

Features

- Input Voltage: 5V $\pm 10\%$
- Output Voltage adjustable: 1.225V to 3.8V
- Output current up to 5A
- Efficiency: 88 % (3.3V/3A)
- Excellent Dynamic Performances
- Buck Converter Topology
- Fixed switching frequency (400kHz)
- Integrated EMC filter
- Input Under-voltage protection
- Thermal Shutdown and Current Limit Protections
- Power Good signal for Output voltage monitoring
- Soft Start, ON/OFF Command
- Space Qualified Technology
- Radiation Hardened design
- Junction Temperature Range $-40^{\circ}\text{C} / +125^{\circ}\text{C}$
- Compact Size and Low Weight
- 14-pin gull wing SMD
- ITAR Free Product

3DPM0211-1-XX



- Size: 26.5 x 25 x 10 mm
- Mass: 15 g

Application

- Low voltage power distribution system for ASICs, FPGAs (ACTEL, XILINX, ...) and Memory (SDRAM, DDR, DDR2, ...)
- Point of Load Regulation / Distributed Power System for Space Applications

General Description

The 3DPM0211-1 POL Converter provides high performances, high reliability, compact size and low weight for Space Applications.

Featuring specific radiation effect mitigation techniques and utilizing space design derating rules, the 3DPM0211-1 POL Converter is an ITAR Free product and features a SEL LET threshold of 80 MeV.cm²/mg and a TID of 50krad(Si).

Based on a Buck topology, the POL module uses a P channel Power MOSFET/Schottky diode stage at 400 kHz switching frequency.

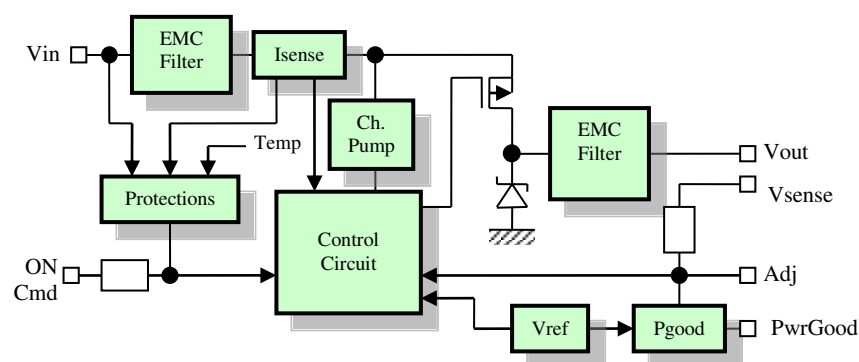
From a 5V now available on almost every digital system, the POL module provides low voltages power supplies for most of today's digital designs. Its Output voltage is adjusted from 1.225V to 3.8V by an external resistor. A very high speed control loop keeps the output voltage within regulation under the high transient load swings commonly found in high speed modern ASICs, FPGAs and Memory devices.

The POL Module is fully protected against output overload, input under-voltage and internal over-heating. The external ON/OFF command and Soft Start function enable any power supply ON/OFF sequencing.

Power Good signal is available for module survey and may be used for Power on Reset.

Input and output EMC filters are integrated to simplify module implementation directly on the digital board with only one additional component (resistor for output voltage adjustment).

Block Diagram



Hi-Rel Point-Of-Load DC/DC Converter

5V $\pm 10\%$ Input, 1.225V to 3.8V Single Output

Radiation Hardened Design

Absolute Maximum Ratings

Operation beyond the following limits may cause module degradation, reliability reduction or permanent damage.

Parameter	Conditions	Min	Typ	Max	Unit
Input Voltage	Continuous	-0.3		6	V
ON Command	Continuous	-0.3		6	V
Output Current	-	Internally Limited			A
Storage Temperature	-	-55		+150	°C

Recommended Operating Conditions

For proper operation, the module should be used within the recommended operating conditions.

Parameter	Conditions	Min	Typ	Max	Unit
Input Voltage	Continuous	4.50	5	5.50	V
ON Command	Continuous	0		V _{in}	V
Output Current	-	0		5	A
Output Power	Continuous			17	W
Junction Temperature	-	-40		+125	°C
Thermal Resistance (θ_{JC})	-			15	°C/W

Mechanical and Environmental Specification

Parameter	Conditions	Typ			Unit
Weight	-		15	16	g
Dimensions	Overall (pin not included)	26.5 (L)	25 (W)	10 (H)	mm

Parameter	Conditions	Min	Typ	Max	Unit
Total Irradiation Dose	-	50			kRad(Si)
Latch-up Immune LET Threshold	-	80			Mev.cm ² /mg
Single Event Transient Immune LET Threshold	-	80			Mev.cm ² /mg

Parameter	Conditions	Remarks
Thermal Cycles	Mil-std-883 Method 1010 Condition B	500 Cycles, -55°C/+125°C
High Temperature Storage	Mil-std-883 Method 1008 JESD22-A103-A	2000hrs, 150°C
Shock	Mil-std-883 Method 2002 Condition B	Y1, 0.5 ms, 1500g
Sinusoidal Vibration	Mil-std-883 Method 2007 Condition A	20Hz-2000Hz peak acceleration 20g – 3 axes
Random Vibration	Mil-std-883 Method 2026 Condition I	Level H/J
HAST	JEDEC STD 22TMA110	264 hrs, +110°C
Outgazing	ESA-PSS-01-702 MA	TML&RML<1%, CVCM<0,1%
Lead Integrity	Mil-std-883 Method 2004	
Solderability	Mil-std-883 Method 2003	
Marking Permanency	Mil-std-883 Method 2015	

Hi-Rel Point-Of-Load DC/DC Converter

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Input Specifications

Parameters are defined over the specified input voltage, output load and temperature range unless otherwise noted.

Parameter	Conditions	Min	Typ	Max	Unit
Input Characteristics					
Input Voltage Range		4.50		5.50	V
Input Current in OFF State			18	22	mA
Input Current in ON State	Vin = 5V, Vout = 3.3V, no load		33	43	mA
ON Command Characteristics					
ON Voltage (Von)		3.9			V
OFF Voltage (Voff)				1.5	V
Hysteresis		0.6	0.8	1.1	V
Input impedance	POL not in protection mode		50		k Ω
	POL in protection mode	4.8			k Ω

Output Specifications

Parameters are defined over the specified input voltage, output load and temperature range unless otherwise noted.

Parameter	Conditions	Min	Typ	Max	Unit
Output Characteristics					
Output Voltage range		1.225		3.8	V
Set-point Accuracy	-40°C to 95°C	-1.1		1.4	%
Load Regulation	min to max load			0.4	%
Ageing drift	10 years @ 50 krad	-0.5		0.5	%
Start-up time	ON cmd -> PGood ON	2	3	4	ms
Load Transient	Iout = +/- 3A, di/dt = 10A/ μ s (min DC load = 750mA)		60	90	mV
Load Capacitance				650	μ F
Output Ripple	Measurement BW limited to 20MHz		35	60	mVpp
			6	10	mVrms
Switching Frequency		370	400	430	kHz
Efficiency	Vin = 5V, Vout = 3.3V / Iout = 3A	85	87.8		%
	Vin = 5V, Vout = 3.3V / Iout = 5A	83	86		%
PGOOD (Power Good) signal					
Output Voltage Threshold	Falling threshold (Vout ok)	94		97	%
	Rising threshold (Vout ko)	92		94	%
Active Voltage Level	Sink current = 1mA			0.7	V

Protections

Parameters are defined over the specified input voltage, output load and temperature range unless otherwise noted.

Parameter	Conditions	Min	Typ	Max	Unit
Overload Protection					
Maximum output Current	Before POL switch OFF	5	6	7.4	A
Under-voltage Protection					
UVD Protection threshold		4.1	4.2	4.3	V
UVD Recovery threshold		4.3	4.4	4.5	V
UVD hysteresis		180	250	300	mV
Internal Temperature Protection					
Internal thermal shutdown temperature		115	125	135	°C

Pin definition & assignments

Pin 1, 2, 10 & 11: GND

Reference ground for the POL module.

Have to be connected on large PCB ground plane for optimal heat dissipation.

Pin 3, 4 & 5: Vin

Input voltage pins. DC supply for the POL Module. These are input pins.

Pin 6: PGOOD

Power Good Open collector signal. Signal used to survey POL correct operation. Pulled to ground when the POL module is running correctly. In open state when the output voltage is not within $\pm 5\%$ of regulation point. This is an output pin.

Pin 7: ON

ON command pin. When left unconnected or connected to a low level voltage, the POL converter is in OFF state. To restart the POL, a high level voltage has to be applied on this pin.

This is an input pin.

Pin 8: Vadj

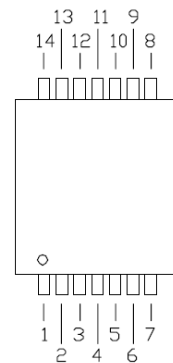
Adjustment pin used to set the output voltage. A resistor connected to ground is used for voltage adjustment. This resistor has to be located close to the POL module with short PCB tracks to minimise risk of noise coupling. This is an output pin.

Pin 9: Vsense

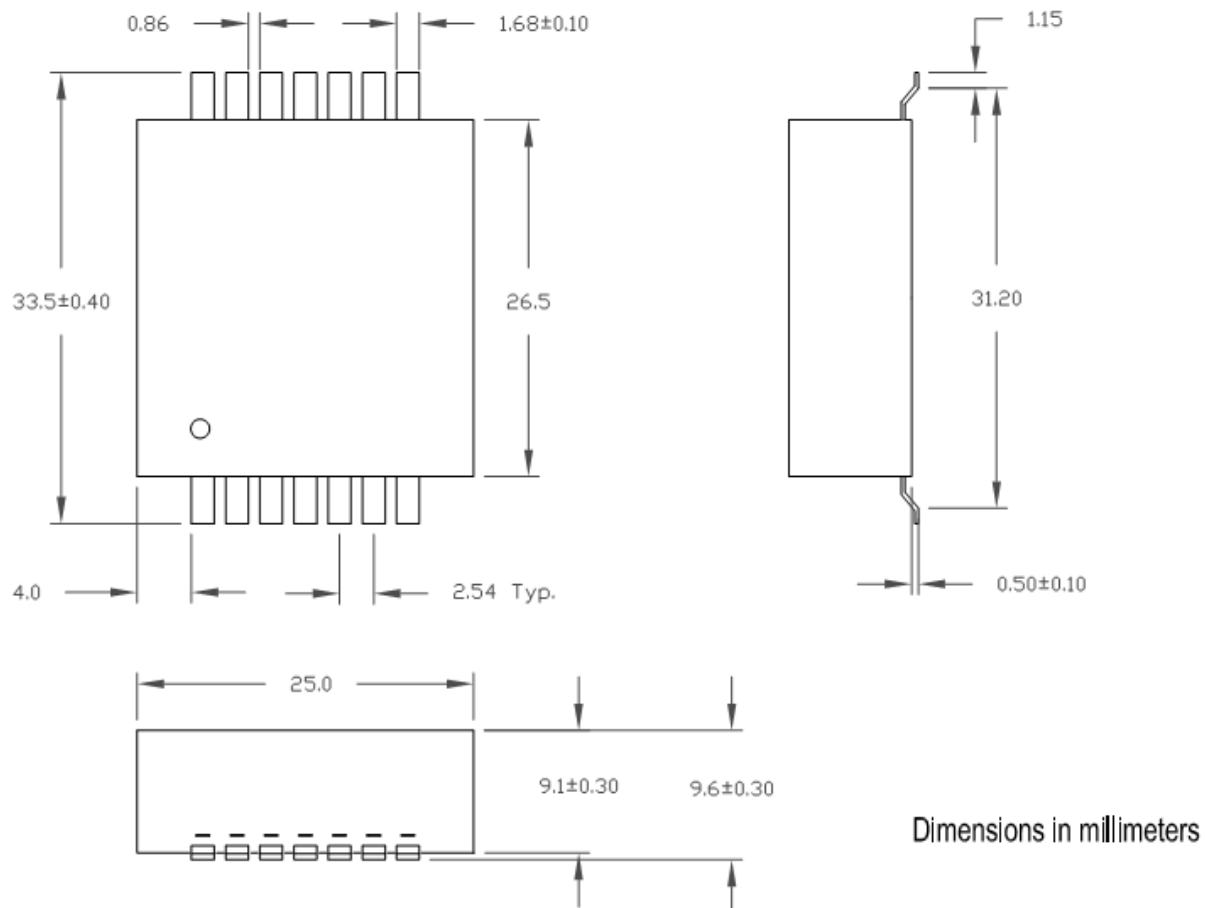
Sense pin. Used to sense the output voltage for improved accuracy. Can be connected to Vout pins for local sensing or connected to Vout at load location for remote sensing. This is an input pin.

Pin 12, 13 & 14: Vout

Output voltage pins. This is the output supply provided by the POL module to power the load. These are output pins.



Module Mechanical Drawing



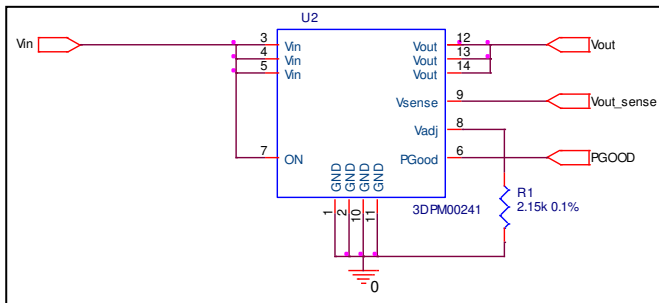
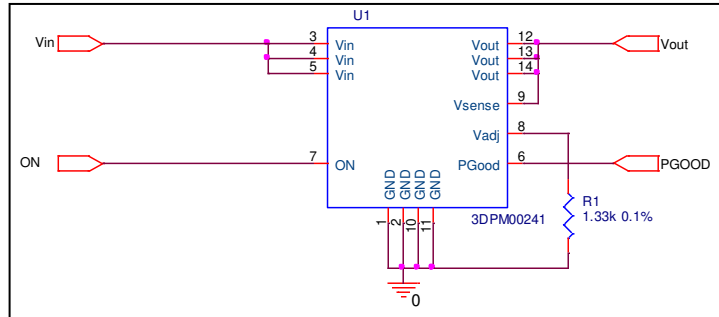
Typical application schematic

Case 1:

Typical application schematic.

For Von voltage greater than 3.9V, the POL module is switched on.

Output voltage is locally sensed by Vsense.
Vout is set to 3.3V by selecting R1 = 1.33k Ω .



Case 2:

POL is always ON (ON pin connected to Vin).
Voltage is regulated at load level through the Vout_sense pin which is connected to Vout at load location. This improves load regulation by removing the influence of track path resistance between the POL and the load (especially for high current applications).

Vout is set to 2.5V by selecting R1 = 2.15k Ω .

Output Voltage Setting

Output voltage is adjusted by setting a resistor value between Vadj and ground. A 0.1% (25 ppm) resistor is recommended to reach the output voltage accuracy performances.

Resistor value is selected according to the following table:

Vout	Radj (kOhm)	Vout	Radj (kOhm)	Vout	Radj (kOhm)
1,225	Open	2,2	2,84	3,3	1,33
1,25	110,00	2,3	2,58	3,4	1,27
1,3	36,91	2,4	2,36	3,5	1,22
1,4	15,82	2,5	2,15	3,6	1,17
1,5	10,00	2,6	2,01	3,7	1,12
1,6	7,38	2,7	1,88	3,8	1,08
1,7	5,83	2,8	1,76	3,9	1,03
1,8	4,81	2,9	1,65	4	1,00
1,9	4,10	3	1,56		
2	3,57	3,1	1,48		
2,1	3,16	3,2	1,40		

Example:

- for Vout = 1.25V, uses Radj = 110k Ω
- for Vout = 1.5V, uses Radj = 10k Ω
- for Vout = 1.8V, uses Radj = 4.81k Ω
- for Vout = 2.5V, uses Radj = 2.15k Ω
- for Vout = 3.3V, uses Radj = 1.33k Ω

Features description

Selected topology for the POL module is a Buck regulator. It uses a P channel MOSFET for the high side switch and a schottky diode for the low side switch to improve the efficiency.

The buck regulator works at a fixed switching frequency of 400kHz to minimize module dimensions. This rather high switching frequency allows maximizing voltage regulation bandwidth to offer very good dynamic performances in case of output current transients. This is very important when the POL module is used to power last generation of digital loads which change their power demand very rapidly.

EMC filters at converter input and output are integrated into the module to avoid the use of external filters which take PCB area and make converter design and integration much more difficult.

Output voltage can be adjusted to the user needs by adding a simple resistor between the Vadjust pin and ground (see table provided before).

POL module is fully protected against output overload. Internal input under-voltage detection and internal over temperature protection are also integrated to offer robust power supply solution (see next section for more details).

ON signal is available for POL ON/OFF command. This external command can also be used to control voltage sequencing in multiple power supplies application (to avoid risk of load latch up).

Output voltage profile during start-up is controlled by the internal soft start function. Voltage profile is the same whatever is the output load. This allows having a close control of the time delay between ON command and final output voltage value.

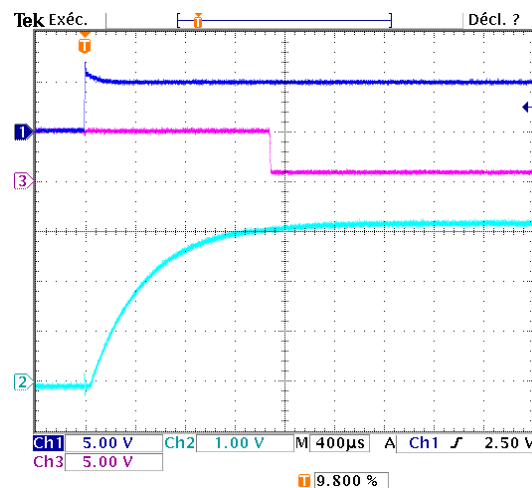


Figure 1: POL Start-up by TC ON
CH1 = ON, CH2 = Vout, CH3 = PGood

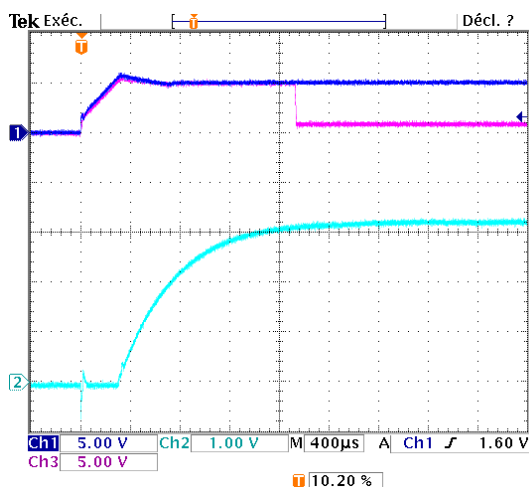


Figure 2: POL Start-up at power up
CH1 = Vin, CH2 = Vout, CH3 = PGood

If ON command is connected to Vin, POL module starts automatically at Vin application. Start-up time is a bit longer (additional delay before output voltage starts due to internal function initialisation).

Power Good status is provided for fine converter monitoring. This signal can also be used to reset digital loads.

Protections

Overload protection:

POL monitors its output current and triggers the overload protection if output current threshold is exceeded. Typical current threshold is 6A.

When in overload conditions, POL is switched OFF after about 200 μ s. It automatically restarts under the control of the soft-start function every about 3ms to check if the abnormal condition is still present.

This low operating duty cycle in overload condition allows controlling POL internal temperature and applied thermal cycles to the power parts. Thanks to this low duty cycle operation, the POL can run in overload condition without reliability reduction.

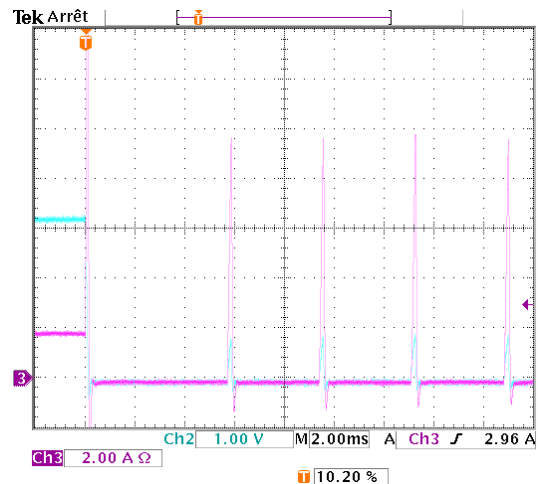


Figure 3: Short circuit application

CH2 = Vout, CH3 = Iout

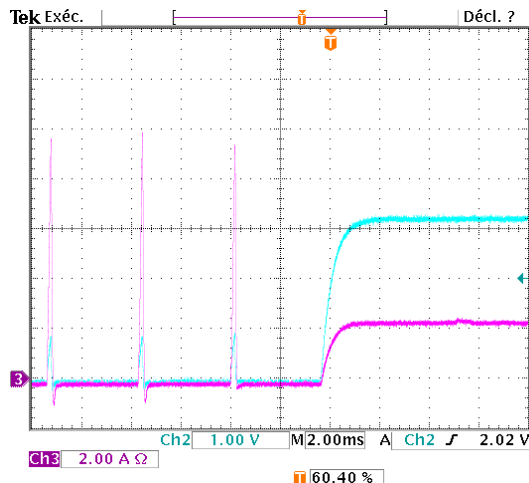


Figure 4: Short circuit is removed

CH2 = Vout, CH3 = Iout

As soon as overload condition is removed, the POL recovers normal condition.

Again, voltage profile is controlled by the soft-start function as in case of normal operation.

Input under-voltage protection:

POL input voltage is monitored by the under-voltage protection.

POL is commanded OFF if input voltage is lower than 4.2V typical. When in OFF state, a minimum voltage of 4.4V typical is needed for the POL to restart. This voltage difference (called hysteresis) avoids oscillation between ON and OFF states at low input voltage.

Internal over-temperature protection:

Internal POL temperature is monitored by the over-temperature protection. Thermal sensor is located close to the most dissipative parts (Power MOSFET and Schottky diode).

If internal temperature at sensor point is greater than 125°C, POL is commanded OFF. It restarts automatically as soon as temperature decreases by at least 5°C.

EMC

POL implements internally input and output filters for easier compliance to EMC requirements. No external filters are required to operate the POL module.

Output filter:

Output filter is designed to almost cancel all output noise.

Observed typical noise when POL is heavily loaded is lower than 40mVpp and less than 5mV rms.

Main noise is at POL switching frequency that is 400kHz.

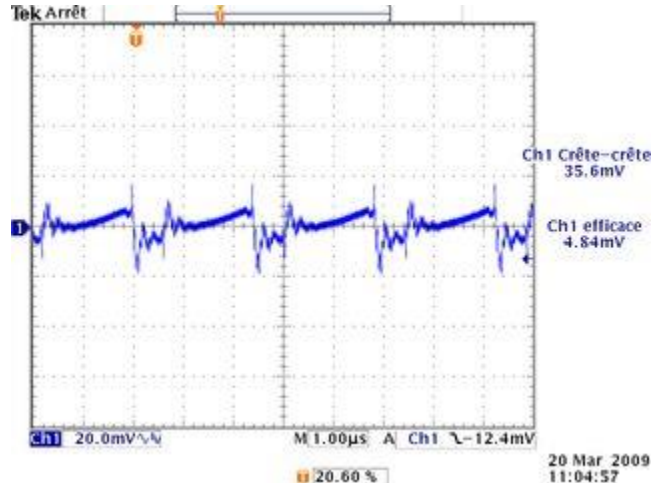


Figure 5: Output noise $V_{out} = 3.3V - 3A$ load

Input Filter:

Input filter is implemented to limit input ripple current draw from the 5V DC supply.

Ripple current reduction is function of the input parasitic inductance presented by the PCB tracks that carries the 5V supply from the source to the POL module.

In most practical situation, the parasitic inductance is high enough to make input current DC.

In worst case situation, min parasitic inductance is estimated to 20nH (1cm PCB track for go and return lines). In this very worst case condition, ripple current at switching frequency is limited to 350mA rms for a POL module fully loaded.

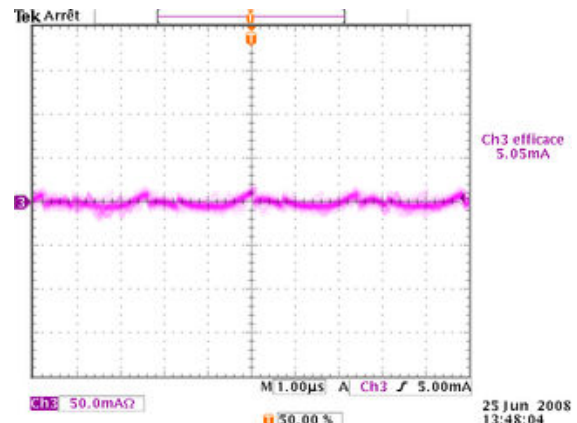


Figure 6: Practical reflected input current

Layout Recommendations

POL module shall be mounted over a large ground plane to minimize thermal resistance (gap filler under to module recommended).

Large tracks shall be used for V_{in} and V_{out} connections.

Because of the high speed regulation loop, R_{adj} shall be located close to the module with short PCB tracks to avoid noise coupling on this line.

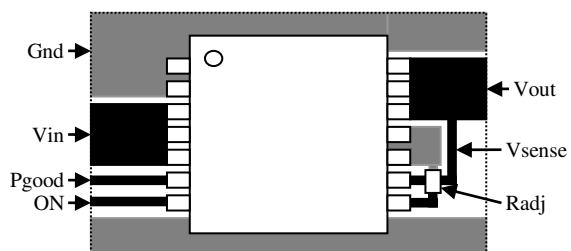


Figure 7: Suggested Module Layout and tracking

Efficiency and Input Current

Efficiency:

The figures below gives the typical POL module efficiency at V_{in} min, V_{in} typ and V_{in} max for the most common output voltages that is 3.3V, 2.5V and 1.5V.

Efficiency is given for output current ranging from 0.5A to 5A.

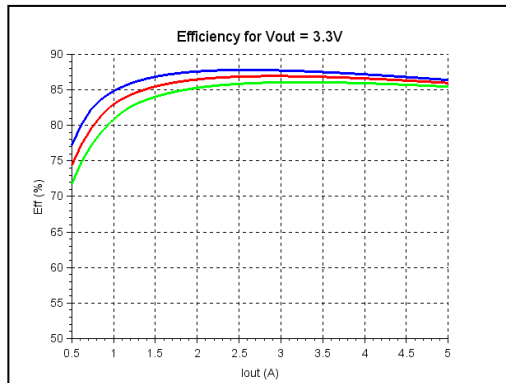


Figure 9: Efficiency @ 3.3V for $V_{in} = 4.5V$ (blue), $V_{in} = 5V$ (red), $V_{in} = 5.5V$ (green)

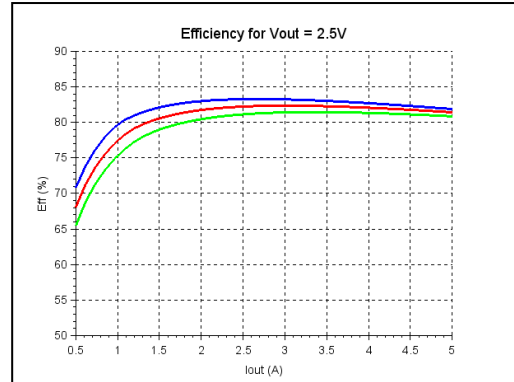


Figure 8: Efficiency @ 2.5V for $V_{in} = 4.5V$ (blue), $V_{in} = 5V$ (red), $V_{in} = 5.5V$ (green)

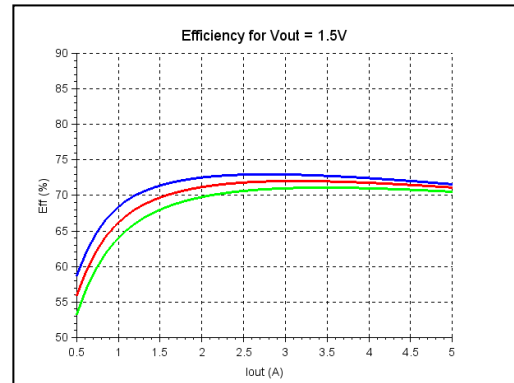


Figure 10: Efficiency @ 1.5V for $V_{in} = 4.5V$ (blue), $V_{in} = 5V$ (red), $V_{in} = 5.5V$ (green)

Input current:

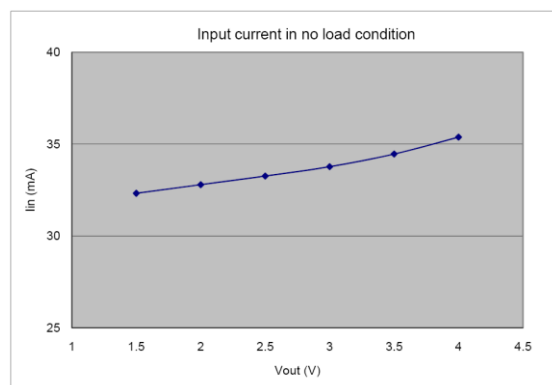


Figure 11: Input current - No load

Input current when POL is ON but not loaded varies with the selected output voltage.

Typical measured input current is given in Figure 11.



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5V $\pm 10\%$ Input, 1.225V to 3.8V Single Output

Radiation Hardened Design

Part Number / Ordering Information

3DPM0211-1-XX
 Temperature Range _____ $\uparrow \uparrow$ Quality Grade (Screening Level)
 C : 0°C / +70°C N : Commercial
 I : -40°C / + 85°C B : Industrial
 S : -40°C / +95°C S : Space

Available Part Numbers:

Part Number	Temperature range	Quality Grade
3DPM0211-1-CN	0°C / +70°C	Commercial
3DPM0211-1-IB	-40°C / + 85°C	Industrial
3DPM0211-1-IS	-40°C / + 85°C	Space
3DPM0211-1-SS	-40°C / +95°C	Space

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