



# Point-of-Load (POL)

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e

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Workshop Apollo, Roma 09/12/2013



# Sommario

- Una breve panoramica di quanto già visto
- Prove e valutazioni condotte nel 2013
- Previsioni di lavoro



# Point-of-Load (POL)

- Verranno presentati brevementi alcuni dispositivi che sono normalmente disponibili in commercio.
- Caratteristiche che appaiono di un certo interesse per APOLLO.



# Cosa serve

- Tensione di alimentazione del POL = 12 V
- Tensione di uscita dal POL = 5V



# Possibili risposte



- Linear Technology LTM4627
- Linear Technology LTM4619
- Linear Technology LTM8033



# Linear Technology LTM4627



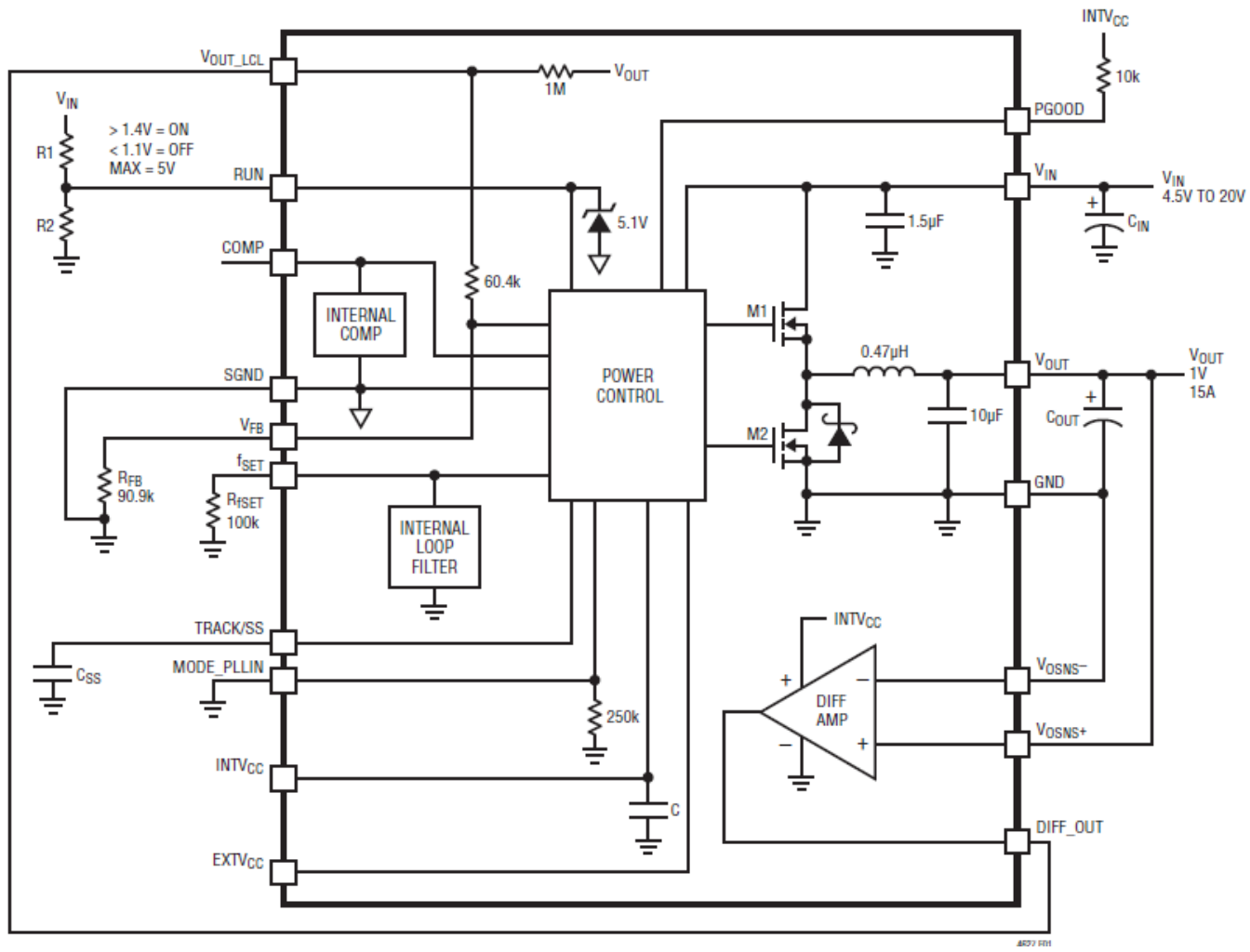
- Complete 15A Switch Mode Power Supply
- Wide Input Voltage Range: 4.5V to 20V
- 0.6V to 5V Output Range
- $\pm 1.5\%$  Total DC Output Error
- Differential Remote Sense Amplifier for Precision Regulation
- Current Mode Control/ Fast Transient Response
- Frequency Synchronization
- Parallel Current Sharing (Up to 60A)



# LTM4627

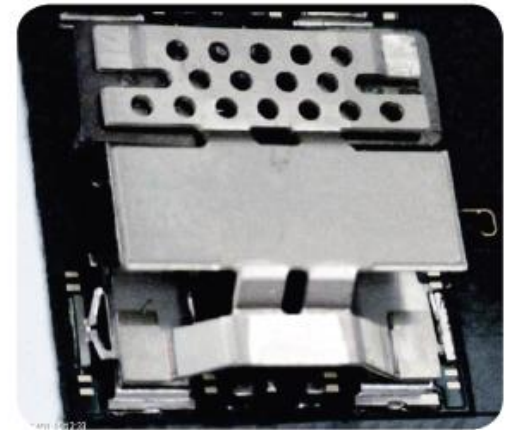
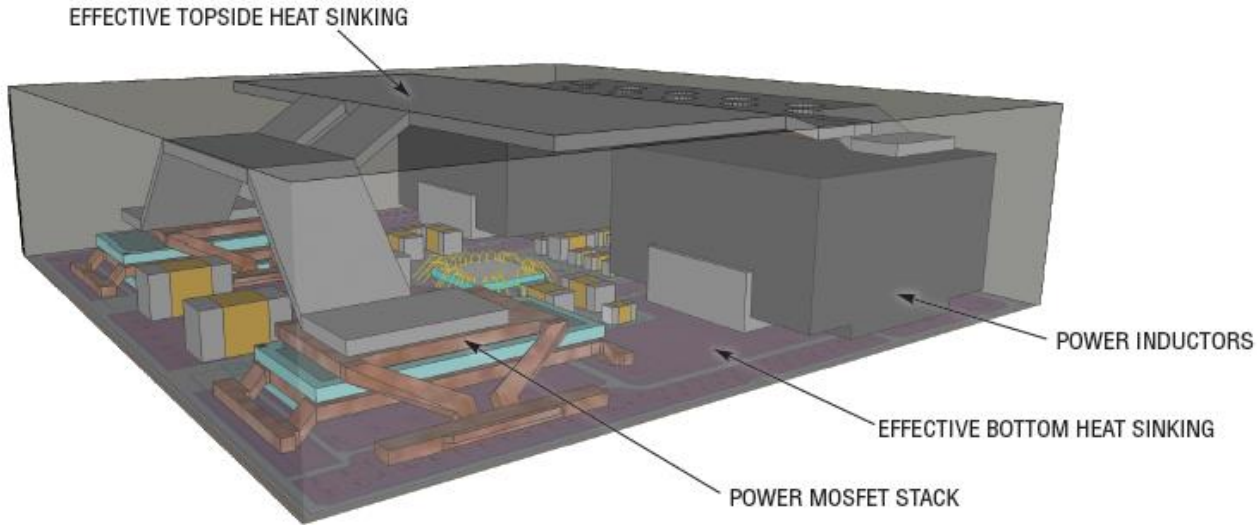


## Schema a blocchi semplificato



# LTM4627

## Vista dal lato e foto



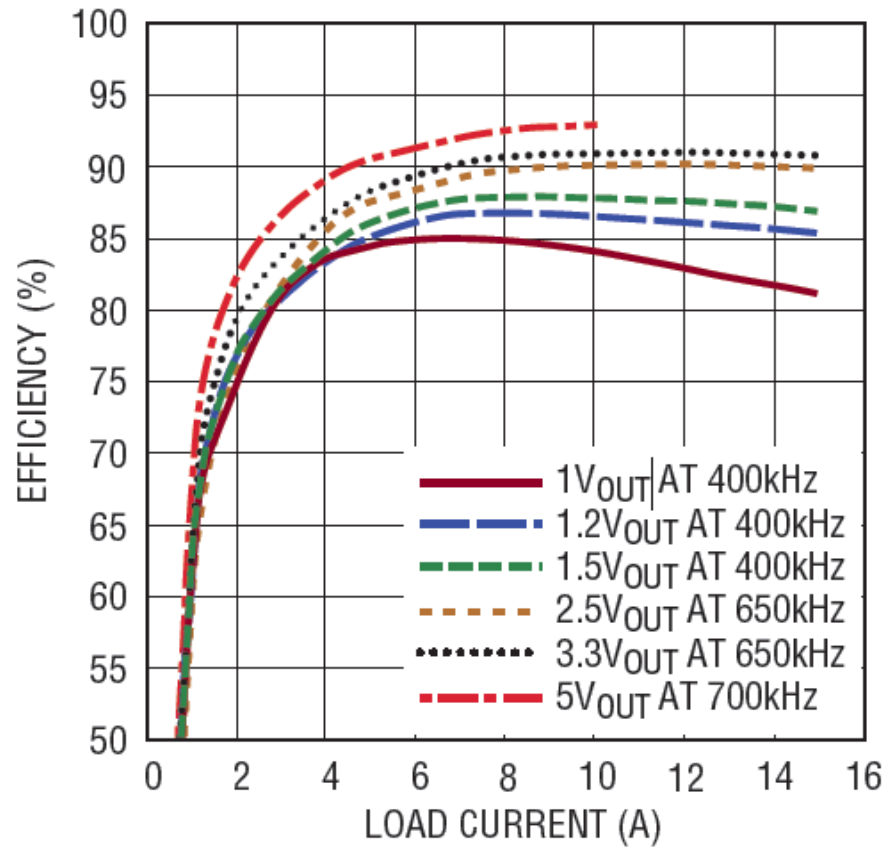


# LTM4627

## Efficienza @ $V_{in} = 12V$



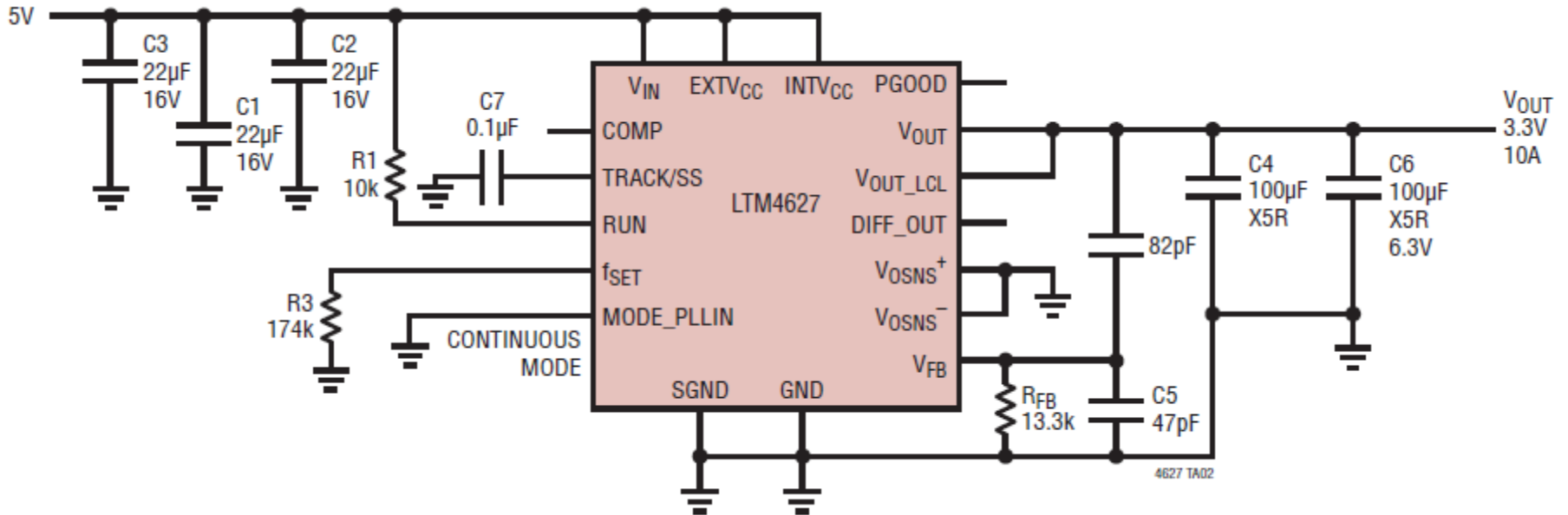
Efficiency vs Load Current  
with  $12V_{IN}$





# LTM4627

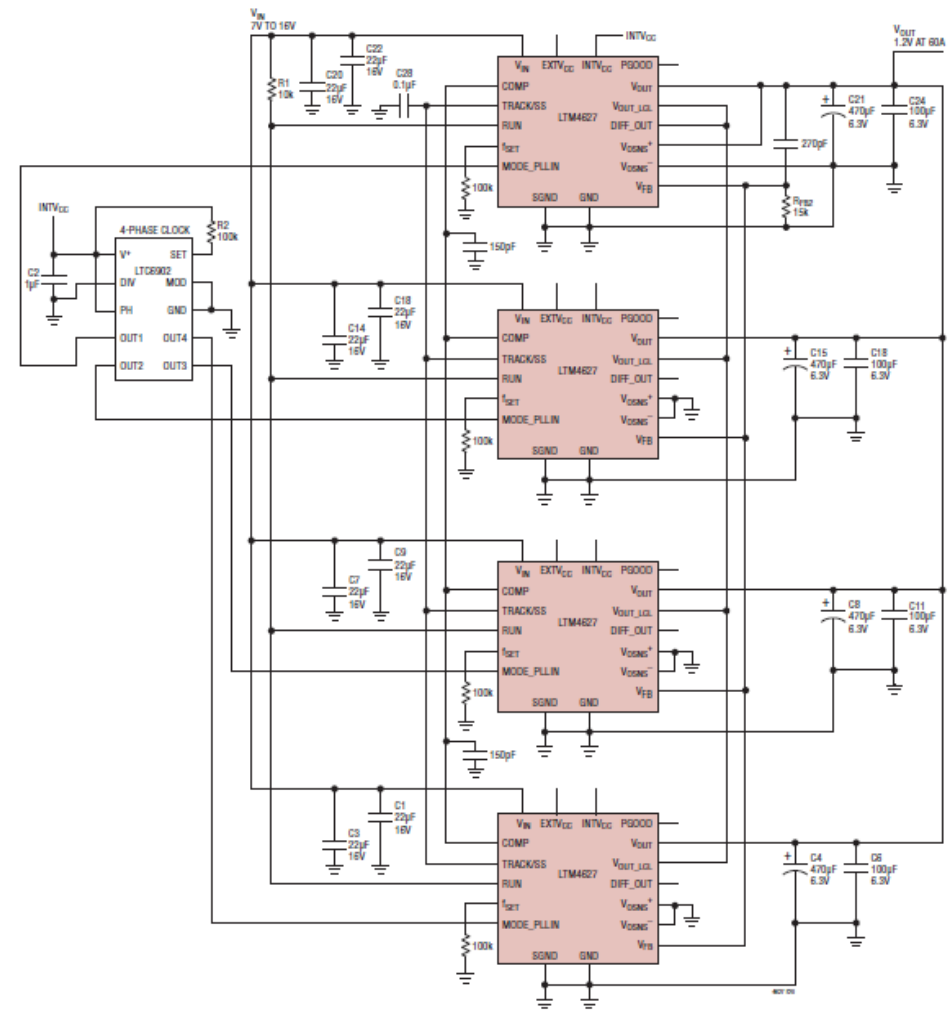
## 3.3 V @ 10A





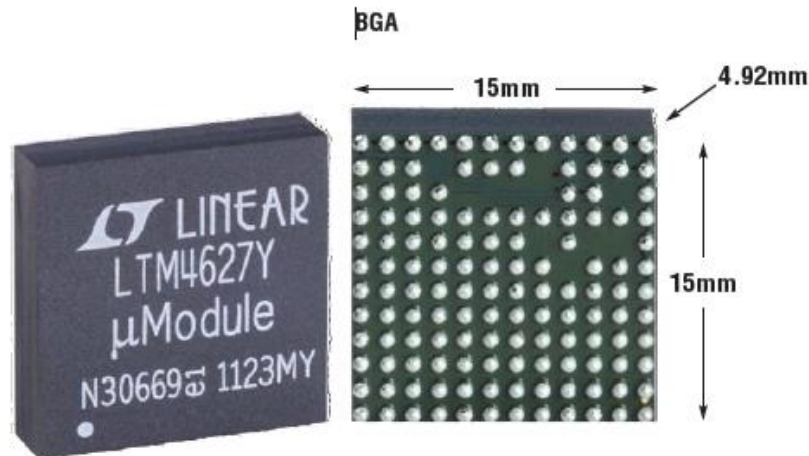
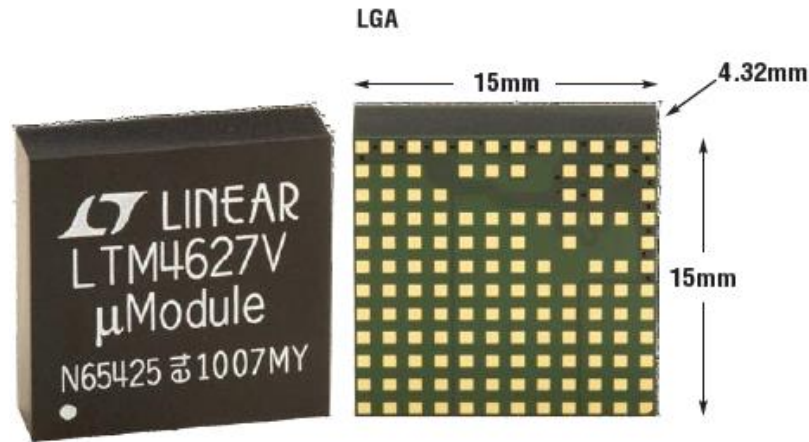
# LTM4627

## 1.2V, 60A, Current Sharing





# LTM4627 Ingombri





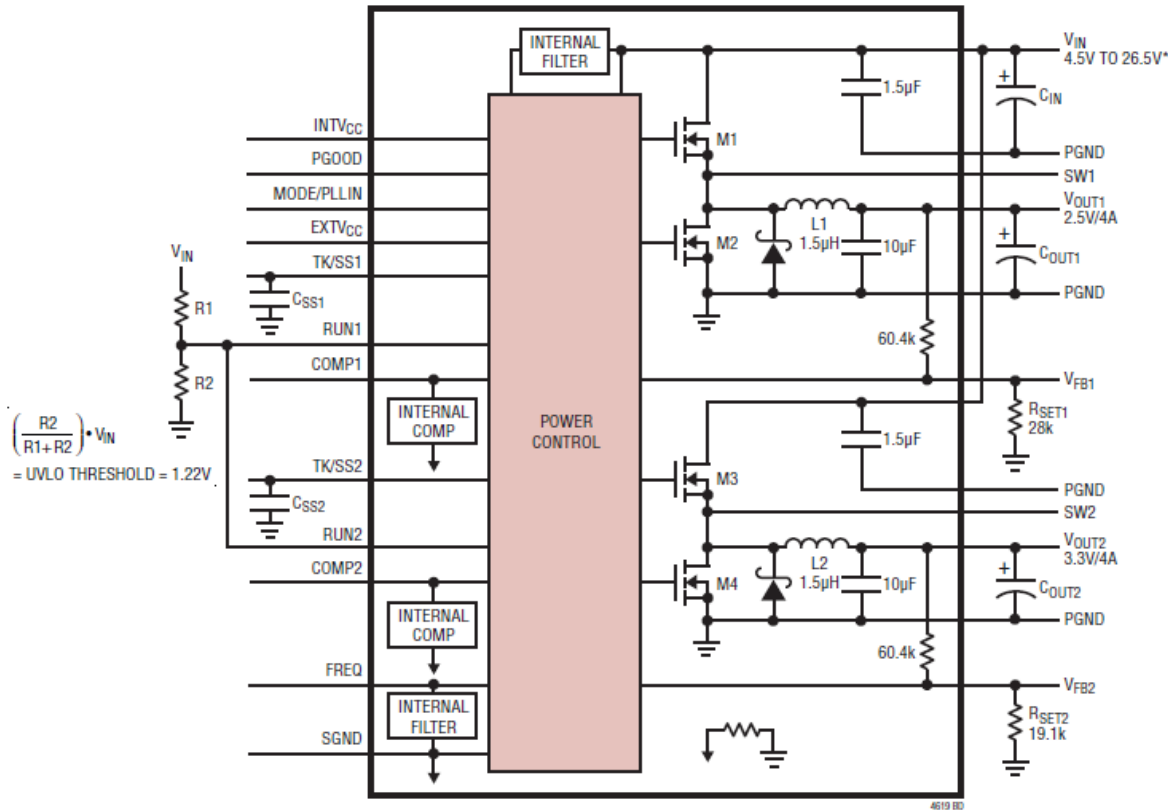
# Linear Technology 4619 Features



- Complete Standalone Power Supply
- Wide Input Voltage Range: 4.5V to 26.5V
- Dual 180° Out-of-Phase Outputs with 4A DC
- Typical, 5A Peak Output Current for Each
- Dual Outputs with 0.8V to 5V Range
- Output Voltage Tracking
- $\pm 1.5\%$  Maximum Total DC Output Error
- Current Mode Control/Fast Transient Response
- Power Good
- Parallel Current Sharing

# Linear Technology 4619

## Schema semplificato



\*USE EXTV<sub>CC</sub> FOR  $V_{IN} \leq 5.5V$ , OR TIE  $V_{IN}$  AND EXTV<sub>CC</sub> TOGETHER FOR  $V_{IN} \leq 5.5V$



# Linear Technology 4619 Applications

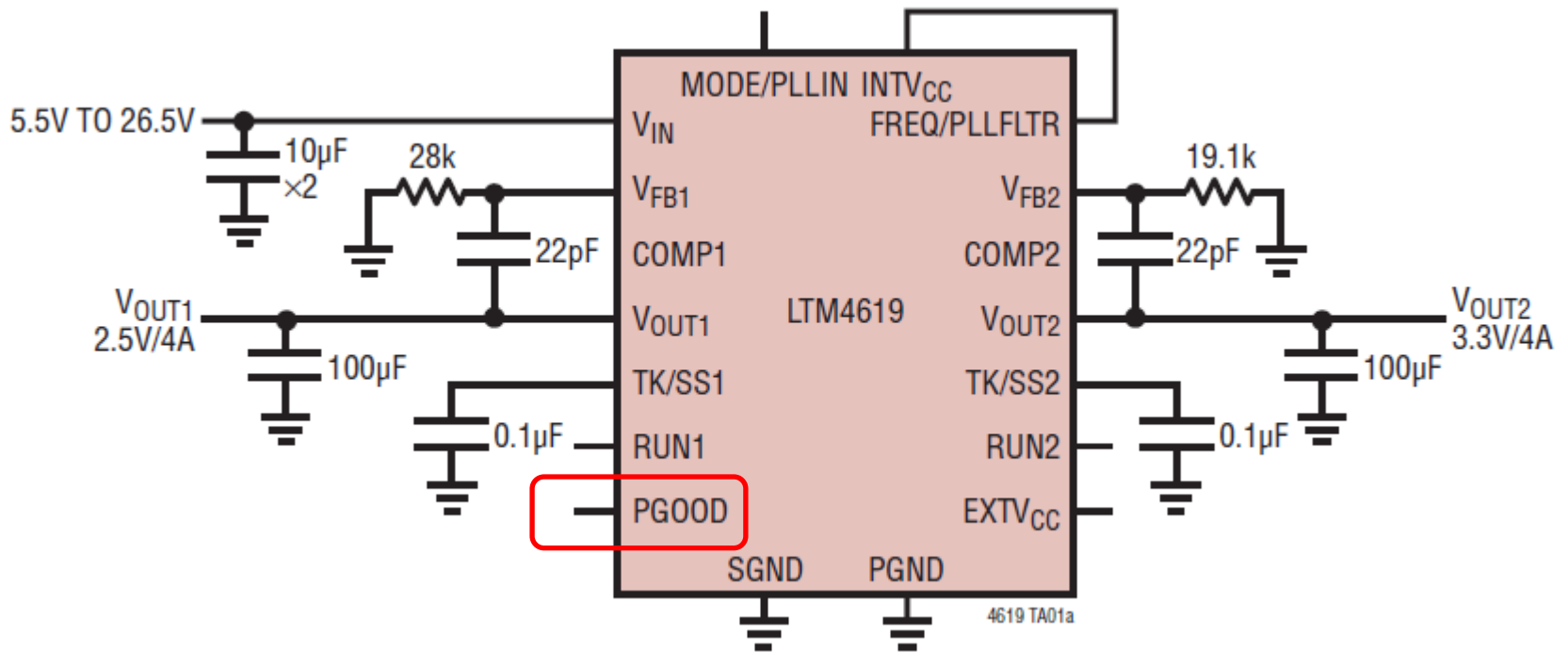


- Telecom and Networking Equipment
- Servers
- Storage Cards
- ATCA Cards
- Industrial Equipment
- **Point of Load Regulation**



# Linear Technology 4619

Dual 4A 3.3V/2.5V DC/DC  $\mu$ Module Regulator







# Linear Technology 4619

## Pgood



- È un segnale di uscita.
- Tipo Open Drain
- L'uscita è normalmente alta e diventa bassa quando la tensione di uscita non rientra nelle specifiche fissate per attivare questo segnale
- $\pm 7.5 \%$
- Disabilitato (ovviamente) durante l'accensione



# Linear Technology 4619

## Setting the output voltage



$$V_{OUT} = 0.8V \cdot \frac{60.4k + R_{SET}}{R_{SET}}$$

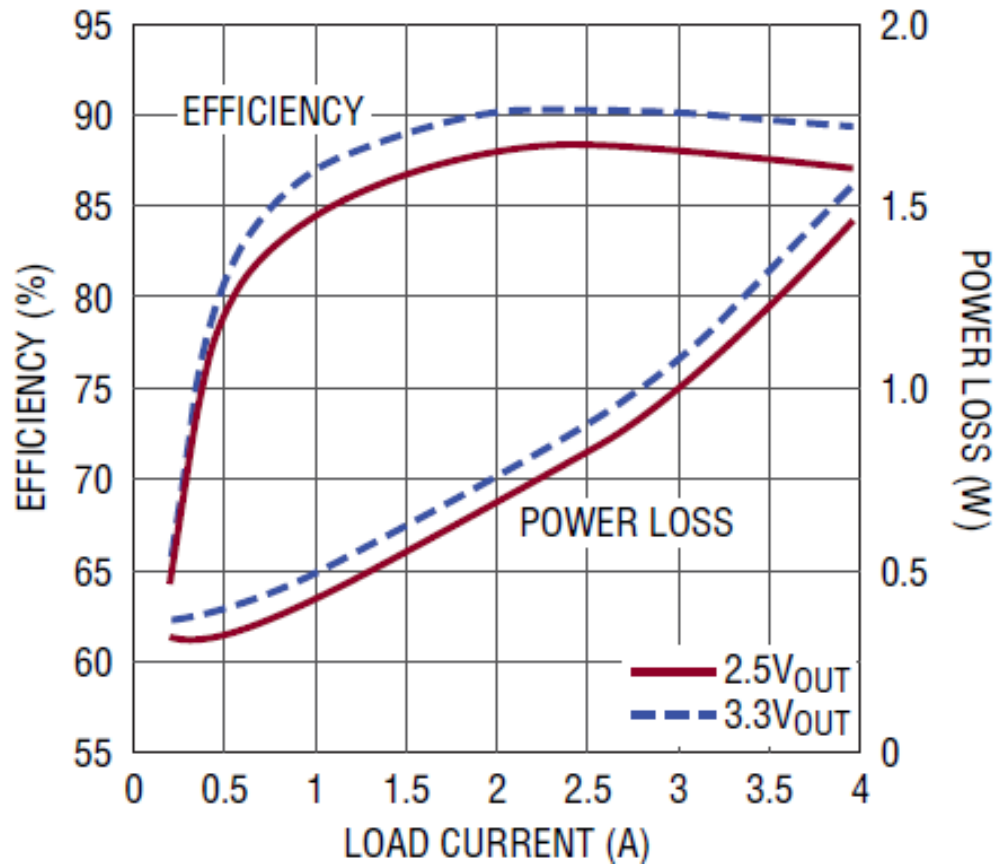
$$R_{SET} = \frac{60.4k}{\left(\frac{V_{OUT}}{0.8V} - 1\right)}$$

**Table 1.  $R_{SET}$  Resistor Table vs Various Output Voltages**

$V_{OUT}$ (V)	0.8	1.2	1.5	1.8	2.5	3.3	5
$R_{SET}$ (k $\Omega$ )	Open	121	68.1	48.7	28.0	19.1	11.5

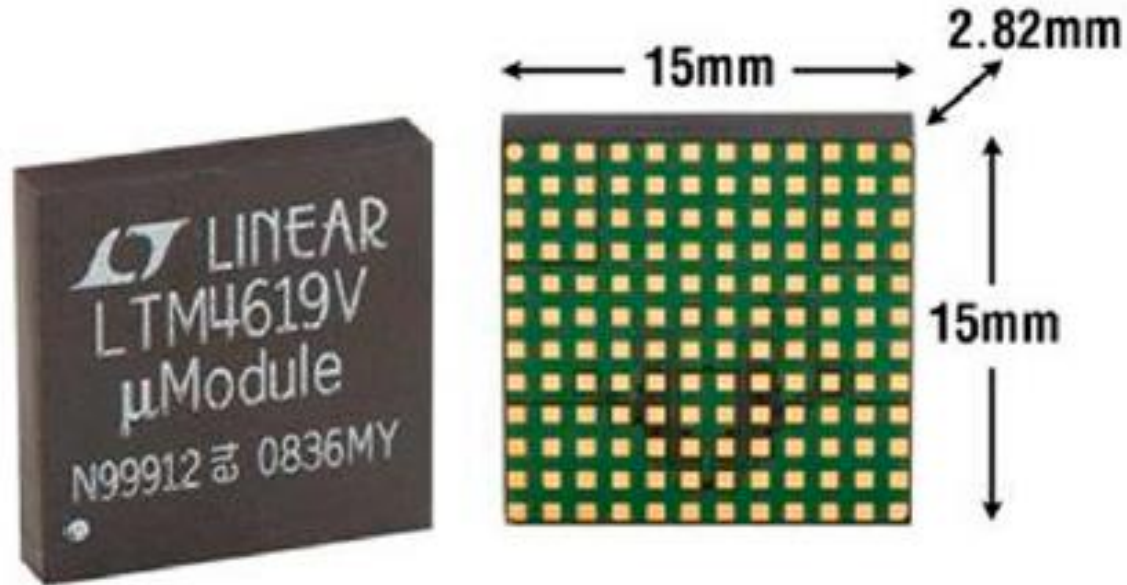
# LTM4619

## Efficiency and Power Loss @ 12V input



# LTM4619

Ingombri



**LGA Package**

**144-Lead (15mm × 15mm × 2.82mm)**

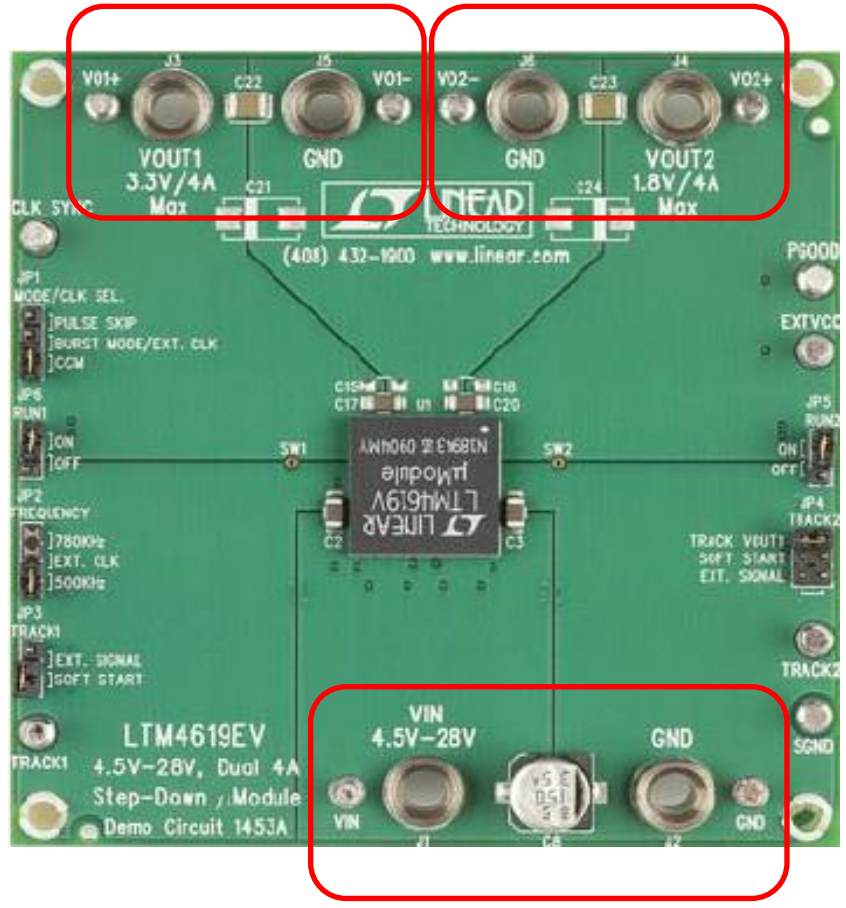
(Reference LTC DWG # 05-08-1816 Rev C)

# Linear Technology 4619

Demo/Evaluation board

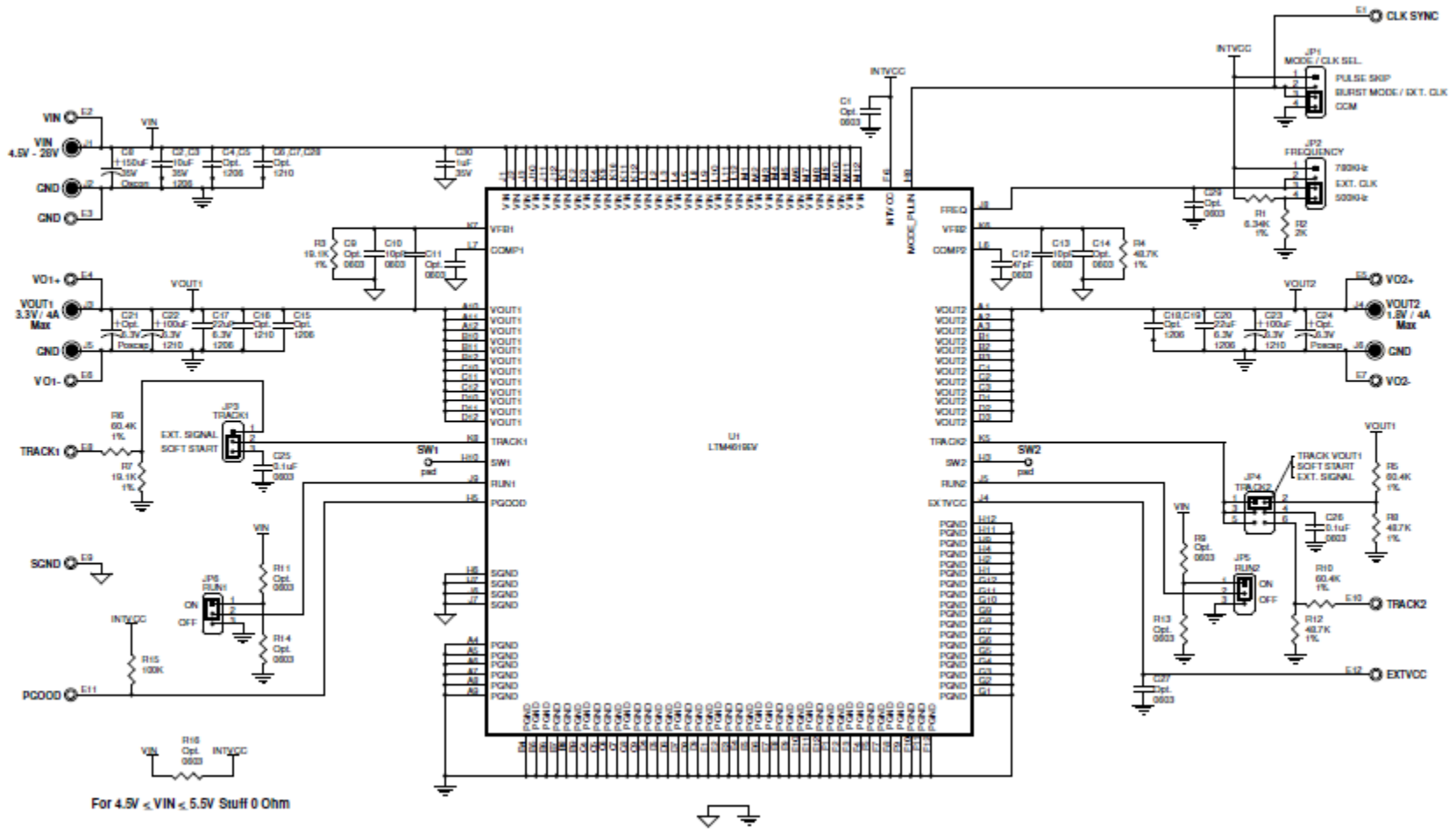
Wednesday, 03/07/2013

A. Lanza, S. Latorre, M. Lazzaroni





# LTM4619



For 4.5V ≤ VIN < 5.5V Stuff 0 Ohm

# Linear Technology 4619

## Setup sperimentale





# Linear Technology 4619

## Condizioni di lavoro



- Il dispositivo è stato configurato in modo tale da avere una tensione di uscita pari 1.8 V su entrambe le uscite.
- Il carico è costituito da un resistore da 0.6  $\Omega$
- La corrente è, quindi pari a 3 A per singola uscita
- La potenza è pari a 5.4 W (per ogni uscita).
- La scheda è alimentata da un alimentatore esterno con una tensione pari a 20 V.
- É stato aggiunto un dissipatore in modo da mantenere il dispositivo ad una tensione di circa 35°C.
- In queste condizioni il dispositivo lavora in prossimità delle migliori condizioni secondo le istruzioni del costruttore.





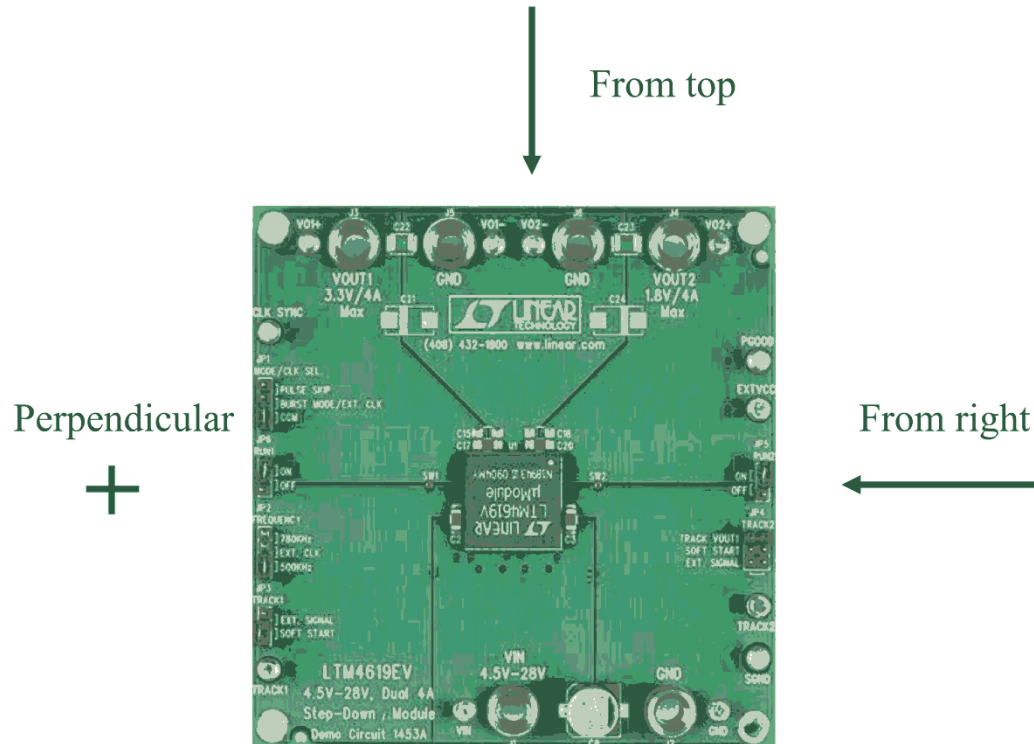
# Linear Technology 4619 Test



- La strumentazione e le apparecchiature sono state accese con sufficiente anticipo da poter escludere la presenza di significative derive termiche.
- Prima di effettuare le misure sono stati fatti tutti i passi necessari per la messa in punto dello strumento utilizzato nella misura del campo magnetico.

# Linear Technology 4619

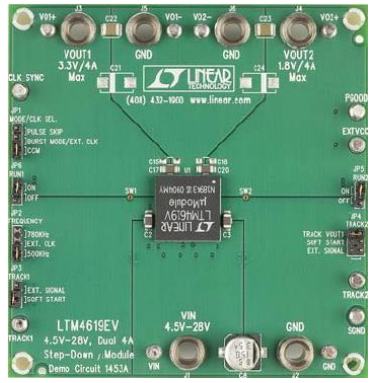
## Come è applicato il campo magnetico



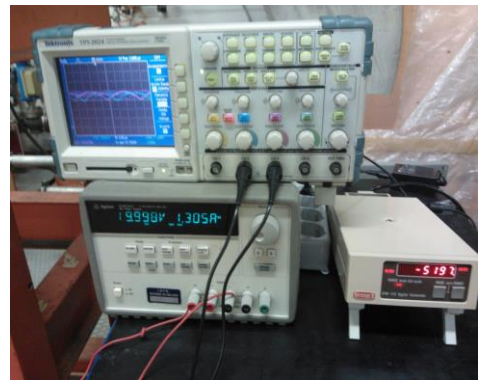
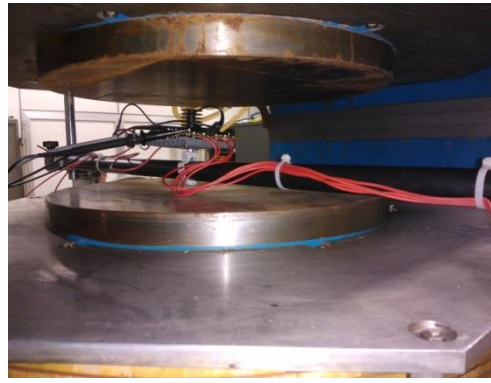


# Linear Technology 4619

## Campo Magnetico perpendicolare



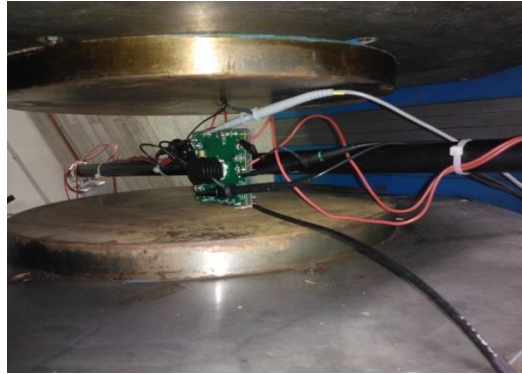
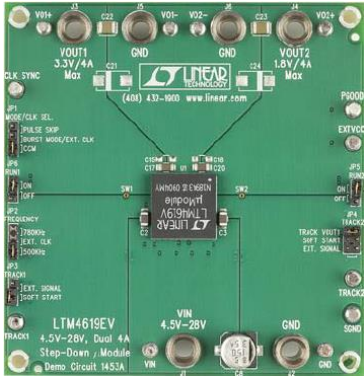
+



Current (A)	Magnetic Field (Gauss)	Current from supply (A)	Ripple (mV pp)	Pgood	Result (OK/KO)
0	30	0.662	-	OK	OK
25	835	0.662	-	OK	OK
50	1680	0.662	-	OK	OK
75	2537	0.662	-	OK	OK
100	3456	0.668	-	OK	OK
125	4325	0.682	moderate	OK	OK
135	4674	0.726	200	OK	OK
150	5197	1.200	500	OK	KO

# Linear Technology 4619

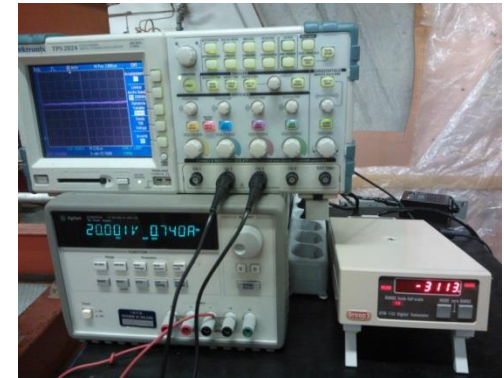
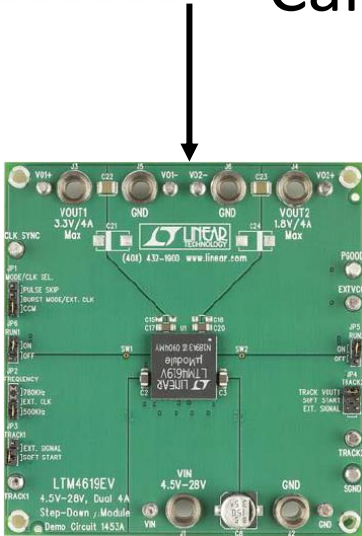
Campo Magnetico orizzontale da destra



Current (A)	Magnetic Field (Gauss)	Current from supply (A)	Ripple (mV pp)	Pgood	Result (OK/KO)
25	867	0.663	-	OK	OK
35	1202	0.665	-	OK	OK
40	1370	0.667	-	OK	OK
50	1719	0.671	-	OK	OK
60	2048	0.679	moderate	OK	OK
80	2904	0.820	200	OK	OK
100	3460	1.030	500	OK	KO

# Linear Technology 4619

## Campo Magnetico orizzontale da sopra



Current (A)	Magnetic Field (Gauss)	Current from supply (A)	Ripple (mV pp)	Pgood (*)	Result (OK/KO)
35	1219	0.664	-	-	OK
50	1730	0.669	-	-	OK
70	2423	0.679	5	-	OK
80	2767	0.693	15	-	OK
90	3113	0.740	300	-	OK
100	3460	0.840	500	-	KO

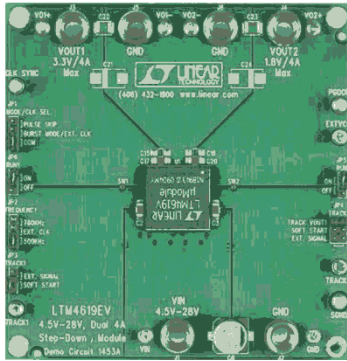


# Linear Technology 4619



## Riassumendo 1

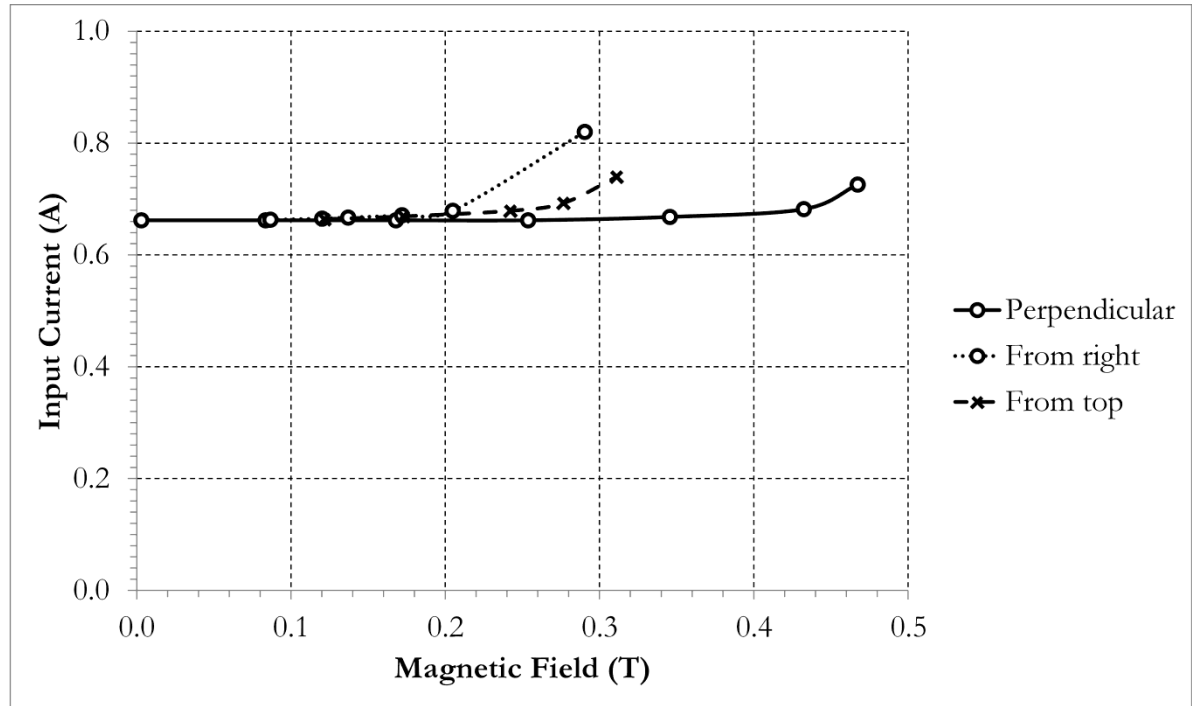
From top



From right

Perpendicular

+

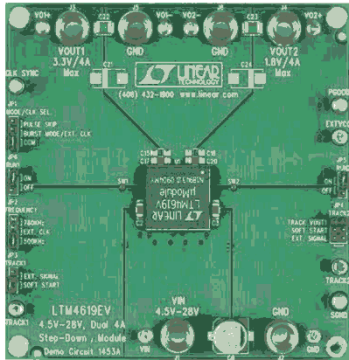


# Linear Technology 4619

## Riassumendo 2

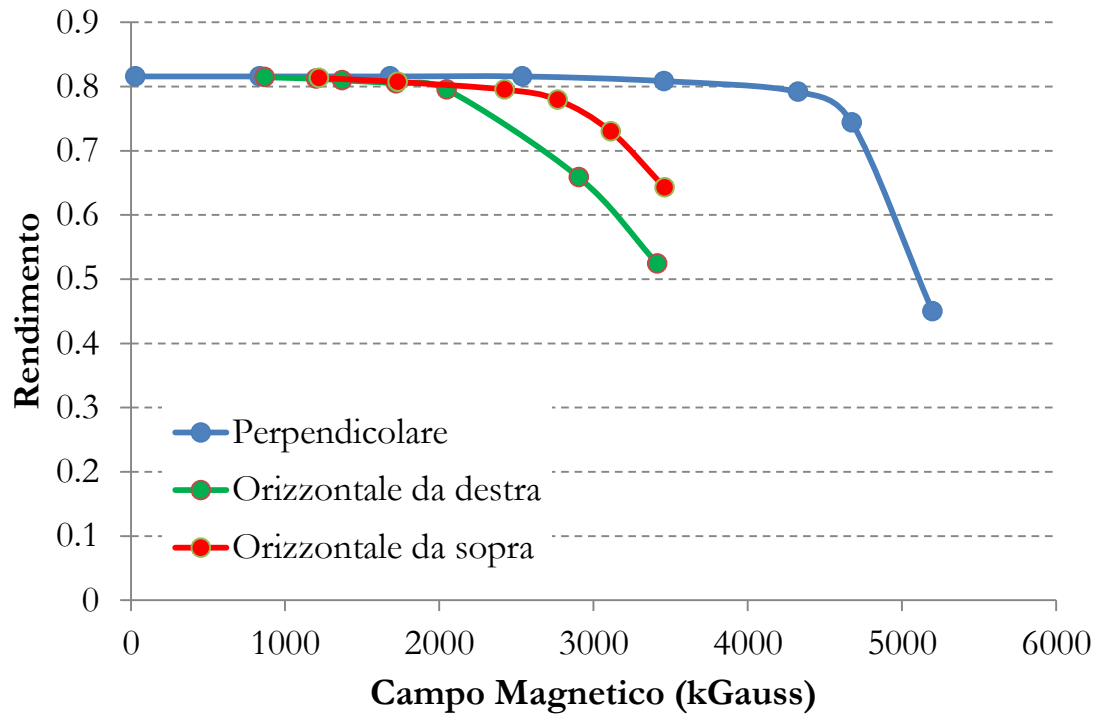


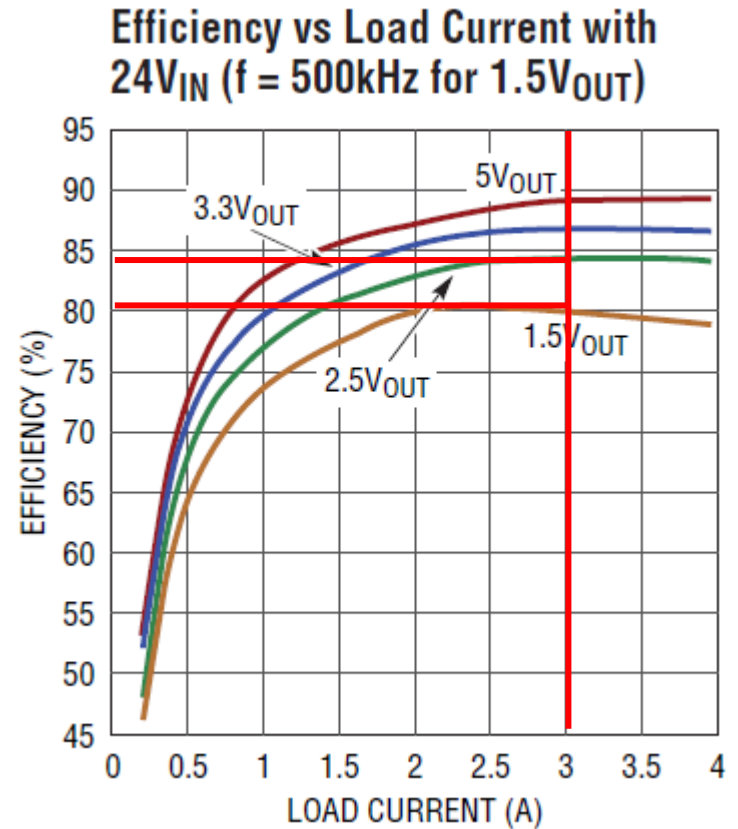
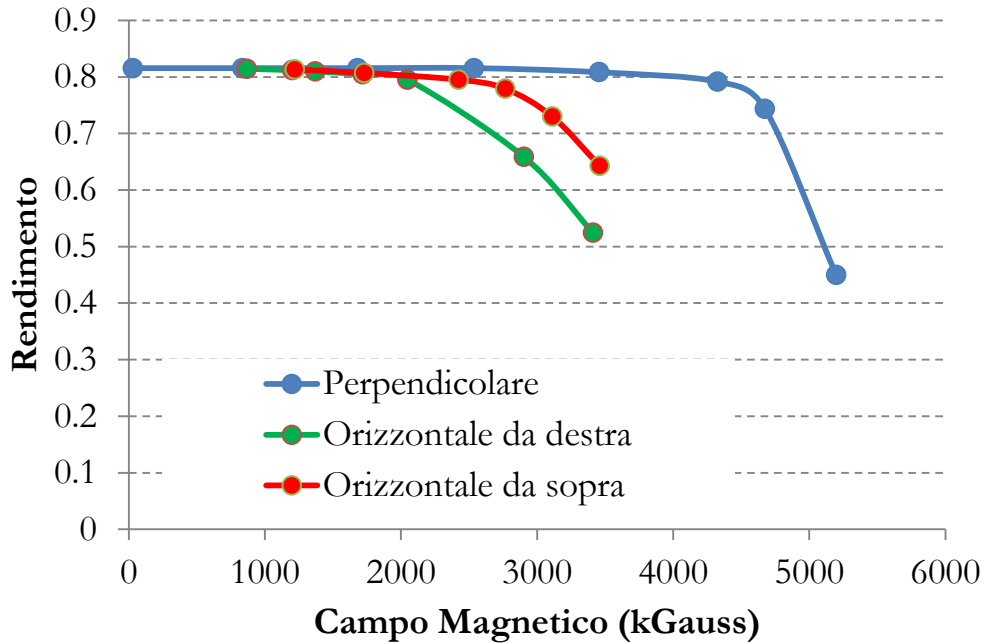
From top



Perpendicular  
+

From right









# Linear Technology 4619

## Conclusioni



- Il dispositivo ha sempre recuperato la sua funzionalità togliendo il campo magnetico.
- Le migliori prestazioni sono state misurate quando il campo magnetico è applicato perpendicolarmente al dispositivo arrivando sino circa 4 kGauss.
- Il caso peggiore si manifesta quando il campo magnetico ha direzione “da destra a sinistra” dove il corretto funzionamento è garantito a circa 2 kGauss.
- Il segnale PGOOD (Power Good) risulta a questo scopo non utilizzabile. Si è avuto modo di constatare che però, nelle normali condizioni d’uso, esso funziona correttamente.



# Linear Technology LTM8033 Features



- Complete Step-Down Switch Mode Power Supply
- Wide Input Voltage Range: 3.6V to 36V
- 3A Output Current
- 0.8V to 24V Output Voltage
- EN55022 Class B Compliant
- Current Share Multiple LTM8033 Regulators for more than 3A Output
- Selectable Switching Frequency: 200kHz to 2.4MHz
- Current Mode Control
- Programmable Soft-Start



# Linear Technology LTM8033 Applications

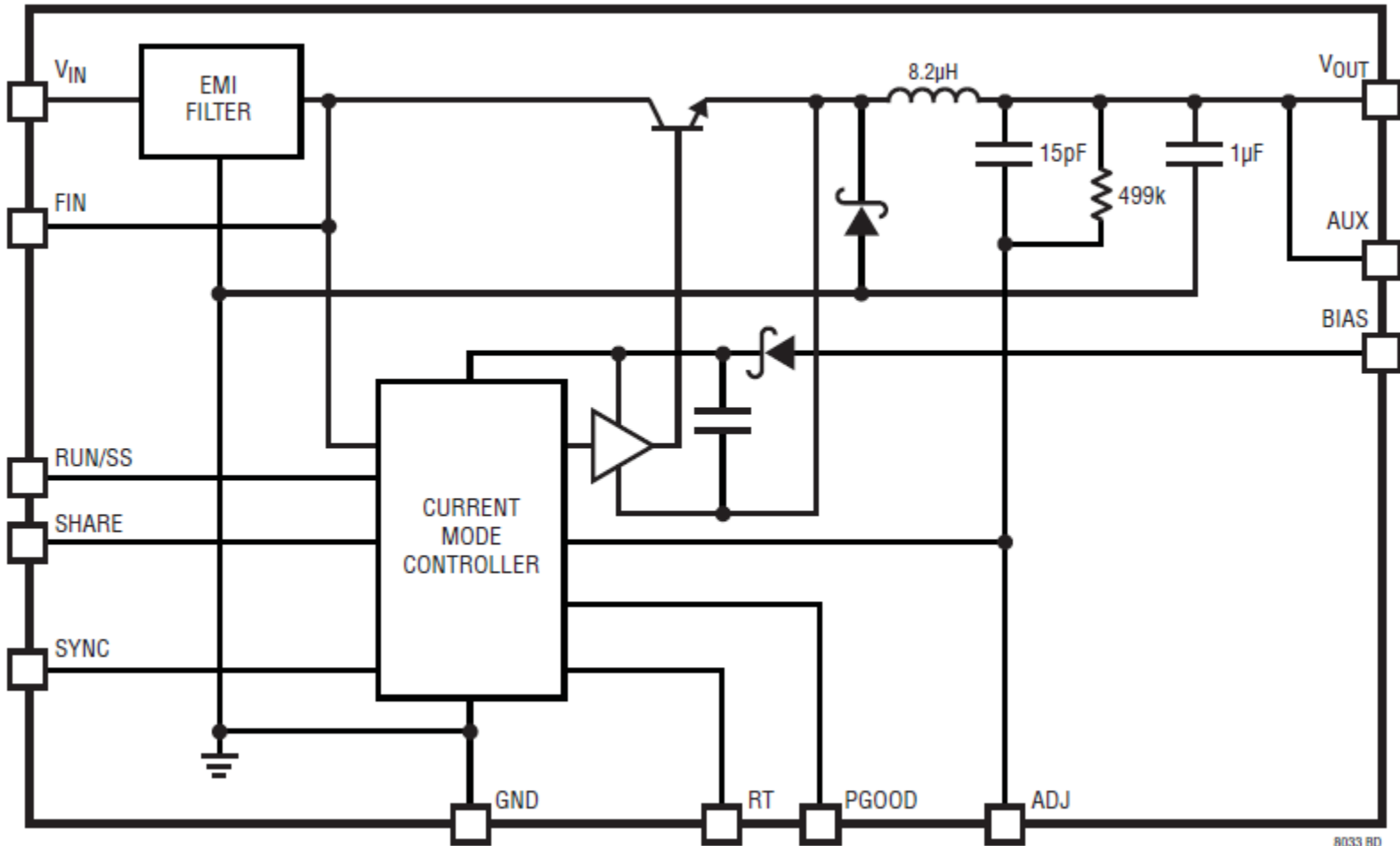


- Automotive Battery Regulation
- Power for Portable Products
- **Distributed Supply Regulation**
- **Industrial Supplies**
- Wall Transformer Regulation



# Linear Technology LTM8033

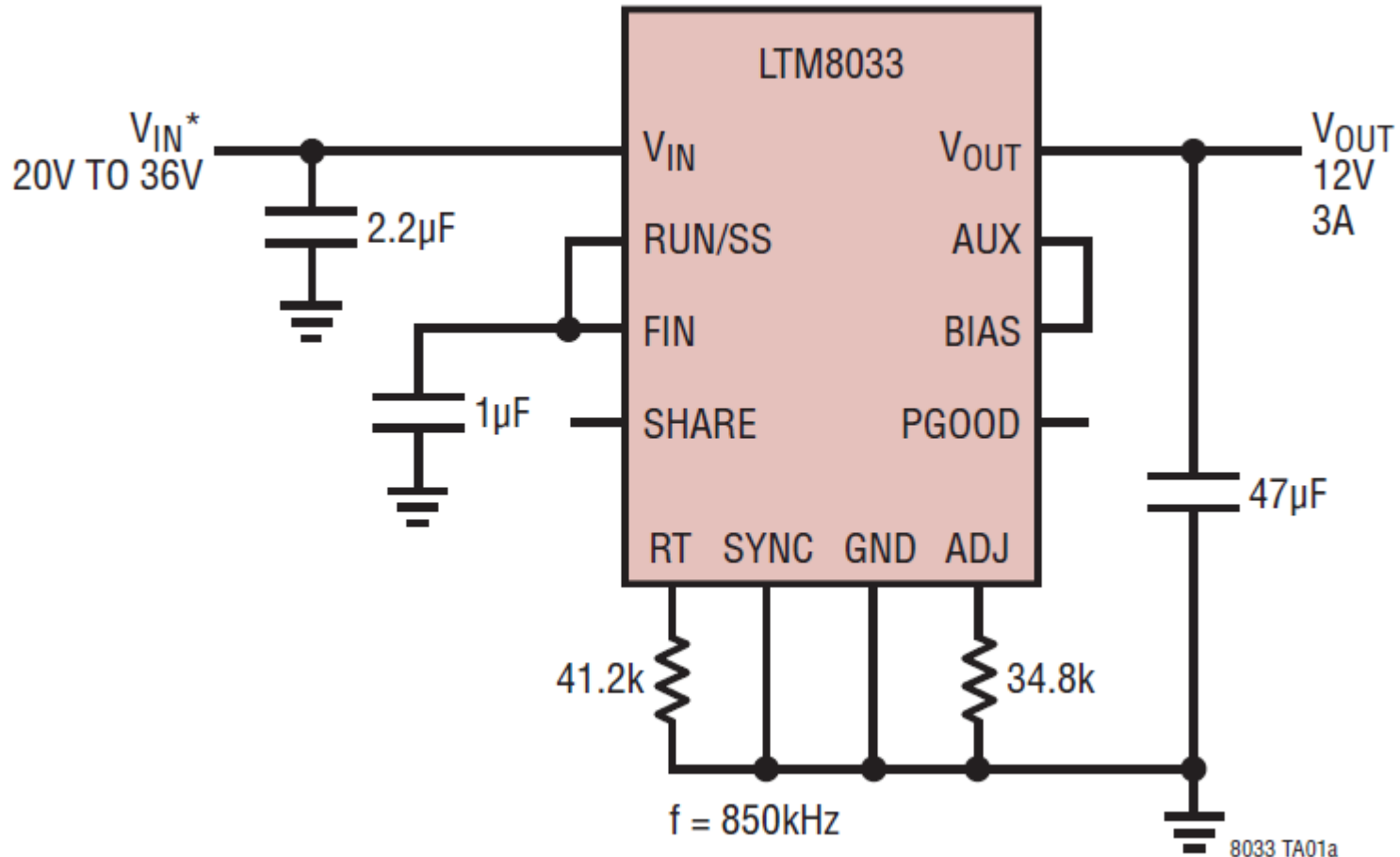
## Schematic





# Linear Technology LTM8033

Ultralow Noise 12V/3A DC/DC  $\mu$ Module Regulator



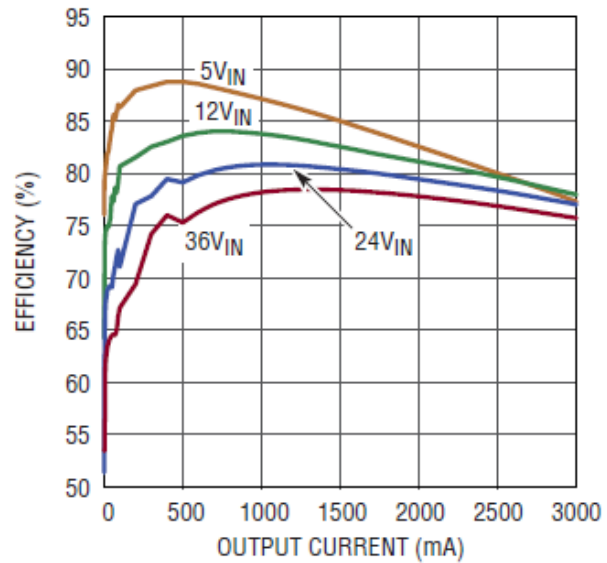


# LTM8033

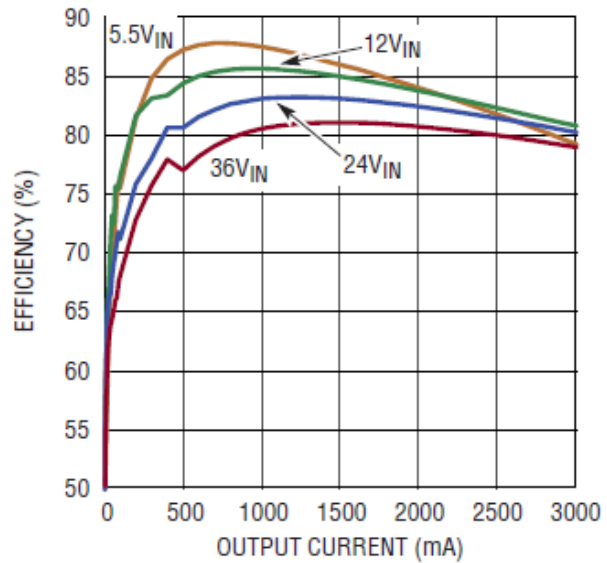
## Efficiency 1 / 2



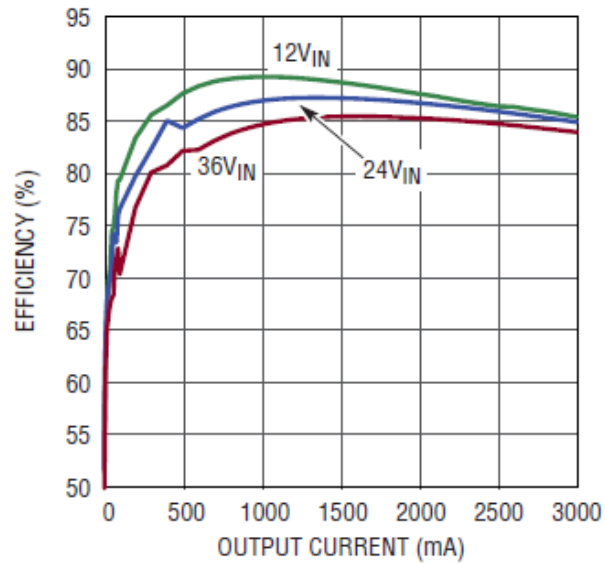
### 2.5V<sub>OUT</sub> Efficiency



### 3.3V<sub>OUT</sub> Efficiency



### 5V<sub>OUT</sub> Efficiency



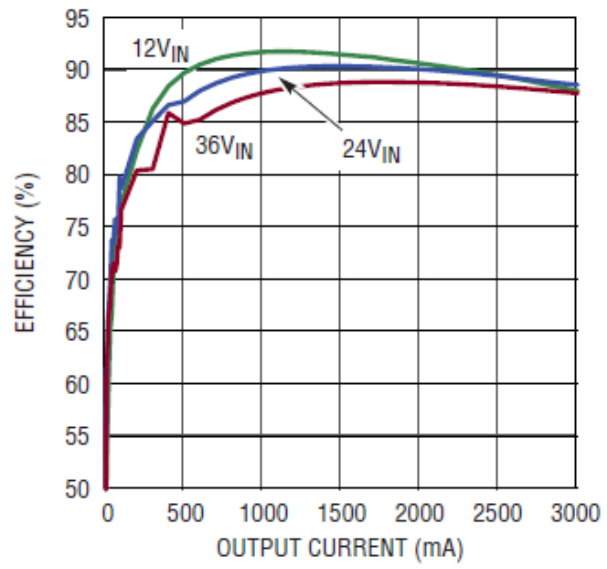


# LTM8033

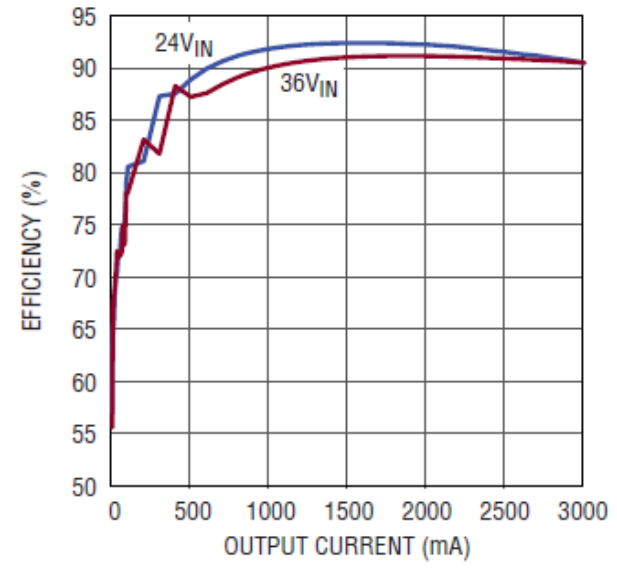
## Efficiency 2 / 2



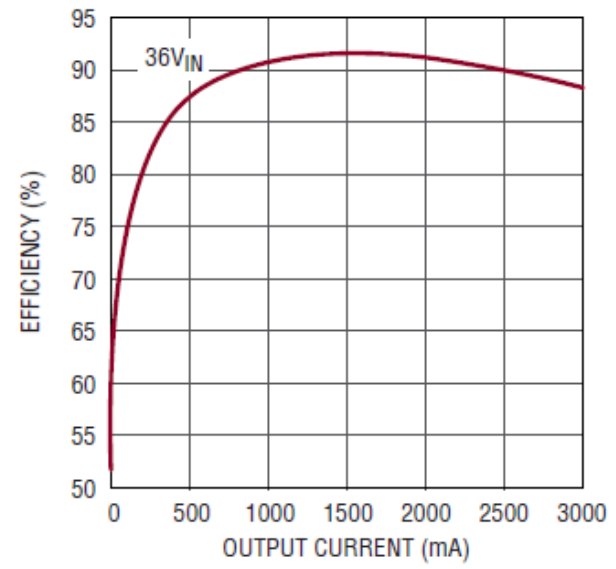
### 8V<sub>OUT</sub> Efficiency



### 12V<sub>OUT</sub> Efficiency



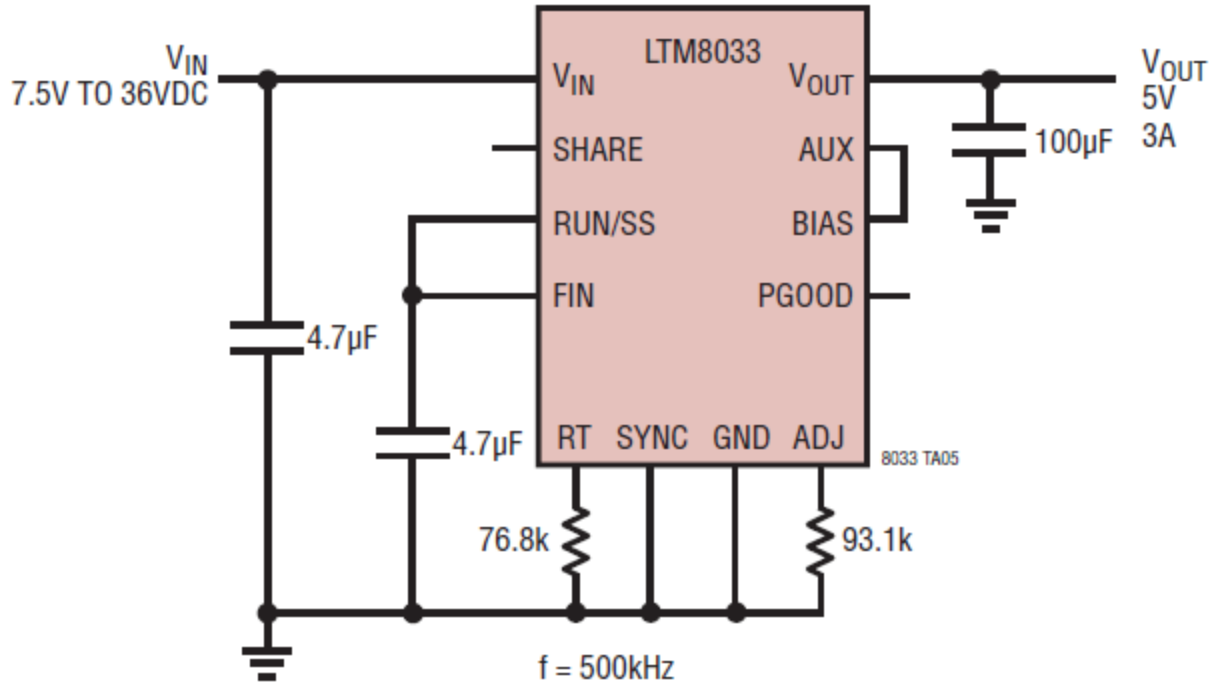
### 18V<sub>OUT</sub> Efficiency





# Linear Technology LTM8033

Ultralow Noise 5V/3A DC/DC  $\mu$ Module Regulator

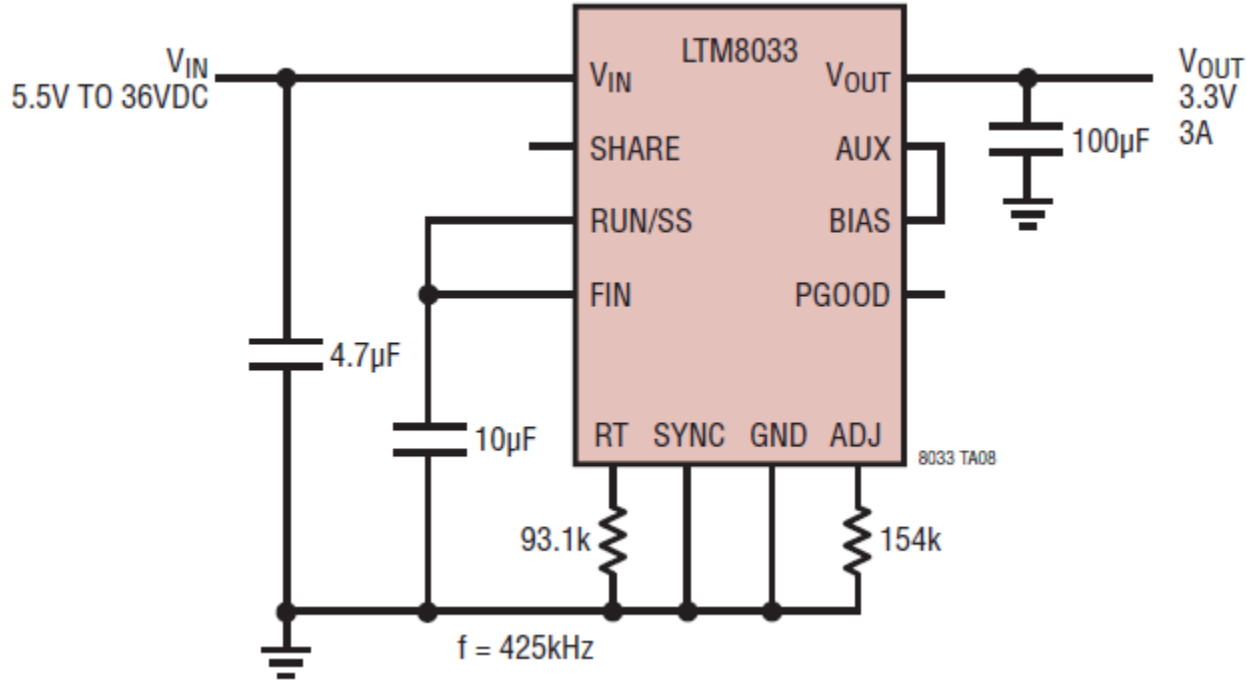






# Linear Technology LTM8033

Ultralow Noise 3.3V/3A DC/DC  $\mu$ Module Regulator





# Linear Technology LTM8033 Test



Sono in programma test in campo magnetico  
19 dicembre 2013  
presso il Lasa di Milano.

# Riferimenti Bibliografici 1

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3. S. Fiore, C. Abbate, S. Baccaro, G. Busatto, M. Citterio, F. Iannuzzo, A. Lanza, S. Latorre, M. Lazzaroni, A. Sanseverino, F. Velardi, *Radiation and magnetic field effects on new semiconductor power devices for HL-LHC experiments*, ArXiv, Data di pubblicazione: 2013-10, Pages(s): 5, Publication state: in press, Proceedings of the International conference on advanced technology and particle physics ( ICATPP 2013), Villa Olmo, Como (Italy), Year: 2013, 23-27 September 2013. Congress number: 14, Publisher: World Scientific, URL: <http://arxiv.org/abs/1310.1902>. Submitted for publication in WSPC 2014.
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5. C. Abbate, M. Alderighi, S. Baccaro, G. Busatto, M. Citterio, P. Cova, N. Delmonte, V. De Luca, S. Gerardin, E. Ghisolfi, F. Giuliani, F. Iannuzzo, A. Lanza, S. Latorre, M. Lazzaroni, G. Meneghesso, A. Paccagnella, F. Rampazzo, M. Riva, A. Sanseverino, R. Silvestri, G. Spiazzi, F. Velardi, E. Zanoni, “Radiation performance of new silicon devices for the LHC experiment upgrades”, Proc. *11th International Conference on Large Scale Application and Radiation Hardness of Semiconductor Detectors*, Florence, Italy, Jul. 3-5, 2013. Submitted for publication in PoS.

# Riferimenti Bibliografici 2

5. C. Abbate, M. Alderighi, S. Baccaro, G. Busatto, M. Citterio, P. Cova, N. Delmonte, V. De Luca, S. Gerardin, E. Ghisolfi, F. Giuliani, F. Iannuzzo, A. Lanza, S. Latorre, M. Lazzaroni, A. Paccagnella, M. Riva, A. Sanseverino, G. Spiazzi, F. Velardi "Developments on DC/DC converters for the LHC experiment upgrades", Proc. *TWEPP 2013 - Topical Workshop on Electronics for Particle Physics*, Perugia (Italy), Sep. 23-27, 2013. Submitted for publication in JINST 2014.
6. P. Cova, N. Delmonte, F. Giuliani, M. Citterio, S. La Torre, A. Lanza, M. Lazzaroni, "Thermal modeling and characterization of power converters for LHC power supplies", Proc. *12th IMEKO TC10 Workshop on Technical Diagnostics - New Perspectives in Measurements, Tools and Techniques for Industrial Applications*, pp. 202-207, Firenze (Italy), Jun. 6-7, 2013. ISBN: 978-88-903149-8-8, Scopus: 2-s2.0-84881560100. Submitted for publication in ACTA IMEKO JOURNAL 2014.
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8. <http://www2.pv.infn.it/~serval/apollo/index.html>.



# Point-of-Load (POL)



Grazie