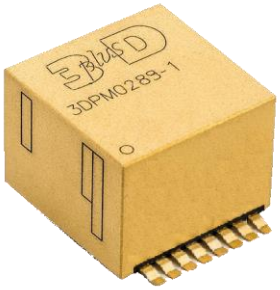
Hi-Rel Point-Of-Load DC/DC Converter
4.5V to 12V Input, 1V to 5V Single Output
Radiation Hardened Design

3DPM0289-1-XX

Features

- Input Voltage: 4.5V to 12V
- Output Voltage adjustable: 1V to 5V
- Output current up to 2A
- Efficiency > 90 % (3.3V/0.3A)
- Parallelization capability
- Excellent Dynamic Performances
- Buck Converter Topology
- Fixed switching frequency (340kHz)
- Integrated EMC filter
- Input under-voltage protection
- Output overload protection
- Internal Temperature protection
- Soft Start, ON/OFF Command
- Space Qualified Technology
- Radiation Hardened design
- Compact Size and Low Weight
- 16-pin gull wing SMD
- ITAR Free Product



- Size: 12.5 x 11 x 9.4 mm
- Mass: 4 g

Application

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

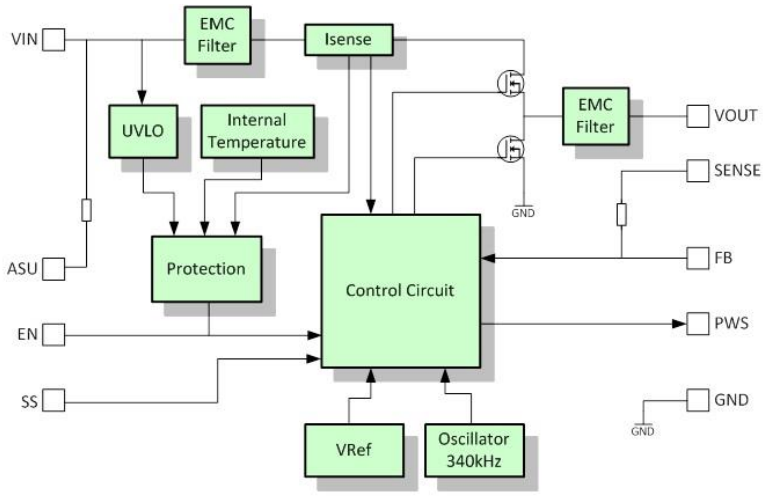
General Description

The 3D PLUS 3DPM0289-1 PoL DC/DC Converter operates over a wide input voltage range (4.5V to 12.0V) and provides up to 2A of output current with an output voltage range of 1.0V to 5.0V.

Based on a Buck topology, the PoL module uses synchronous rectification to boost efficiency higher than 90% (3.3V/from 0.3A to 1.5A). Switching frequency is fixed at 340 kHz. EMC filters are integrated to simplify module implementation and output voltage is adjustable through an external resistor. Module is fully protected against output overload, input under-voltage and internal over-temperature.

Featuring specific radiation effect mitigation techniques and utilizing space design de-rating rules, the PoL Converter features a SEL LET threshold of 80 Mev.cm2/mg and a TID of 40krad (Si).
The 3D PLUS 3DPM0289-1 is an ITAR Free product.

Block Diagram



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		15	V
Output Current	-	0		2.7	A
ON Command	Continuous	-0.3		5.5	V
Junction Temperature	-	-40		+125	°C
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 (Note 1)	Continuous	4.5		12	V
Output Voltage (Note 1)	-	1		5	V
Output Current (Note 1)	-	0		2	A
ON Command	EN(OFF state)	0		1.1	V
	EN(ON state)	2.7		5.5	V
Output Power	Continuous			7.5	W
Thermal Resistance (θ_{JA})	-			25	°C/W

Mechanical and Environmental Specification

Parameter	*Conditions*	*Typ*			*Unit*
Weight	-			4	g
Dimensions	Overall (pin not included)	12.5 (L)	11 (W)	8.9 (H)	mm

Parameter	*Conditions*	*Min*	*Typ*	*Max*	*Unit*
Total Irradiation Dose	-	40			krad(Si)
Latch-up Immune LET Threshold	-	60			MeV.cm^2/mg
Single Event Transient Immune LET Threshold	-	60			MeV.cm^2/mg

Parameter	*Conditions*	*Remarks*
Thermal Cycles	Mil-std-883 Method 1010 Condition B	500 Cycles, -55°C/+125°C
Mechanical Shocks	Mil-std-883 Method 2002 Condition B	Y1, 0.5ms, 1500g
Sine Vibrations	ECSS-Q-ST-70-08C Table 13-2 Spacecraft	25Hz-2000Hz peak acceleration 20g – 3 axes
Random Vibrations	ECSS-Q-ST-70-08C Table 13-3 Spacecraft	3 axes
HAST	JESD22 Method A101B	1000 h, +85°C, 85% RH
Lead Integrity	Mil-std-883 Method 2004	-
Solderability	Mil-std-883 Method 2003	-
Marking Permanency	Mil-std-883 Method 2015	-

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 (Note 1)	-	4.5		12	V
Input Current in OFF State	Vin= 5V, Vout= 3.3V, Iout $_{max}$=2A			30	µA
Input Current in ON State	Vin= 5V, Vout= 3.3V, Iout $_{max}$=2A	4		8	mA

Output Specifications

Parameters are defined over the specified operating conditions, Vin= 5V, Vout= 3.3V, Iout= 500mA, unless otherwise noted.

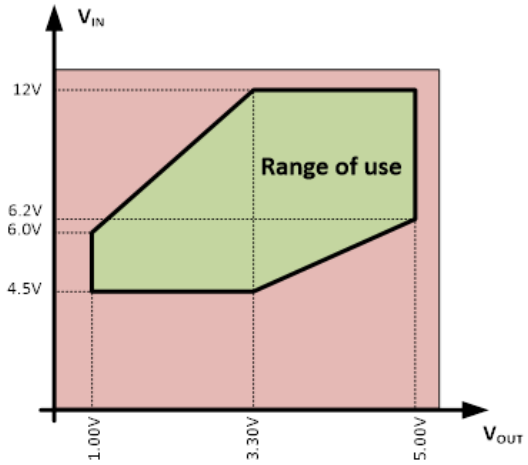
Parameter	*Conditions*	*Min*	*Typ*	*Max*	*Unit*
Output Characteristics					
Output Voltage range (Note 1)	-	1		5	V
Load Regulation	Iout = 0mA to 500mA			-3	%/A
	Iout = 500mA to 2A			-1.25	%/A
Line Regulation	Vin = 4.5V to 12V			-0.2	%/V
Output Ripple	Measurement BW limited to 20MHz Iout=1.5A			12	mVrms
				80	mVpp
	Measurement BW limited to 20MHz Iout=2A			12	mVrms
				80	mVpp
Load Transient	Iout = +/- 1A, di/dt = 10A/µs (min DC load = 500mA)		75	100	mV
Switching Frequency	-		340		kHz
Efficiency	Vin = 5V, Vout = 3.3V, Iout= 500mA	90	94		%
	Vin = 5V, Vout = 3.3V, Iout= 2A	82	87		%
	Vin = 12V, Vout = 5V, Iout= 1.5A	84	89		%

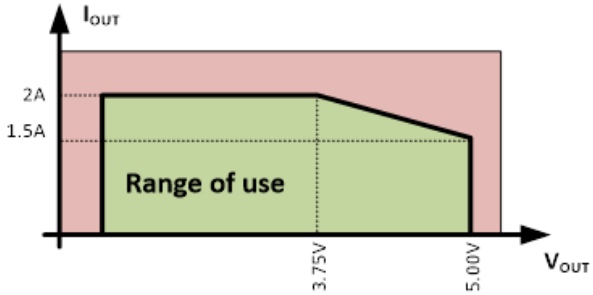
Protections

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

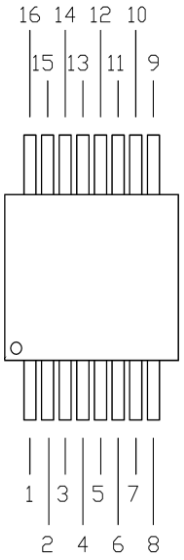
Parameter	*Conditions*	*Min*	*Typ*	*Max*	*Unit*
Overload Protection					
Maximum output Current	Before PoL switch OFF	2			A
Under-voltage Protection					
UVD Protection threshold	Vin = 5V, Vout = 3.3V, Iout= 1A	3.5		4.1	V
UVD Recovery threshold	Vin = 5V, Vout = 3.3V, Iout= 1A	3.8		4.48	V
UVD hysteresis	-		220		mV
Internal Temperature Protection					
Internal thermal shutdown temperature	-	115	125	135	°C

Note 1: The range of use is specified here below (Input Voltage, Output Voltage and Output Current).





Pin definition & assignments



Pin 1, 8, 9, 10 & 11: GND
Reference ground for the PoL module.
Have to be connected on large PCB ground plane for optimal heat dissipation.

Pin 6 & 7: Vin
Input voltage pins. DC supply for the PoL Module. These are input pins.

Pin 2: PWS
Power Sharing pin. The PWS pin is used to compensate the regulation control loop in case of two modules are used in parallel. If only one module is used this pin must be left unconnected. This is an input pin.

Pin 3: SS
Soft-Start control pin. The SS pin controls the soft-start period. A capacitor must be connected from the SS pin to the GND pin to set the soft-start period. An internal 47nF capacitor sets the soft-start period to 4ms. This is an input pin.

Pin 4: ASU
Automatic Start-Up pin. This pin must be connected to the EN pin to set an automatic start-up. An internal 100kΩ pull-up resistor is connected to the Vin. This is an input pin.

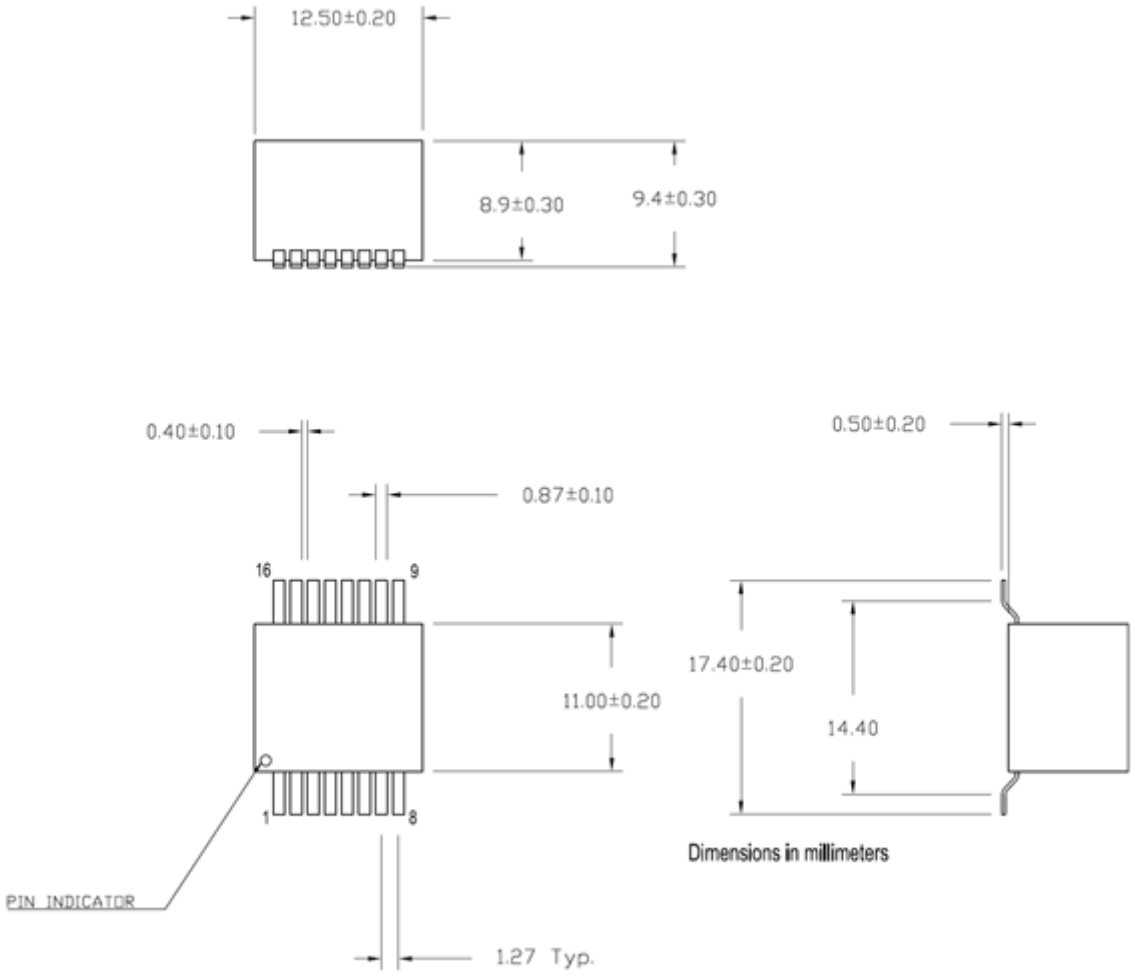
Pin 5: EN
Enable pin. The EN pin is a digital input pin that enables or disables the regulator. For an automatic start-up the ASU pin must be used. This is an input pin.

Pin 12: FB
FeedBack pin. The FB pin senses the output voltage in order to regulate this voltage. The FB pin to the ground through a resistor. This is an input pin.

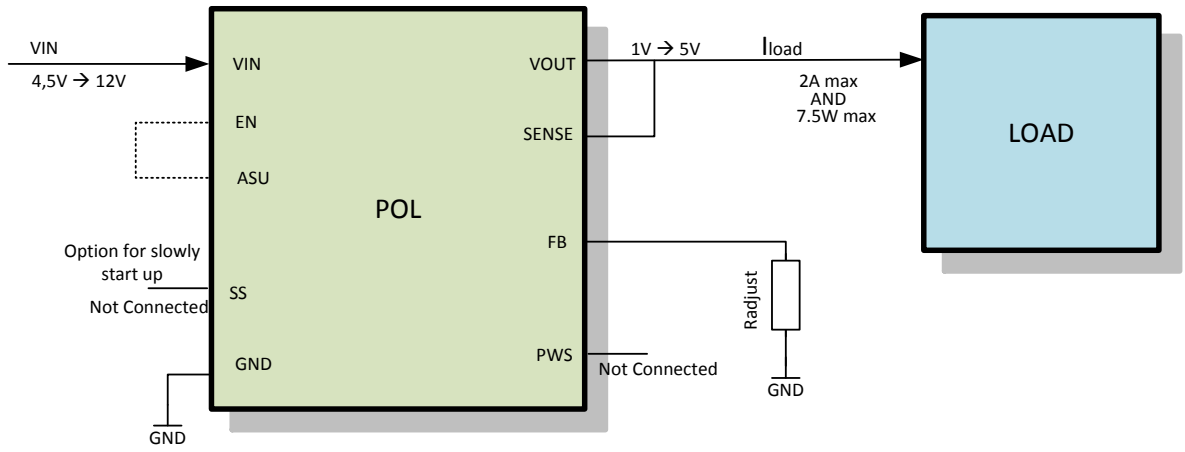
Pin 13: Sense
Sense pin. Used to sense the output voltage for improved accuracy. Can be connected to Vout pins for local sensing or connected to Vout at load location for remote sensing. This is an input pin.

Pin 14, 15 & 16: Vout
Output voltage pins. This is the output supply provided by the PoL module to power the load and can be tuned through the FB pin from 1V to 5V. These are output pins.

Module Mechanical Drawing

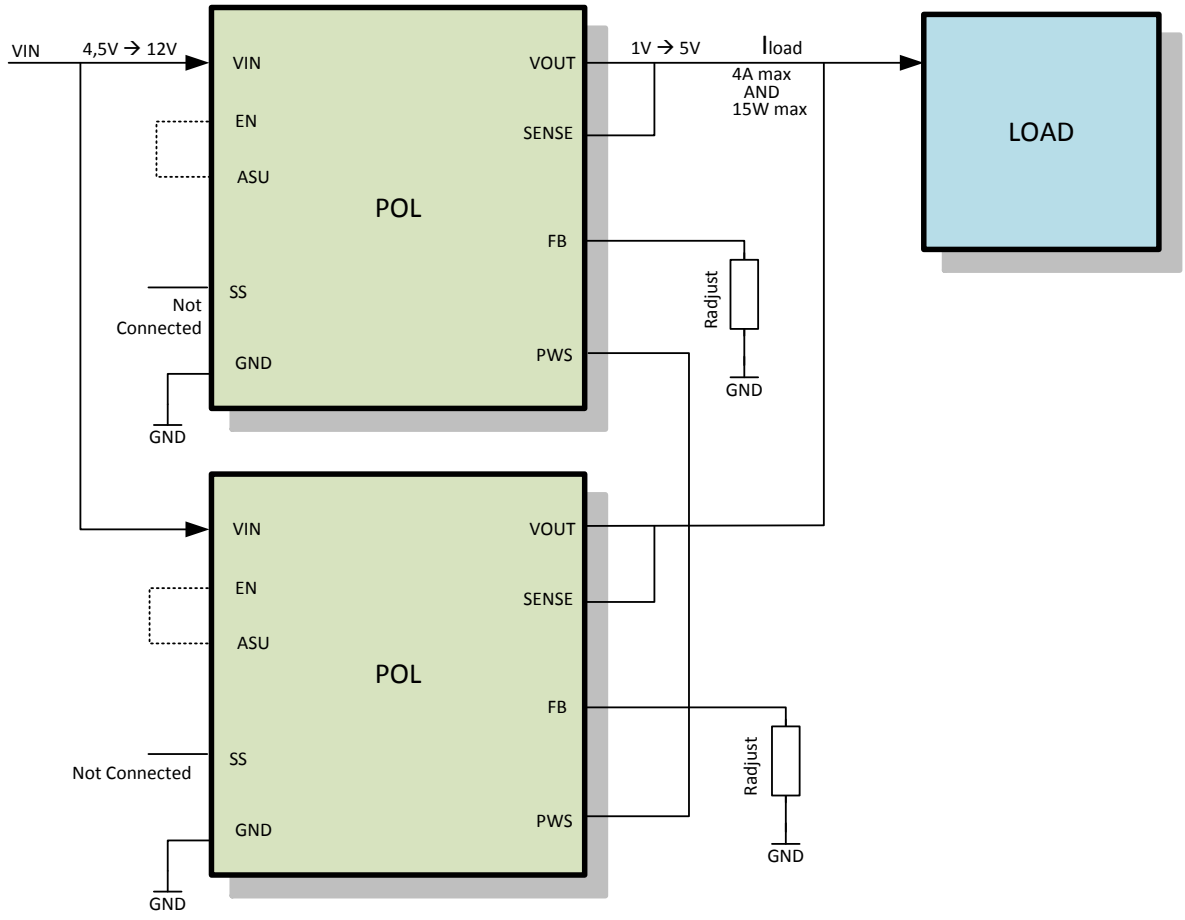


Typical application schematic



Typical Application Schematic

For increased output current, two PoL modules can operate in parallel configuration to achieve up to 4A. No external component needs to be added. Only PWS pins must be connected together making possible an equitable sharing of the current between the two PoL converters. The circuit configuration for paralleling PoL is the following one:



Circuit configuration for paralleling PoL

Each FeedBack pin shall be connected to ground through a resistor (the two resistors must have the same value) placed as close as possible to the module.

Output Voltage Setting

Output voltage is adjusted by setting a resistor value between the FB pin and ground. Resistor value is selected according to the following formulae, to reach the output voltage accuracy performances:

$$V_{out} = (R_{adj} + 5.92) \cdot \frac{0.9050}{R_{adj}} \quad (1)$$

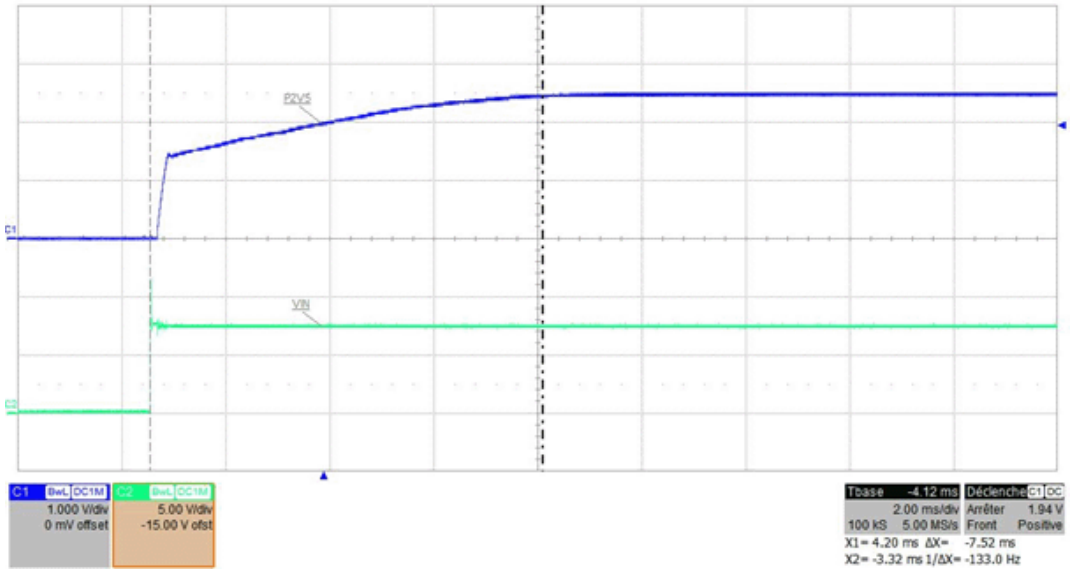
$$R_{adj} = \frac{(5.92 \times 0.9050)}{V_{out} - 0.9050} \quad (2)$$

Example:

- for Vout = 1.8V, uses Radj = 5.90kΩ (E48 series)
- for Vout = 2.5V, uses Radj = 3.32kΩ (E48 series)
- for Vout = 3.3V, uses Radj = 2.26kΩ (E48 series)

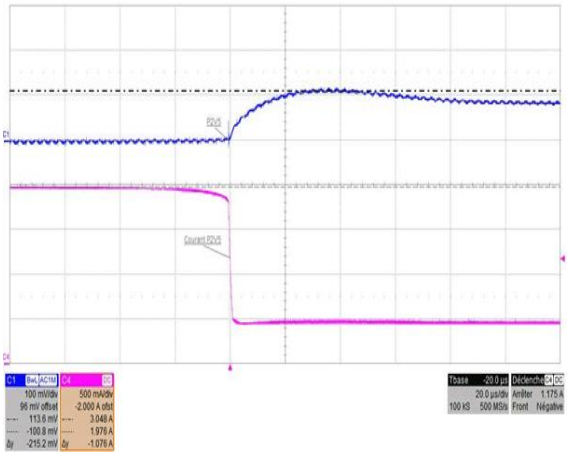
Typical performances

An Automatic Start-up can be selected connecting the ASU pin to the Enable pin. The internal start-up period is 4ms by default and can be increased by using an external capacitor connected to the Soft Start pin. The output voltage profile is shown in the figure below:

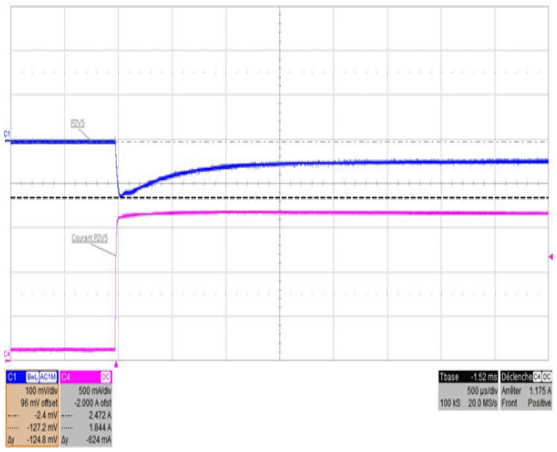


Start-up trough ASU
C1 = Vout (1V/div); C2 = Vin (5V/div); X= 2ms/div

Output voltage can be set by adding a resistor between the FeedBack pin and ground (see table provided before). The PoL behaviour during output current transients has been characterized. The PoL converter offers very good performances in terms of regulation of the output voltage as can be seen from the figures below:



Load Regulation for Iout: 2A to 450mA
C1 = Vout (100mV/div); C2 = Iout (500mA/div)



Load Regulation for Iout: 100mA to 2A
C1 = Vout (100mV/div); C2 = Iout (500mA/div)

Protections

Output overload protection:

An internal current protection at 2A threshold is included. This protection is a current control mode and in case of overload, the duty cycle of the converter is limited and the output voltage decreases.

Input under-voltage protection:

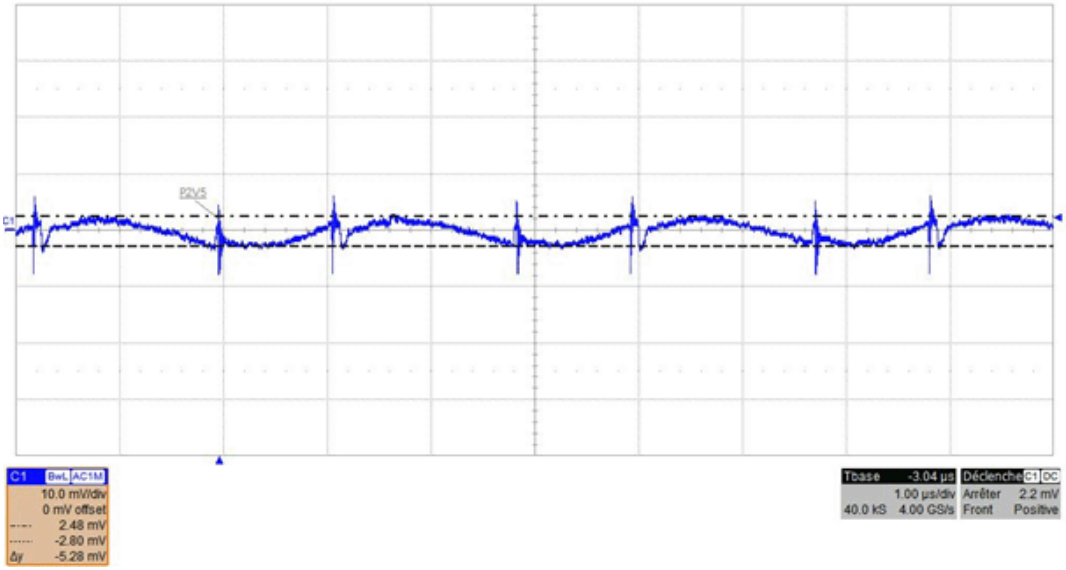
An input under voltage lockout is provide and the module is switched off in case the input voltage decrease under 4.1V.

Internal Temperature protection:

A thermal sensor is included inside the module, close to the switching transistors in order to provide an internal thermal protection. The protection is triggered when temperature reaches 160°C ±15°C.

EMC

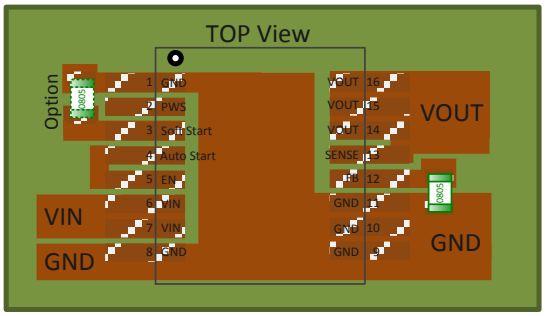
The PoL converter includes input and output filters to withstand the input/output inrush currents and to avoid differential mode susceptibility. The switching frequency of the Buck regulator is fixed at 340kHz and the output filter guaranteed an output noise of 20mV at maximum frequency.
EMC filters are integrated into the module preventing the use of external filters, saving PCB area and making converter design and integration much easier.



Output Noise for Vin = 7.5V, Vout = 2.5V Iout = 2A @ 340kHz
C1 = Vout (10 mV/div)

Layout Recommendations

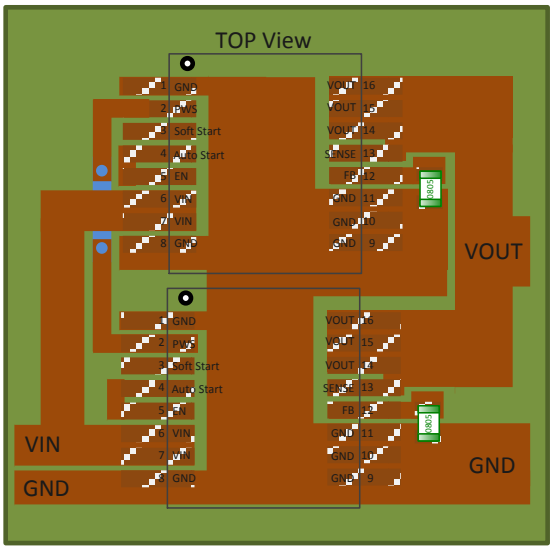
The module is a non-isolated synchronous buck converter. It shall be mounted over a common ground plane and connected to the case of the module. Moreover, all GND pins shall be connected together to the dedicated ground plan.



Recommended Layout for PoL module

The resistor connected to the FeedBack pin, shall be connected as close as possible to the module in order to avoid the noise that could be generated from the regulation loop. The FeedBack pin is directly connected to the input of the error amplifier and this pin is very sensitive. Large tracks shall be used for Vin and Vout pins.

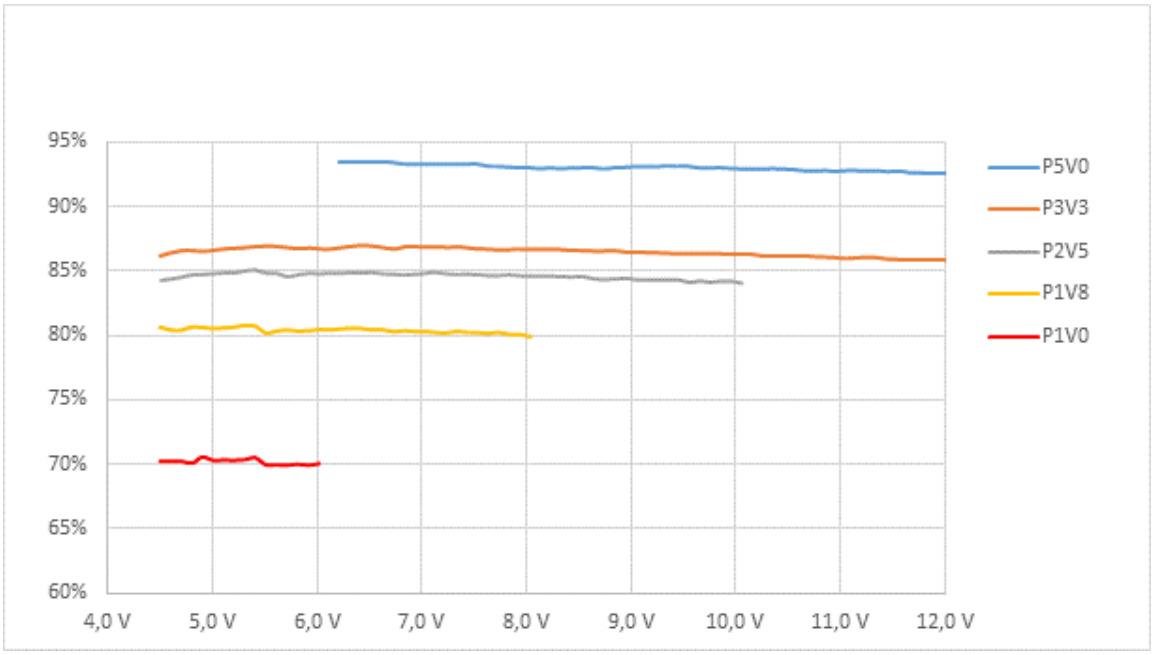
In case of two PoL working in parallel, the connection between each PoL shall be as short as possible, as show in the following layout.



Recommended Layout for two PoL modules

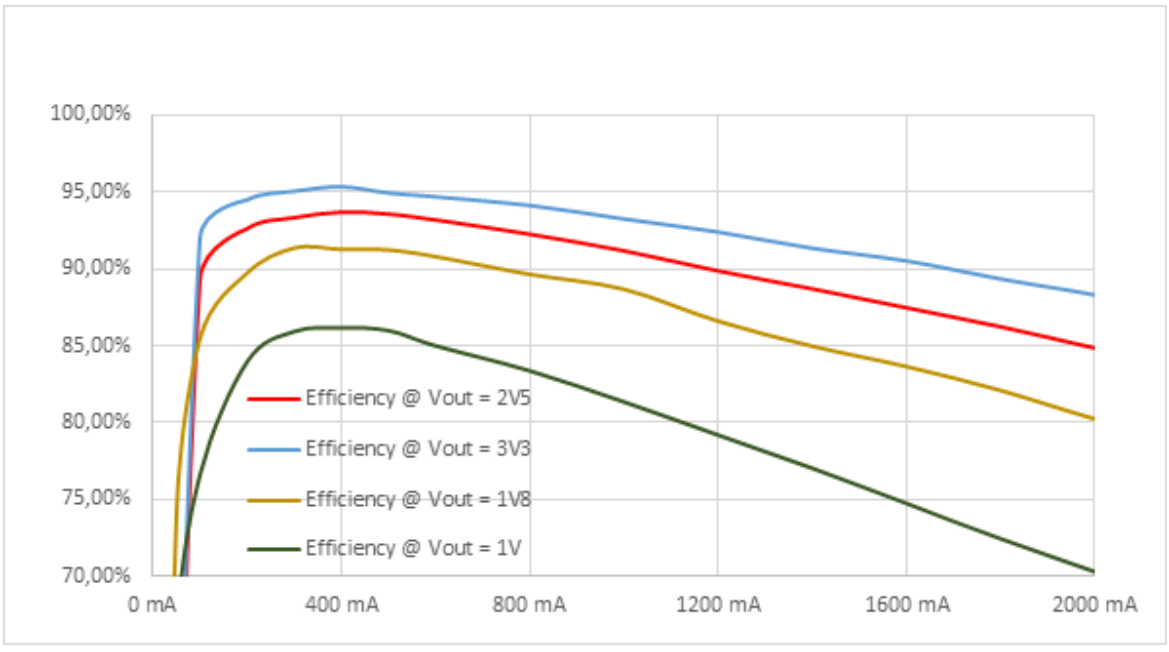
Efficiency

The figures below gives the PoL module efficiency for the most common output voltages 1.0V, 1.8V, 2.5V, 3.3V and 5V.



Efficiency @ 2A for Vout = 1.0V, 1.8V, 2.5V, 3.3V and 5V

For an output voltage of 3.3V, the efficiency is higher than 90% for almost the whole range of output current. As can be seen in the figure below, for an output current from 100mA to 1.7A.



Efficiency @ Vout = 3.3V for Iout up to 2A

Part Number / Ordering Information

3DPM0289-1-XX

Temperature Range
C : 0°C /+70°C
I : -40°C / + 85°C

Quality Grade (Screening Level)
N : Commercial
B : Industrial
S : Space

Available Part Numbers:

Part Number	Temperature range	Quality Grade
3DPM0289-1-CN	0°C /+70°C	Commercial
3DPM0289-1-IB	-40°C / + 85°C	Industrial
3DPM0289-1-IS	-40°C / + 85°C	Space

Main Sales Office

FRANCE	3D PLUS 408, rue Hélène Boucher ZI. 78532 BUC Cedex	Tel : 33 (0)13 0 83 26 50	Fax : 33 (0)1 39 56 25 89	Web : www.3d-plus.com email : sales@3d-plus.com	- **DISTRIBUTOR**
USA	3D PLUS USA, Inc 151 Callan Ave Suite 310 San Leandro, CA 94577	Tel : +1 650 215 8146		eemail : sales@3d-plus.com	