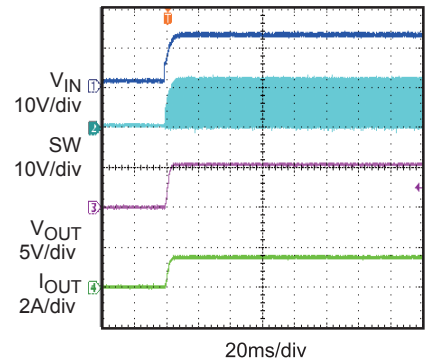
**EVB TEST RESULTS (continued)**

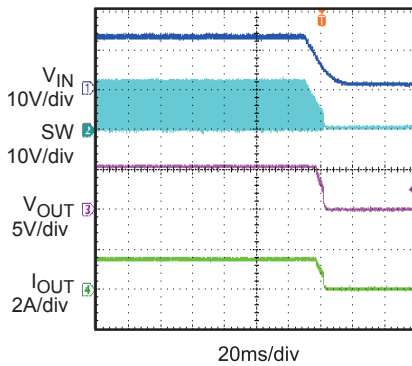
Performance waveforms are tested on the evaluation board.

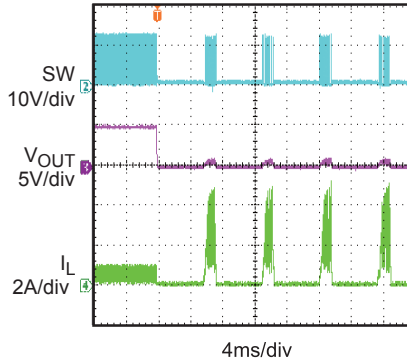
**C1=100 $\mu$ F, C2=2.2 $\mu$ F, C8=22 $\mu$ F, C9=100 $\mu$ F, L=33 $\mu$ H, R<sub>SENSE</sub>=100m $\Omega$ , R5=100 $\Omega$ , R7=165 $\Omega$ , T<sub>A</sub>=25 $^{\circ}$ C, unless otherwise noted.**
**Steady State**

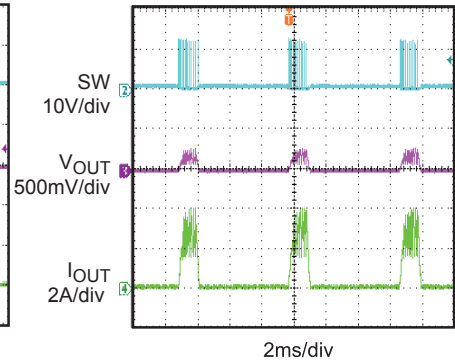
 V<sub>IN</sub>=12V, V<sub>OUT</sub>=5V, I<sub>OUT</sub>=1.5A E-Load

**Steady State**

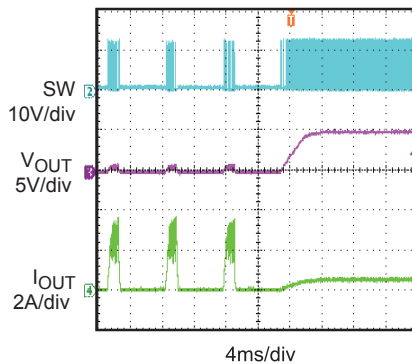
 V<sub>IN</sub>=50V, V<sub>OUT</sub>=5V, I<sub>OUT</sub>=1.5A E-Load

**Power Ramp Up**

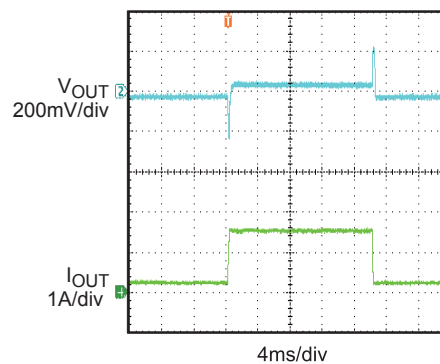
 V<sub>IN</sub>=12V, V<sub>OUT</sub>=5V, I<sub>OUT</sub>=1.5A Resistor Load

**Power Ramp Down**

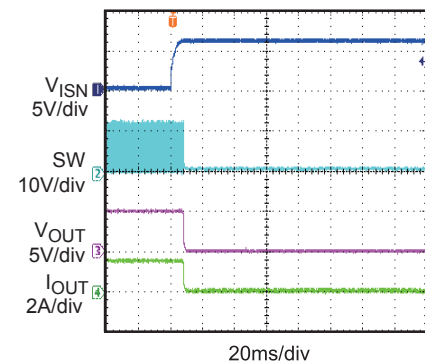
 V<sub>IN</sub>=12V, V<sub>OUT</sub>=5V, I<sub>OUT</sub>=1.5A Resistor Load

**Short Circuit Enter**

 V<sub>IN</sub>=12V, V<sub>OUT</sub>=5V, I<sub>OUT</sub>=0.5A

**Short Circuit Steady**

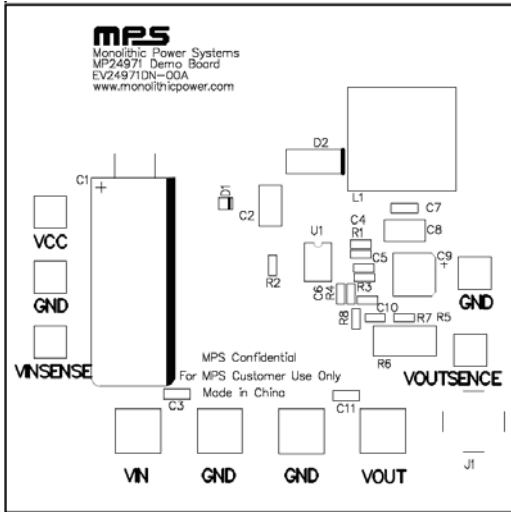
 V<sub>IN</sub>=12V, V<sub>OUT</sub>=5V

**Short Circuit Recovery**

 V<sub>IN</sub>=12V, V<sub>OUT</sub>=5V, I<sub>OUT</sub>=0.5A

**Load Transient Response**

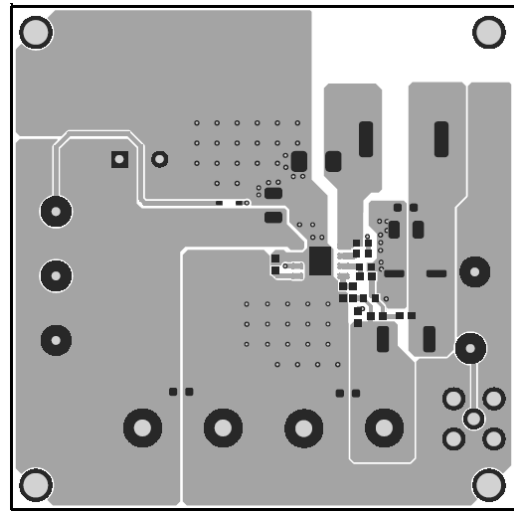
 V<sub>IN</sub>=12V, V<sub>OUT</sub>=5V, I<sub>OUT</sub>=0.3A-1.5A Slew Rate=6.4mA/ $\mu$ s

**Over Voltage Protection**

 V<sub>IN</sub>=12V, V<sub>OUT</sub>=5V, I<sub>OUT</sub>=1.5A Add an 6V External Power to ISN


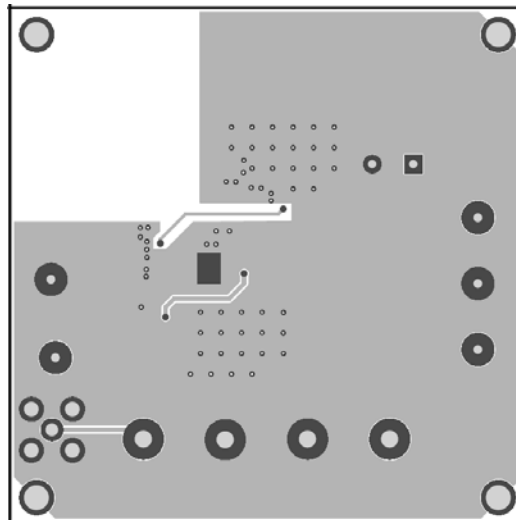
**PRINTED CIRCUIT BOARD LAYOUT**



**Figure 1—Top Silk Layer**



**Figure 2—Top Layer**



**Figure 3—Bottom Layer**

## QUICK START GUIDE

1. The output voltage of this board is fixed to 5V. The board layout accommodates most commonly used inductors and output capacitors.
2. Attach the positive and negative ends of the load to the VOUT and GND pins, respectively.
3. Attach the input voltage ( $8V \leq V_{IN} \leq 50V$ ) and input ground to the VIN and GND pins, respectively.
4. The output current limit is set as:

$$I_{OUT\_L} = \frac{100mV}{R_{SENSE}} \times \frac{R5 + R7}{R7}$$

5. Programming the short circuit current limit.

When output voltage is lower than 200 mV, the current limit is described by:

$$I_{OUT\_SL} = \frac{100mV - 6.2\mu A \times R3}{R_{SENSE}} \times \frac{R5 + R7}{R7}$$

6. The output line compensation is set via R2

$$R2 = \frac{R_{SENSE} \times 6 \times 300k\Omega}{R_{TRACE}} \times \frac{R7}{R5 + R7}$$

Where, the  $R_{TRACE}$  is the resistance of the output line.

7. RC filter connected to ISN and ISP pin is better to be set as  $RC \geq 10^{-5}s$ , and it should meet

$$R3 + \frac{R5 \times R7}{R5 + R7} = R4, \quad C5 = C6$$

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