

## 1 Introduction

PMP9012 is an IEEE802.3af, Type 1 compliant powered device. The reference design is a dual output non-isolated flyback converter capable of outputting 5V at 580mA and 3.3V at 900mA.

## 2 Configurable features

### 1.1 Features

- Good efficiency, non-isolated, synchronous flyback design.
- 34V to 57V adapter input capability
- IEEE 802.3af type-1 hardware classification
- 5V@580mA and 3.3V@900mA output.

### 1.2 Applications

- IEEE 802.3af-compliant devices
- Video and VoIP telephones
- Multiband access points
- Security cameras
- Pico-base stations

### 3 Electrical specifications

#### TPS23785BEVM-522 Electrical and Performance Specifications

Parameter	Condition	Min	Typ	Max	Units	
<b>Power Interface</b>						
Input voltage	Applied to the power pins of connectors J1 or J4	0	-	57	Volts	
Operating voltage	After start up.	34	-	57		
Input UVLO, POE input J1	Rising input voltage	-	-	36.1		
	Falling input voltage	29.14	-	-		
Detection voltage	@ device terminals	3	-	10		
Classification voltage	@ device terminals	13	-	21.0		
Classification current	Rclass = 137 ohms	17.6	-	19.4	mA	
Inrush current-limit		100	-	180		
Operating current-limit		850	-	1100		
<b>DC/DC Converter</b>						
Output voltage	Vin=48V ILOAD ≤ ILOAD (max)	5V Output	4.94	-	4.98	Volts
		3.3V Output	3.310	-	3.311	
Output current	Vin=48V	5V Output	-	-	580	mA
		3.3V Output	-	-	900	
Output ripple voltage, pk-to-pk	Vin = 48V, ILOAD = 580mA	5V Output	-	21	-	mV
	Vin = 48V, ILOAD = 900mA	3.3V Output	-	27	-	
Switching frequency		-	250	-	kHz	

## 4 Efficiency

### 4.1 $V_{in}=48V$

PoE end-to-end, converter, and adapter efficiencies is shown for  $V_{IN}=48V$  for different output powers.

Output Power (J5)		Output Power (J6)		Input Power (J1)		Input Power (Converter)		POE (End-to-End)	Converter
Iout (5V)	Vout (5V)	Iout (3.3V)	Vout (3.3V)	Iin	Vin	Iin	Vin	Efficiency %	Efficiency %
546.2	4.9493	902.6	3.3108	129.5	47.85	128.7	47.326	91.85%	93.45%
546.8	4.9471	802.3	3.3109	122	47.85	122	47.342	91.84%	92.83%
262.8	4.9713	902.9	3.3111	98.1	47.85	98.1	47.37	91.52%	92.45%
262.8	4.9698	802.6	3.3111	93	46.8	93	46.31	91.07%	92.03%
171.5	4.9754	702.2	3.3114	75.12	47	75.12	46.548	90.03%	90.90%
128.1	4.9772	601.9	3.3111	62.786	47.15	62.786	46.707	88.86%	89.70%
101.5	4.9778	501.6	3.3113	52.446	47.27	52.446	46.839	87.38%	88.18%
71.75	4.9762	401.3	3.3111	41.904	47.39	41.904	46.974	84.89%	85.64%
42.231	4.9778	300.8	3.3111	31.532	47.51	31.532	47.11	80.52%	81.20%
22.476	4.9744	100.1	3.3114	14.292	47.7	14.292	47.33	65.02%	65.53%
15.562	4.9744	59.9	3.3115	11.77	47.74	11.77	47.382	49.08%	49.45%

Output Power (J5)		Output Power (J6)		Input Power (J4)		Adapter
Iout (5V)	Iout (3.3V)	Iout (3.3V)	Vout(3.3)	Iin	Vin	Efficiency %
546.4	4.9481	903.4	3.3103	130.1	47.985	91.21%
546.4	4.9475	801.9	3.3111	122.5	48.01	91.11%
262.8	4.9717	900.4	3.3113	98.6	48.01	90.58%
262.6	4.9693	814.1	3.3109	92.2	47.988	90.41%
171.6	4.9752	694.2	3.3111	73.6	47.989	89.25%
128.1	4.9773	603.5	3.3113	62.4	47.988	88.03%
101.6	4.9778	513.5	3.3114	53.1	47.99	86.57%
71.71	4.9777	393.3	3.3115	41.982	47.511	83.19%
42.211	4.9779	302.5	3.3115	32.292	47.623	78.80%
22.482	4.9753	99.55	3.3119	15.864	47.86	58.16%
15.563	4.9745	61.089	3.3116	12.462	47.855	46.90%

## 4.2 Vin=57V

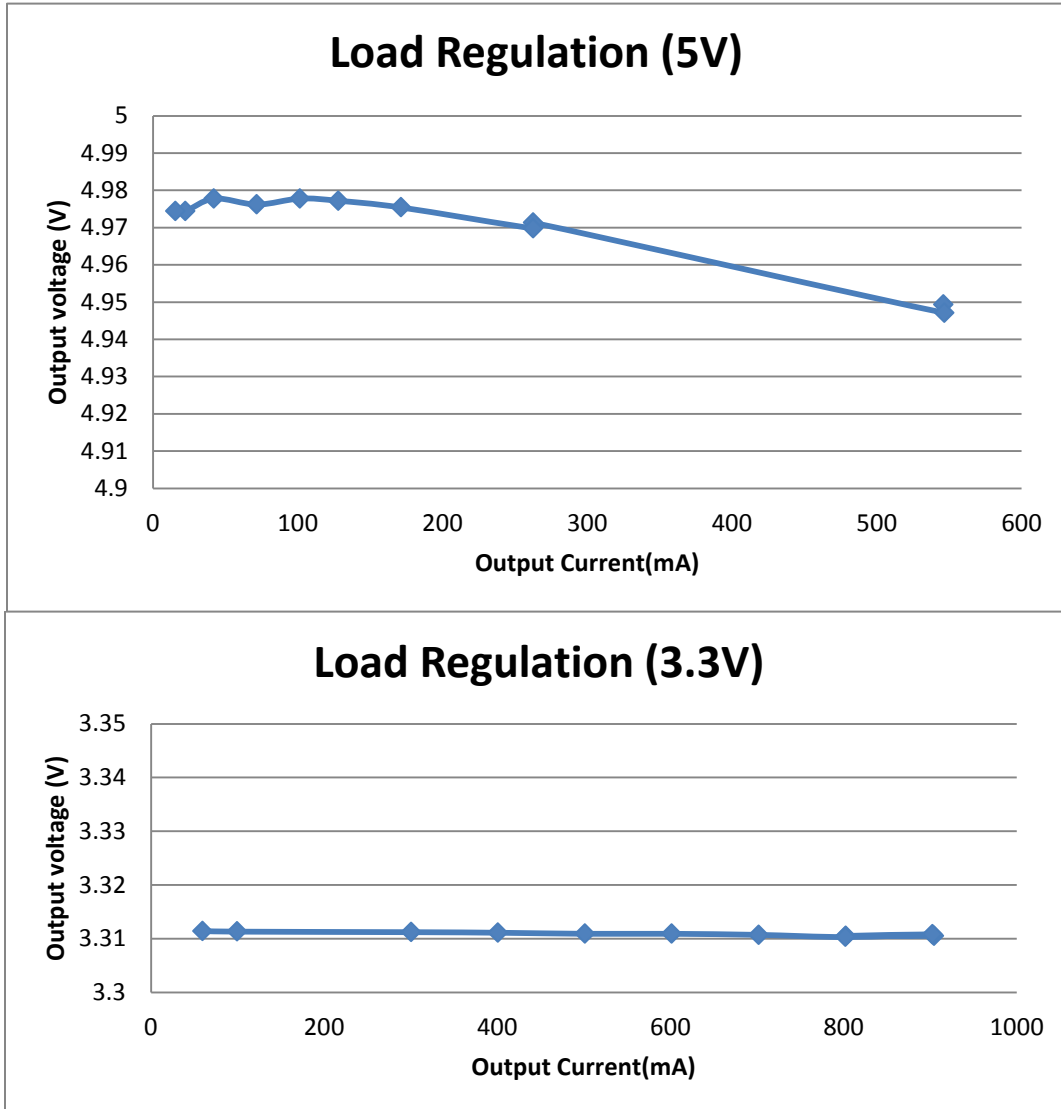
PoE end-to-end, converter, and adapter efficiencies is shown for VIN=57V for different output powers.

Output Power (J5)		Output Power (J6)		Input Power (J1)		Input Power (Converter)		POE (End-to-End)	Converter Efficiency
Iout (5V)	Vout (5V)	Iout (3.3V)	Vout (3.3V)	Iin	Vin	Iin	Vin	Efficiency %	%
547.3	4.9517	903.5	3.3108	108.5	57.12	108.5	56.63	91.99%	92.79%
546.9	4.9505	802.6	3.311	101.8	57.4	101.8	56.9	91.81%	92.62%
262.9	4.9726	903	3.3111	83.673	56.46	83.673	55.98	90.96%	91.74%
262.8	4.9711	803.3	3.311	77.806	56.24	77.806	55.78	90.64%	91.39%
171.6	4.9764	703	3.3113	63	56.41	63	55.97	89.53%	90.24%
128.1	4.9814	602.5	3.3113	52.9	56.59	52.9	56.17	87.96%	88.62%
101.6	4.9773	502.2	3.3114	44.3	56.64	44.3	56.22	86.43%	87.08%
71.722	4.9773	401.9	3.3115	35.665	56.73	35.665	56.32	83.42%	84.03%
42.214	4.9771	301.5	3.3113	27.074	56.84	27.074	56.45	78.53%	79.07%
22.477	4.974	100.6	3.3113	13.573	57	13.573	56.62	57.51%	57.89%
15.561	4.9735	50.439	3.3113	10.061	57.04	10.061	56.69	42.59%	42.85%

Output Power (J5)		Output Power (J6)		Input Power (J4)		Adapter
Iout (5V)	Iout (3.3V)	Iout (3.3V)	Vout(3.3)	Iin	Vin	Efficiency %
547.5	4.9516	901.6	3.3108	110.2	57.06	90.59%
546.9	4.9506	802.5	3.3112	102.8	57.4	90.92%
262.9	4.9724	902.8	3.3111	84.633	56.45	89.93%
262.7	4.9711	801.1	3.3113	78.667	56.17	89.59%
171.6	4.9765	701	3.3114	64	56.34	88.06%
128.1	4.9765	600.9	3.3107	53.744	56.47	86.56%
101.6	4.9767	500.2	3.311	45.163	56.56	84.63%
71.739	4.9768	399.6	3.3112	36.35	56.67	81.56%
42.225	4.9767	300	3.3114	27.802	56.77	76.26%
22.477	4.9783	98	3.3116	14.204	56.93	53.97%
15.561	4.9732	49	3.3117	10.651	56.97	39.50%

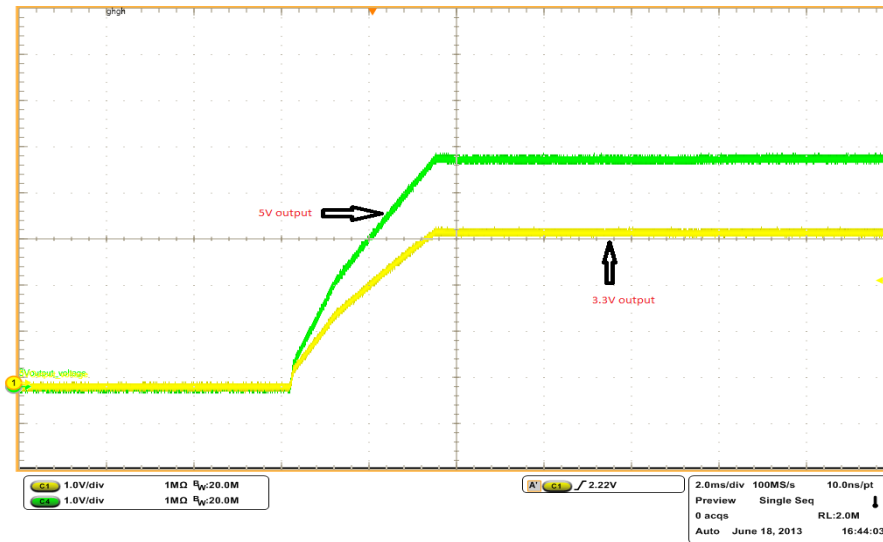
## 5 Load Regulation

Vin=48V DC at J1



## 6 Start up

The scope plot below shows the 5V and 3.3V output voltage startup waveform after the application of 48V dc at J1. The outputs were loaded to 580mA (5V) and 900mA (3.3V).



## 7 Switch Node Waveforms

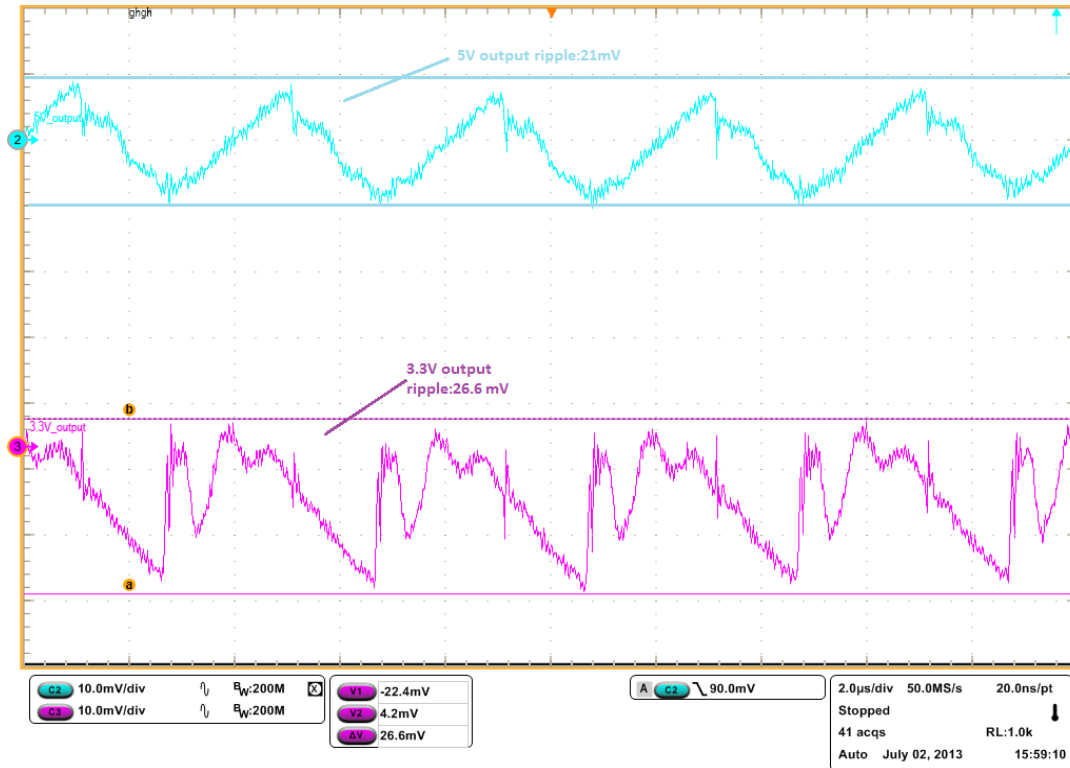
The scope plot below shows the waveforms on the drain of the secondary side FET (CH3 and CH4) and the primary side FET (CH1). The outputs are loaded at 580mA(5V) and 900mA(3.3V). Vin = 48V DC at J1. Note: CH3 has 1/20 attenuation.



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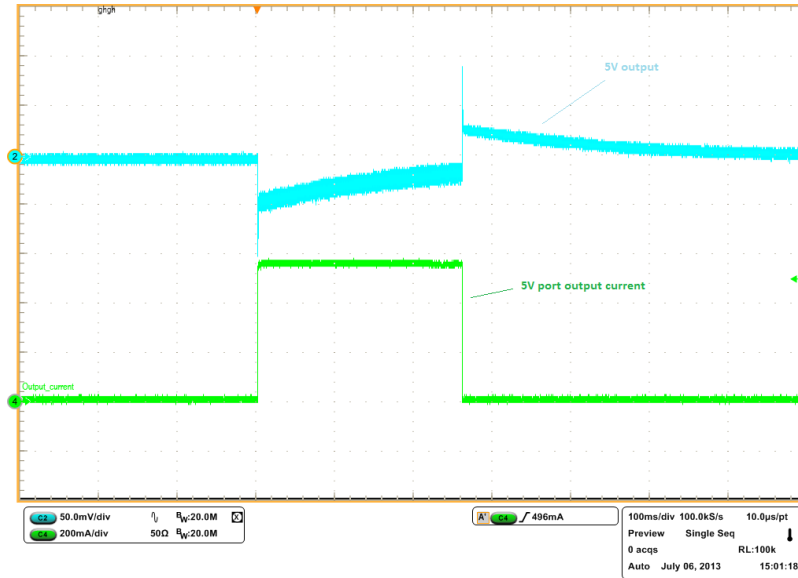
## 8 Output Ripple Voltage

The 5V and 3.3V output ripple voltage are shown in the scope plot below (J5 and J6). The scope plot was taken with the output loaded to 580mA (5V) and 900mA (3.3V).  $V_{in} = 48V$  dc at J1.



## 9 Load Transients

The scope plots below shows the 5V output voltage when the load current is pulsed from no load to 580mA.  $V_{in} = 48V_{dc}$  at J1.



The scope plots below shows the 3.3V output voltage when the load current is pulsed from 30mA to 375mA.  $V_{in} = 48V_{dc}$  at J1.

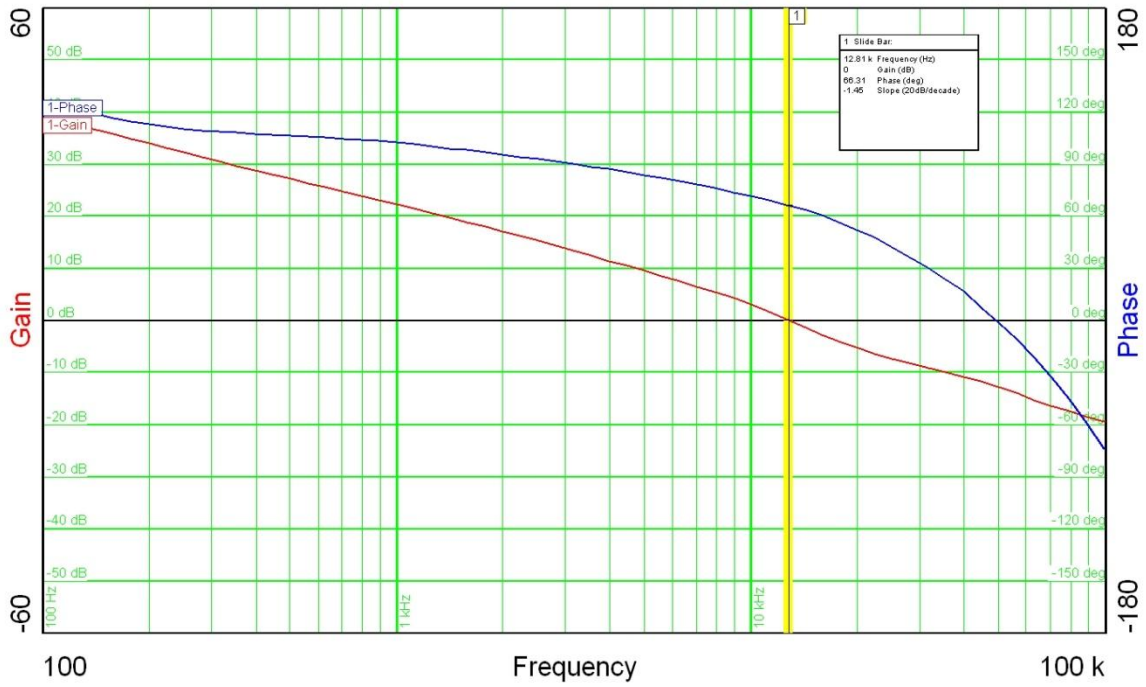




## 10 Control Loop Gain / Stability

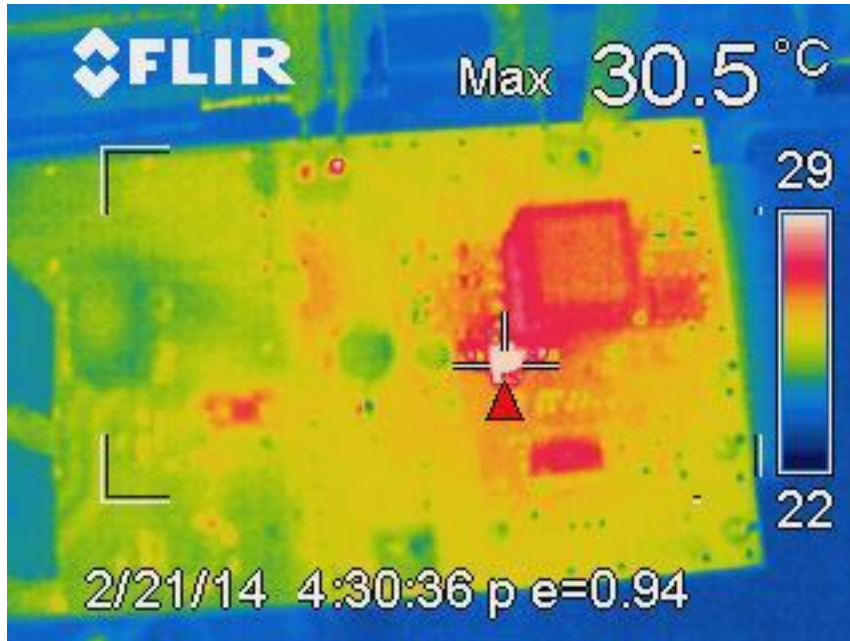
The table below shows the loop gain and phase margin. The output was loaded to full load.

Input voltage	48VDC	
Gain/Phase	Crossover	Phase Margin
PWR522A	12.81kHz	66.31°



## 11 Thermal

The below image is a thermal image of PMP9012 operating at full load.



## 12 IEEE802.3af Compliance

The table below shows the results of the Sifos Technologies PoE Powered Device Analyzer using 1.5W output power.

Test Parameter	Description	Analyzer Results	Pass/Fail
Rdet	Detection resistance (2.7 to 10.1 Volt band)	25.82k ohms	P
Cdet	Detection capacitance (2.7 to 10.1 Volt band)	0.107uF	P
Iclass	Classification signature current (15 – 20 Volt band)	18.3mA	P
Class	PD Class determined from classification	2	P
Type	PD Type determined from classification	1	-
Von	Voltage at which PD draws load current	35.7V	P
Voff	Voltage at which PD stops load current	31.7V	P
Einr	Capacitive charging energy (watt-sec) over worst 20msec sub-interval of Inrush interval – a failure indicates an linrush_pd violation while a pass indicates very low inrush interoperability risk	0.067Ws	P
<b>Single-Event Classification</b>			
Power	Average PD power draw following the 50msec inrush interval	1.5W	P
Peak	Maximum PD transient load following the 50msec inrush interval	1.53W	P
Imax	Maximum transient load current sampled following the 50msec inrush interval	31.9mA	-
Imin	Minimum load current sampled after power-up. (Note: PD's meeting DC MPS signature criteria described in IEEE 802.3at paragraph 33.3.8 will report 10mA or higher.)	31.0mA	P
lavg	Average load current following the 50msec inrush interval	31.4mA	-

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