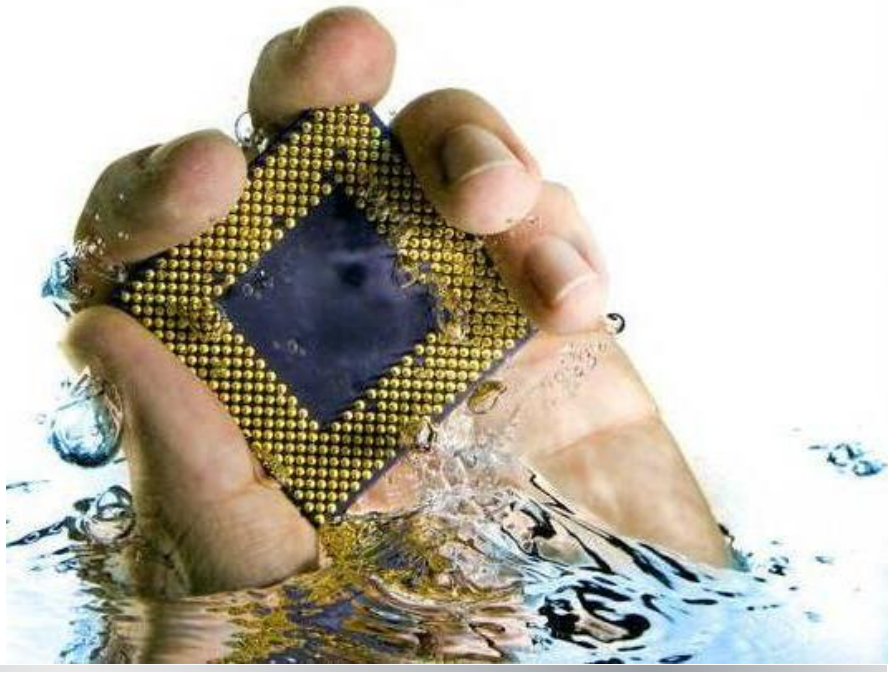
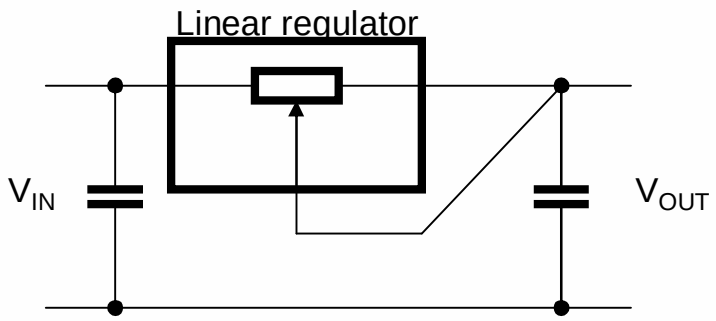
POWER SUPPLY SOLUTIONS



Linear (dissipative) solution versus switching

Dissipative

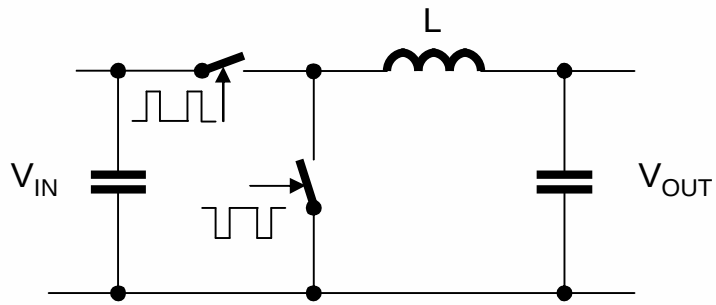


The linear regulator change resistance between input and output to keep output voltage constant. The unused energy is dissipated.

Benefits

- ❑ *Simple and fast design*
- ❑ *Low noise*
- ❑ *No EMI issue*

Switching



Energy is stored in the inductor during ON time and delivers to output during off time.

Benefits

- ❑ *High efficiency*
- ❑ *Low size*
- ❑ *Output voltage can be higher or negative compare to input*

Linear (dissipative) solution versus switching

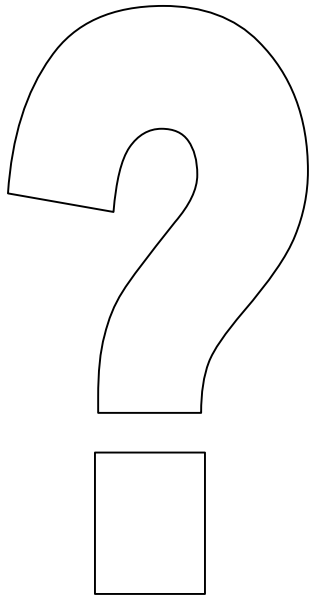
Example 1

VIN = 24 V DC
VOUT = 5 V DC
IOUT = 5 A
POUT = 25 W

Linear solution:
η = 20.8 %
PLOSS = 95 W

Switching solution:
η = 85 % (estimation)
PLOSS = 4.4 W

Compare



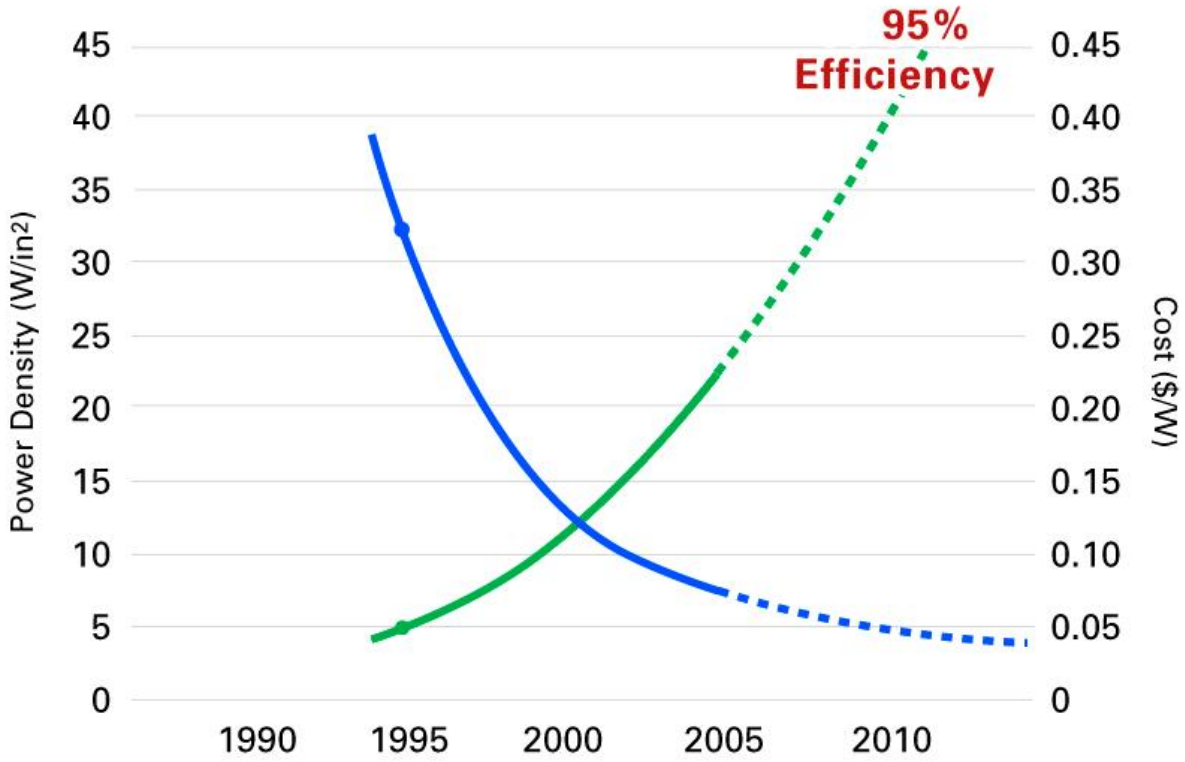
Example 2

V_{IN} = 3.3 V DC
V_{OUT} = 2.5 V DC
I_{OUT} = 20 mA
P_{OUT} = 50 mW

Linear solution:
η = 75.7 %
P_{LOSS} = 16 mW

Switching solution:
η = 65 % (estimation)
P_{LOSS} = 27 mW

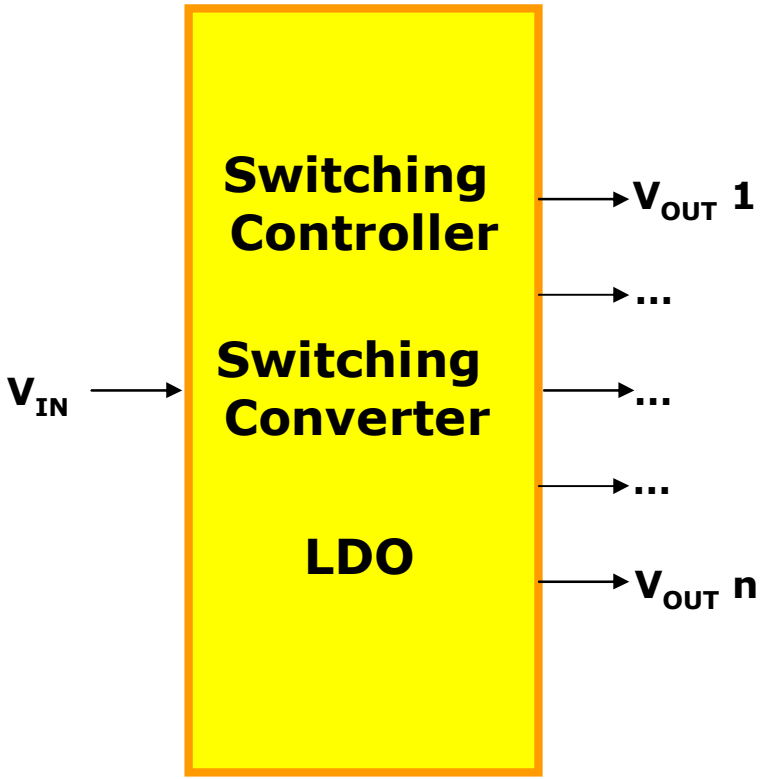
Point Of Load (POL) DC-DC Trends

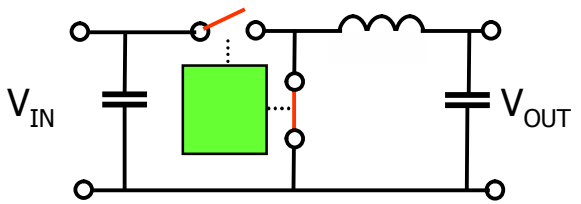


- 2010: New Architectures & Component Technologies

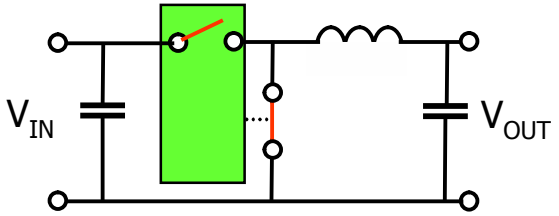
Computing Requirements moving to Consumer & Communications Systems (Information Technology Systems)

DC-DC Post regulation: Basics

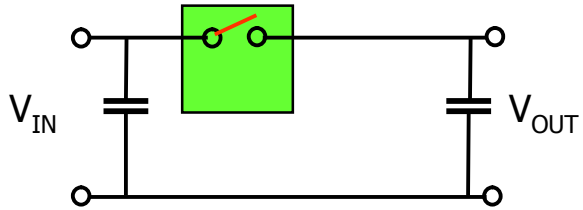




Controller: external mosfets

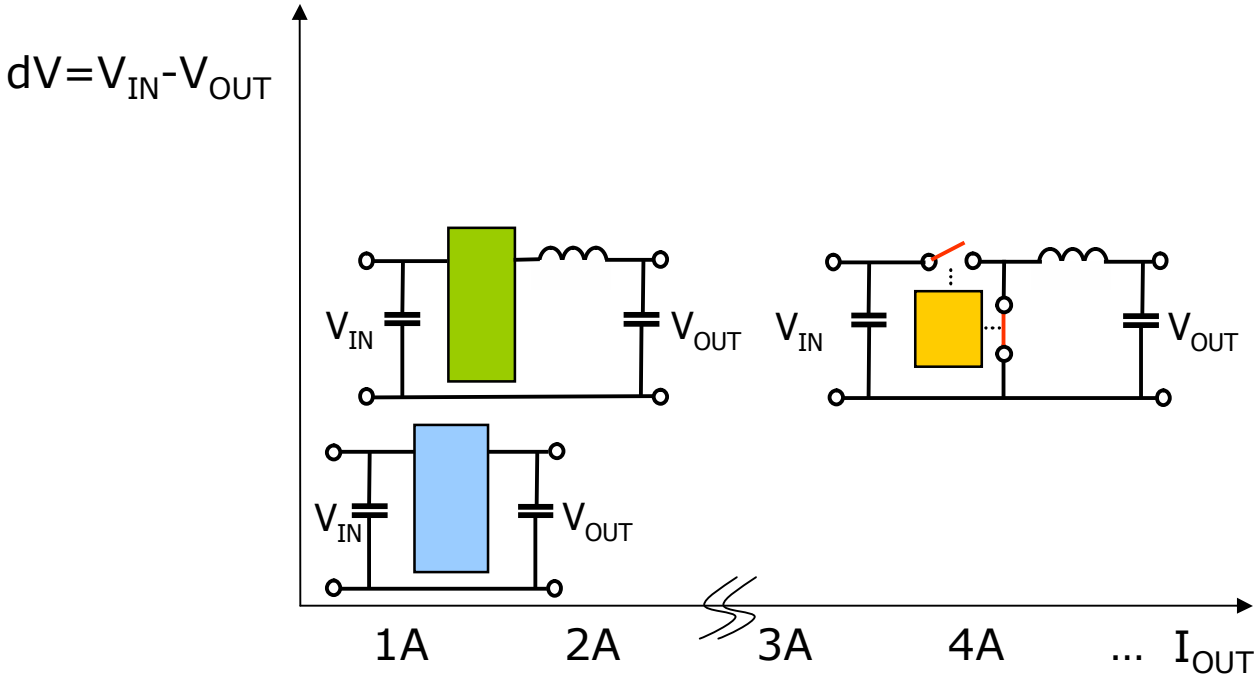


Converter: internal mosfet(s)



LDO: no inductor

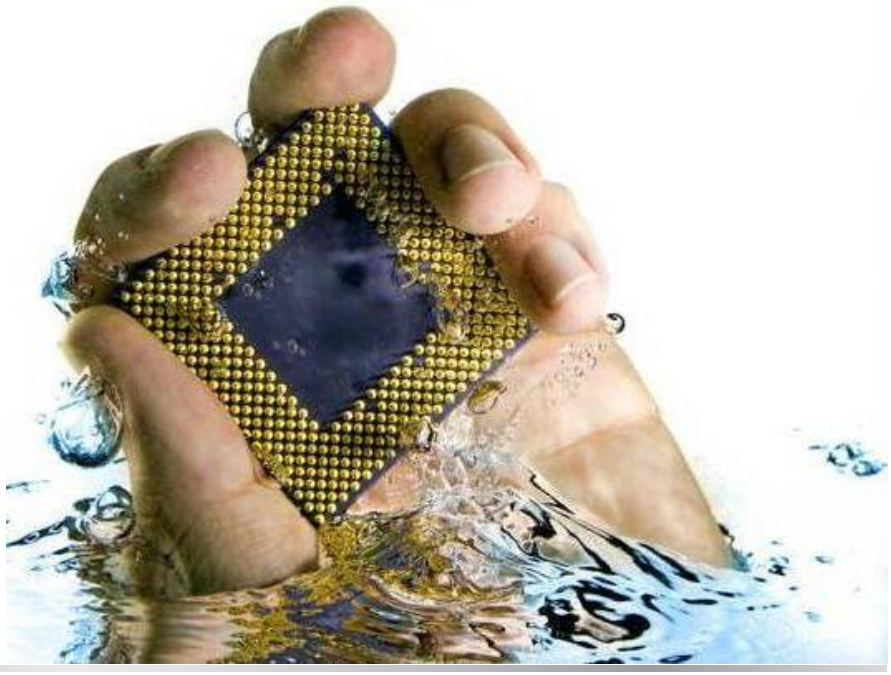
How to select the correct topology: two simple criteria



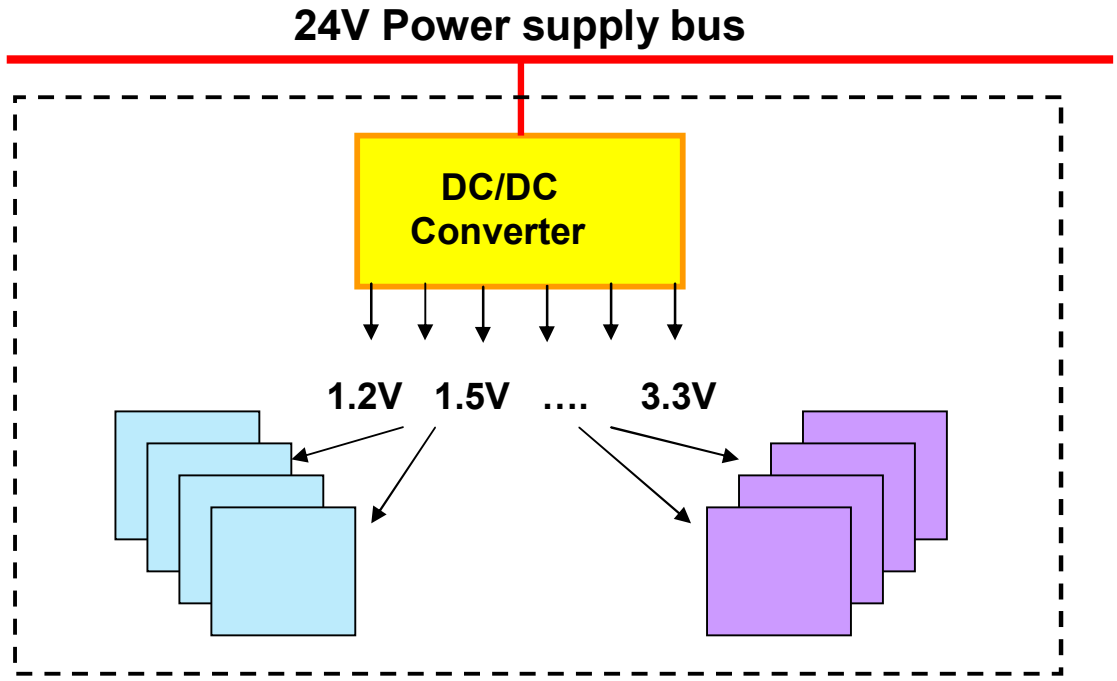
1. *dV : LDO efficiency is $\eta = V_{OUT}/V_{IN}$: bigger ΔV → lower efficiency*
   example: V_{IN}=12V, V_{OUT}=5V → efficiency <50%)

2. *I_{OUT}: it is a trade off between cost / efficiency and application area:*
   discrete MOSFET have better R_{DSON} compared with integrated ones , but you need a "2 packages solution" (MOSFET + controller) compared with monolithic switching regulators (MOSFET and controller in one package)

DC / DC Converters

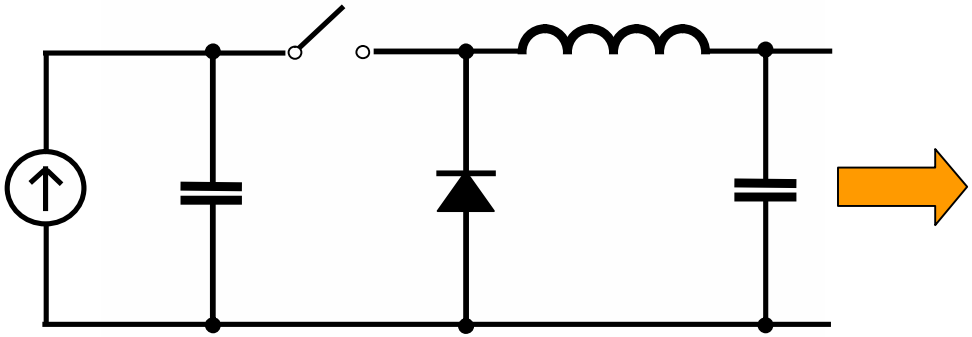


Standard V_{IN} BUS: 24V



MONOLITHIC DC-DC CONVERTERS

BUCK CONVERTER



Supported by:

- L497X
- L597XD, L6902D
- L598X, L798X
- L6925-6-8

$$V_{OUT} = V_{IN} \cdot D_{IDEAL}$$

$$D_{IDEAL} = \frac{V_{OUT}}{V_{IN}}$$

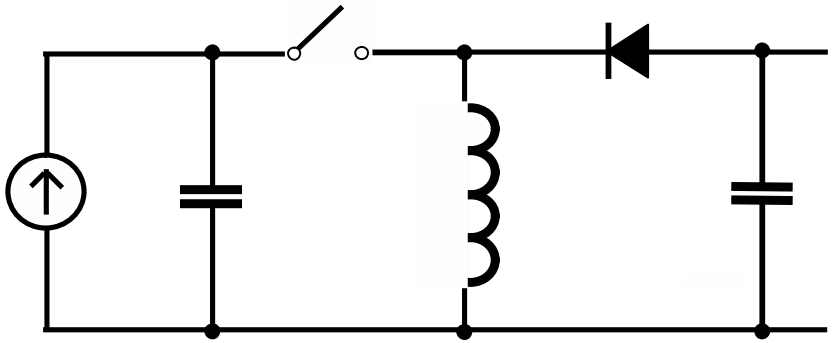
$$r = \frac{V_{OUT}}{I_{OUT} \cdot L \cdot f_{SW}} \cdot (1 - D_{REAL})$$

$$I_{SW,RMS} = I_{OUT} \sqrt{D_{REAL} \cdot \left[1 + \frac{r^2}{12}\right]}$$

$$I_{SW,PK} = I_{OUT} \cdot \left(1 + \frac{r}{2}\right)$$

The power losses make $D_{REAL} > D_{IDEAL}$

BUCK-BOOST CONVERTER



Supported by:

- **L497X**
- **L597XD, L6902D**
- **L598X, L798X**

$$V_{OUT} = -V_{IN}\frac{D_{IDEAL}}{1-D_{IDEAL}}$$

$$D_{IDEAL} = \frac{|V_{OUT}|}{|V_{OUT}| + V_{IN}}$$

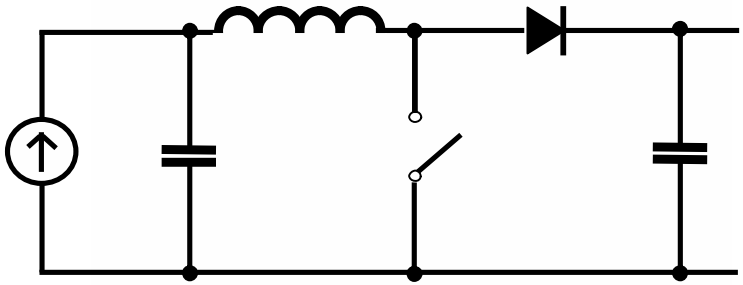
$$r = \frac{V_{OUT}}{I_{OUT}\cdot L\cdot f_{SW}}(1-D_{REAL})^2$$

$$I_{SW,RMS} = \frac{I_{OUT}}{1-D_{REAL}}\sqrt{D_{REAL}\cdot\left[1+\frac{r^2}{12}\right]}$$

$$I_{SW,PK} = \frac{I_{OUT}}{1-D_{REAL}}\cdot\left(1+\frac{r}{2}\right)$$

The power losses make $D_{REAL} > D_{IDEAL}$

BOOST CONVERTER



Supported by:

- **L6920D**
- **L6920DB**

$$V_{OUT} = \frac{V_{IN}}{(1-D)}$$

$$I_{IN} = I_L$$

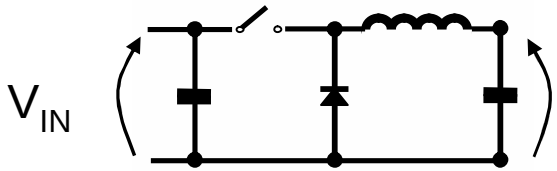
$$D = 1 - \frac{V_{IN}}{V_{OUT}}$$

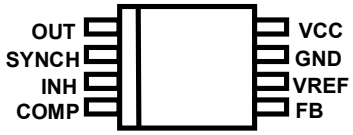
$$I_{SW,RMS} = I_{LED}\sqrt{D \cdot \left[1 + \frac{r^2}{12}\right]}$$

$$r = \frac{V_{OUT}}{I_{LED} \cdot L \cdot f} \cdot D \cdot (1-D)^2$$

L597x Family

- P-channel power MOS: no bootstrap capacitor
- 100% maximum duty cycle
- Wide input voltage range (4V up to 36V)
- Constant current protection
- Embedded protection features
- Typical RDSon=250mΩ
- Alternative topologies: inverting buck-boost, positive buck boost

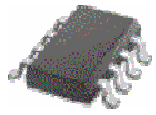




Device	Package	Ipk [A]	Iout [A]	Vin (V)	Vout (V)	Fsw [KHz]	Extra functions
L5970D	SO8	1.5	1	4.4V to 36V	0.5V to Vin	250	Inhibit, Vref, Sync
L5970AD	SO8	1.5	1	4.4V to 36V	0.5V to Vin	500	Inhibit, Vref, Sync
L5972D	SO8	2	1.5	4.4V to 36V	1.23V to Vin	250	-
L5973AD	HSOP8	2	1.5	4.4V to 36V	0.5V to Vin	500	Inhibit, Vref, Sync
L5973D	HSOP8	2.5	2	4.4V to 36V	0.5V to Vin	250	Inhibit, Vref, Sync

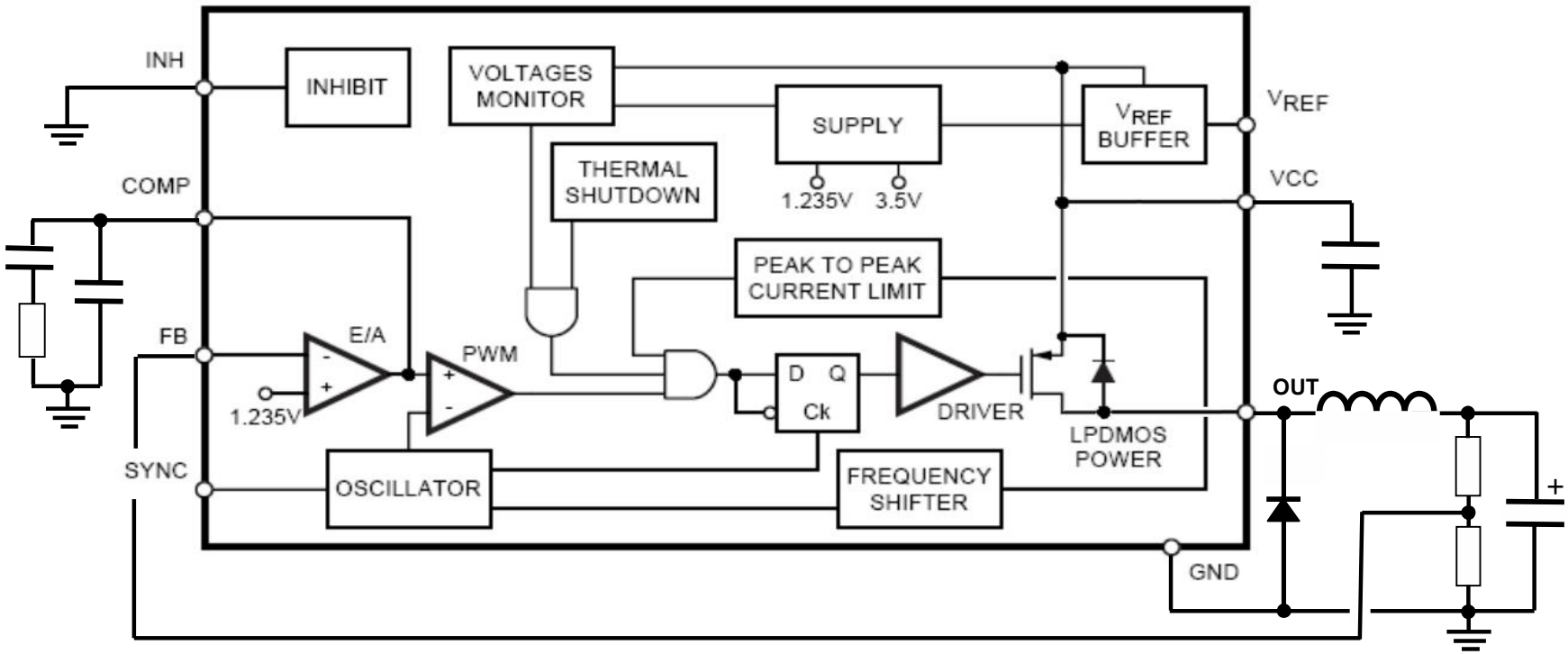
* all but L5972D

HSO8 - Rth j-amb 40C/W

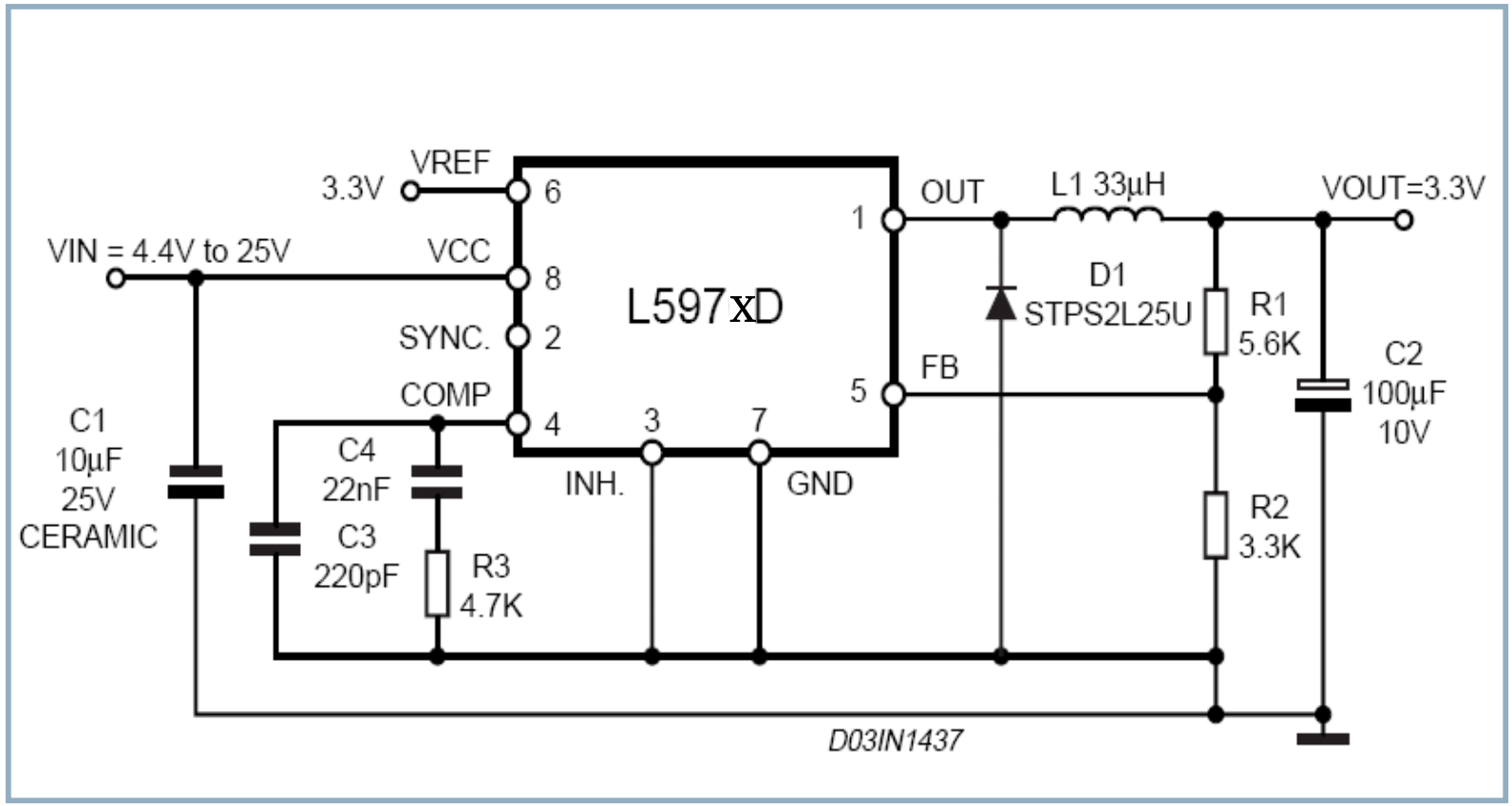


SO8 - Rth j-amb 115C/W
Rth j-amb 62C/W for L5972D

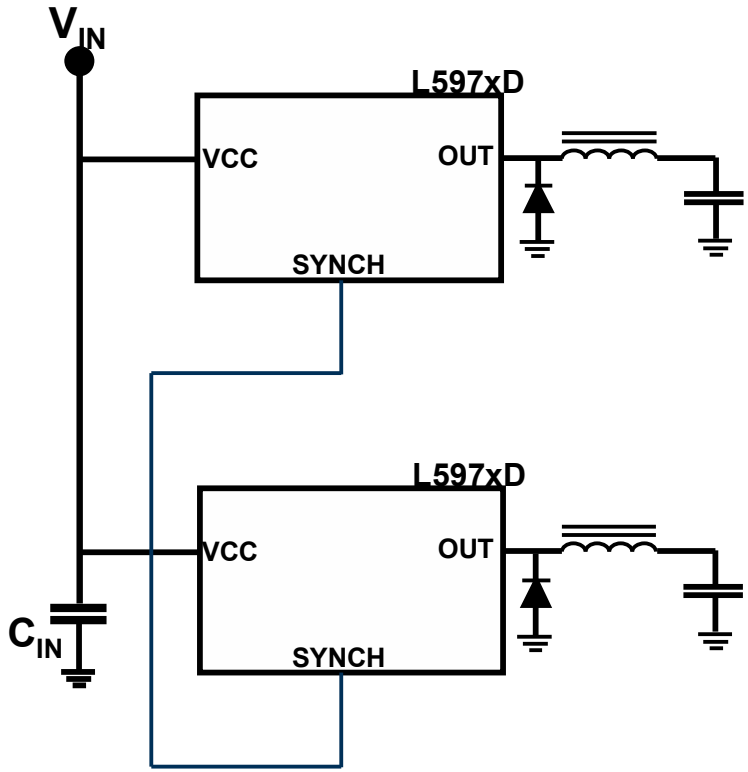
L597x - Internal block diagram



L597x: Test Application Circuit



L597xD – Master / Slave synchronization



f_{SW} = 250 or 500kHz ± 10%

When two or more devices are synchronized, the one with higher switching frequency works as master and it provides the synchronization signal to the slaves

L597x main competitors and applications

Competitors:

- National Semiconductor
- Linear Technology
- Monolithic Power

Where is used?

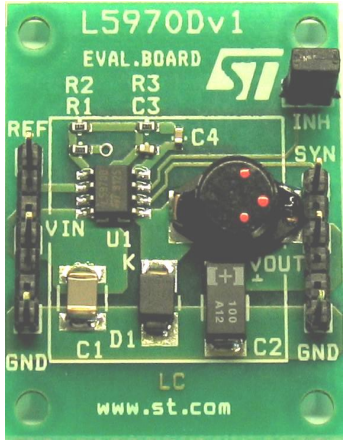
- Consumer
- Industrial
- Networking
- Computer

Applications:

- LCD TV, PDP TV, Notebook and palmtop computers
- Set top boxes, DVD players and recorders
- Battery chargers, portable data terminals
- Modems, DC-DC converter modules
- Optical storage, hard disk drives, printers, audio and graphic cards
- PLC
- Printers
- DC-DC converter modules

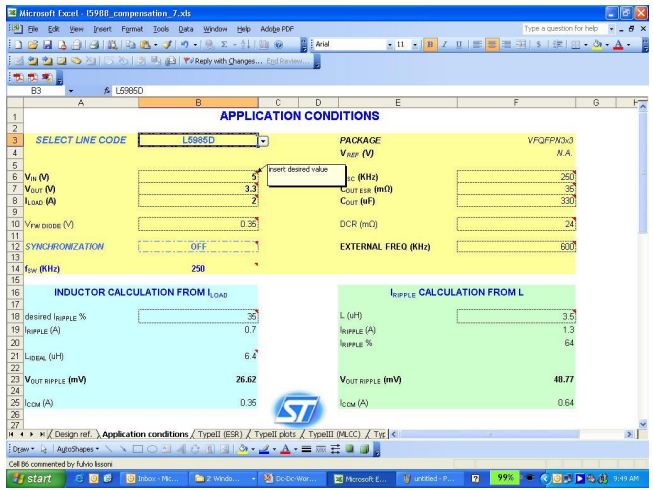
L597x promotional tools

P/N	Datasheet	Application note	Evaluation board
L5970D	available	AN1330	EVAL5970D
L5970AD	available	--	
L5972D	available	AN1517	EVAL5972D
L5973D	available	AN1518	EVAL5973D
L5973AD	available	AN1723	EVAL5973AD
L6902D	available	Data brief	EVAL6902D



SPREAD SHEET:

- to dimension output filter
- to compensate the loop
- to estimate Tj and efficiency



Now available on request !

A597x Customers & Applications

MAJOR CUSTOMERS

harman international

DELPHI

BOSCH

Continental

Visteon

HELLA
Ideas today for the cars of tomorrow

MAGNETI MARELLI

MAJOR APPLICATIONS

NG

Few examples…

harman international **L5973D in integrated navigation system**

A597xD rear camera Modules and lighting Modules

HELLA Ideas today for the cars of tomorrow

MAGNETI MARELLI **5973D/AD in integrated navigation systems**

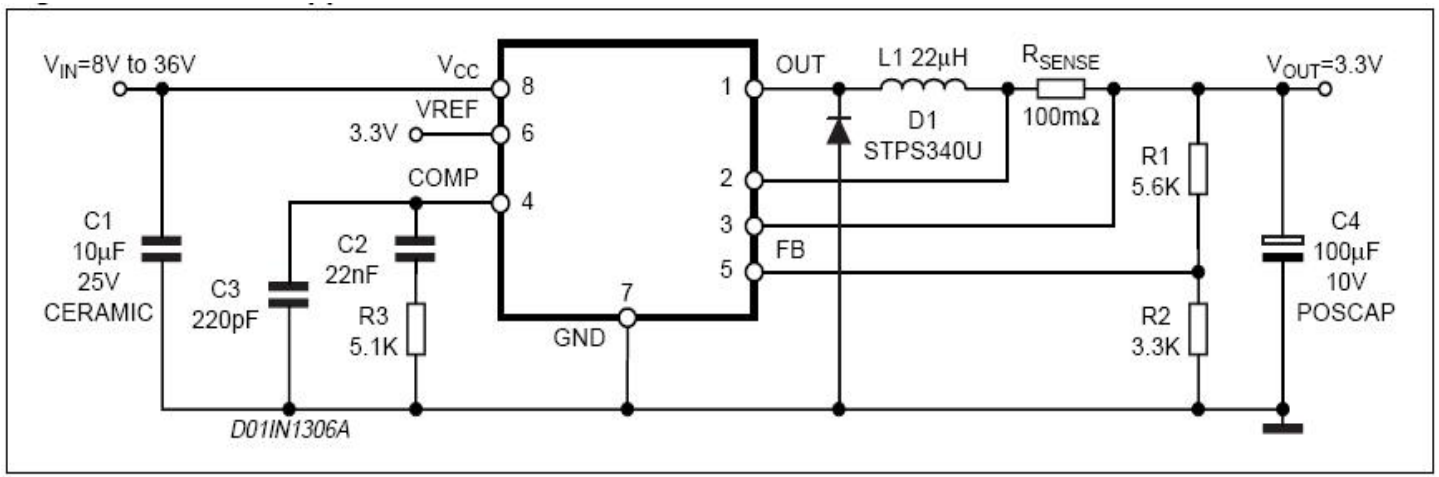
Continental **L5970D in integrated navigation systems And car audio**

preh **B5973D in electronic control unit for active steering**

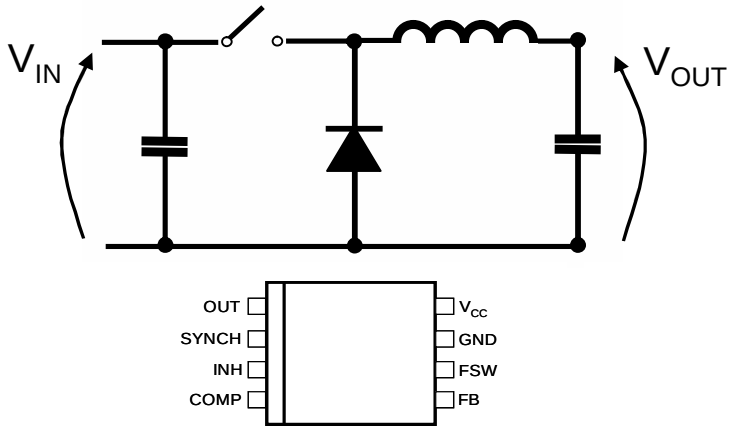
L6902D Key Features

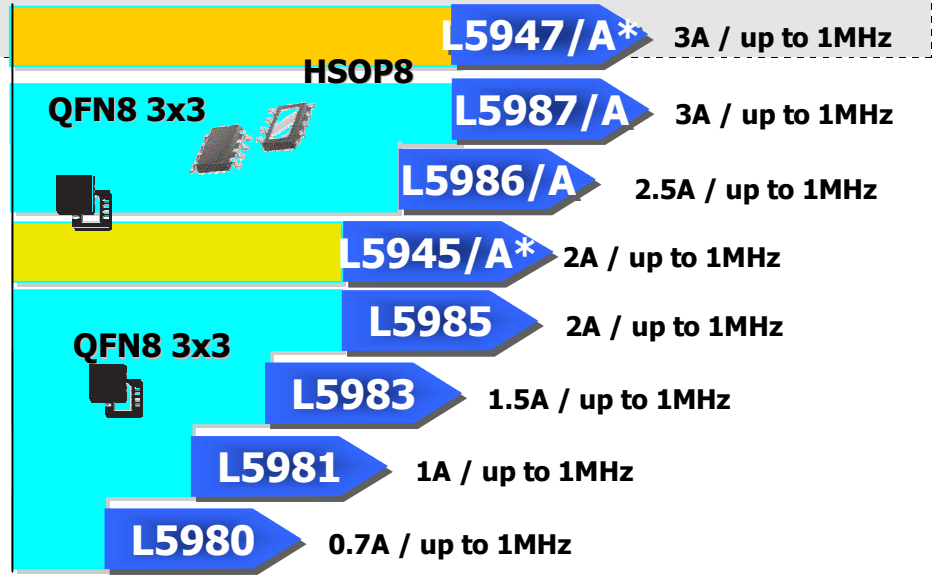
- P-channel power MOS: no bootstrap capacitor
- Constant Current (CC) or Constant Voltage (CV) operation
- Wide input voltage range (8V up to 36V)
- CV implements OVP protection in CC
- Embedded protection features
- Typical RDSon=250mΩ
- 1A in small SO8 package with minimum external component count
- 1A Adjustable current limit (V_{CS+} - V_{CS-}=100mV)
- High switching frequency (250KHz)
- External V_{REF} available
- Alternative topologies: inverting buck-boost, positive buck boost

SO8 - Rth j-amb 115°C/W



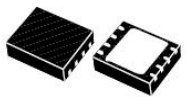
L598x Family





- Up to 3A in small QFN3x3-8L or HSOP8 package
- P-channel power MOS: no bootstrap capacitor & 100% maximum duty cycle
- Wide input voltage range (2.9V up to 18V)
- Closed loop soft start
- Adjustable switching frequency up to 1MHz
- Synchronization capability (out of phase)
- Embedded protection features (Over current, Over temperature)
- Typical RDSon=140mΩ
- Alternative topologies: inverting buck-boost, positive buck boost

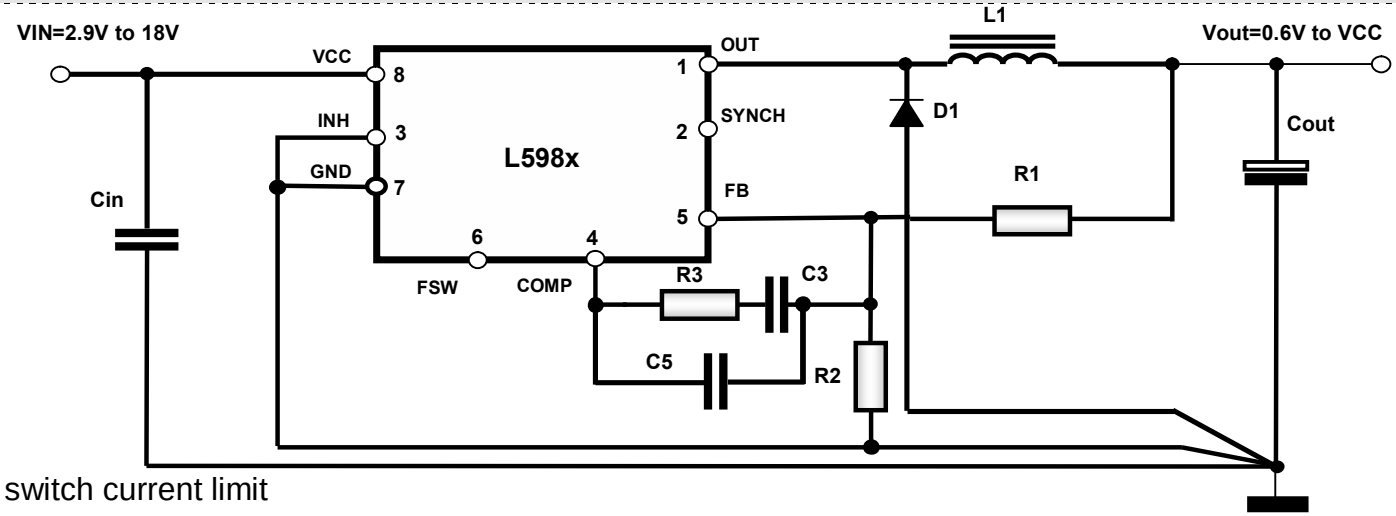
* Low cost versions with cheaper testing procedure



QFN 3x3 8L - Rth j-amb 60°C/W

HSO8 - Rth j-amb 40° C/W

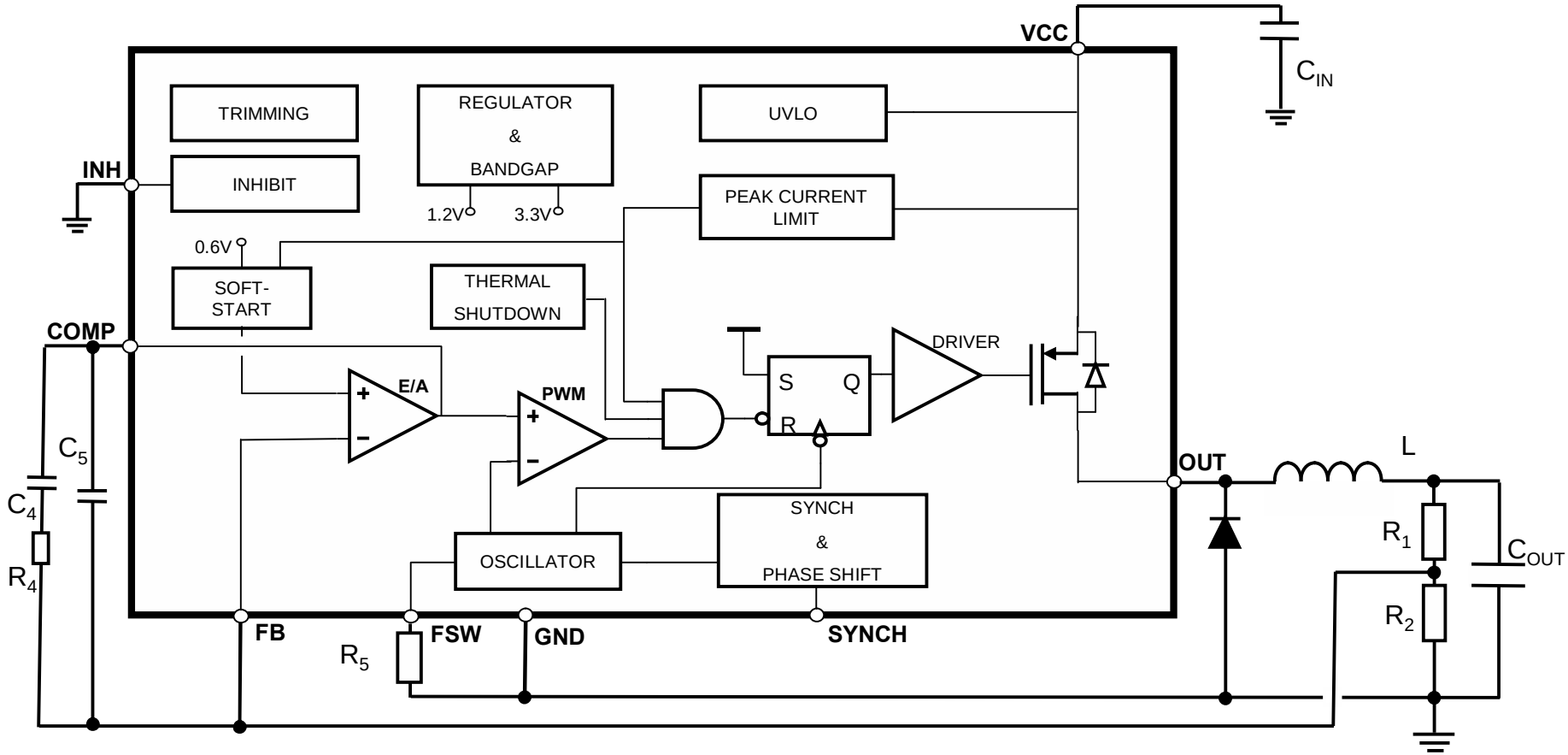
L598x - Typical application circuit



(*) Minimum switch current limit

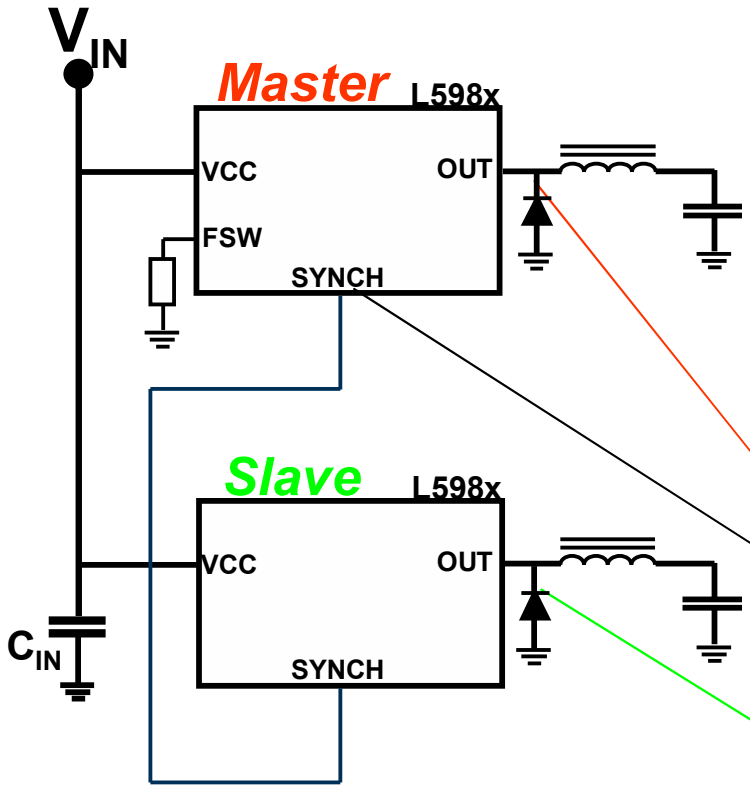
Device	Package	Ipk [A] (*)	Iout [A]	Vin [V]	Vout [V]	Fsw [kHz]	Extra functions
L5980	QFN3x3-8L	1.0	0.7	2.9 – 18	0.6 - Vin	250 – 1000 (adj.)	Soft start, Synch, Inhibit
L5981	QFN3x3-8L	1.5	1.0	2.9 – 18	0.6 – Vin	250 – 1000 (adj.)	Soft start, Synch, Inhibit
L5983	QFN3x3-8L	2.0	1.5	2.9 – 18	0.6 – Vin	250 – 1000 (adj.)	Soft start, Synch, Inhibit
L5985	QFN3x3-8L	2.5	2.0	2.9 – 18	0.6 – Vin	250 – 1000 (adj.)	Soft start, Synch, Inhibit
L5945/A	QFN3x3-8L/HSOP8	2.5	2.0	2.9 – 18	0.6 – Vin	250 – 1000 (adj.)	Soft start, Synch, Inhibit
L5986/A	QFN3x3-8L/HSOP8	3.0	2.5	2.9 – 18	0.6 – Vin	250 – 1000 (adj.)	Soft start, Synch, Inhibit
L5987/A	QFN3x3-8L/HSOP8	3.5	3.0	2.9 – 18	0.6 – Vin	250 – 1000 (adj.)	Soft start, Synch, Inhibit
L5947/A	QFN3x3-8L/HSOP8	3.5	3.0	2.9 - 18	0.6 - Vin	250 – 1000 (adj.)	Soft start, Synch, Inhibit

L598x - Internal Block Diagram



L598x - Master/Slave Synchronization

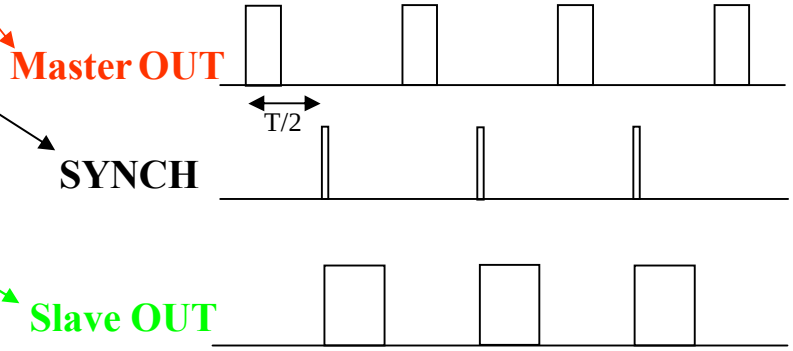
180 ° Out of Phase Synchronization



Device with higher switching frequency works as master.

The SYNCH has one half a period of phase shift.

The slave device is synchronized with 180 ° phase shift, reducing the RMS current flowing into input capacitor.



L598x main competitors and applications

Competitors:

- National Semiconductor LM2734, LM2650
- Monolithic Power MP158x series, MP1411
- Texas Instruments TI6211x series

Where is used?

- Consumer
- Industrial
- Networking
- Computer

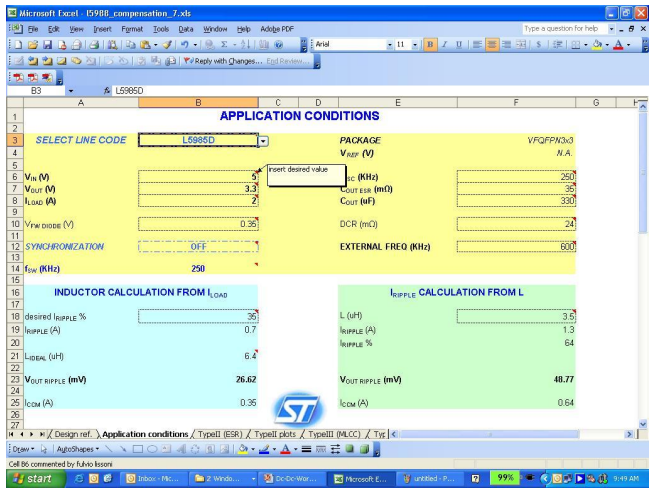
Applications:

- Notebook and palmtop computers
- Set top boxes, DVD players and recorders
- Battery chargers, portable data terminals
- Modems, DC-DC converter modules
- Optical storage, hard disk drives, printers, audio and graphic cards

L598x Promotional tools

P/N	Datasheet with App. info	Evaluation Board
L5980	Available	EVAL5980
L5981	Available	EVAL5981
L5983	Available	EVAL5983
L5985	Available	EVAL5984
L5945	Available	EVAL5945
L5986	Available	EVAL5986
L5987	Available	EVAL5986
L5947	Available	EVAL5947

Evaluation board available also for the" A" versions as:
EVAL5945A, EVAL5986A, EVAL5987A and EVAL5947A



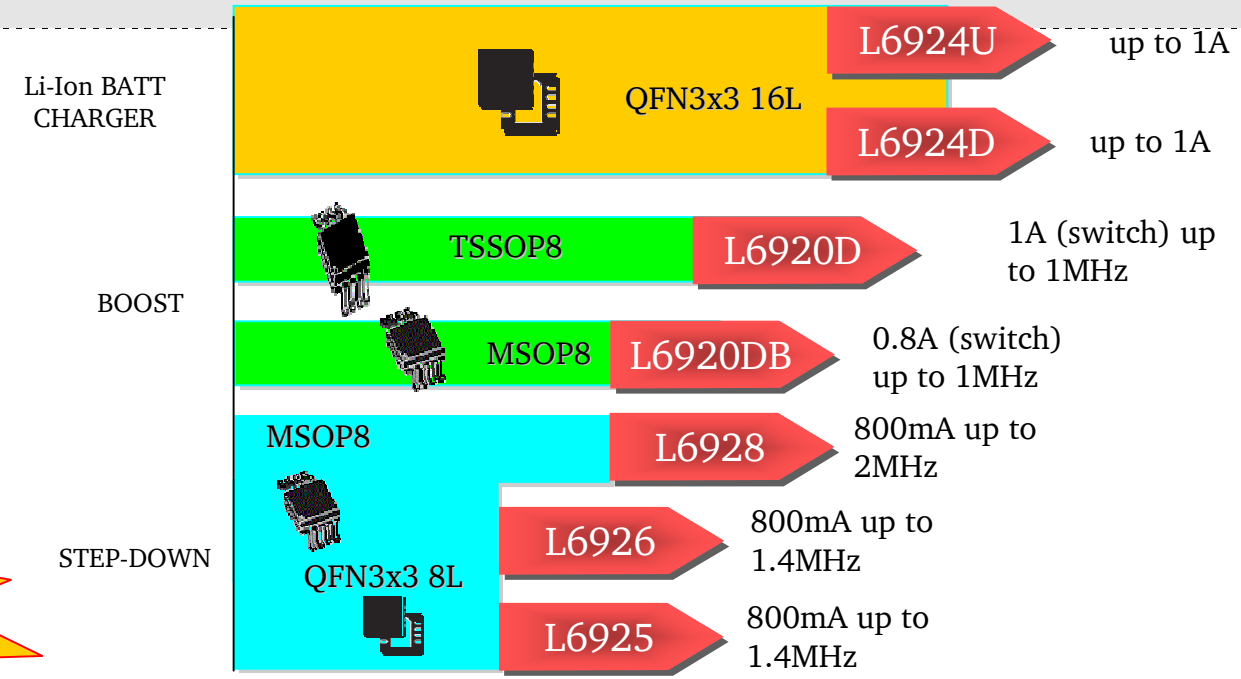
SPREAD SHEET:

- to dimension output filter
- to compensate the loop
- to estimate Tj and efficiency

Now available on request !

L692x Family: Key Features

- Very small packages
- Internal synchronous switch
- Small number of external components
- Micro power consumption
- High efficiency
- Short circuit protection, OVP, thermal shutdown
- Battery detection

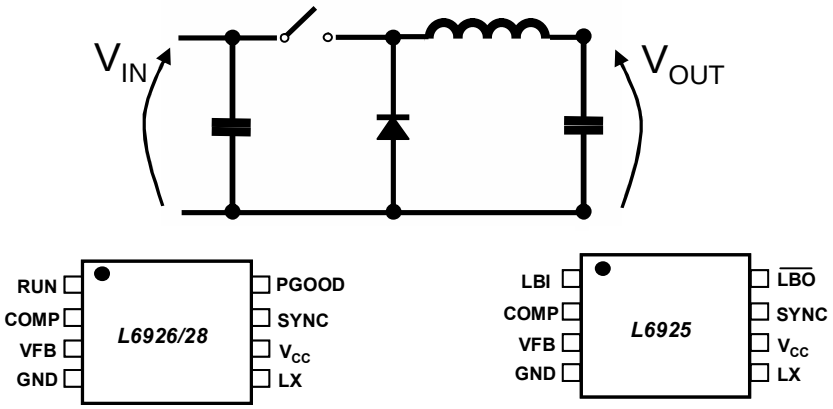


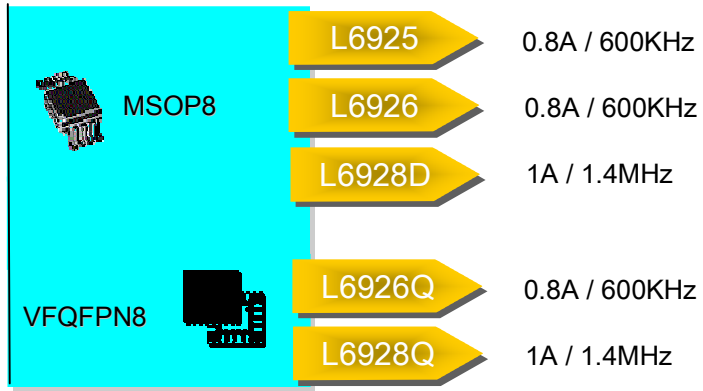
Suggested for Portable application

Device	Package	Type	Ipk [A]	Iout [A]	Vin [V]	Vout [V]	Fsw [KHz]	Extra functions
L6920D	TSSOP8	SU	1	0.5	0.6 - 5.5	2 - 5.2	up to 1000	LBI&LBO, Vref, SHDN
L6920DB	MSOP8	SU	0.8	0.4	0.6 - 5.5	1.8- 5.2	up to 1000	LBI&LBO, Vref, SHDN
L6925D	MSOP8	SD	1.2	0.8	2.7 - 5.5	0.6 - Vin	600	UVLO2.7V, LBI&LBO
L6926	MSOP8	SD	1.2	0.8	2 - 5.5	0.6 - Vin	600	PGOOD, RUN, SYNC
L6926Q1	QFN3x3-8L	SD	1.2	0.8	2 - 5.5	0.6 - Vin	600	PGOOD, RUN, SYNC
L6928D	MSOP8	SD	1.2	0.8	2 - 5.5	0.6 - Vin	1400	PGOOD, RUN, SYNC
L6928Q1	QFN3x3-8L	SD	1.2	0.8	2 - 5.5	0.6 - Vin	1400	PGOOD, RUN, SYNC

Step-down regulators for low power applications:

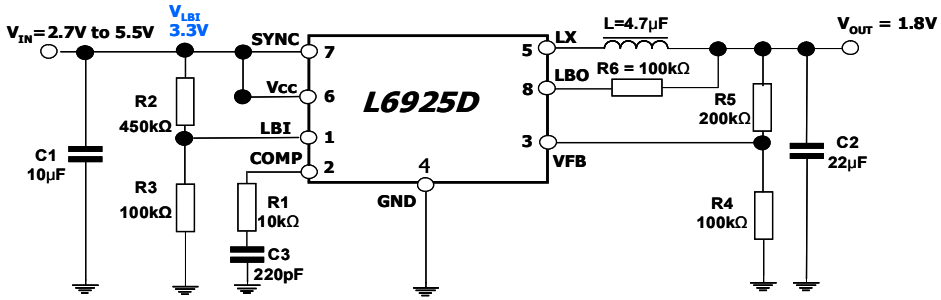
L6925/26/28

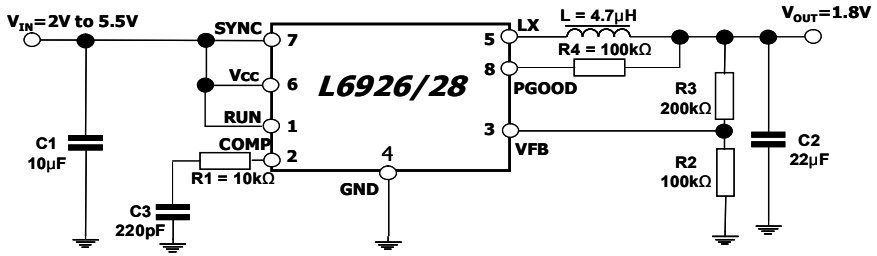




- V_{IN} range: 2V÷5.5V (L6926/28), 2.7V÷5.5V (L6925)
- V_{OUT} adjustable from 0.6V up to V_{IN}
- Internal synchronous switch
- Very low quiescent current
- High efficiency
- Selectable Low Noise and Low Consumption Modes
- Low drop-out operation (up to 100% duty cycle)
- Overvoltage and shortcircuit protection
- Thermal shutdown

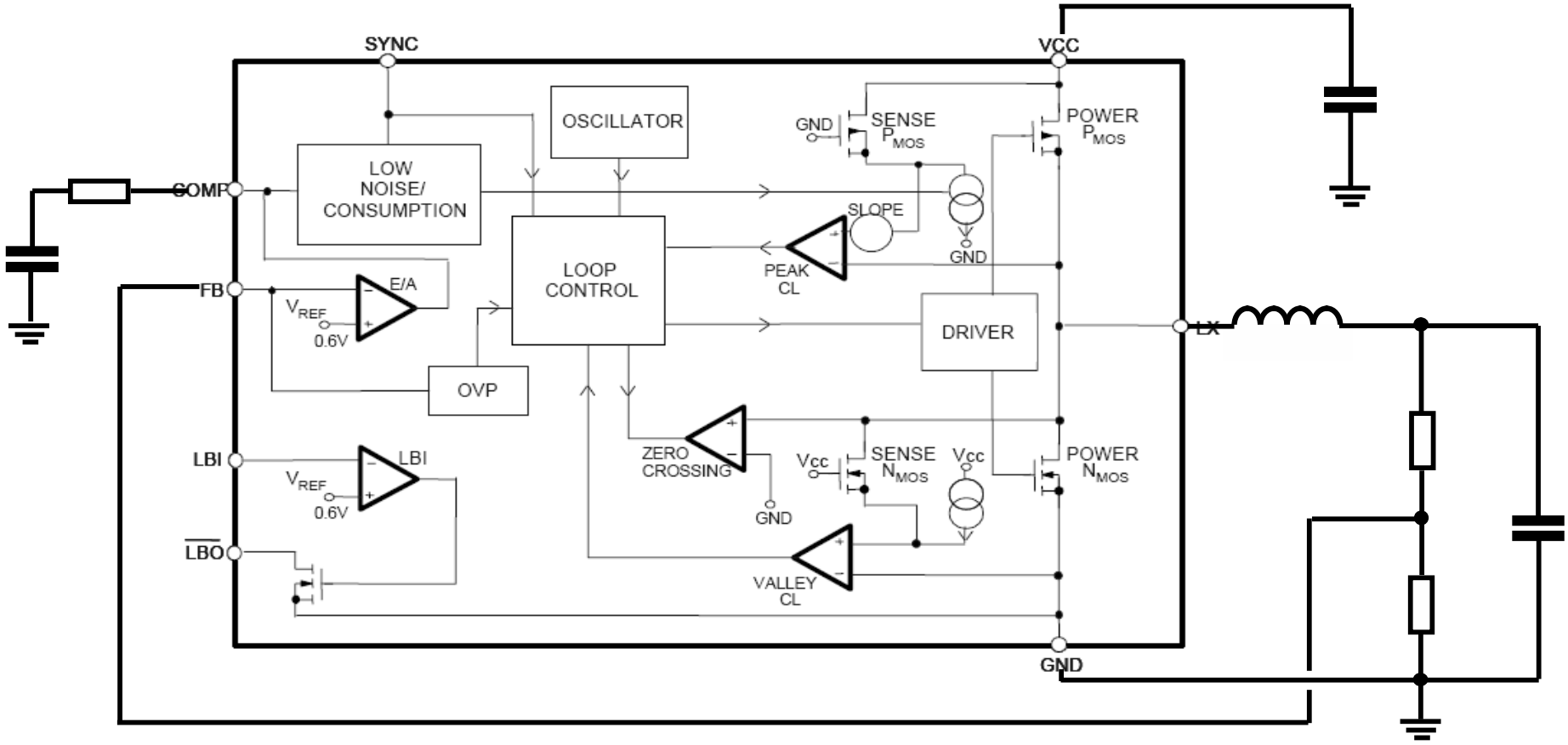
L6925/26/28: typical application circuits



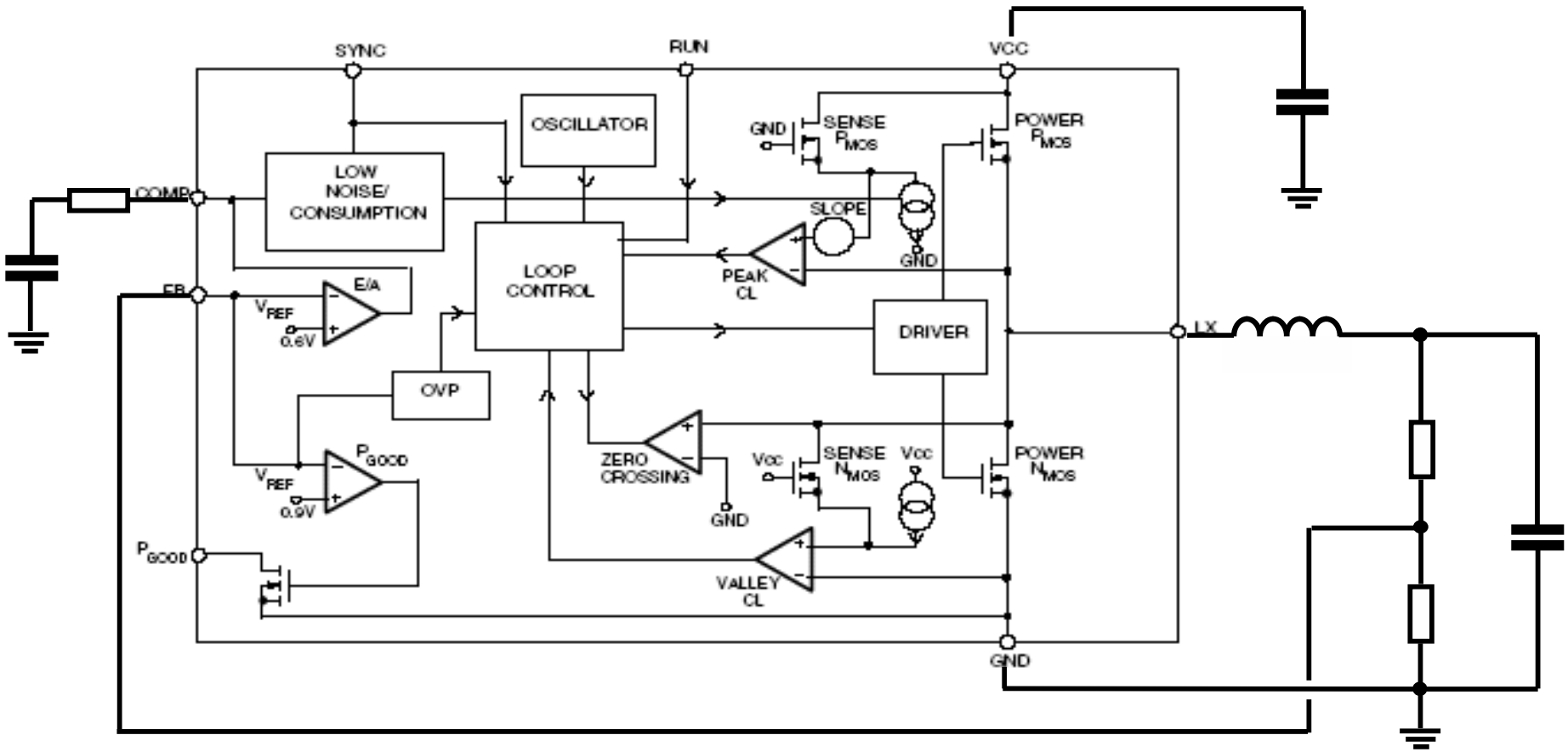


Device	Package	Iout [A]	Vin [V]	Vout [V]	Fsw [kHz]	Other features
L6925D	MSOP8	0.8	2.7V ÷ 5.5V	0.6V ÷ V_{IN}	600	Low battery detection, externally synchronizable from 500kHz up to 1.4MHz
L6926/L6926Q	MSOP8, VFQFPN8	0.8	2V ÷ 5.5V	0.6V ÷ V_{IN}	600	PGOOD, RUN, externally synchronizable from 500kHz up to 1.4MHz
L6928D/Q	MSOP8, VFQFPN8	0.8	2V ÷ 5.5V	0.6V ÷ V_{IN}	1400	PGOOD, RUN, externally synchronizable from 1MHz up to 2MHz

L6925D : internal block diagram

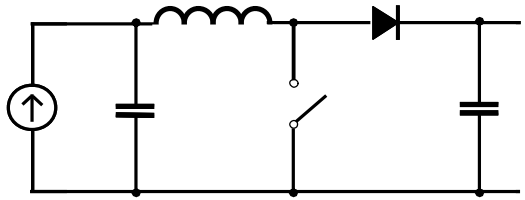


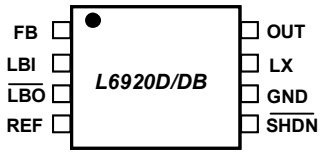
L6926/28 : internal block diagram



Step-up regulators for low power applications:

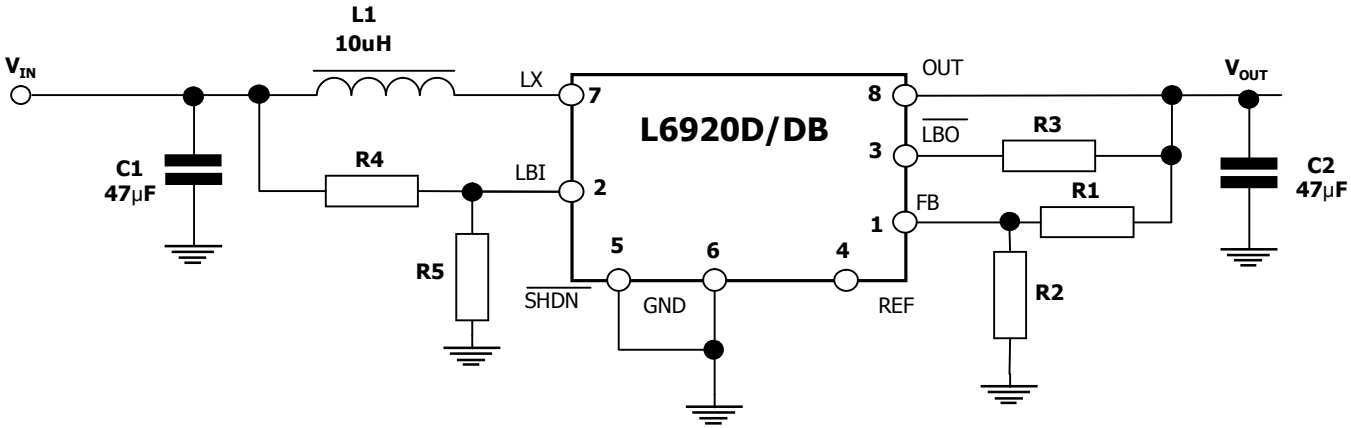
L6920D/L6920DB





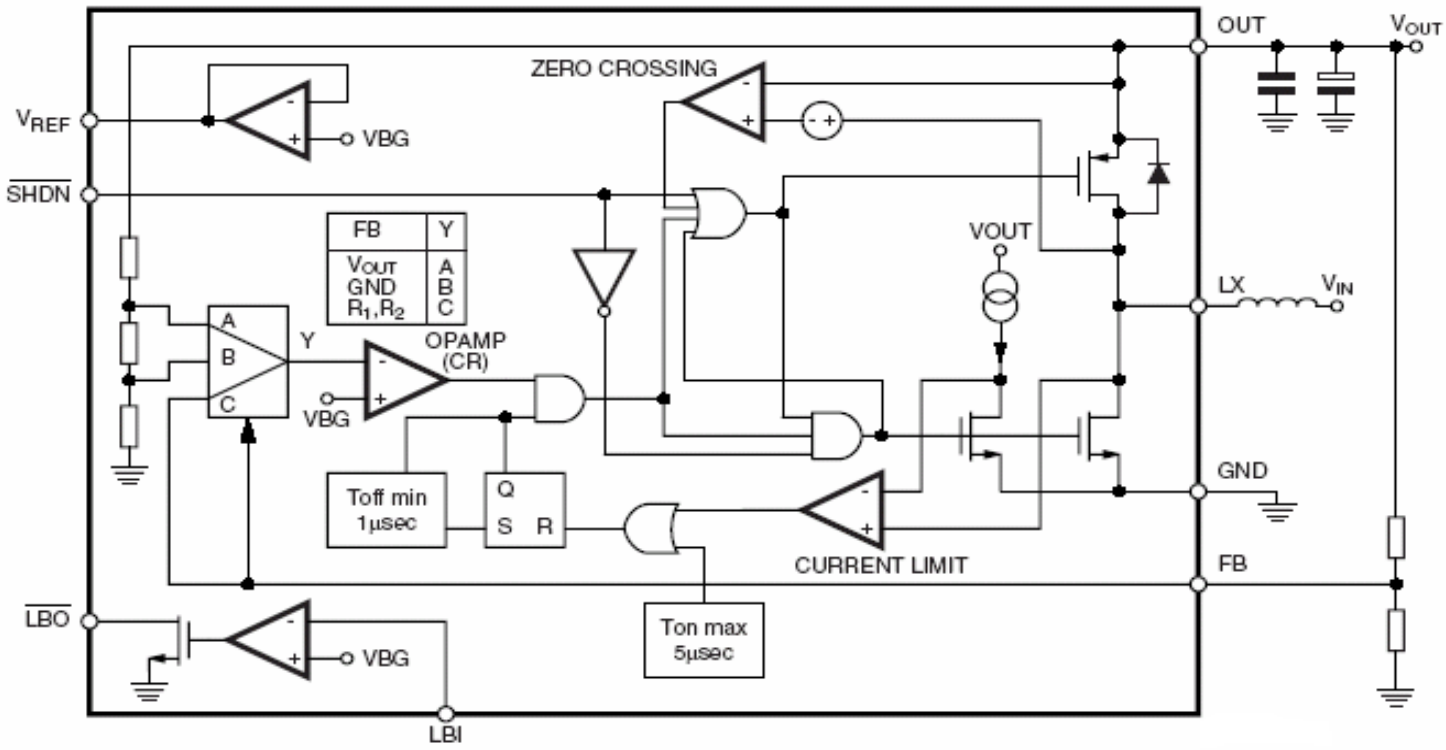
- 0.8V (L6920DB) or 1V (L6920D) start-up input voltage
- Operating input voltage up to 5.5V
- VOUT adjustable from 1.8V (L6920DB) or 2V (L6920D) up to 5.2V
- 3.3V and 5V default output voltages
- Internal synchronous switch
- High efficiency
- Low battery voltage detection
- Reverse battery protection
- 750mA (L6920DB) or 1A(L6920D) switch current limit

L6920D/DB: typical application circuit



Device	Package	I_{SW} [A]	V_{IN}[V]	V_{OUT} [V]	Other features
L6920D	TSSOP8	1	up to 5.5V (start-up at 1V)	• Default 3.3V or 5V • Adjustable from 2V up to 5.2V	Low battery detection, reverse battery protection
L6920DB	MSOP8	0.75	up to 5.5V (start-up at 0.8V)	• Default 3.3V or 5V • Adjustable from 1.8V up to 5.2V	Low battery detection, reverse battery protection

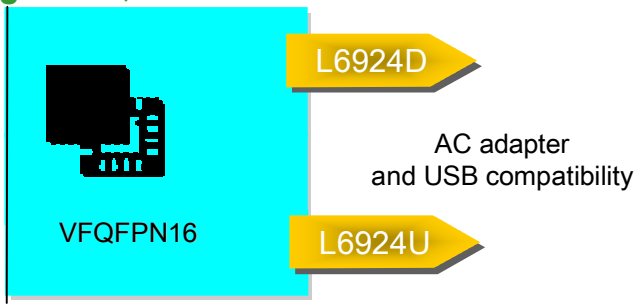
L6920D/DB: internal block diagram



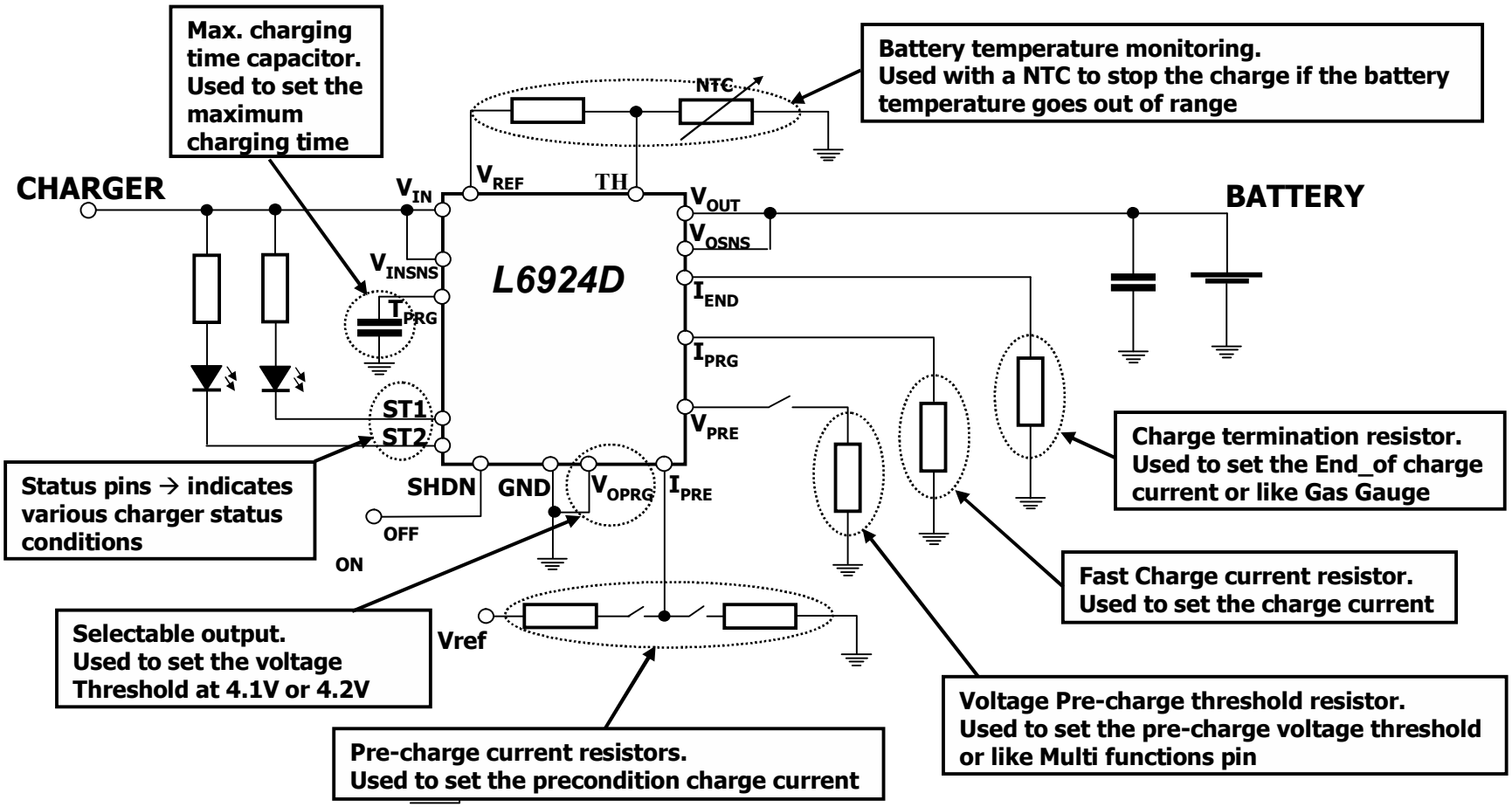
Single Li-Ion cell battery chargers:

L6924D and L6924U

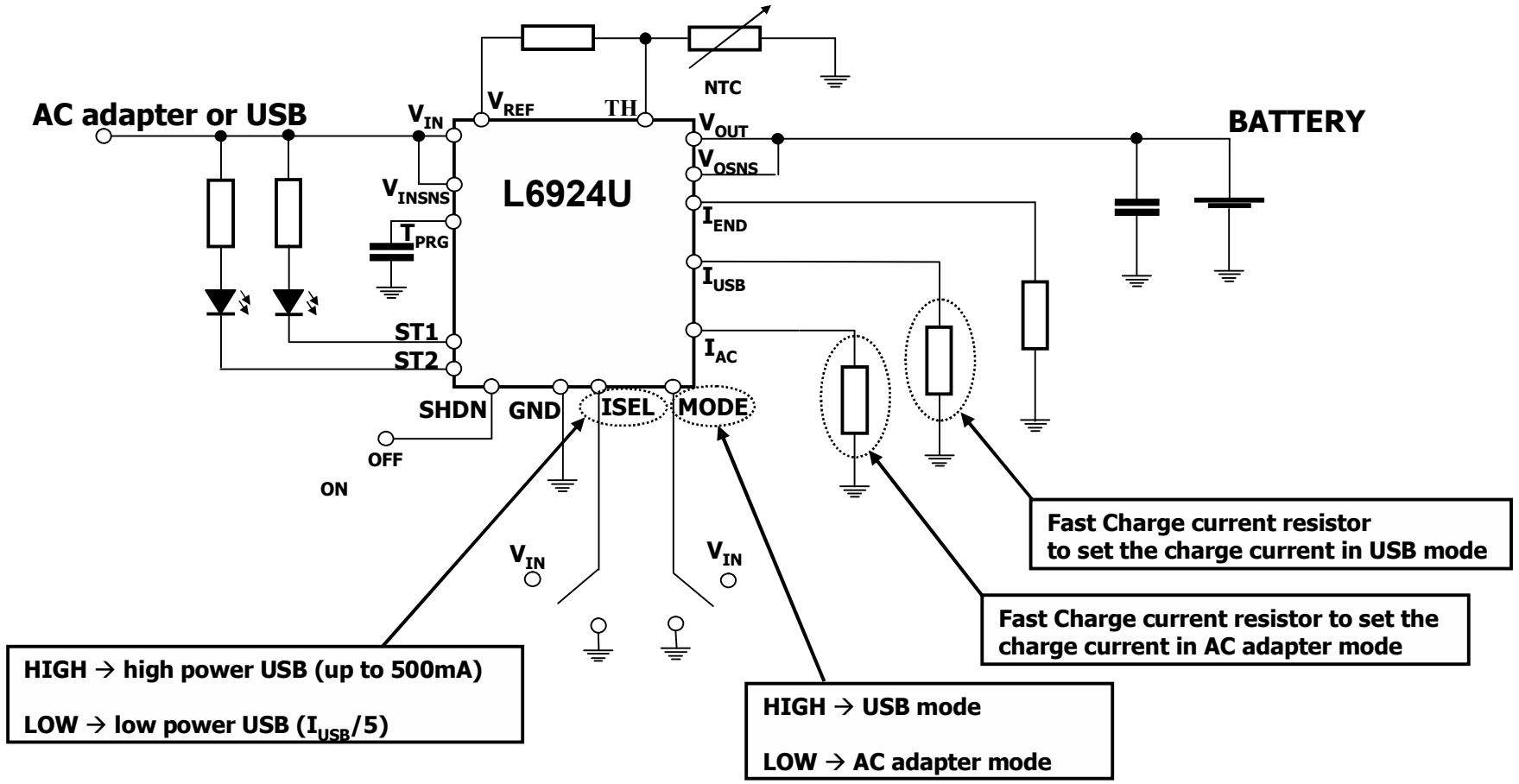
- Fully integrated solution, with a power MOSFET, reverse blocking diode, sense resistor, and thermal protection
- Both linear and quasi-pulse operation
- Closed loop thermal control
- Vin from 2.5V to 12V
- USB BUS-compatible (L6924U)
- Programmable charge current up to 1A
- Programmable charge current up to 500 mA in USB mode (L6924U)
- Programmable pre-charge current (L6924D)
- Support for USB high and low power input (L6924U)
- Programmable end-of-charge current
- Programmable pre-charge voltage threshold (L6924D)
- Programmable charge timer
- Programmable output voltage at 4.1V and4.2V, with ±1% output voltage accuracy (L6924D)
- NTC or PTC thermistor interface for battery temperature monitoring and protection
- Flexible charge process termination (L6924D)
- Full set of default charging parameters
- Status outputs to drive LEDs or to interface with a host processor
- Small VFQFPN 16-leads package (3mm x 3mm)



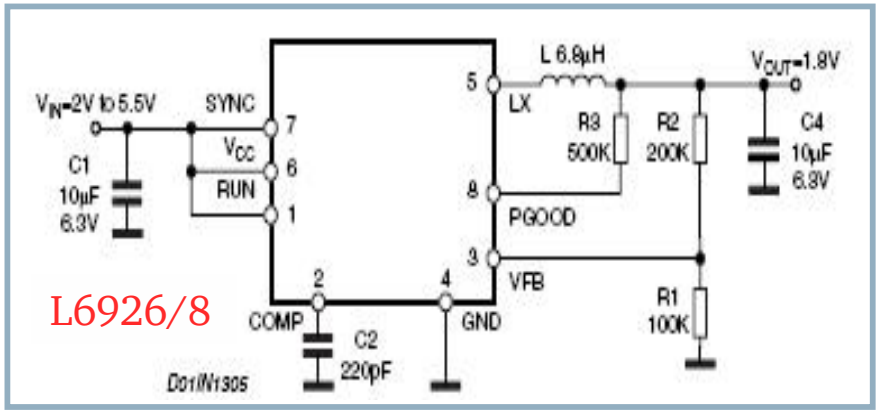
L6924D: typical application circuit

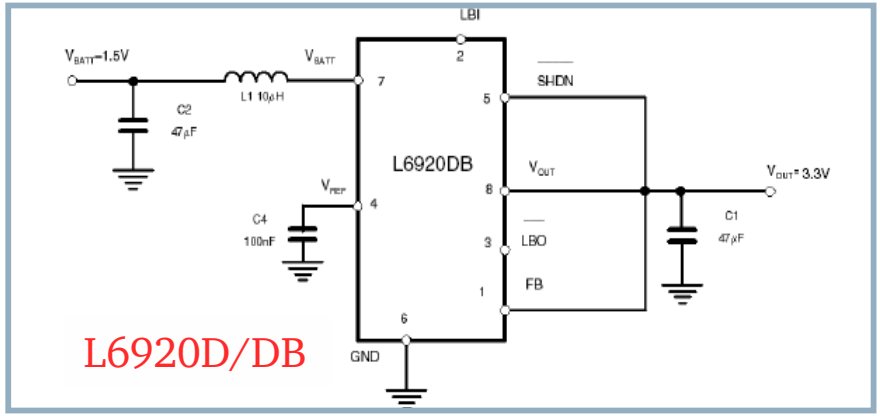


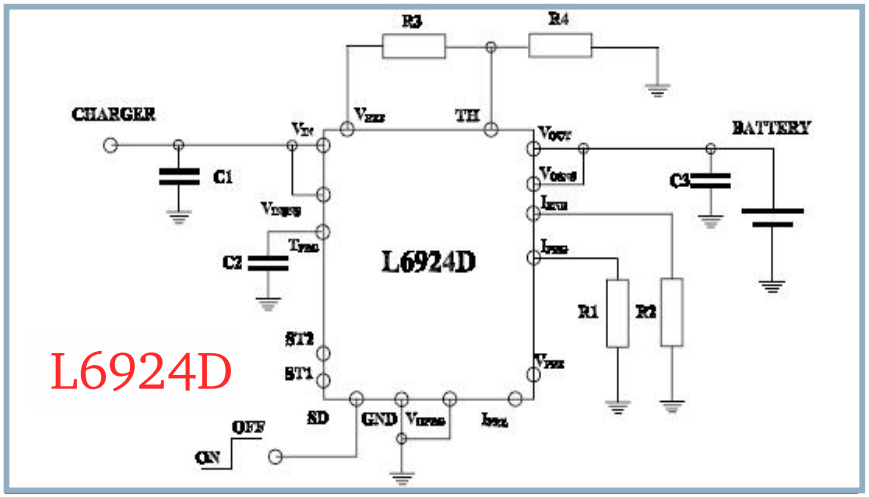
L6924U: typical application circuit

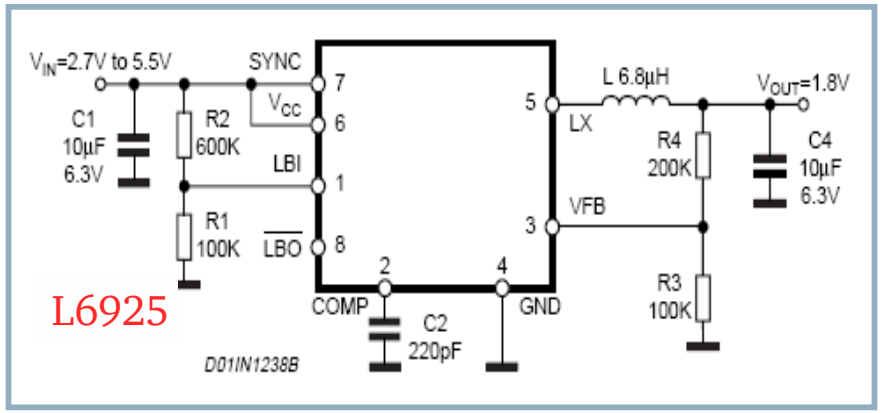


L692x: Application Circuits









L692x main competitors and applications

Competitors:

L6925/26/28
- National Semiconductor (LTC3410)
- Linear Technology (LM3671/LM3673)

- L6920D/DB
- Texas Instruments (TPS6102x)
- Linear Technology

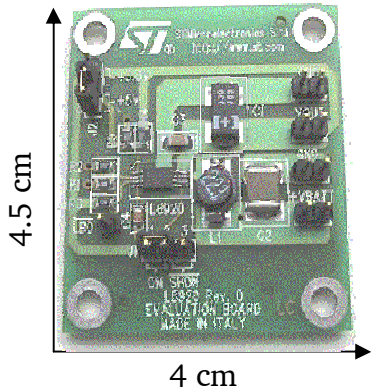
- L6924D/U
- Texas Instruments (BQ24001/2/3)
- Intersil (ISL6294)

Where is used?
- Consumer
- Medical
- Computer

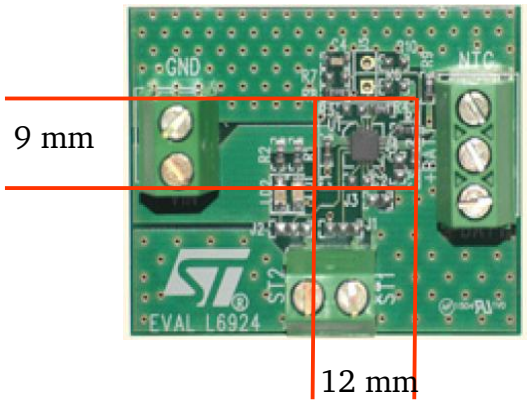
Applications:
- MP3 Players
- PDA
- DSC
- GPS
- hand held equipment
- Glucose meters

L692x promotional tools

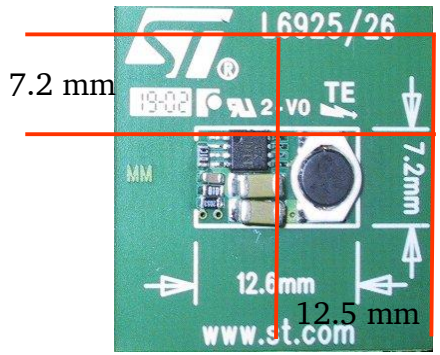
P/N	Datasheet	Application note	Evaluation board
L6920D	Available	--	EVAL6920D
L6920DB	Available	AN2206	EVAL6920DB1
L6924D	Available	--	EVAL6924D
L6924U	Available	--	EVAL6924U
L6925	Available	AN1893	On request *
L6926	Available	AN1881	EVAL6926
L6928	Available	AN2115	EVAL6928



L6924D



L6925D/26/28D

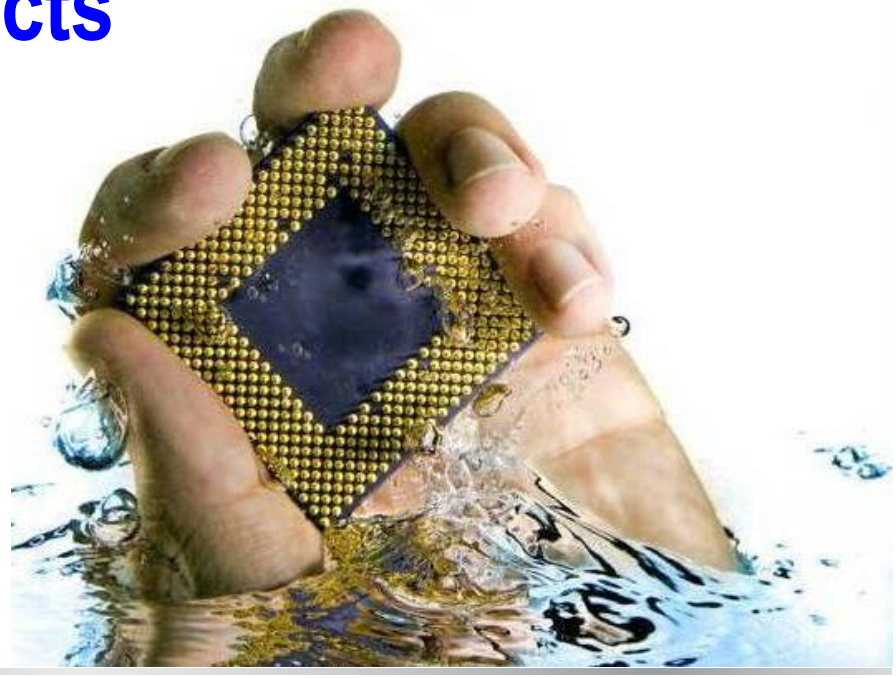


NEW PRODUCTS!!!

Suggested in new projects only when:

Vin<18V

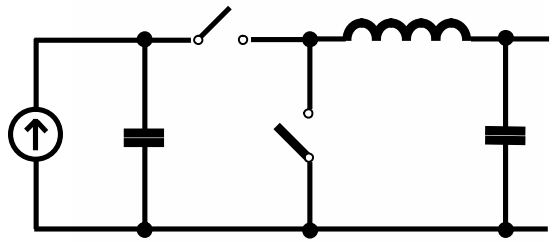
Iout>3A



L5988-9D Key Features

- Up to 4A in small HTSSOP 16 package with minimum external component count
- Synchronous rectification with P-channel power MOS: no bootstrap capacitor
- Wide input voltage range (2.9V up to 18V)
- High switching frequency (400KHz, adjustable up to 1MHz)
- Adjustable Soft-start and Inhibit function
- Embedded over current (adjustable threshold), over voltage and thermal protection
- PGood signal (L5989D) Synchronization capability(180° out of phase) (L5988D)
- Pre-bias start-up capability
- Multifunction pin (adjustable UVLO, latched/no latched OVP and sink-mode capability)
- 1.8v ± 2% reference voltage
- Suitable for MLCC output filter
- Typ R_{DSon}=75mΩ for HS and 65mΩ for the LS

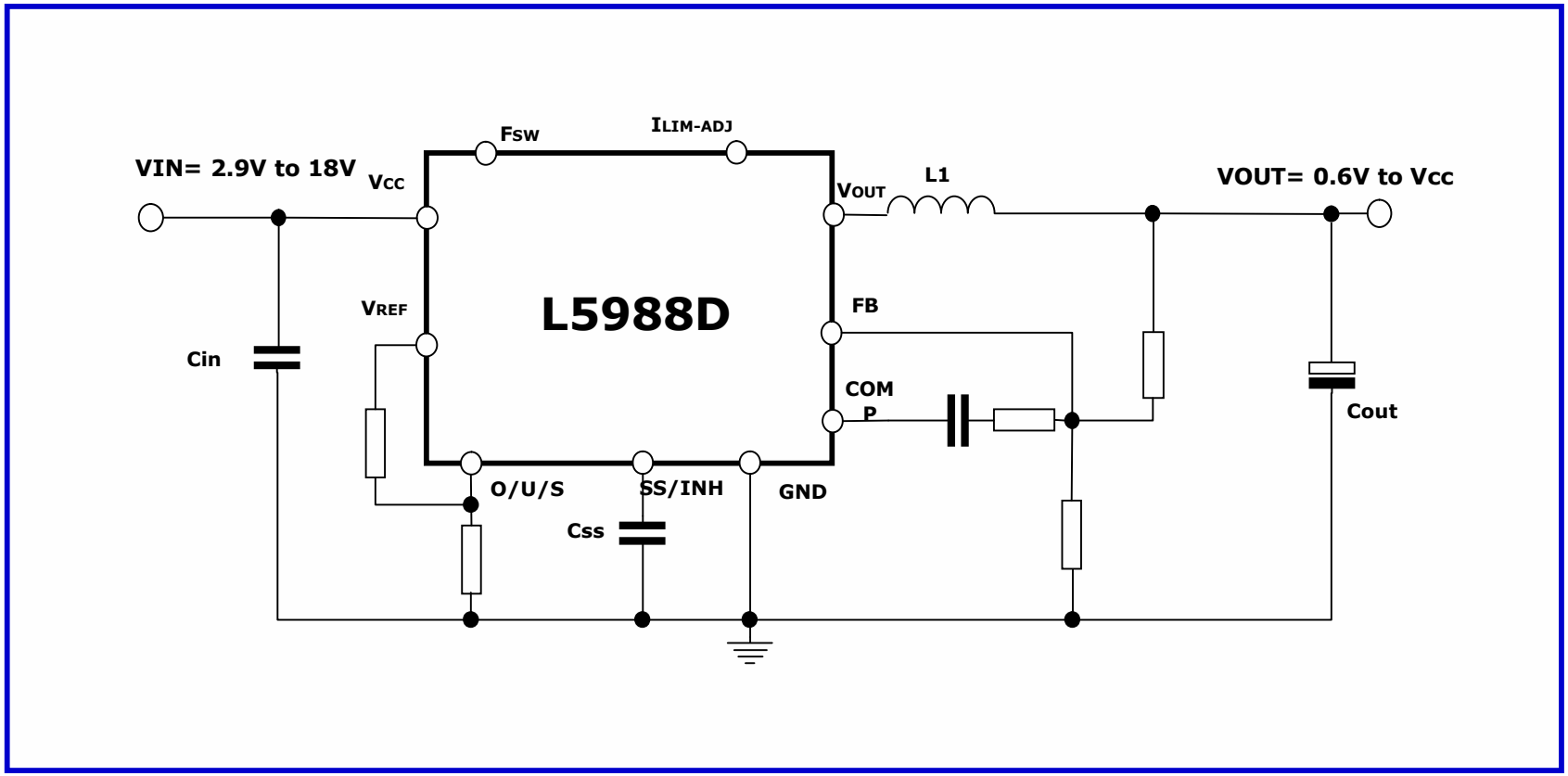
HTSSOP 16 - Rth j-amb 40°C/W



SYNCH. RECT.
For an higher
EFFICIENCY

Device	Package	Ipk [A]	Iout [A]	Vin (V)	Vout (V)	Fsw [KHz]	Extra functions
L5988D	HTSSOP 16	5	4	2.9V to 18V	0.6V to Vin	400	Synchronization
L5989D	HTSSOP 16	5	4	2.9V to 18V	0.6V to Vin	400	Pgood

L5988D Application Test Circuit



L5988/9D main competitors and applications

Competitors:

- National Semiconductor LM2650
- Monolithic Power MP1570, MP22xx series

Where is used?

- Consumer
- Industrial
- Networking
- Computer

Applications:

- Notebook and palmtop computers
- Set top boxes, DVD players and recorders
- Battery chargers, portable data terminals
- Modems, DC-DC converter modules
- Optical storage, hard disk drives, printers, audio and graphic cards

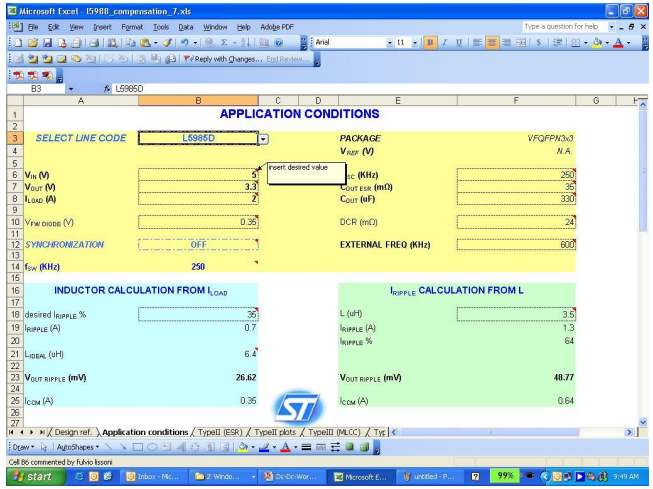
L5988D-89D – Promotional tools

P/N	Datasheet	Application note	Evaluation board
L5988D	available	--	EVAL5988D
L5989D	available	--	EVAL5989D

SPREAD SHEET:

- to dimension output filter
- to compensate the loop
- to estimate Tj and efficiency

Now available on request !

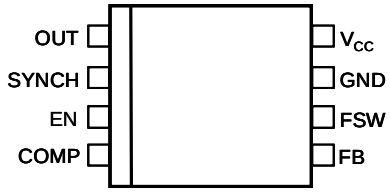


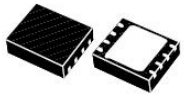
UNDER DEVELOPMENT!!!

Increasing the input voltage

L7980/A-1/A Key Features

- More than 3A in both small QFN3x3-8L and HSOP8 packages with minimum external component count
- P-channel power MOS: no bootstrap capacitor
- Wide input voltage range (4.5V up to 28V)
- High switching frequency (250KHz, adjustable up to 1MHz) with Synchronization capability (180° out of phase)
- Internal Soft-start
- Enable pin
- Embedded protection features (Over current, Over temperature)
- Suitable for MLCC output filter
- Typ R_{DSon}=180mΩ
- 100% maximum duty cycle
- Synchronization capability (180° out of phase)
- Alternative topologies: inverting buck-boost, positive buck boost





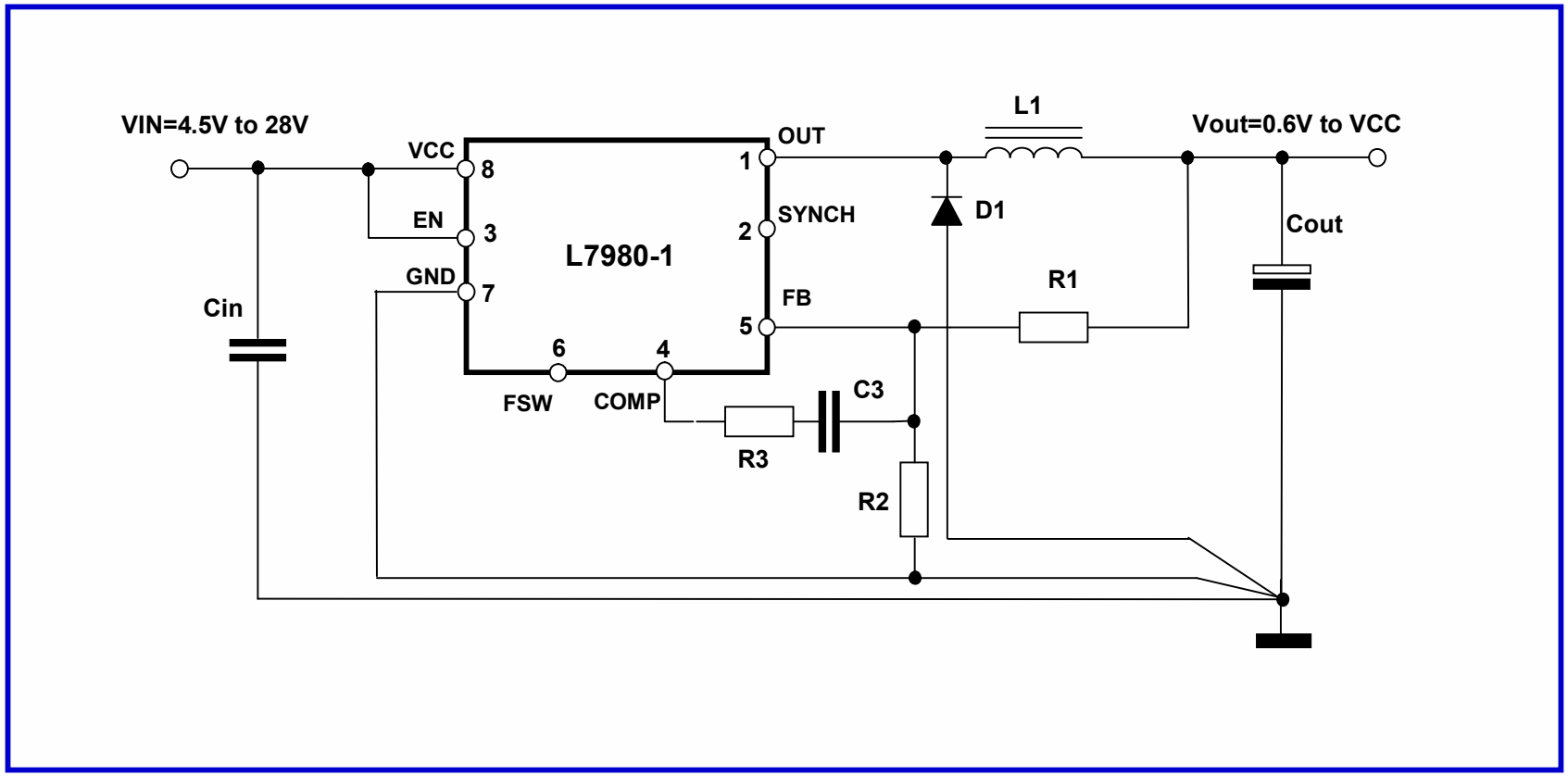
QFN 3x3 8L - Rth j-amb 60°C/W

HSO8 - Rth j-amb 40° C/W

Device	Package	Ipk [A](*)	Iout [A]	Vin [V]	Vout [V]	Fsw [kHz]	Extra functions
L7980/A	QFN3x3-8L/HSOP8	2.5	2.0	4.5 – 28	0.6 - Vin	250 – 1000 (adj.)	Soft start, Synch, Enable
L7981/A	QFN3x3-8L/HSOP8	3.7	3.0	4.5 – 28	0.6 – Vin	250 – 1000 (adj.)	Soft start, Synch, Enable

(*) Minimum switch current limit

L7980/A-1/A Application Test Circuit



L7980-1 - Promotional tools

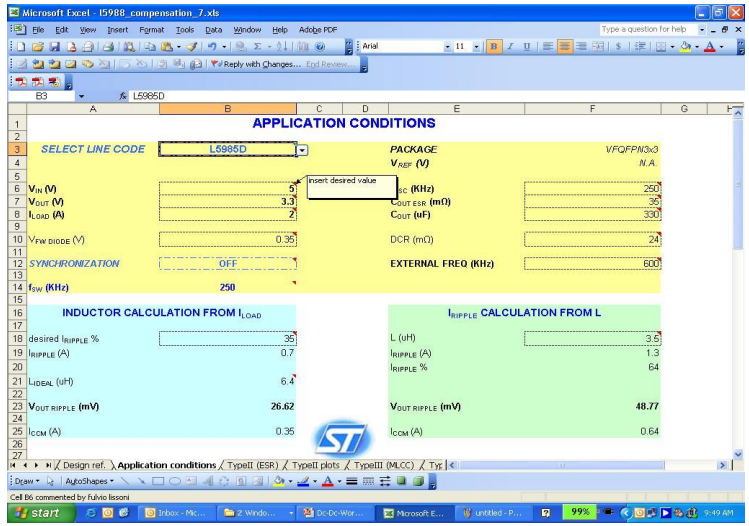
P/N	Datasheet	Evaluation Board
L7980	Available	EVAL7980 (*)
L7980A	Available	EVAL7980A (*)
L7981	Available	EVAL7981 (*)
L7981A	Available	EVAL7981A (*)

*** ON REQUEST**

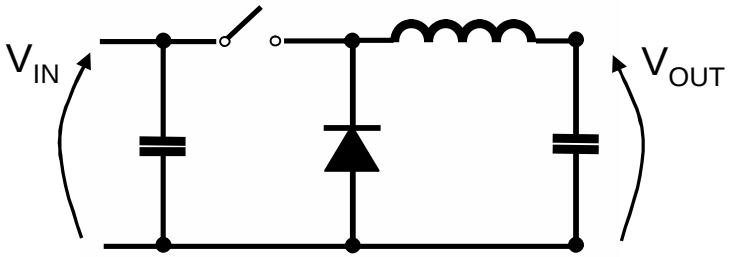
SPREAD SHEET:

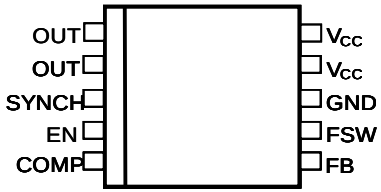
- to dimension output filter
- to compensate the loop
- to estimate Tj and efficiency

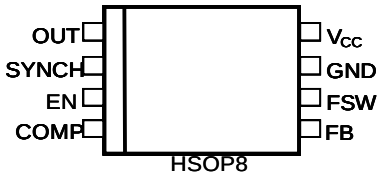
Now available on request !



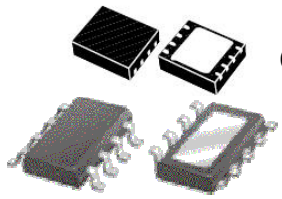
L7985-6 Step-down







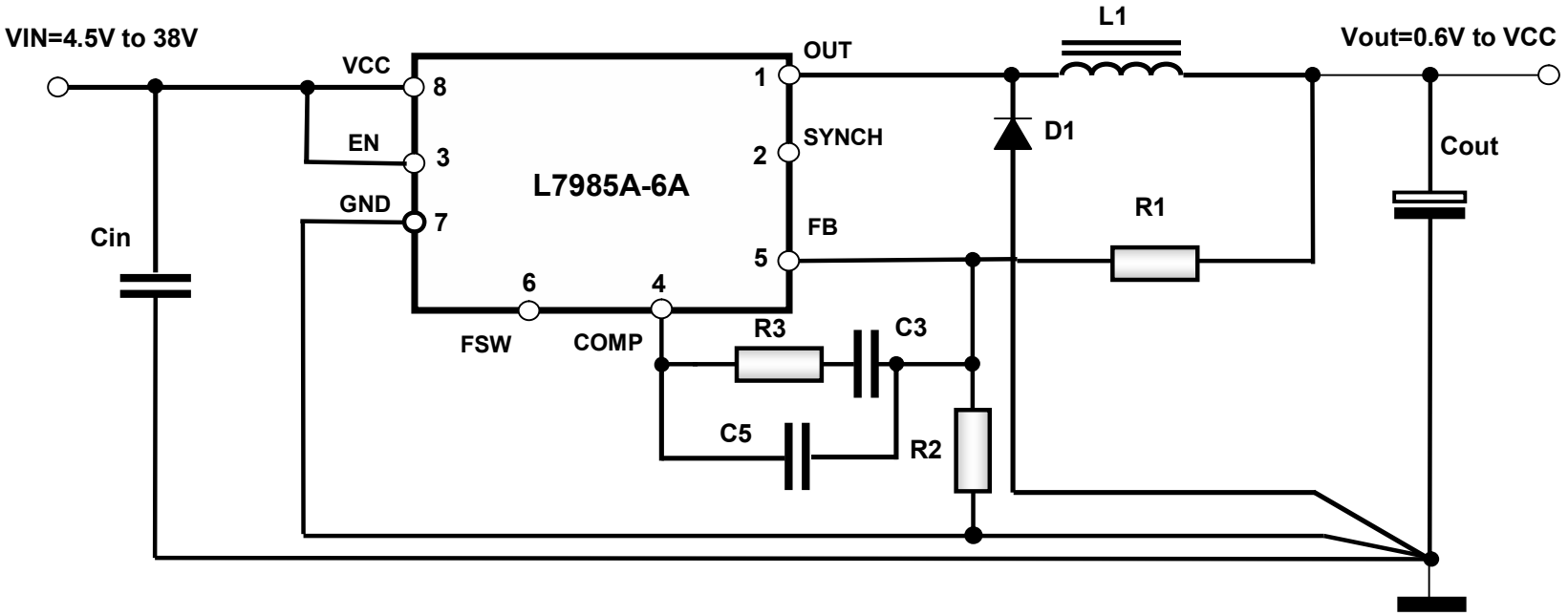
- More than 3A in both small QFN3x3-10L and HSOP8 packages with minimum external component count
- P-channel power MOS: no bootstrap capacitor & 100% maximum duty cycle
- Wide input voltage range (4.5V up to 38V)
- High switching frequency (250KHz, adjustable up to 1MHz) with Synchronization capability (180° out of phase)
- Internal Soft-start
- Enable pin
- Suitable for MLCC output filter
- Embedded protection features (Over current, Over temperature)
- Typical RDSon=150mΩ
- Alternative topologies: inverting buck-boost, positive buck boost



QFN 3x3 10L - Rth j-amb 60°C/W

HSO8 - Rth j-amb 40° C/W

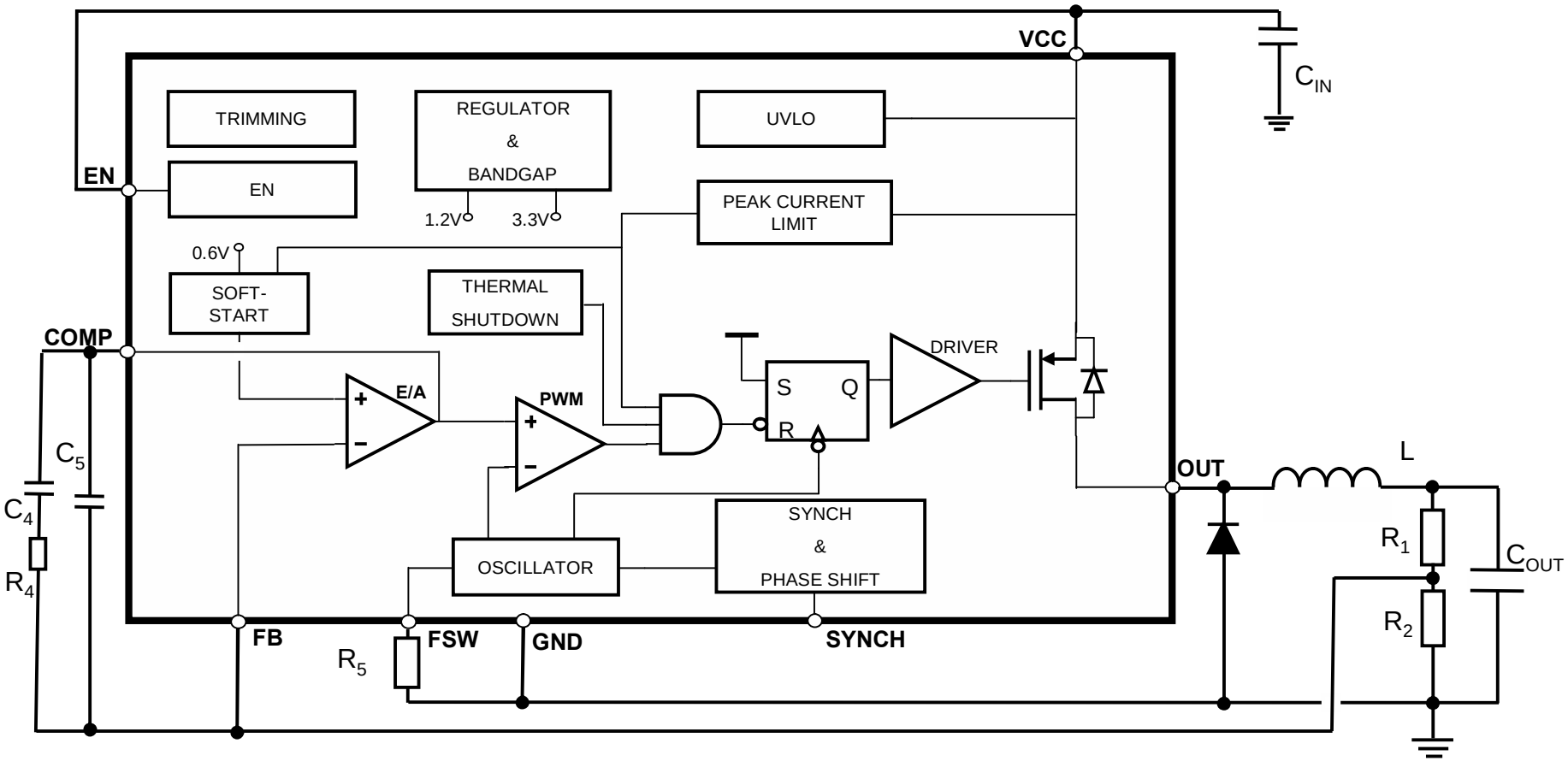
L7985-6 - Typical application circuit



Device	Package	Ipk [A] (*)	Iout [A]	Vin [V]	Vout [V]	Fsw [kHz]	Extra functions
L7985/A	QFN3x3-10L/HSOP8	2.5	2.0	4.5 – 38	0.6 - Vin	250 – 1000 (adj.)	Soft start, Synch, Enable
L7986/A	QFN3x3-10L/HSOP8	3.7	3.0	4.5 – 38	0.6 – Vin	250 – 1000 (adj.)	Soft start, Synch, Enable

(*) Minimum switch current limit

L7985-6 - Internal Block Diagram



L7985-6 - Promotional tools

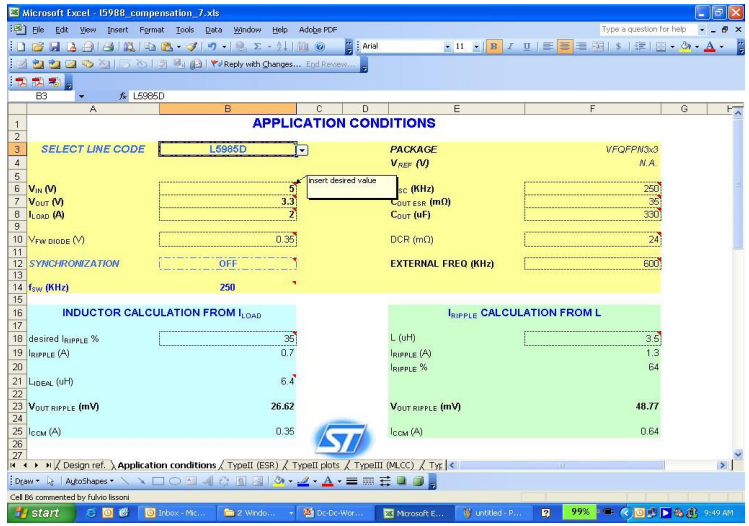
P/N	Datasheet	Evaluation Board
L7985	Available	EVAL7985 (*)
L7985A	Available	EVAL7985A (*)
L7986	Available	EVAL7986 (*)
L7986A	Available	EVAL7986A (*)

*** ON REQUEST**

SPREAD SHEET:

- to dimension output filter
- to compensate the loop
- to estimate Tj and efficiency

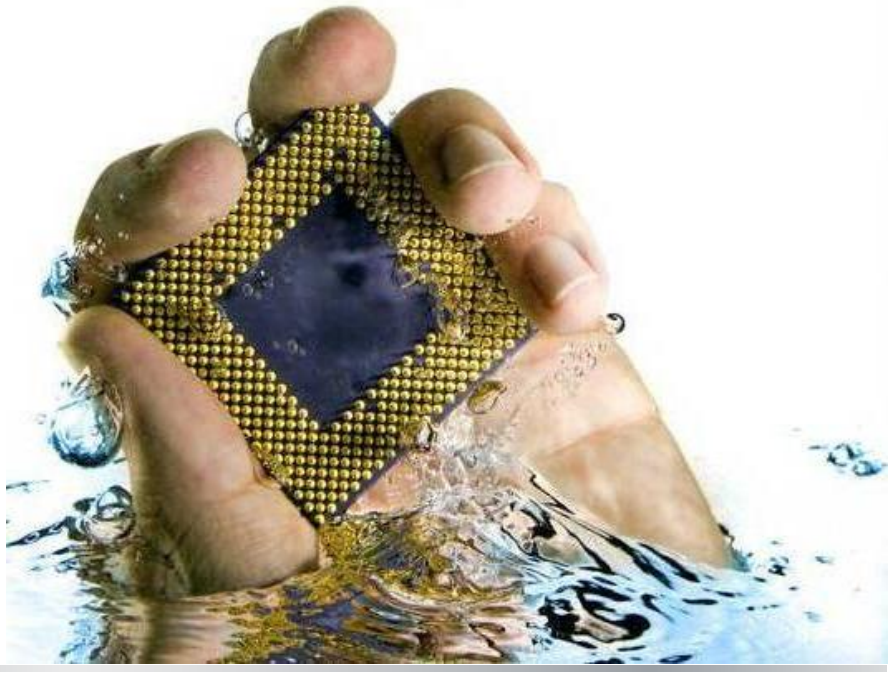
Now available on request !



Comparison table

Feature \ Device	L597x	L598x	L5988-9D	L7980/1	L7985/6
Input Voltage (V)	4.4 to 36	2.9 to 18	2.9 to 18	4.5 to 28	4.5 to 38
Iout (A)	Up to 2	Up to 3	4	Up to 3	Up to 3
Package	SO-8/HSOP8	DFN3x3-8L	HTSSOP16	DFN3x3-8L/ HSOP-8L	DFN3x3-10L/ HSOP-8L
Synch rect.	--	--	Yes	--	--
Rdson (typ. mΩ)	250	140	75 (HS)-65 (LS)	180	150
Fsw (kHz)	250	250 Adj up to 1000	400 Adj 200 to 1000	250 Adj up to 1000	250 Adj up to 1000
Soft Start	--	Internal digital	Adj	Internal digital	Internal digital
Synchronization	Yes	with phase shift 180°	with phase shift 180°	with phase shift 180°	with phase shift 180°
MLCC as Cout	--	Yes	Yes	Yes	Yes
Enable/INH	Yes	Yes	Yes	Yes	Yes
Vref	Yes	--	Yes	--	--

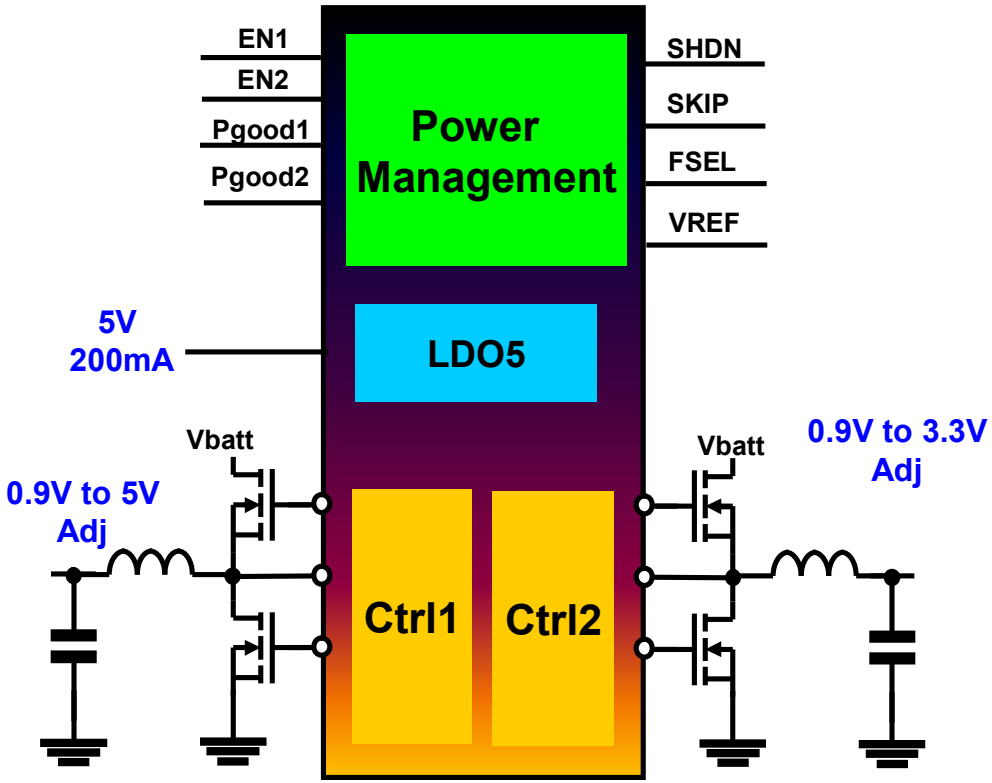
DC/DC CONVERTER FOR MULTIPLE SOLUTION



PM6680A: DUAL CTRL Adj

MCU/FPGA Power

❑Controller	Constant ON TIME
❑Vin Range	4.5V to 36V Battery Input
❑Vo Precision	1.0% Over Line and Load
	0.9V to 3.3V, 0.9 to 5V adj
❑Linear	5V - 100mA (200mA peak)
❑Current Limit	Current-Sense on Rdson LS
❑Protections	UVL, OVP, Ilim, Pgood
❑Soft Start	Fixed internal at 2ms
❑Frequency	Selectable 200kHz to 500kHz
❑Vref	1.25V ±1% Reference Output
❑Light load	Pulse skip
❑Package	VFQFPN(5x5) 32 pin
❑Others	Fsw min 33kHz at light load
	Soft Off discharge output cap

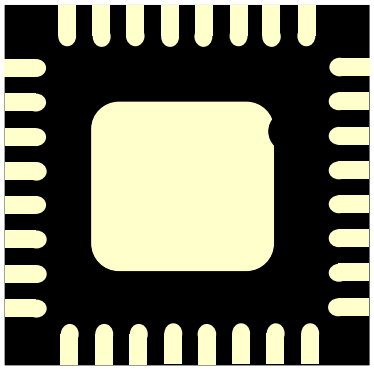


PM6680A: PACKAGE & Pin Out

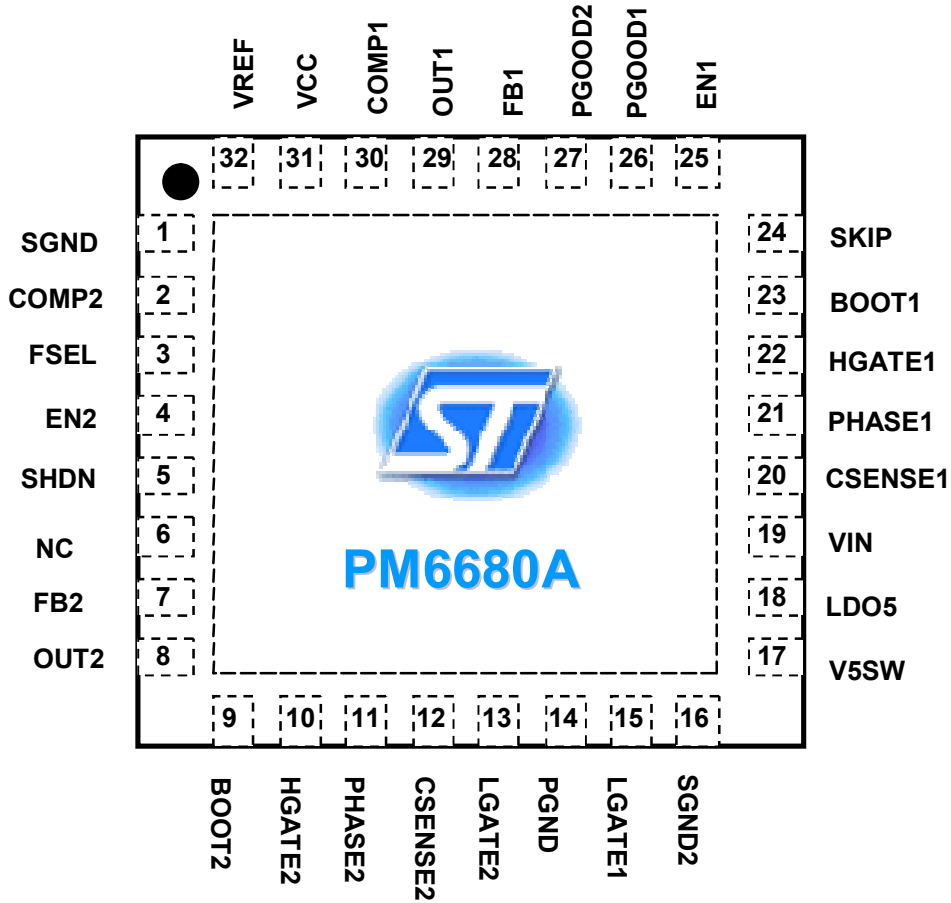
VFQFPN 5x5x1mm 32pin (TQFN)

TOP VIEW

SIDE VIEW



BOTTOM VIEW



Rth j/a = 35 °C/W

4-layer JEDEC board

PM6670A: PWM ctrl for DDR2-3

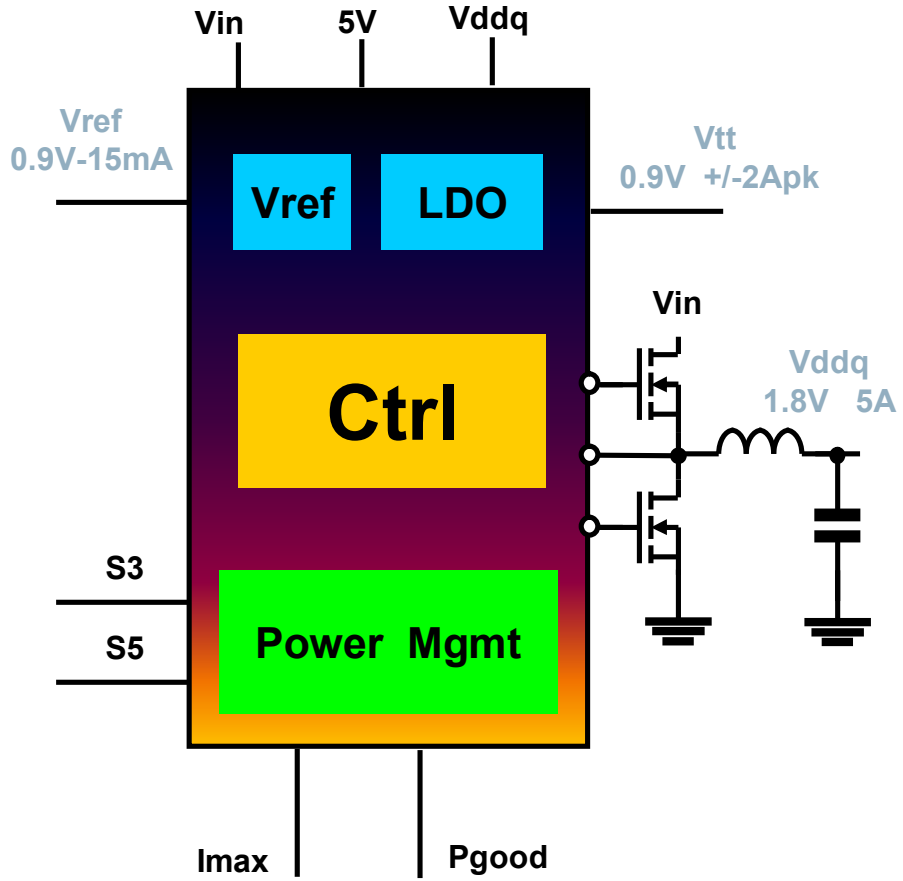
VDDQ Sync Buck Controller

- Wide-Input Voltage Range: 3.0V to 36V
- Supports Ceramic Output Capacitors
- Supports Soft-Off in S4/S5 States
- Current Sensisng from RDS(on)
- Output voltage 1.8V (DDR2) or 1.5V (DDR3) or adj.

VTT 2-Apk LDO

VREF Buffered Reference

- Capable to Sink and Source 2A
- Requires only 20uF Ceramic Output Capacitor
- Buffered Low Noise 15-mA Reference
- Accuracy ±18 mV for both VREF and VTT
- Supports High-Z in S3 and Soft-Off in S4/S5
- Tracking with Vddq



PM6670S: DDR2-3 power supply controller

VDDQ C.O.T. Buck Controller

- Wide-Input Voltage Range: 4.5V to 28V
- 200kHz to 500kHz switching frequency
- Supports Ceramic Output Capacitors
- Supports Soft-Off in S4/S5 States
- Current Sensing from RDSON
- Output voltage 1.8V (DDR2) or 1.5V (DDR3) or adj

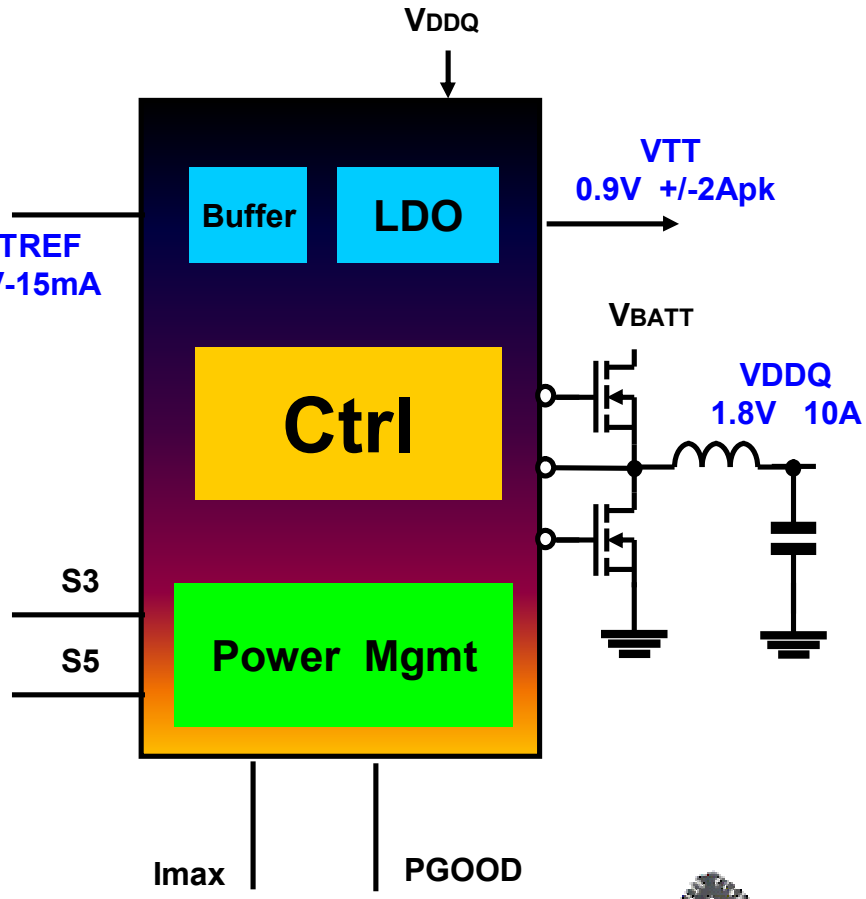
VTTREF Buffered Reference

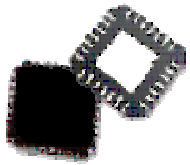
- ±15mA Low Noise Output
- ±2% Accuracy respect to VDDQ/2

VTT ±2Apk LDO

- Capable to Sink and Source 2A
- Requires only 20uF Ceramic Output Capacitor
- Output Current Foldback
- Supports High-Z in S3 and Soft-Off in S4/S5

- Package VFQFPN 4x4 - 24pin

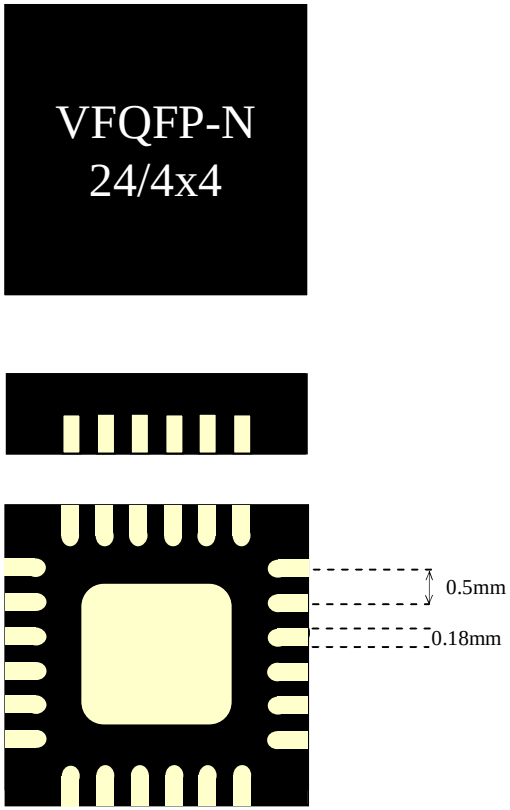


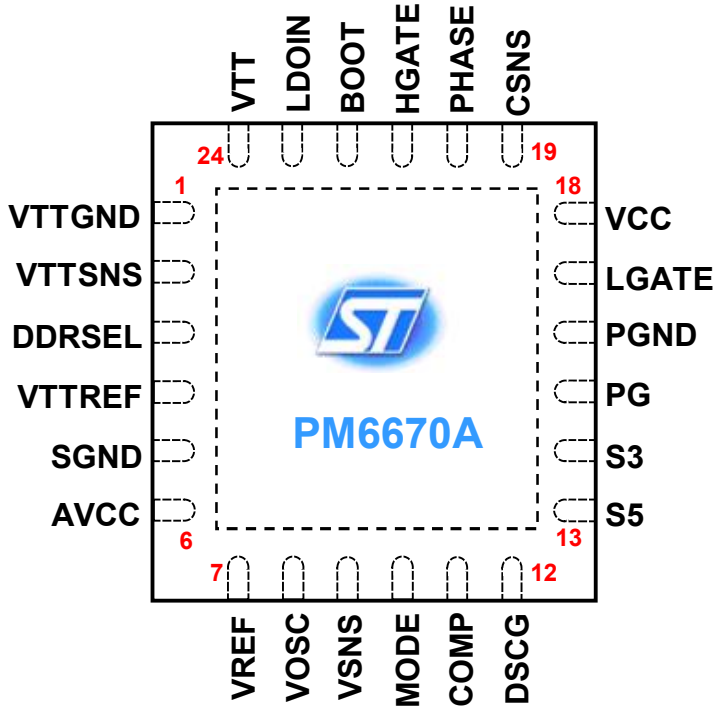


VFQFPN 4x4- 24

PM6670A: PACKAGE & Pin Out

VFQFPN 4x4x1mm 24pin (TQFN)





Rth j/a = 42 °C/W

4-layer JEDEC board

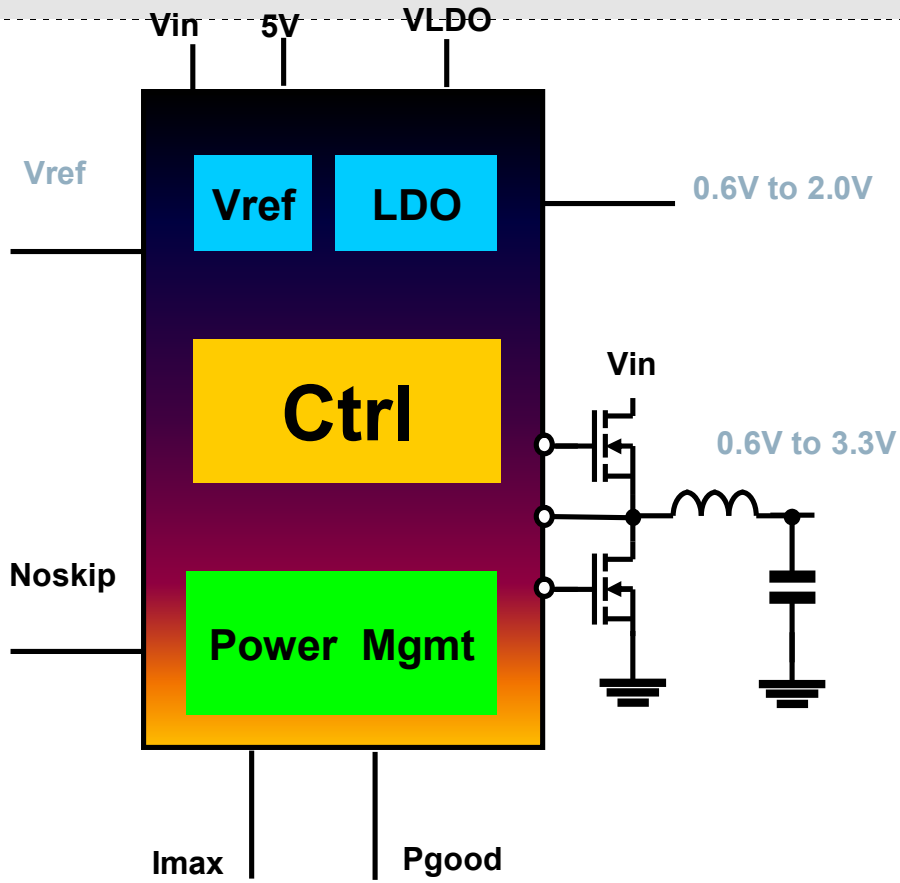
PM6675A: PWM ctrl for GDDR3-4

Sync Buck Controller

- Wide-Input Voltage Range: 3.0V to 36V
- Supports Ceramic Output Capacitors
- Supports Soft-Off
- Current Sensing from RDS(on)
- Output voltage adj from 0.6V to 3.3V

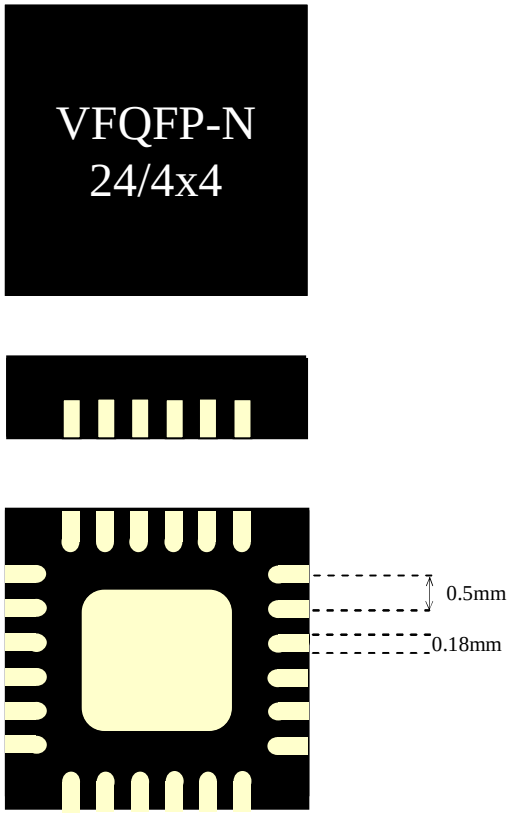
2-Apk LDO

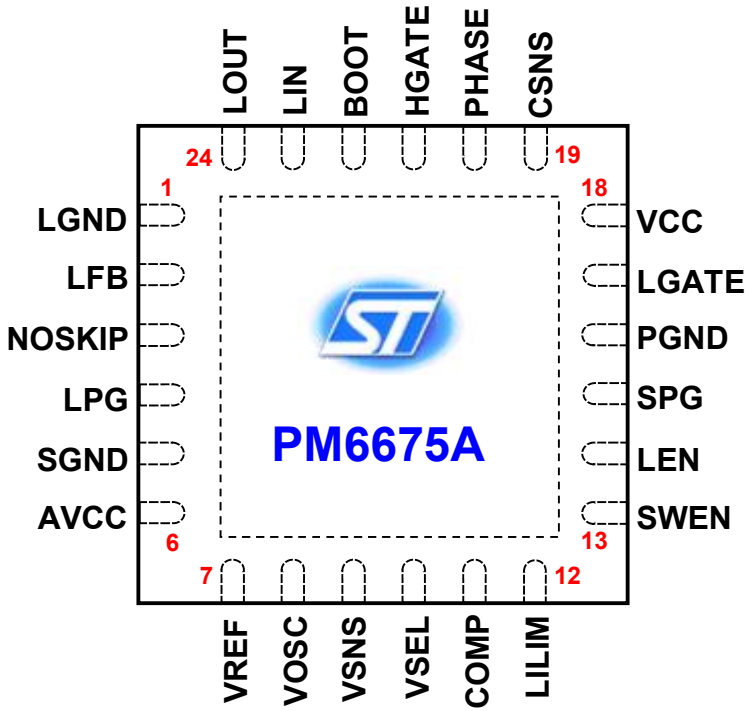
- Capable to Sink and Source 2A
- Requires only 20uF Ceramic Output Capacitor
- Output voltage adj from 0.6V to 2.0V



PM6675A: PACKAGE & Pin Out

VFQFPN 4x4x1mm 24pin (TQFN)





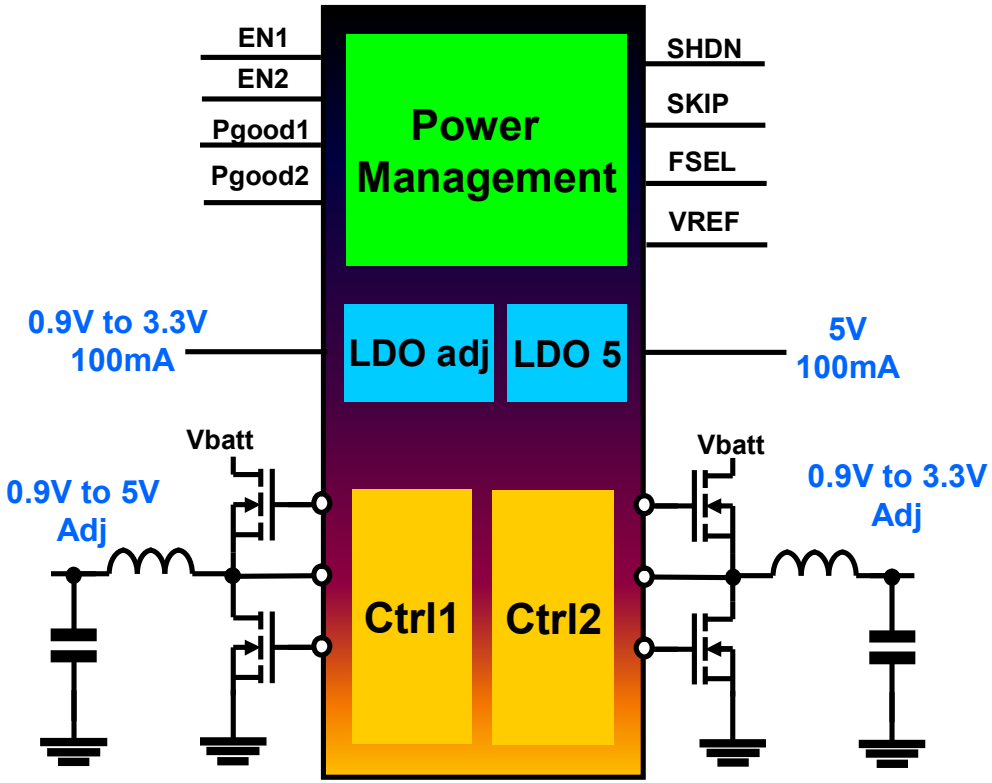
Rth j/a = 42 °C/W

4-layer JEDEC board

PM6681A: DUAL CTRL+LDO adj

MCU/FPGA Power

❑Controller	Constant ON TIME
❑Vin Range	4.5V to 36V Battery Input
❑Vo Precision	1.0% Over Line and Load
	0.9V to 3.3V, 0.9 to 5V adj
❑Linear	adj. 0.9V to 3.3V and 5V - 50mA
	❑ (100mA peak)
❑Current Limit	Current-Sense on Rdson LS
❑Protections	UVL, OVP, Ilim, Pgood
❑Soft Start	Fixed internal at 2ms
❑Frequency	Selectable 200kHz to 500kHz
❑Vref	1.25V ±1% Reference Output
❑Light load	Pulse skip
❑Package	VFQFPN(5x5) 32 pin
❑Others	Fsw min 33kHz at light load
	Soft Off discharge output cap

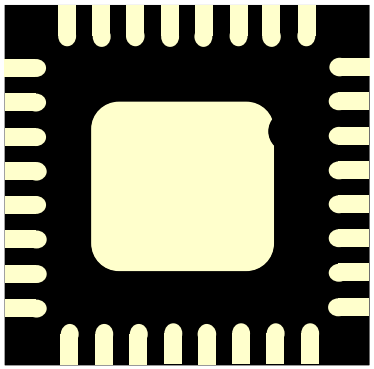


PM6681A: PACKAGE & Pin Out

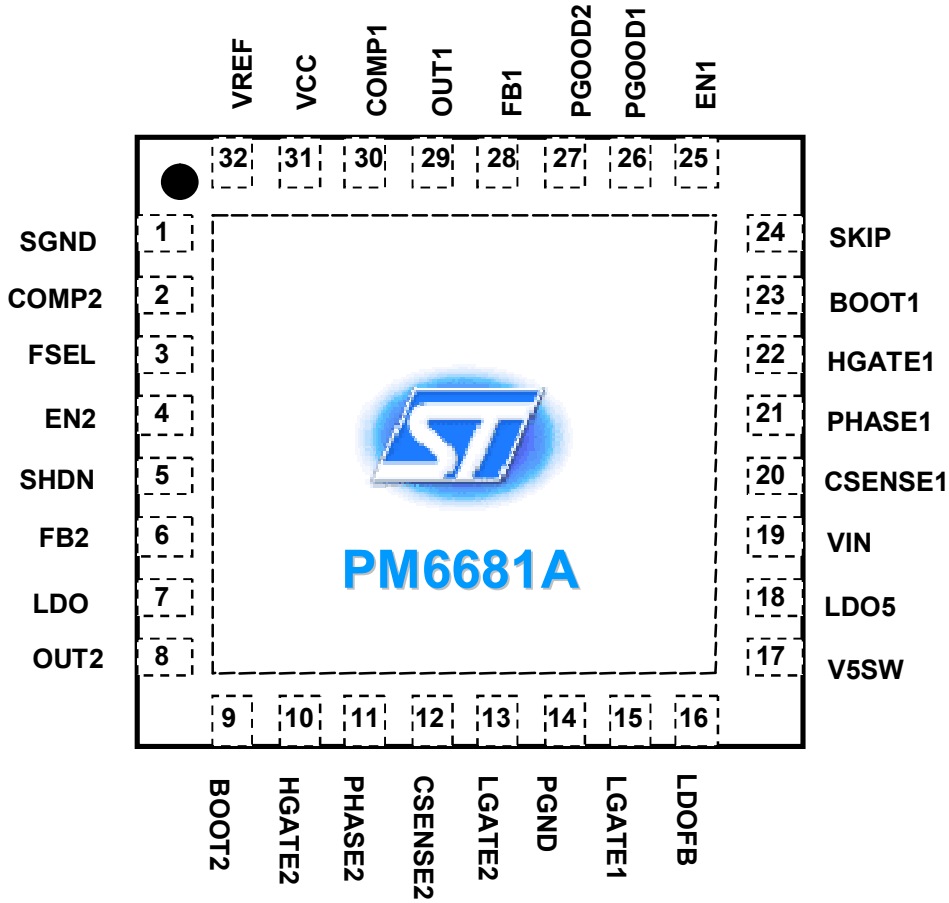
VFQFPN 5x5x1mm 32pin (TQFN)

TOP VIEW

SIDE VIEW



BOTTOM VIEW



Rth j/a = 35 °C/W

4-layer JEDEC board

PM6641: Monolithic VR for Multimedia applications

DDR2/3 (VDDQ) and Chipset Supply

- Three Out-Of-Phase, independent SMPS
- Input Voltage Range: 2.7V to 5.5V
- Fast Response, Constant Frequency CM Control
- Pulse-Skipping at light loads
- 500kHz to 1MHz Switching Frequency
- 0.8V to 4.7V Adjustable Outputs Voltage
- Supports Ceramic Output Capacitors
- S3/S5 States-Compliant DDR Section
- Selectable Tracking-Discharge for VDDQ
- Programmable Current Limit and SS
- Active Soft-End for all Outputs
- Latched UVP and OVP
- Thermal Protection

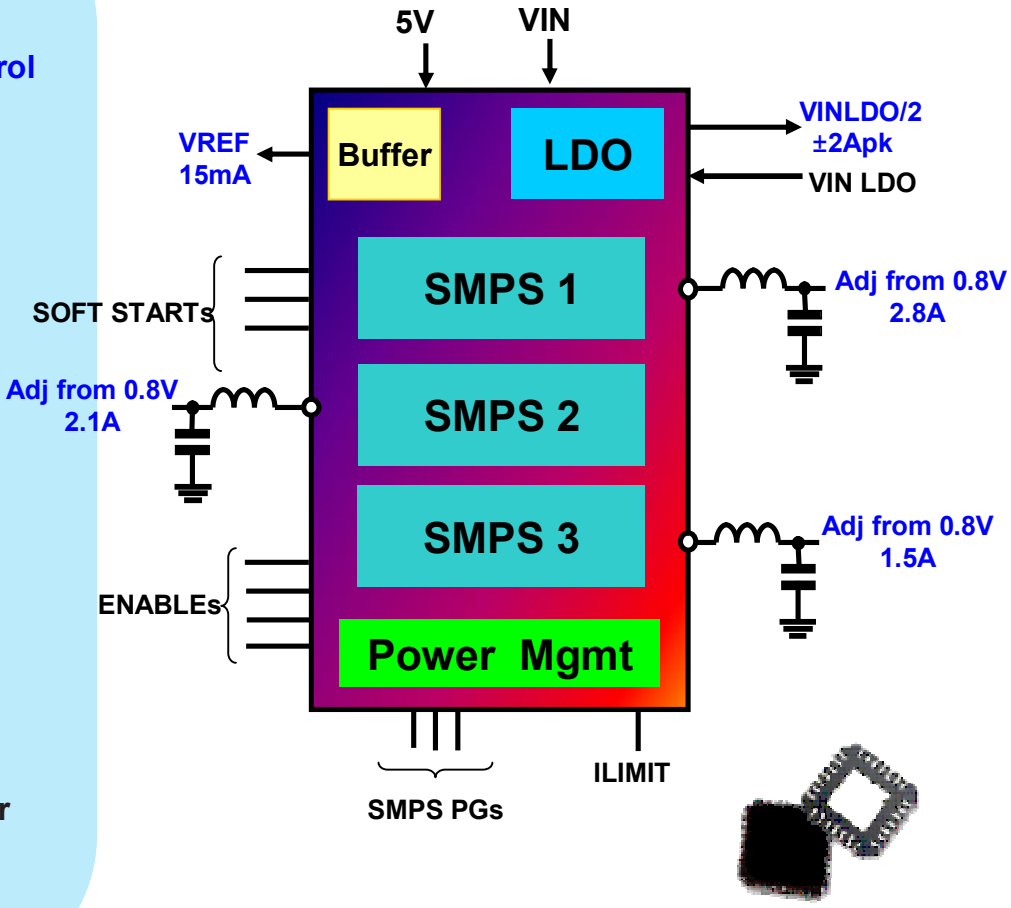
DDR2/3 Reference (VTTREF)

- ±15mA Low Noise Buffered Output
- ±2% Accuracy respect to VDDQ/2

DDR2/3 Termination Voltage (VTT)

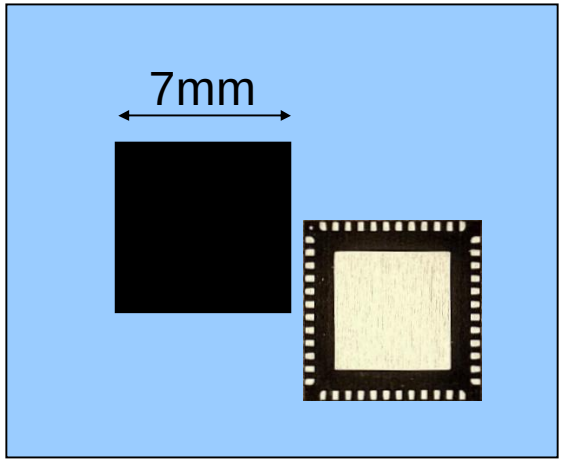
- Up to ±2A LDO Linear Regulator
- Requires only 20uF Ceramic Output Capacitor
- Output Current Foldback
- Supports High-Z in S3 and Soft-Off in S4/S5

- Small Package: VFQFPN 7x7 - 48pin

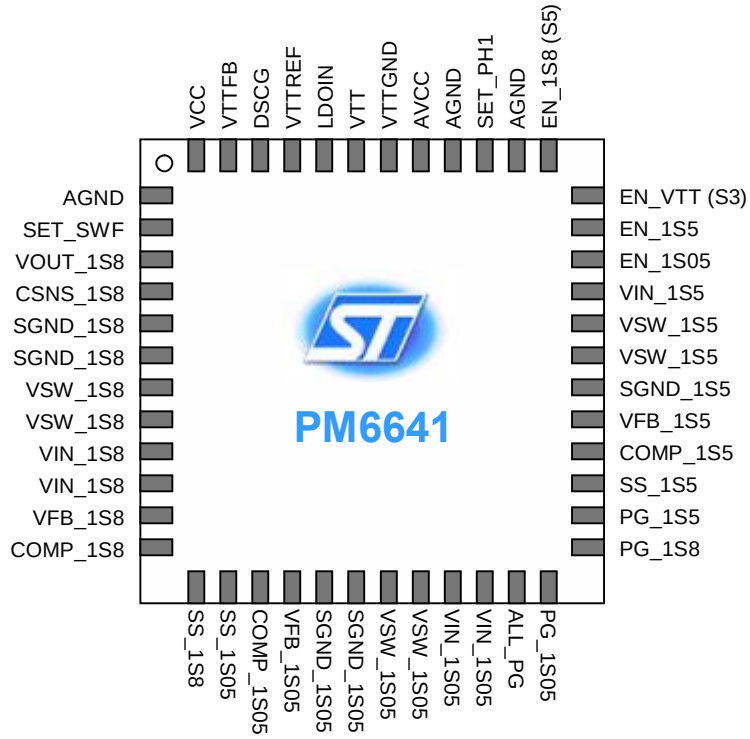


VFQFPN 7x7- 48

PM6641: Pinout and Package



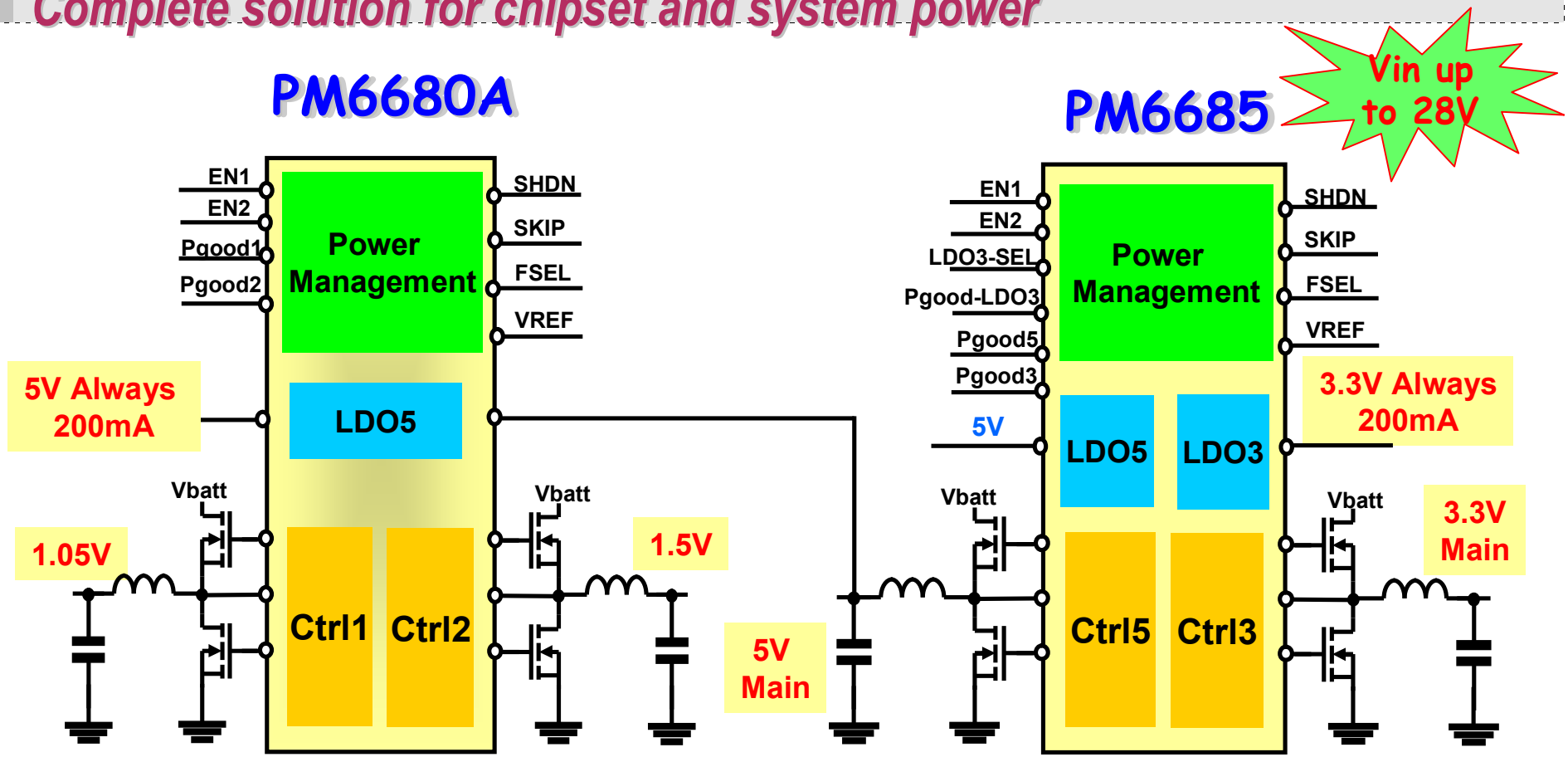
VFQFPN 7x7 – 48



$R_{Th_{j-a}} = 25\ °C/W$

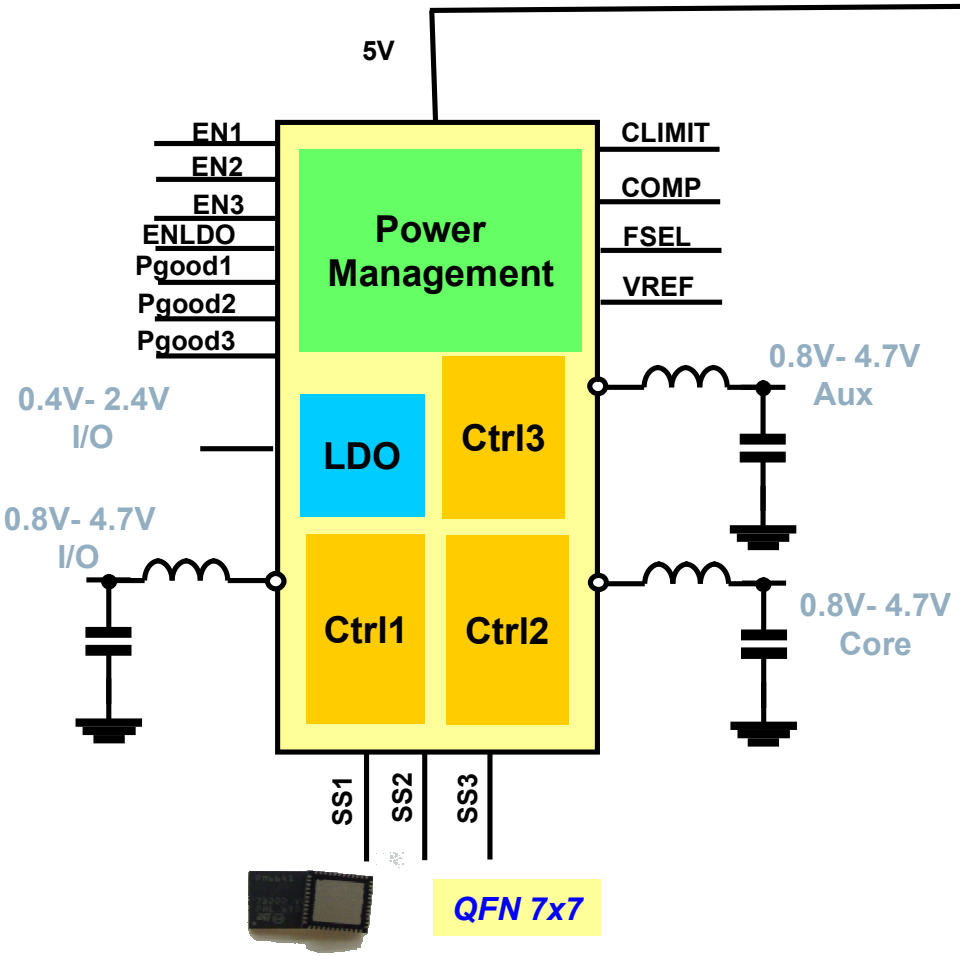
(4-layer JEDEC board)

Complete solution for chipset and system power



Flexible and Complete Solution-24V BUS for FPGA/MCU Power Supply

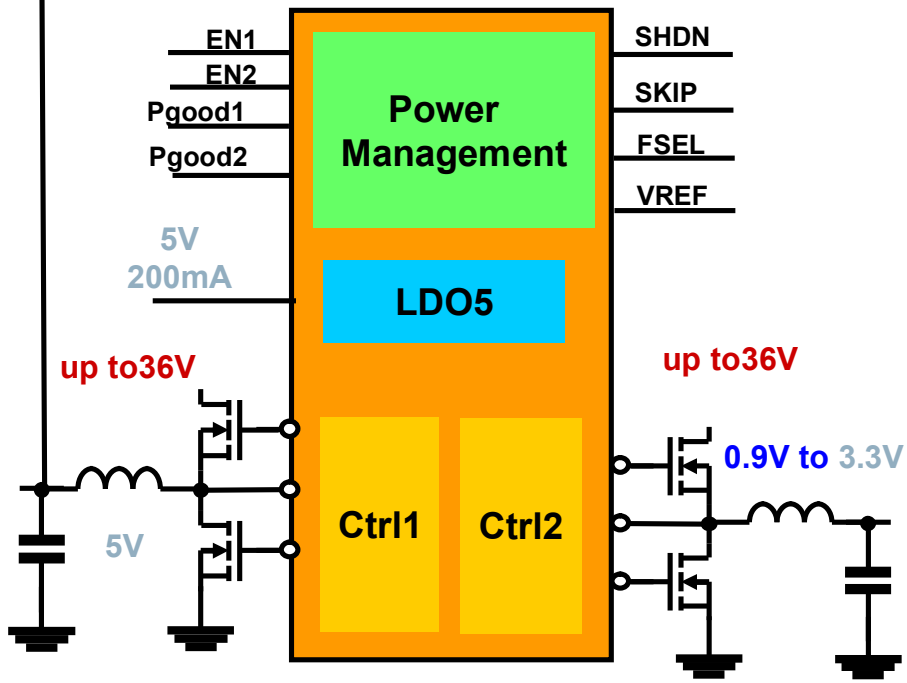
PM6641



QFN 7x7

PM6680A

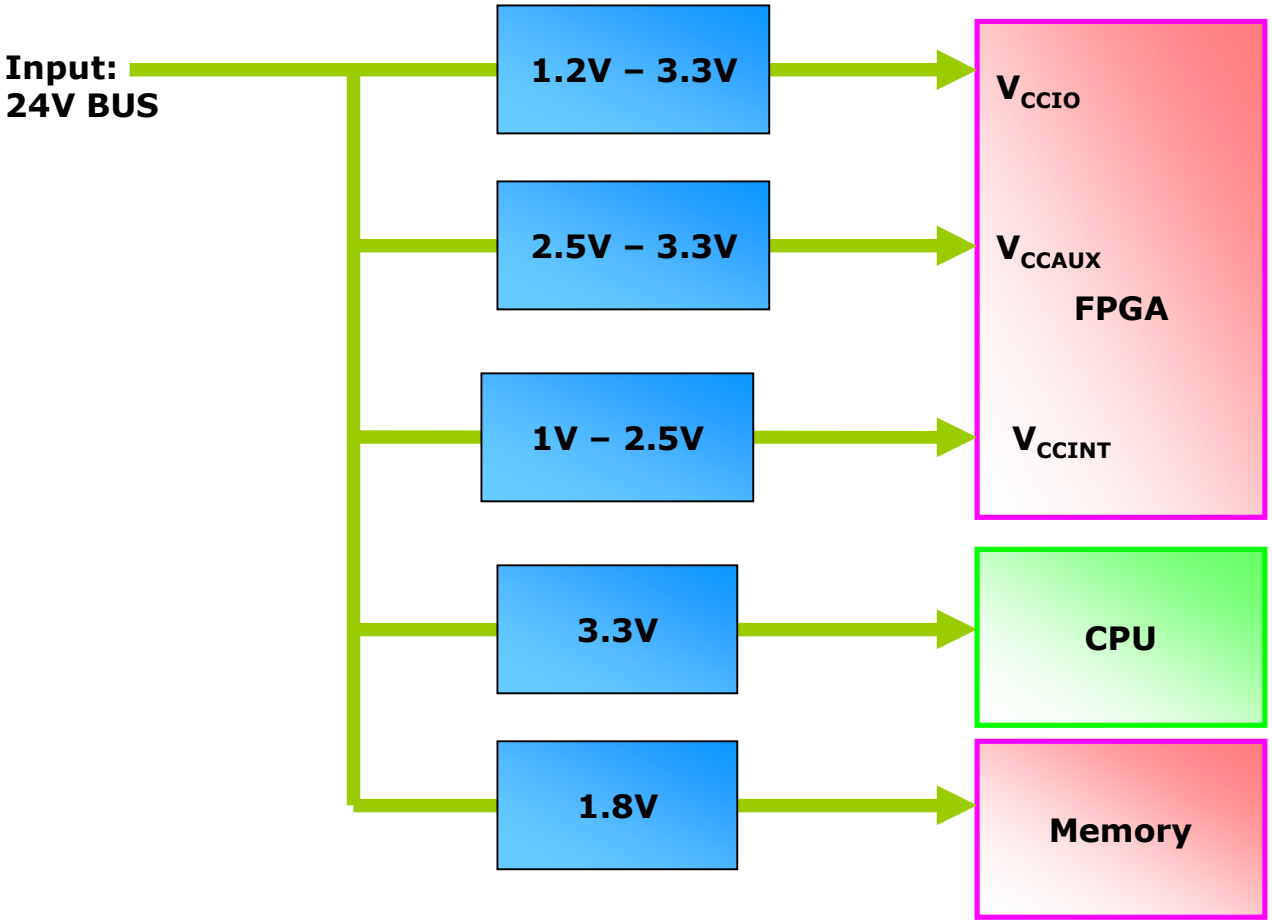
Vin up to 36V

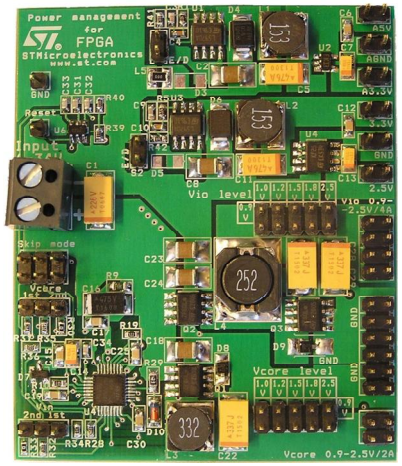


QFN 5x5

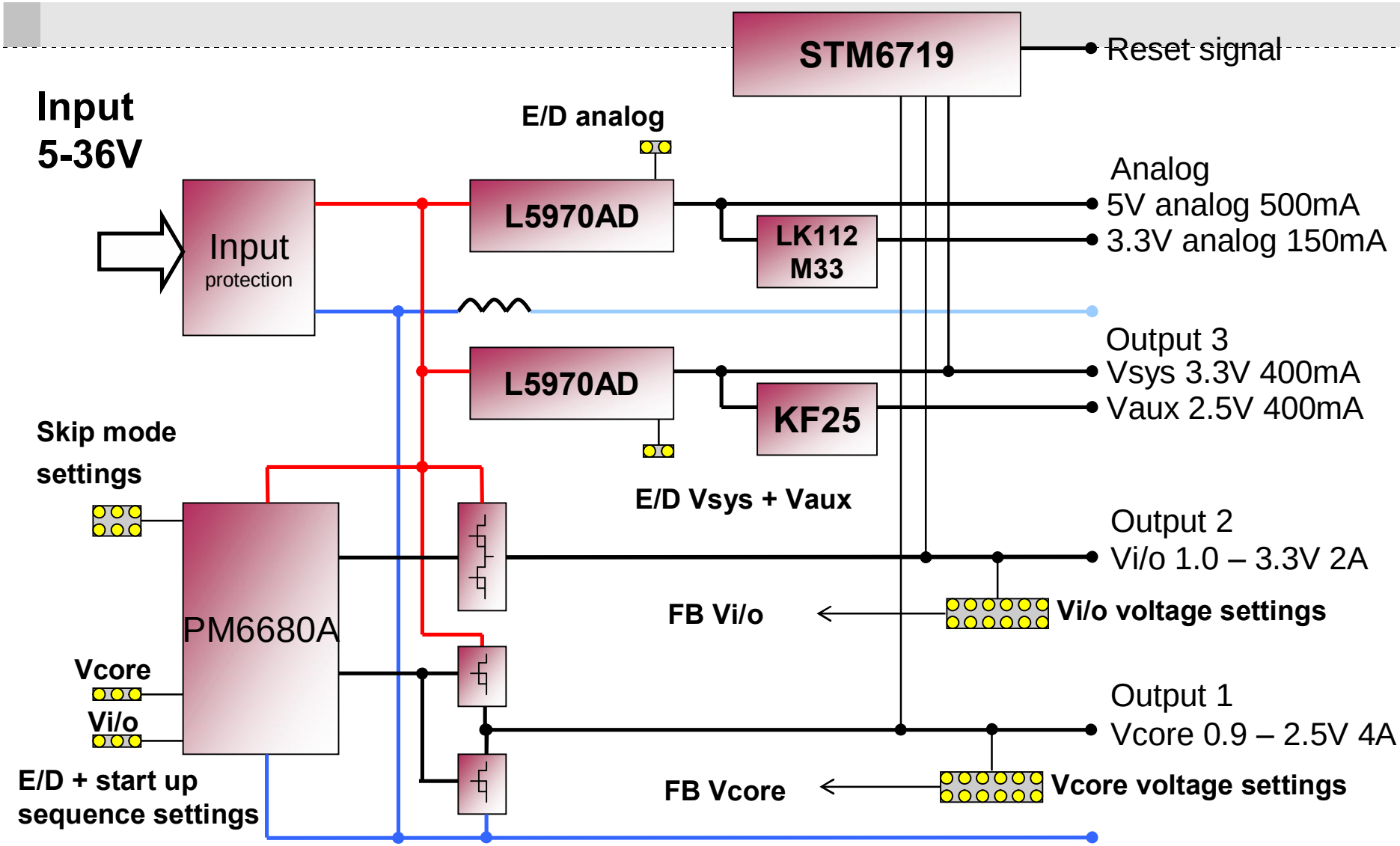
Example of system PM:

FPGA + CPU + Memories → STEVAL-PSQ001V1

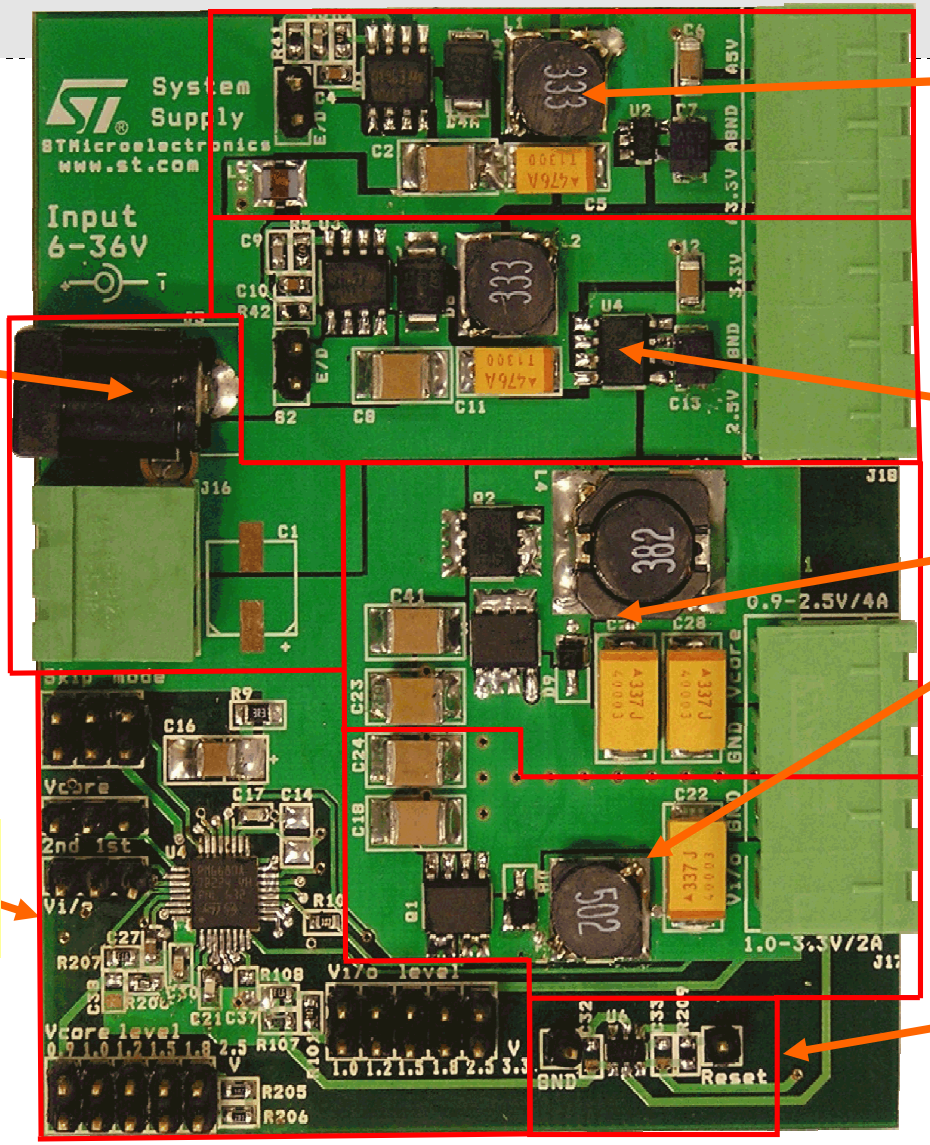




Block diagram



System Solution – Function Blocks



Analog 3.3V/0.15A
output 5V/0.5A

Input 5 – 36V

Output_3 2.5V/0.4A
3.3V/0.4A

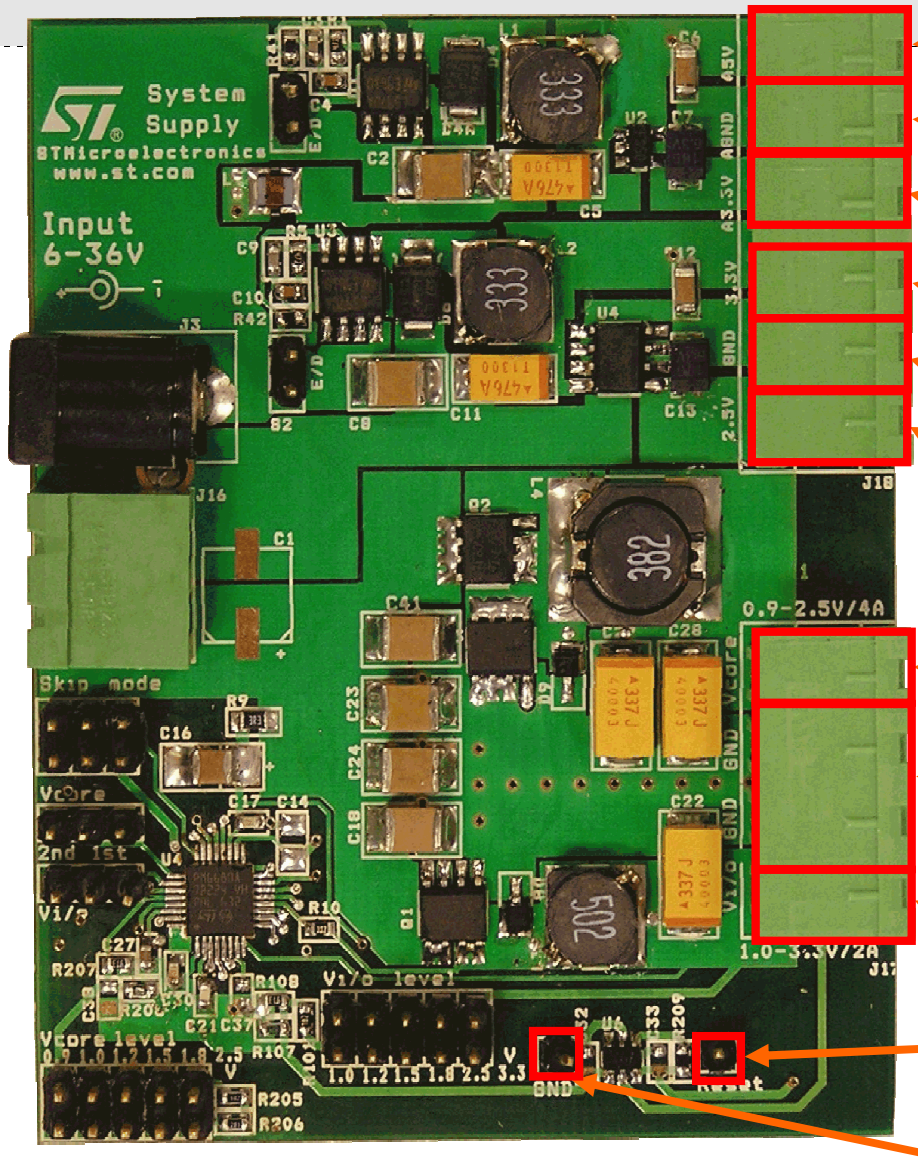
Output_2 0.9 – 2.5V/4A

Output_1 1.0 – 3.3V/2A

Control part for
outputs 1 and 2

Reset circuit

System solution – Outputs



Analog 5V/0.5A positive

Analog 3.3V, 5V GND

Analog 3.3V/0.15A positive

Output_3 3.3V/0.4A positive

Output_3 2.5V, 3.3V GND

Output_3 2.5V/0.4A positive

Output_1 0.9 – 2.5V/4A positive

Output1,2 0.9 – 2.5V common GND

Output_2 1.0 – 3.3V/2A positive

Reset output

Reset GND

System Solution – Control Pins

Analog E/D

Output3 E/D

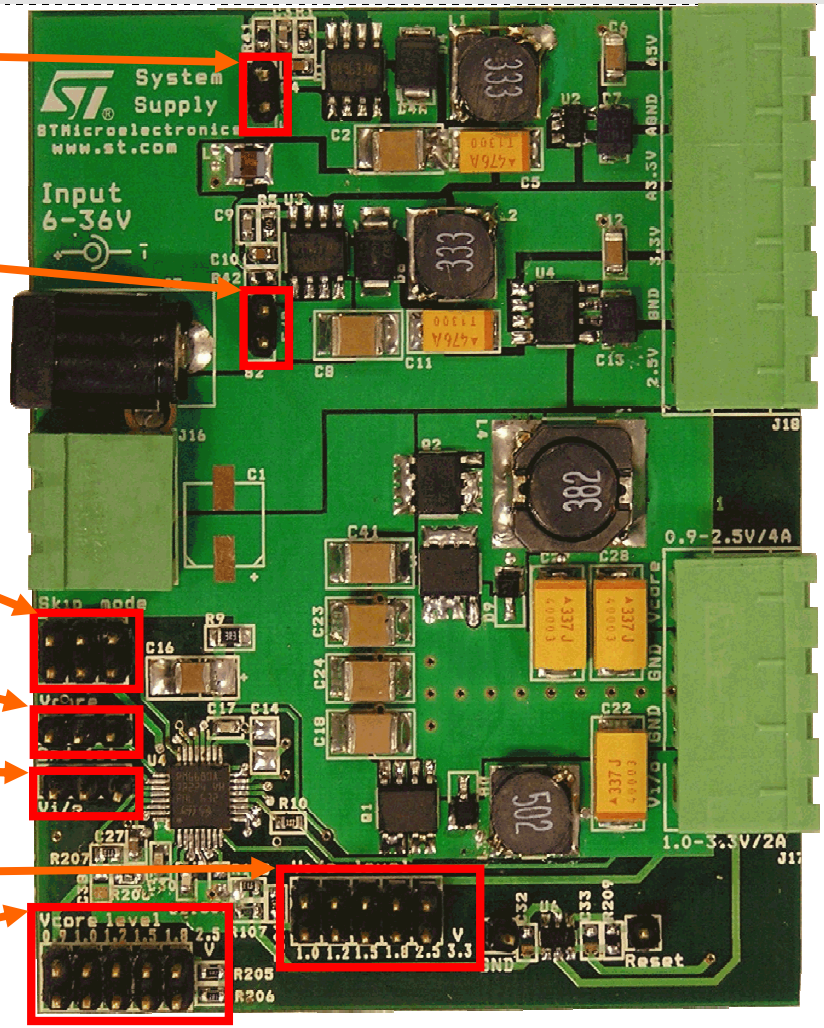
Skip mode for outputs 1 and 2

Output1 E/D and start up sequence

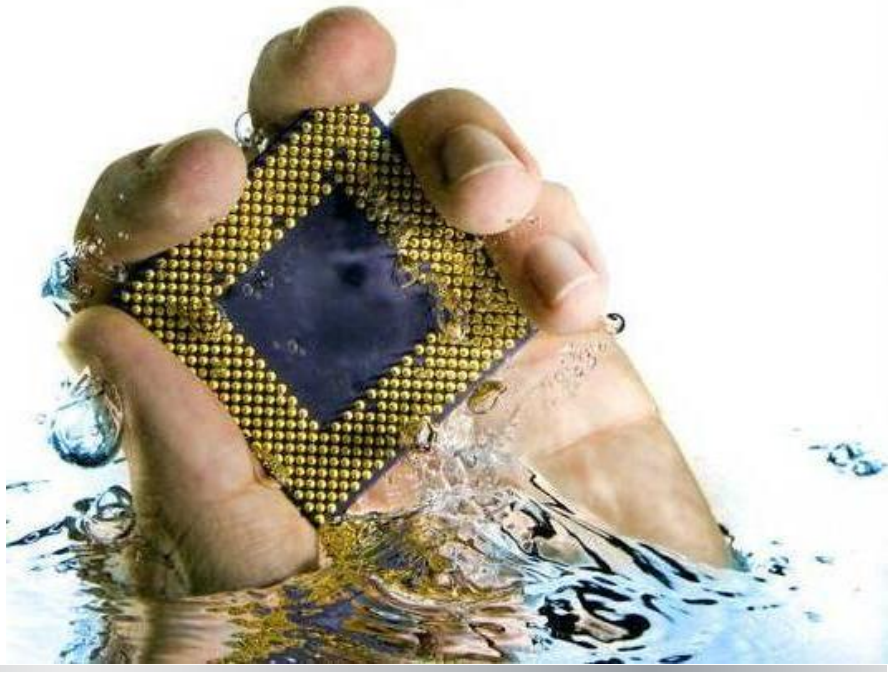
Output1E/D and start up sequence

Output2 voltage setting

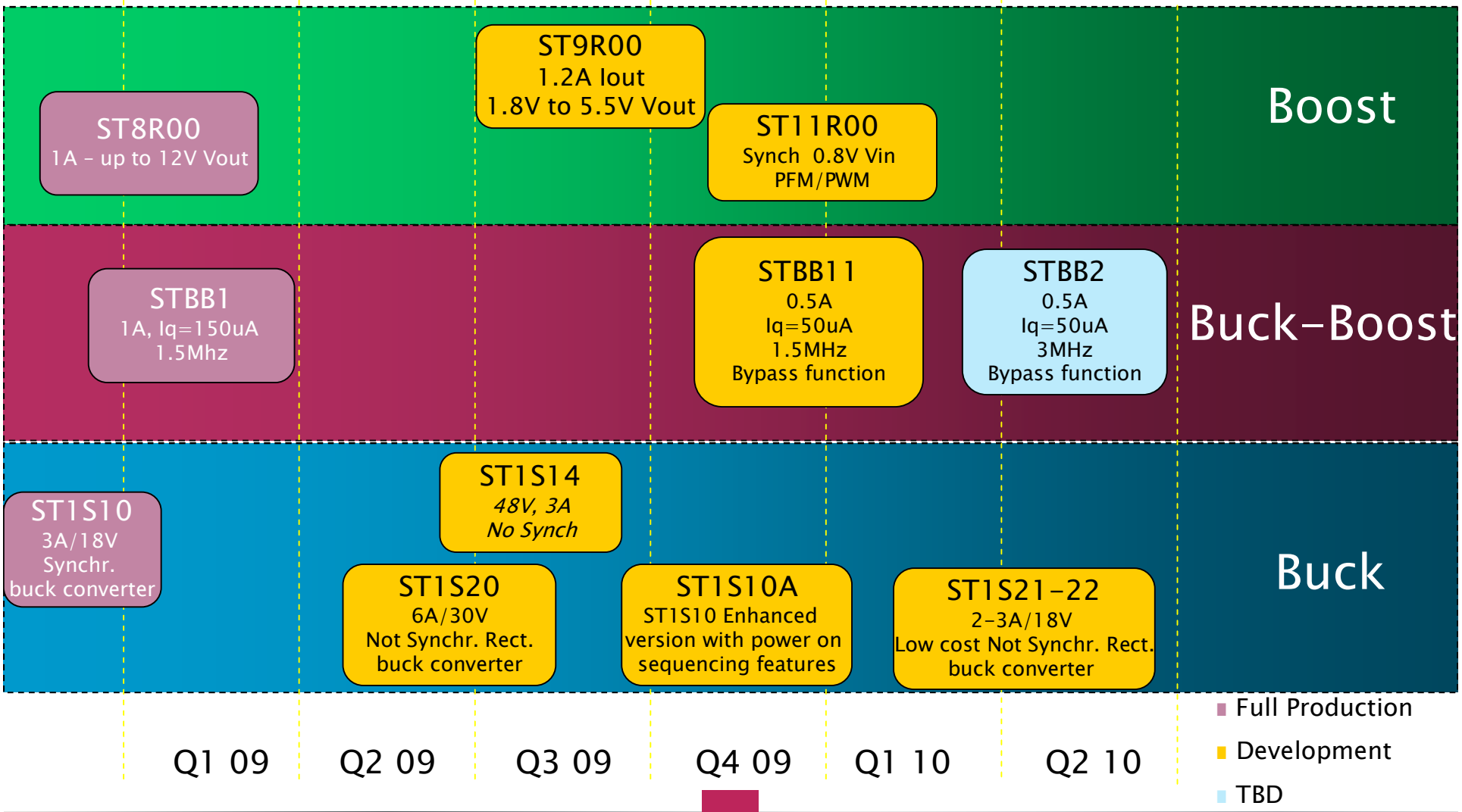
Output1 voltage setting



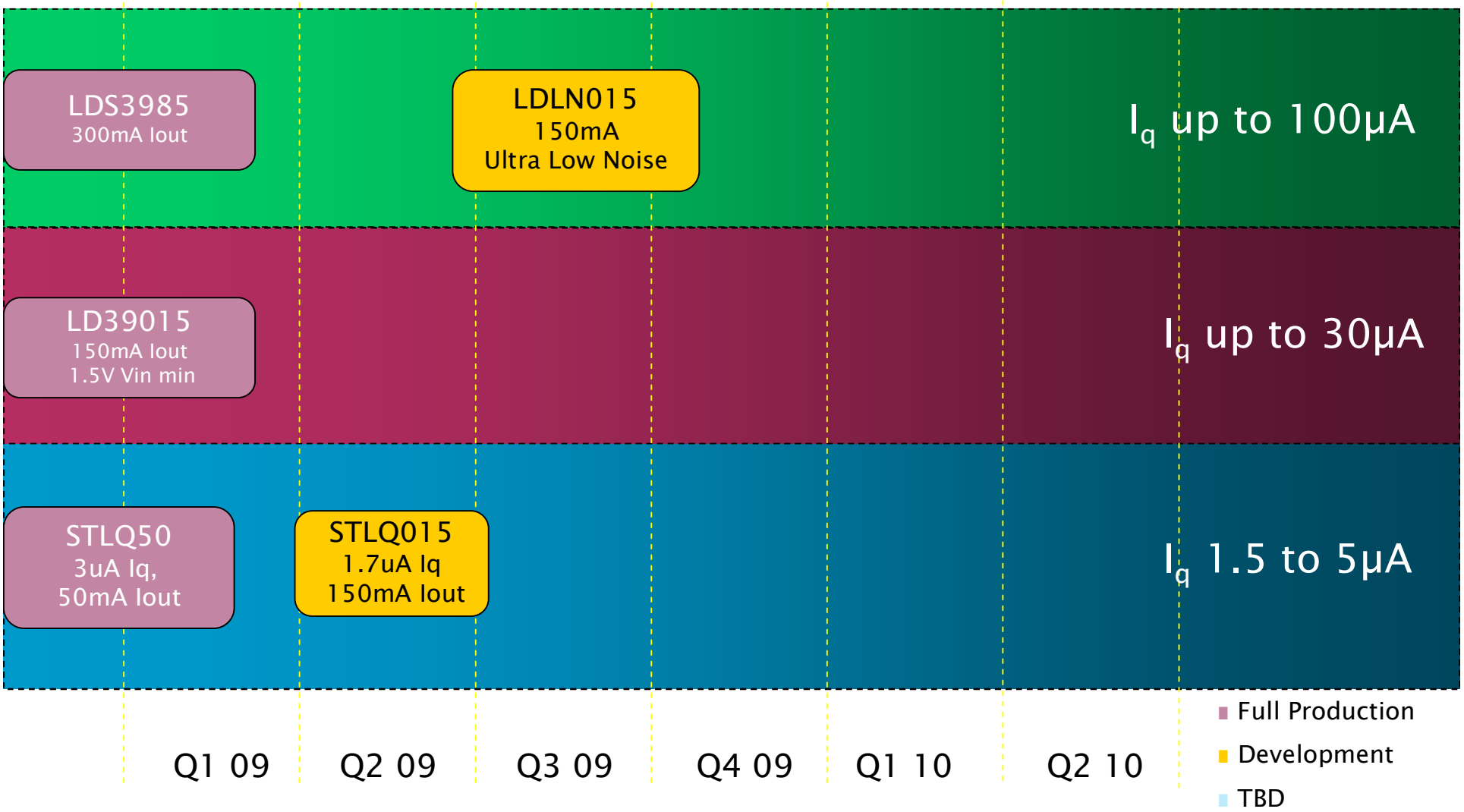
DC-DC converters
2009- 2010 ROAD MAP



DC/DC - Product strategy



LDO(Low Current) Product strategy



STEP-DOWN DC-DC CONVERTERS
Complete Product family - key specifications

DEVICE	I_{OUT}(A)	V_{OUT} (V)	V_{IN}(V)	Fsw(MHz)	Note
ST1S03	1.5	Adj from 0.8V to 12V	3 to 16V	1.5	
ST1S03A	1.5	Adj from 0.8V to 5.5V	2.5 to 7V	1.5	I
ST1S06 ST1S06A	1.5	Adj from 0.8V to 5.5V	2.5 to 7V	1.5	SR I + SR
ST1S09 ST1S09I	2	Adj from 0.8 to 5V	4.5 to 5.5V 2.7 to 5.5V	1.5	PG + SR I + SR
ST1S10	3	Adj from 0.8 to 15V	2.5 to 16V	0.9	Ext Synch from 0.4Mhz to 1.2MHz + SR+I
ST1S12	0.7	Adj from 0.6V	2.5 to 6V	1.7MHz	I + SR
ST1S14	3	Adj from 1.22V	4.5 to 45V	0.7	PG + I
ST1S10A	3	Adj from 0.8 to 15V	2.5V to 16V	0.9	I+PG+SR Phase Shift, Seq on-off
ST1S20	6	Adj from 2.5V	5 to 30V	0.35/0.7	Selectable Sw Freq

I= Inhibit PG= Power Good SR = Synchronous Rectification
White items are products under development

STEP-UP DC-DC Converters

Product family Key Specifications

DEVICE	IOUT(A)	VOUT (V)	VIN(V)	Fsw(MHz)	Note
ST8R00	1	from 6 to 12V	from 4 to 6V	1	I
ST9R00	1.2	from 1.8V to 5.5V	from 1.8V to 5.5V	1.5	
ST11R00	0.3	from 1.8 to 5.5V	from 0.8 to 5.5V	1	I

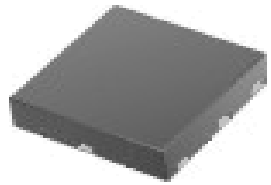
I= Inhibit
White items are products under development

ST1S03

1.5A, 1.5MHz, ADJ, Step-Down DC-DC Converter

Main Characteristics:

- Switching Frequency: 1.5MHz
- Output Current Capability: 1.5A max over all operating conditions
- Output Voltage: Adjustable from 0.8V feedback voltage
- Absolute max Input Voltage: 16V
- Soft-Start circuit to reduce inrush current
- Efficiency: up to 85%
- Load Transient Response: overshoot or undershoot <7%V_O
- Short Circuit Removal Response: overshoot <5% V_O
- Temperature Range: from 0 to 125°C
- Short Circuit and Thermal Protection
- Power-on Delay (50-100µs)
- Technology: BCD6
- VFN 3x3mm Package Type

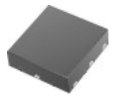


DFN 3x3 – 6L

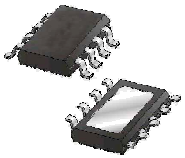
STEVAL-ISA042V1
STEVAL-ISA042V2

3A Step-Down DC-DC with Synchronous Rectification

Main Characteristics:

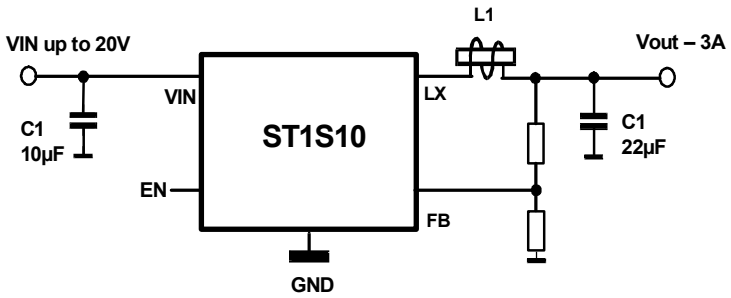


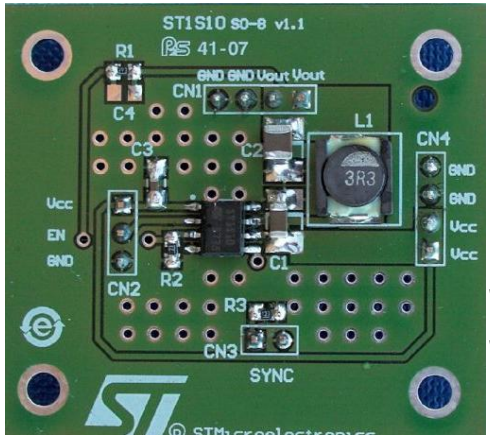
DFN – 8L
4x4mm



SO-8 Exposed Pad

- PWM fixed frequency 900KHz. It can be ext synch from 0.4 to 1.2MHz
- Output Current Capability: 3A max over all operating conditions
- Output Voltage: Adjustable from 0.8V feedback voltage
- Ceramic Capacitors and small Inductor
- 3.3V, 5V Fixed Output Voltages under customer request
- Max Operating Input voltage up to 18V
- Soft-Start circuit to reduce inrush current
- Efficiency: up to 90%
- Fast Transient Response
- Available with logic control Electronic Shutdown
- PPAK and DFN Packages





STEVAL-ISA044V1
STEVAL-ISA044V2

ST1S10A

3A, 0.9 MHz Adjustable Step Down Dc-Dc Converter

Synchronous Rectification, On/Off sequence and phase shift

Main Characteristics:

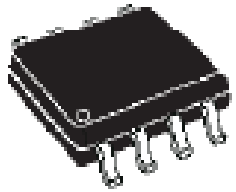
- Same as ST1S10
- Power good function
- Sync pin to let 2 devices work with 180° phase shift
- Adjustable UVLO
- Integrated and external programmable soft start function
- External compensation
- 100% Duty cycle
- Package HTSSOP16

HTSSOP16

Under development

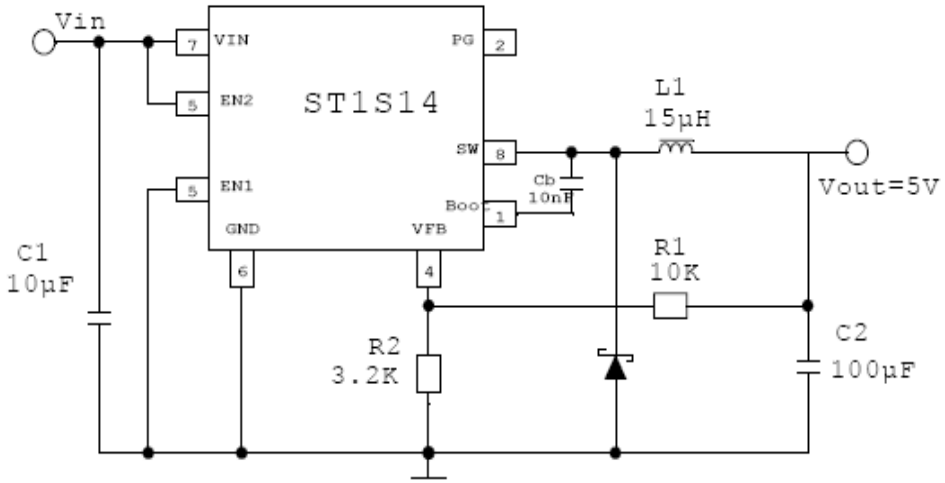
48V High Max Input Voltage, 3A, 0.7MHz, Adjustable, Step-Down DC-DC

Main Characteristics:



SO8 Exp.

- PWM fixed frequency 0.7MHz.
- Output Current Capability: 3A max over all operating conditions
- Output Voltage: Adjustable from 1.22V to 90% of max Vin
- Input Voltage: from 4.5V to 50V
- Power Good
- Soft-Start circuit to reduce inrush current
- Efficiency: up to 95%
- Fast Transient Response
- Logic control Electronic Shutdown
- SO8 Exposed Pad Package

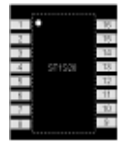


Under development

35V High Max Input Voltage, 6A, 0.7MHz, Adjustable, Step-Down DC-DC

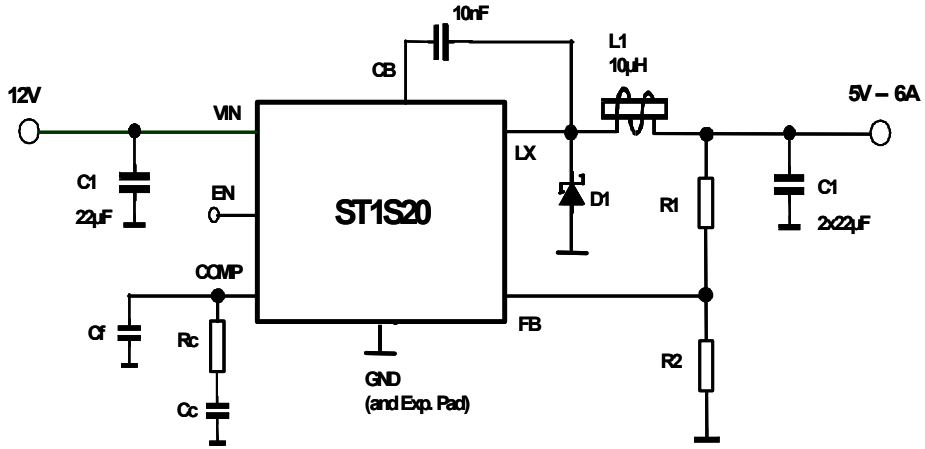
Main Characteristics:

HPAK-7L



DFN5x4-16L

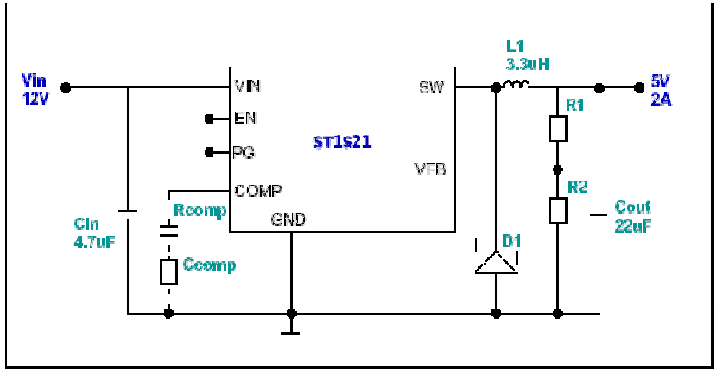
- PWM fixed frequency 0.7MHz.
- Output Current Capability: 6A max over all operating conditions
- Output Voltage: Adjustable from 0.8V to 85% of max Vin
- Input Voltage: from 5V to 35V
- Soft-Start circuit to reduce inrush current
- Efficiency: up to 95%
- Fast Transient Response
- Logic control Electronic Shutdown
- HPAK & DFN5x4 Packages



Under development

ST1S21
2A step-down switching regulator

TYPICAL APPLICATION CIRCUIT



Under development

FEATURES

- 2A DC output current
- 4V to 18 input voltage
- Output voltage adjustable from 1.25V
- 1MHz switching frequency
- Integrated 150mOhm Power Mosfet
- Internal Soft-start
- UVLO function for Vin<4V
- Enable function
- Power Good function
- Efficiency up to 92%
- Zero load current operation
- Over current and thermal protection
- SO-8 package

SO-8

APPLICATIONS

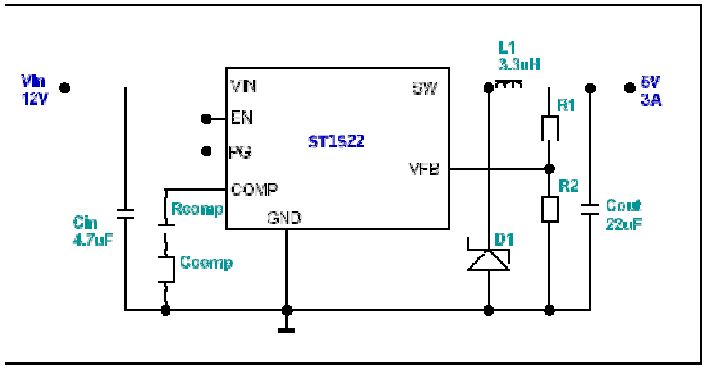
- Pre Regulator for Linear Regulators
- Battery Chargers
- STB, TVs, DVD

DESCRIPTION

The ST1S21 is a step-down DC-DC regulator with integrated high side Power Mosfet. It is able to deliver up to 2A DC current to the load over a wide input supply range from 4V to 16V, while the output voltage can be set starting from 1.25V to VINx0.90%.
The high switching frequency allows the use tiny surface-mount components. Only an inductor, a schottky diode and two capacitors are required. The device is thermal protected and current limited to prevent damages due to accidental short circuit.

ST1S22
3A step-down switching regulator

TYPICAL APPLICATION CIRCUIT



Under development

FEATURES

- 3A DC output current
- 4V to 18V input voltage
- Output voltage adjustable from 1.25V
- 1MHz switching frequency
- Integrated 150mOhm Power Mosfet
- Internal Soft-start
- UVLO function for Vin<4V
- Enable function
- Power Good function
- Efficiency up to 90%
- Zero load current operation
- Over current and thermal protection
- DFN 3x3 package

DFN 3x3

APPLICATIONS

- Pre Regulator for Linear Regulators
- Battery Chargers
- STB, TVs, DVD

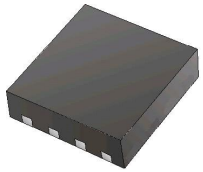
DESCRIPTION

The ST1S22 is a step-down DC-DC regulator with integrated high side Power Mosfet. It is able to deliver up to 3A DC current to the load over a wide input supply range from 4V to 18V, while the output voltage can be set starting from 1.25V to VINx0.90%.
The high switching frequency allows the use tiny surface-mount components. Only an inductor, a schottky diode and two capacitors are required. The device is thermal protected and current limited to prevent damages due to accidental short circuit.

1A, DC-DC , Synchronous Step-Up Converter

Main Characteristics:

- Adjustable Output Voltage: from 6V to 12V
- Vin_max =6V
- DC-DC Switching Frequency: 1.2MHz or 600Khz
- Output Current: up to 1A
- Internal Synchronous Rectification
- Efficiency up to 90% (Output set to 9V)
- Logic Control Electronic Shutdown
- Output Current CUT-OFF when in shutdown



QFN 4X4MM -8L

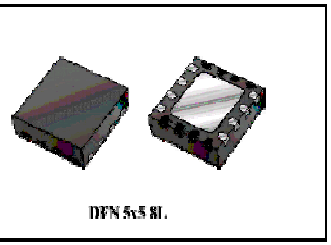
Demo board available on request

ST8R00

MICROPOWER 1A DC/DC CONVERTER
SYNCRONOUS STEP UP

DRAFT SPECIFICATION

- VERY LOW SUPPLY CURRENT
- REGULATED OUTPUT VOLTAGE
- WIDE RANGE OF OUTPUT VOLTAGE ADJUSTABLE FROM 6V TO 12V
- OUTPUT VOLTAGE ACCURACY ±2%
- OUTPUT CURRENT UP TO 1A
- LOW RIPPLE AND LOW NOISE
- SYNCRONOUS RECTIFICATION
- HIGH EFFICIENCY (V_{OUT} = 9V TYP. 90%)
- FEW EXTERNAL COMPONENTS
- VERY SMALL PACKAGE DFN 5x5 8L

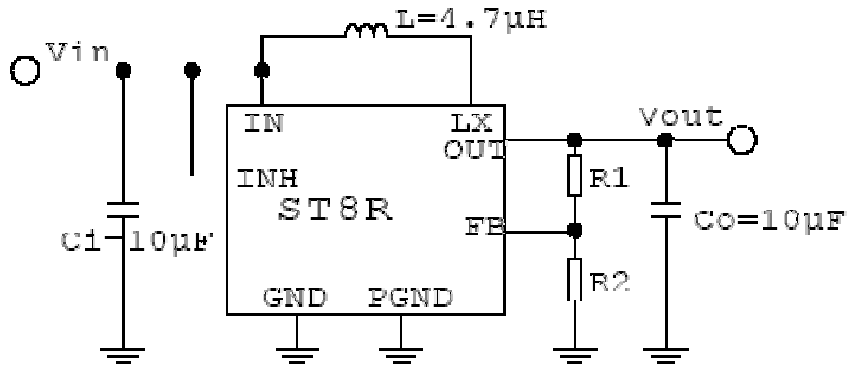


DFN 5x5 8L

DESCRIPTION

The ST8R00 is a synchronous high efficiency PWM

The ST8R00 is suitable to be used in equipment where low noise, low ripple and low supply current are required. The ST8R00 is available in a very small package: DFN5x5 -8L.

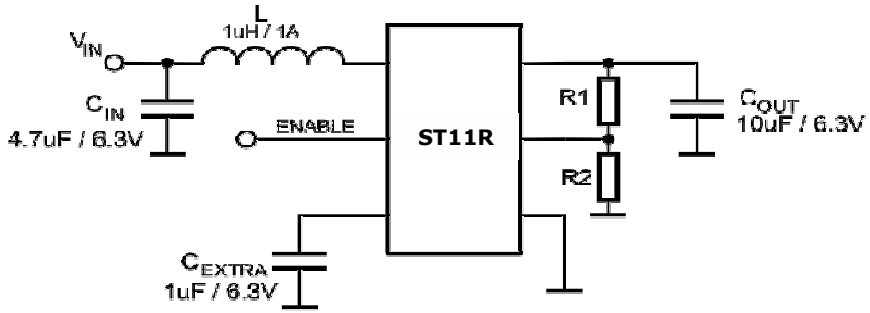


Step-up DC-DC converter for battery powered systems

Main Characteristics:

- Efficient Synchronous Boost Converter
- Operating input voltage range 0.8 V to 5.5 V
- Adjustable output voltage from 1.8 V up to 5.5 V
- Output Voltage Accuracy: +/-3%
- 100 mA Output Current at 3.3V from 0.9V Input Voltage
- 200 mA Output Current at 3.3V from 1.8V Input Voltage
- 300 mA Output Current at 5V from 3.3V Input Voltage
- Switching frequency 1MHz
- Enable function; Load disconnect during Shutdown
- Quiescent current less than 20 mA (no load condition)
- SOT23-6L package

1.1 Application schematic



List of Components

Component	Value	Part number	Package / Size	Vendor
L	1uH/1A	VLS252012-1R0	2.5x2x1mm	TDK
C_{IN}	4.7uF/6.3V		0603	TDK
C_{OUT}	10uF/6.3V		0603	TDK
C_{EXTRA}	1uF/6.3V		0402	TDK
R1	based on V_{OUT}		0402	
R2	based on V_{OUT}		0402	

Under development

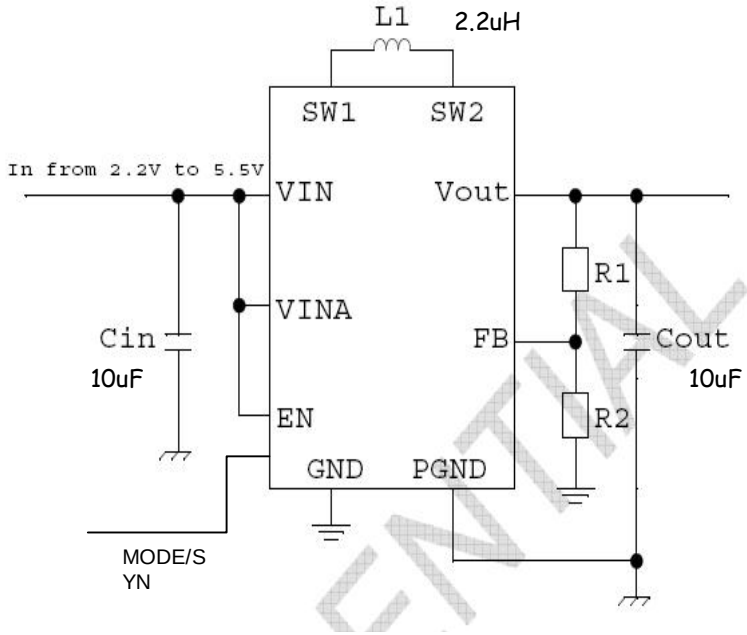
STBB1

Buck-Boost DC-DC CONVERTER

Main Characteristics:

- High efficiency (94%) single inductor Buck-Boost Switching Regulator
- Operating input voltage range from 2.2V to 5.5 V
- Adjustable output voltage from 1.2V to 5.5 V
- Synchronous rectification
- 1A output current
- Switching frequency 1.5MHz
- Enable function
- Quiescent current less than 1mA in shutdown condition, 120uA max over all the temperature range
- MLP3x3-10L package

Demo board available on request



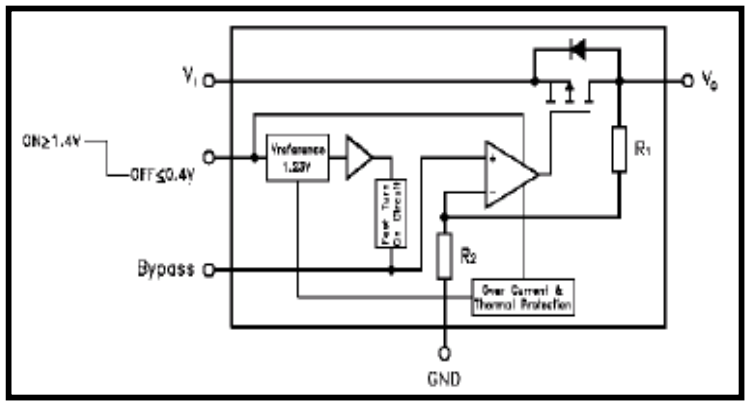
LDS3985
Single Channel 300mA ULDO Vreg with SHDN

Main Characteristics:

- Fixed Vout (values ranging from 1.25V to 5V on request)
- Guaranteed Output Current up to 300mA
- Dropout voltage: 250mV Maximum @ 150mA
- Quiescent current: 250µA max in all operating conditions
- Fast Turn-On Time (200µs)
- Stable with Low E.S.R. ceramic capacitors
- Very Low Noise: 30µVRMS from 10Hz to 100kHz
- Logic Controlled Electronic Shutdown
- Packages available: MLP 3X3 and SOT23-5L

MLP 6L
3X3mm

SOT23-5L



Low Supply Voltage - Very Low Dropout- Low Output Voltage

Main Characteristics:

- Operating input voltage: from 1.5V to 5.5V
- Guaranteed Output current 150mA
- Ultra Low Dropout Voltage (150mV TYP at 100mA LOAD)
- Very Low Quiescent Current (25µA TYP @ no load 35µA MAX @ 150mA load; MAX 1µA in OFF mode)
- Wide Output voltage range choice: from 0.8V TO 3.3V
- Output Voltage tolerance 2%
- Logic Controlled Electronic Shutdown
- Very good Supply Voltage Rejection
- Stable with low ESR ceramic capacitors
- Package: SOT666, SOT23-5L

SOT666

SOT23-5L

STLQ50

Very Low Iq Regulator

Main Characteristics:

- 2.3V to 12V input voltage range
- 3µA quiescent current
- Output voltages (1.8, 2.5, 3.3, 5.0V)
  - ✓ Adjustable
- Internal thermal protection

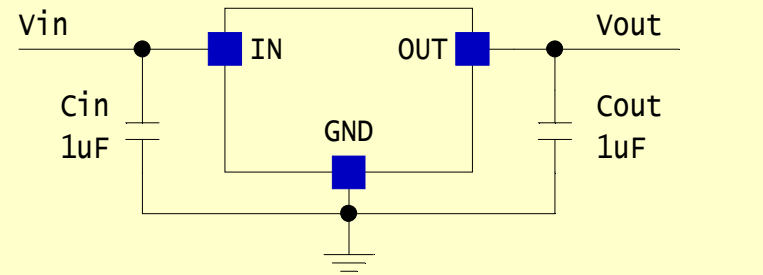
The STLQ50 is a LDO Regulator with a typical quiescent current of 3µA

The very low current consumption and the tiny package make it

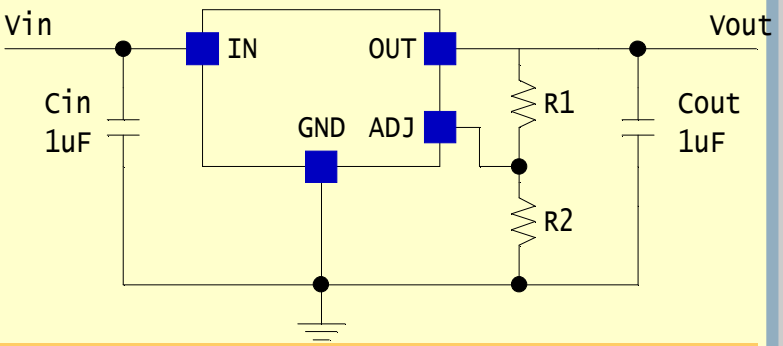
suitable for battery powered equipment that must have very long

life time:

- Glucose meter
- smoke detector
- real time clock backup power
- Electronic sensors
- Alarms

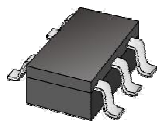


Fixed version



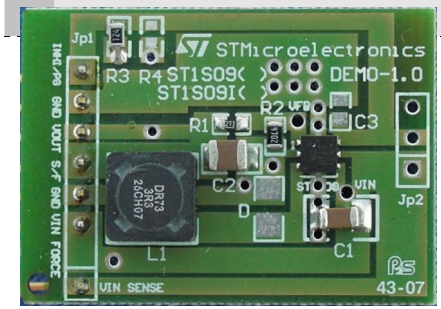
Adjustable version

SOT23-5L



SOT323-5L
(SC70)

Demo boards

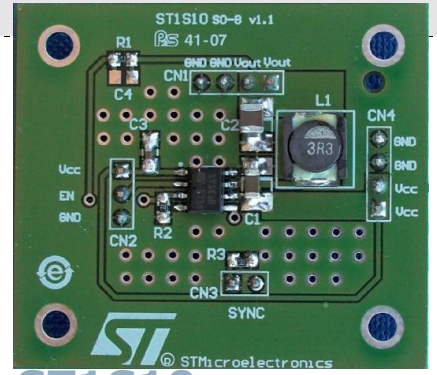


ST1S09

STEVAL-ISA045V1
STEVAL-ISA045V2
STEVAL-ISA046V1
STEVAL-ISA046V2

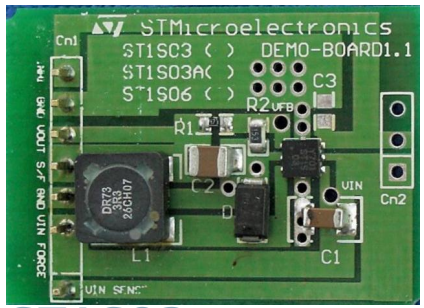
ST1S03A

STEVAL-ISA047V1
STEVAL-ISA047V2



ST1S10

STEVAL-ISA044V1
STEVAL-ISA044V2

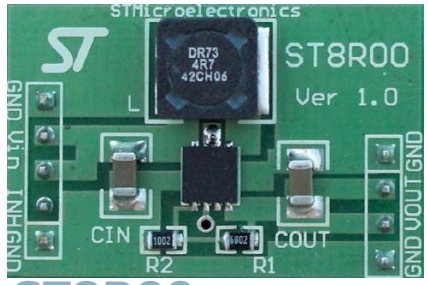


ST1S03

STEVAL-ISA042V1
STEVAL-ISA042V2
STEVAL-ISA043V1
STEVAL-ISA043V2

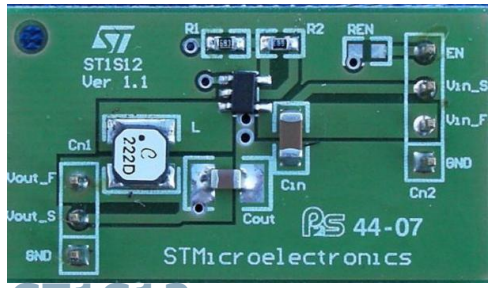
ST2S06

STEVAL-ISA049V1
STEVAL-ISA049V2



ST8R00

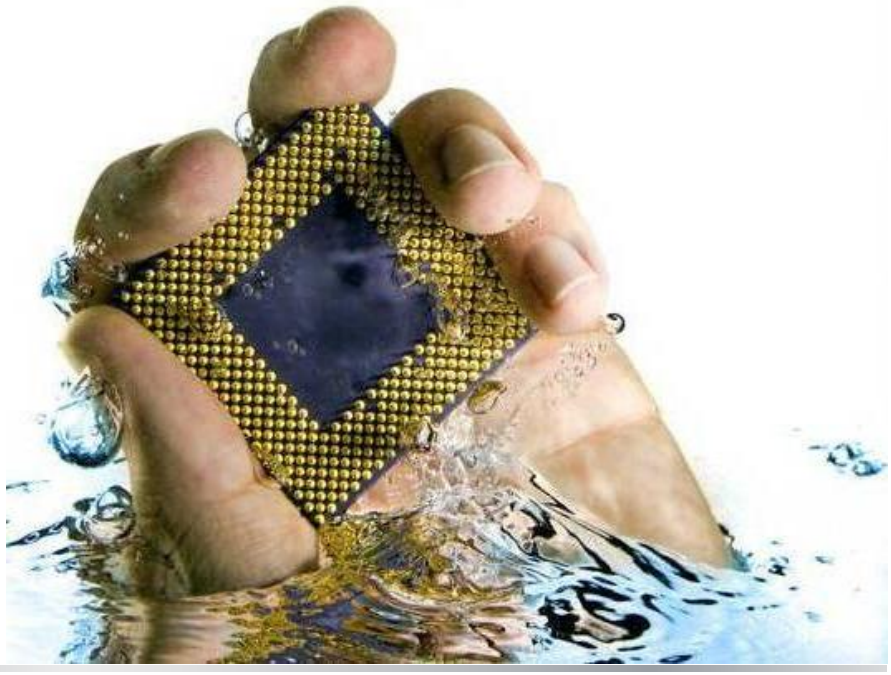
STEVAL-ISA048V2



ST1S12

STEVAL-ISA055V1
STEVAL-ISA055V2

AC / DC Conversion



New EU regulations

Ecodesign requirements

1. One year after this Regulation has come into force:

   (a) Power consumption in 'off mode':

   Power consumption of equipment in any off-mode condition shall not exceed 1,00 W.

   (b) Power consumption in 'standby mode(s)':

   The power consumption of equipment in any condition providing only a reactivation function, or providing only a reactivation function and a mere indication of enabled reactivation function, shall not exceed 1,00 W.

   The power consumption of equipment in any condition providing only information or status display, or providing only a combination of reactivation function and information or status display, shall not exceed 2,00 W.

   (c) Availability of off mode and/or standby mode

   Equipment shall, except where this is inappropriate for the intended use, provide off mode and/or standby mode, and/or another condition which does not exceed the applicable power consumption requirements for off mode and/or standby mode when the equipment is connected to the mains power source.

2. Four years after this Regulation has come into force:

   (a) Power consumption in 'off mode':

   Power consumption of equipment in any off-mode condition shall not exceed 0,50 W.

   (b) Power consumption in 'standby mode(s)':

   The power consumption of equipment in any condition providing only a reactivation function, or providing only a reactivation function and a mere indication of enabled reactivation function, shall not exceed 0,50 W.

   The power consumption of equipment in any condition providing only information or status display, or providing only a combination of reactivation function and information or status display shall not exceed 1,00 W.

- **Total stand-by input power limite to 0.5W in 2013 in Europe**
- **Australia is going further with a limit at 0.3W**

Code of Conduct on Energy Efficiency of External Power Supplies.

SCOPE

Scope of this Code of Conduct are single voltage external ac-dc and ac-ac power supplies for electronicand electrical appliances, including among others AC adapters, battery chargers for mobile phones, domestic appliances, power tools and IT equipment, in the output power range 0.3W to 250W. As the name implies, external power supplies are contained in a separate housing from the end-use devices they are powering. This specification does not cover dc-dc power supplies, or any internal power supplies (those contained inside the product). In most cases power supplies are specified by the appliance manufacturer; production can be at the appliance manufacturer or at a dedicated manufacturer.

No Load Power Consumption

Table 1.1: No-load Power Consumption (excluding external power supplies up to 8 W for mobile handheld battery driven applications)

Rated Output Power (P_{no})	No-load power consumption from 1.1.2009
≥ 0.3 W and < 50 W	0.30 W
≥ 50 W and < 250 W	0.50 W

Table 1.2: No-load Power Consumption for external power supplies up to 8 W for mobile handheld battery driven applications

Rated Output Power (P_{no})	No-load power consumption
≥ 0.3 W and ≤ 8.0 W	0.25 W from 1.1.2009 to 31.12.2010
≥ 0.3 W and ≤ 8.0 W	0.15 W from 1.1.2011

Energy-Efficiency Criteria for Active Mode

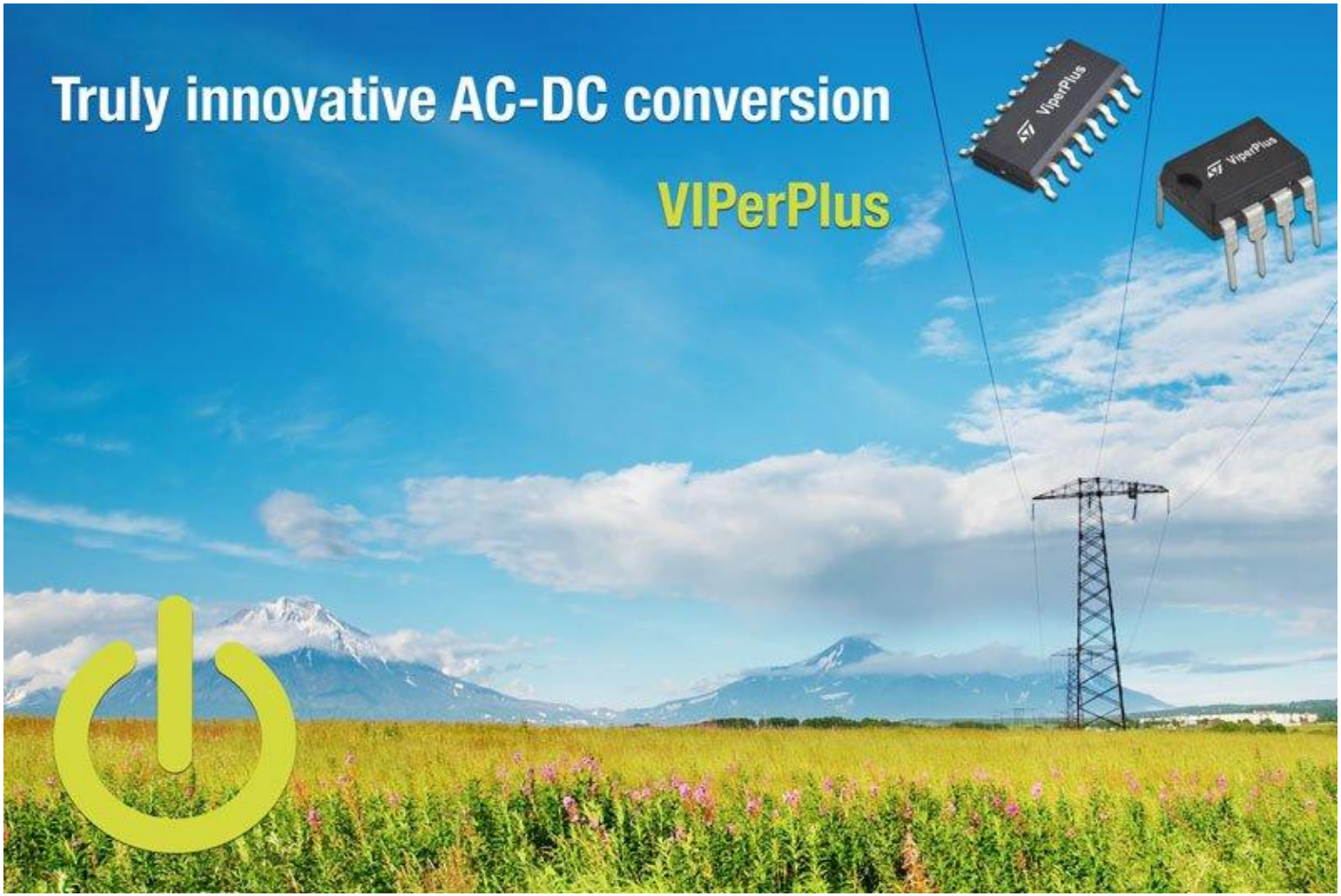
Table 2.1: Energy-Efficiency Criteria for Active Mode (excluding Low Voltage external power supplies)

Rated Output Power (P_{no})	Minimum Four Point Average Efficiency in Active Mode (expressed as a decimal) [2] from 1.1.2009
$0 < W \leq 1$	$\geq 0.48 * P_{no} + 0.140$
$1 < W \leq 49$	$\geq [0.0626 * \ln(P_{no})] + 0.622$
$49 < W \leq 250$	≥ 0.870

Table 2.2: Energy-Efficiency Criteria for Active Mode for Low Voltage external power supplies[3]

Rated Output Power (P_{no})	Minimum Four Point Average Efficiency in Active Mode (expressed as a decimal) [4] from 1.1.2009
$0 < W \leq 1$	$\geq 0.497*P_{no}+0.067$
$1 < W \leq 49$	$\geq [0.075*\ln(P_{no})]+0.561$

A low voltage model is an EPS with a nameplate output voltage of less than 6 volts and a nameplate output current greater than or equal to 550 milliamps.


Truly innovative AC-DC conversion
VIPerPlus

VIPer+ introduces:

- AGGRESSIVE stand-by losses
- ROBUSTNESS power section and high level protection
- REDUCTION of total SMPS components count and EASY SMPS design
- PORTFOLIO differentiation: better TAILORED to specific applications

VIPer™ plus Strategy

- Products better TAILORED to specific applications
- Very AGGRESSIVE standby losses, < 50mW
- Drastic REDUCTION of total components count
- SIMPLE design
- Proprietary packaging
- products PORTFOLIO differentiation:

  Topology (FF,QR)

  RDSon (from 20Ω to 1Ω)

  Power range (from 0 to 40W)

  Packaging, (S)DIP & SMD

VIPer™ plus Functionalities

- Aggressive power supply STAND BY consumption…. < 50 mW
- Fixed frequency with JITTERING for EMI reduction
- Quasi Resonant operation for very high EFFICIENCY and very low EMI
- Adjustable CURRRENT LIMIT (I_{DLIM})
- SOFT START UP: minimize the stress and maximize the reliability
- BROWN OUT: minimize the RMS drain current & guaranty a monotonic descending output during the power down
- EXTRA POWER TIMER (VIPer28)
- High operating temperature (up to 150 °C)

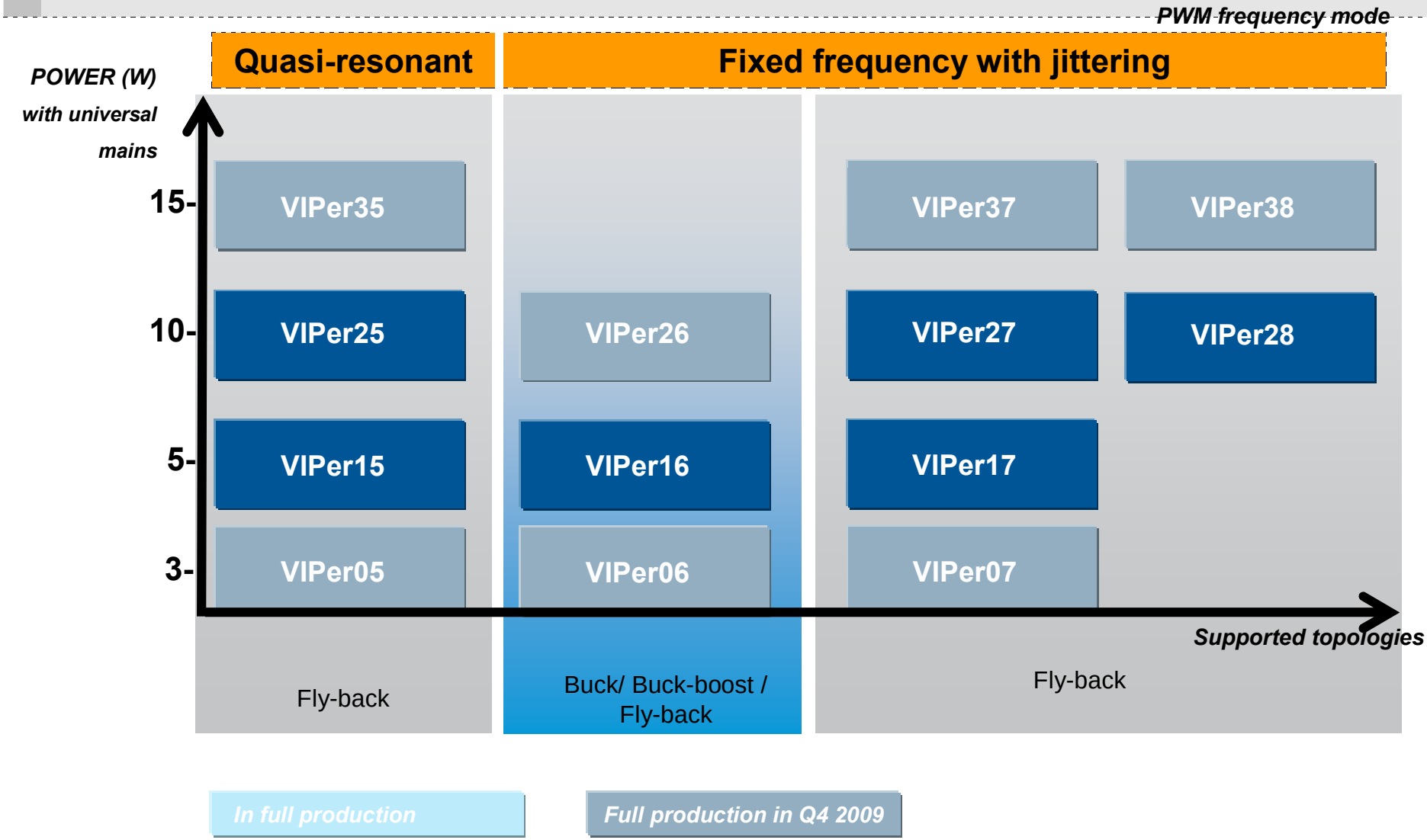
VIPer™ plus Protections

- ***Over voltage protection*** *(OVP)*
- ***2nd over current protection*** *(2nd OCP)*
- ***Over load protection*** *(OLP)*
- ***Over temperature protection + hysteresis*** *(OTP)*
- ***Max Duty Cycle at 70%***

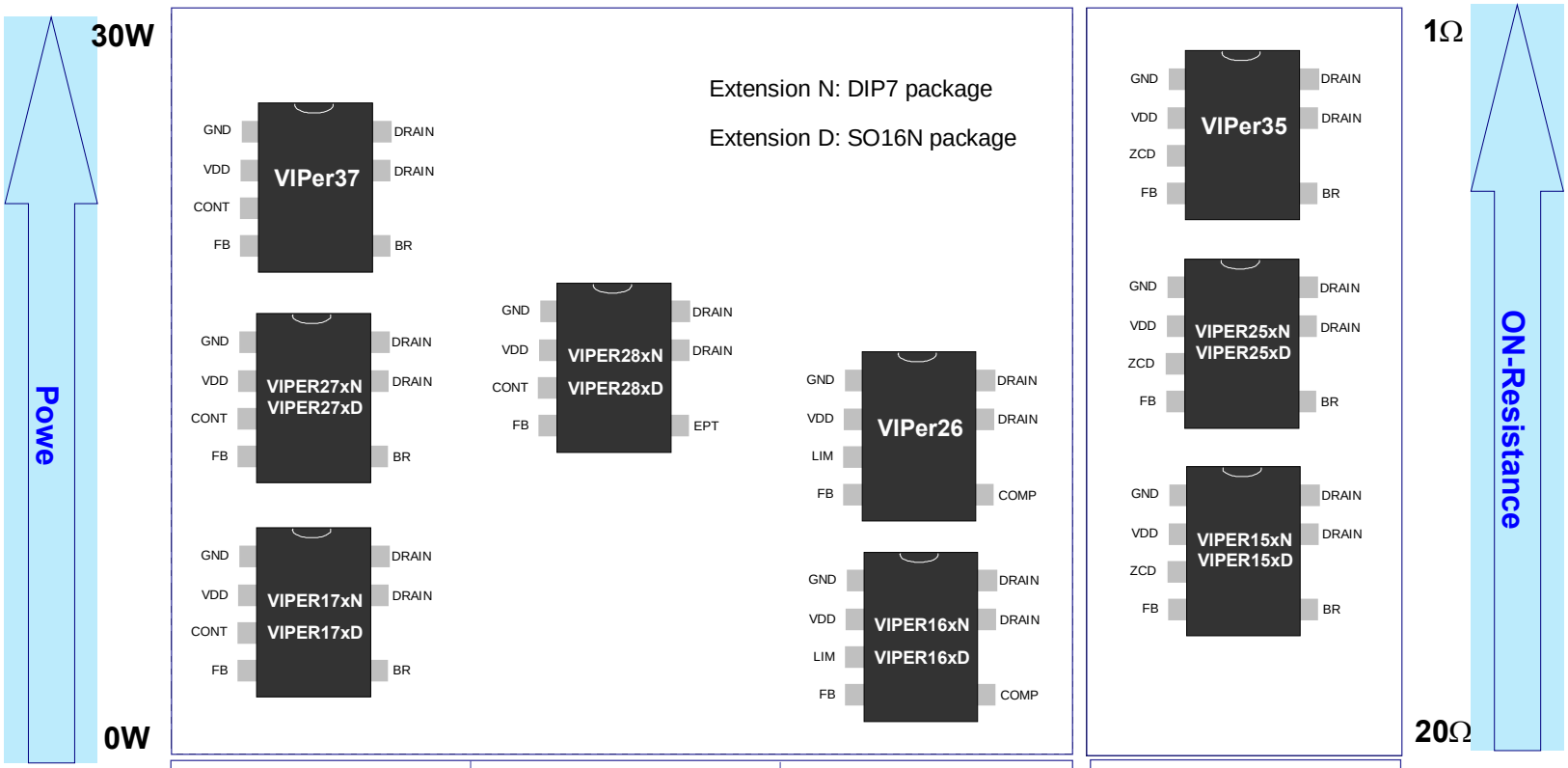
AUTO RESTART MODE

after every fault condition

VIPerPlus ROADMAP



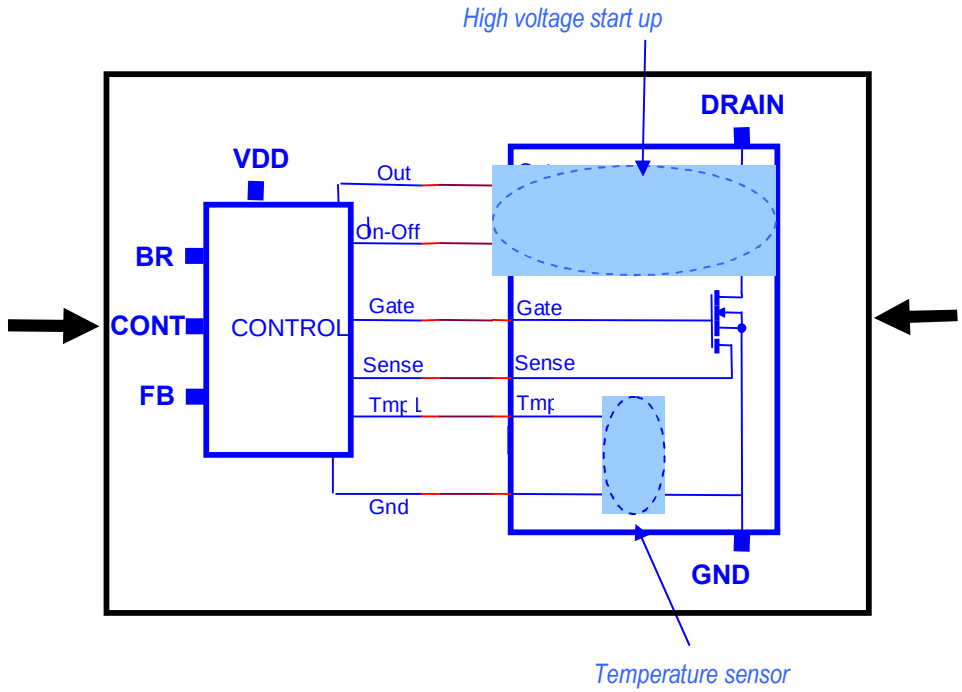
VIPerPlus introduces: +differentiation



VIPer+ introduction: new double chip approach

BCD6

Mixed Signal



SuperMESH ,

800V avalanche rugged

VIPerPlus selection guide

Power up to	RDSon (max)	IDLIM (max)	VIPer selection	Packages		Switching Frequency			Mass Production	Datasheet
				DIP 7	SO16N	FF 60kHz	FF 115kHz	QR		
5 W (wide range input)	24 Ohm	400 mA	VIPER15LD		√			√ limited to 150kHz	Wk30	st.com
			VIPER15LN	√				√ limited to 150kHz	YES	st.com
			VIPER15HD		√			√ limited to 225kHz	Wk30	st.com
			VIPER15HN	√				√ limited to 225kHz	YES	st.com
			VIPER16LD		√	√			YES	st.com
			VIPER16LN	√		√			YES	st.com
			VIPER16HD		√		√		YES	st.com
			VIPER16HN	√			√		YES	st.com
			VIPER17LD		√	√			YES	st.com
			VIPER17LN	√		√			YES	st.com
			VIPER17HD		√		√		YES	st.com
			VIPER17HN	√			√		YES	st.com
12 W (wide range input)	7 Ohm	700 mA	VIPER25LD		√			√ limited to 150kHz	Wk30	st.com
			VIPER25LN	√				√ limited to 150kHz	YES	st.com
			VIPER25HD		√			√ limited to 225kHz	Wk30	st.com
			VIPER25HN	√				√ limited to 225kHz	YES	st.com
			VIPER27LD		√	√			Wk30	st.com
			VIPER27LN	√		√			YES	st.com
			VIPER27HD		√		√		Wk30	st.com
			VIPER27HN	√			√		YES	st.com
		800 mA	VIPER28LD		√	√			Wk30	st.com
			VIPER28LN	√		√			YES	st.com
			VIPER28HD		√		√		Wk30	st.com
			VIPER28HN	√			√		YES	st.com

VIPer+ by power and functionality

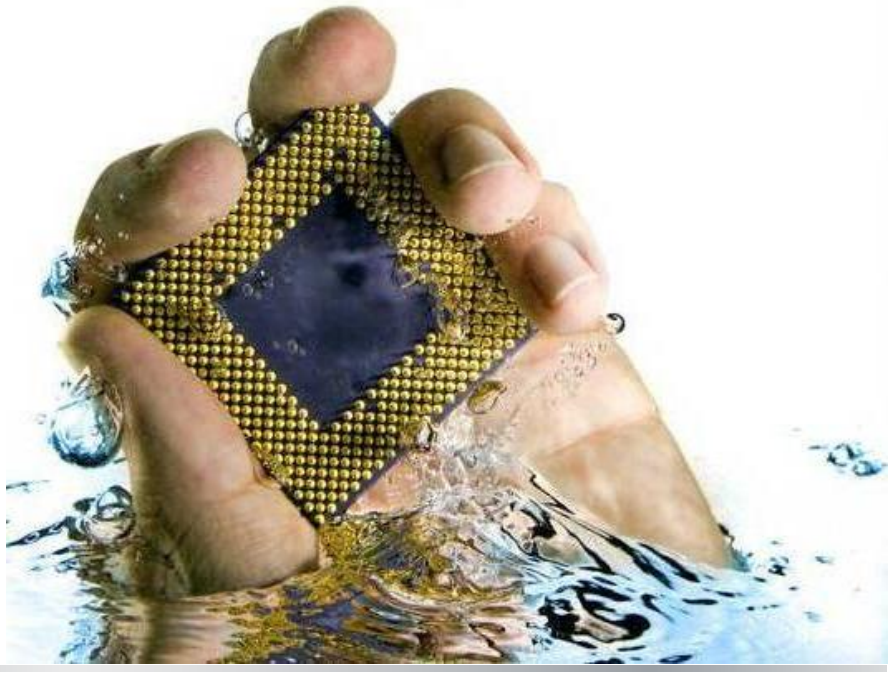
In green: to be highlighted in white good applications

VIPer+ functionalities	Power SECTION: 800V Avalanche Rugged								
	R_{DSON} : 24 Ohm			R_{DSON}: 7 Ohm				R_{DSON}: 4 Ohm	
	I_{DLIM} : 400mA			I_{DLIM} : 700mA			800mA	1A	1A
	VIPER15	VIPER16	VIPER17	VIPER25	VIPER26	VIPER27	VIPER28	VIPER35	VIPER37
Fixed Frequency PWM current mode controller			√			√	√		√
Quasi Resonant PWM current mode controller	√			√				√	
Fixed frequency PWM current mode controller with embedded EA		√			√				
Limiting Drain current with adjustable set point	√	√	√	√	√	√	√	√	√
Fixed frequency 60kHz(L type) or 115kHz(H type) with JITTERING		√	√		√	√	√		√
Advanced Stand-by management	√	√	√	√	√	√	√	√	√
Automatic Autorestart after fault	√	√	√	√	√	√	√	√	√
Advanced Over Load and short circuit management	√	√	√	√	√	√	√	√	√
Accurate Over Voltage Protection	√		√	√		√	√	√	√
Open loop failure detection		√			√				
Feed Forward Compensation	√			√				√	
On board soft start up	√	√	√	√	√	√	√	√	√
Hysteretic Thermal shut-down	√	√	√	√	√	√	√	√	√
Brown-out protection	√		√	√		√			√
Extra Power Timer for Peak Power management							√		
Eliminates bias winding supply		√							

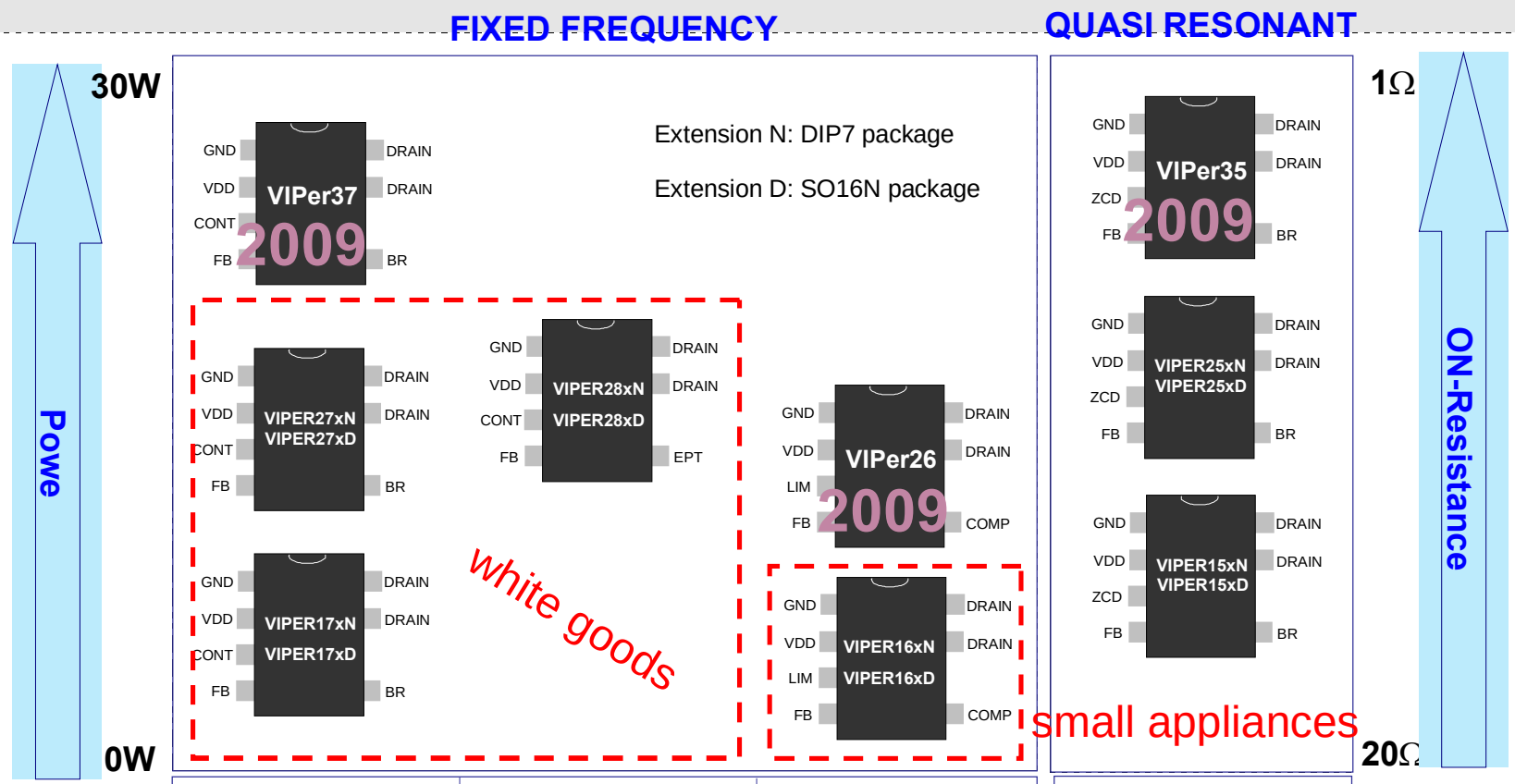
VIPerPlus evaluation boards and application notes

Order Codes	VIPer part	Short description	Application Note	Input voltage [Vac]	Output voltage [V]	Output current [A]
STEVAL-ISA060V1	VIPER17HN	ISOLATED FLY-BACK PSU	AN2753	85-265	12	0.5
EVALVIPER17L-7W	VIPER17LN	ISOLATED FLY-BACK PSU	AN2803	85-265	12	0.5
STEVAL-ISA058V1	VIPER17LN	ISOLATED FLY-BACK PSU (std-by 30mW)	AN2864	85-265	5	1
EVLVIP17-5WCHG	VIPER17HN	BATTERY CHARGER (FLY-BACK ISO)	AN2840	85-265	5	1
STEVAL-ILL017V1	VIPER17HN	LED DRIVER (FLY-BSCK NON ISO)	AN2811(draft)	220±10%	7	0.5
STEVAL-ISA062V1	VIPER17HN	ISOLATED FLY-BACK PSU	AN2934	85-265	5 / 12	0.5 / 0.25
EVLVIPER28H-10W	VIPER28HN	ISOLATED FLY-BACK PSU	TBD	85-265	5	2.4
EVLVIPER28L-10W	VIPER28LN	ISOLATED FLY-BACK PSU	AN2950(draft)	85-265	5	2.4
EVLVIP16H-4WFN	VIPER16HN	NON ISOLATED FLY-BACK PSU	TBD	85-265	16	0.25
EVLVIP16L-4WFN	VIPER16LN	NON ISOLATED FLY-BACK PSU	TBD	85-265	16	0.25
EVLVIP16H-4WFL	VIPER16HN	ISOLATED FLY-BACK PSU	TBD	85-265	16	0.25
EVLVIP16L-4WFL	VIPER16LN	ISOLATED FLY-BACK PSU	TBD	85-265	16	0.25
STEVAL-ISA010V1	VIPER16LN	NON ISOLATED BUCK CONVERTER	AN2872(draft)	85-500	12 / 5	0.15

Auxiliary Supplies in Home Appliance using VIPer+



VIPer+: differentiation



*** VIPER16xD, VIPER28xD, VIPER15xD: engineering samples available on request**

*** VIPER27xD, VIPER25xD, VIPER25xN: engineering samples on Q2/2009**

Typical Applications (white goods)

- **Facts:**
  - These applications already embedd control units requiring an auxiliary SMPS
  - PI well established

- **Opportunities:**
  - Many application need to be redesigned to be compliant with new EU regulations

- **Competitve advantages (VIPerX7):**
  - Robustness of the VIPer+ family (800V avalanche rugged PowerMOSFET)
  - Very low stand-by power
  - Price
  - Specified high shut down temperature (cooking hubs control units)

Emerging Applications

- **Facts:**
  - Most of these applications (small appliances) were not requiring auxiliary supplies based on SMPS up to now
  - Simple cheap capacitive supply

- **Opportunities:**
  - New EU regulations for low stand-by power consumption
  - Increased current consumption due to more electronics embedded

- **Competitve advantages (VIPer16):**
  - Compact solution
  - Robustness of the VIPer+ family (800V avalanche rugged PowerMOSFET)
  - Low stand-by power (allowing to meet even EuP + Australian requirements)
  - Price

Still not in focus

- Corded tools with no stand-by function
- Unless BLDC drive or SR drive
- Unless auxiliary supply has to deliver a high output current (limit at 50mA to 100mA)

- Applications with a hard switch
- Unless replaced with capacitive touch keys (nice to have)

AN2864 STAND BY PERFORMANCE OPTIMIZED WIDE RANGE INPUT 5V/1A OUTPUT VIPER17L DEMO-BOARD

Table 1. Electrical specification

Parameter	Symbol	Value
Input Voltage range	V_{IN}	[$90V_{RMS}$; $265V_{RMS}$]
Output Voltage	V_{OUT}	5V
Max Output Current	I_{OUT}	1A
Precision of output regulation	Δ_{VOUT_LF}	±5%
High Frequency output Voltage ripple	Δ_{VOUT_HF}	50mV

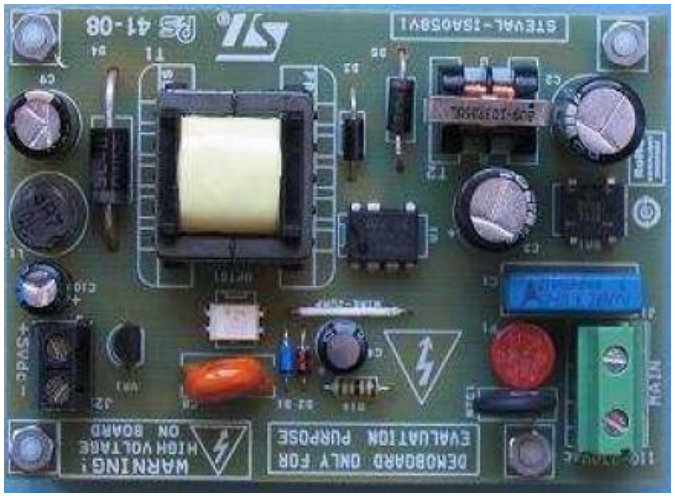
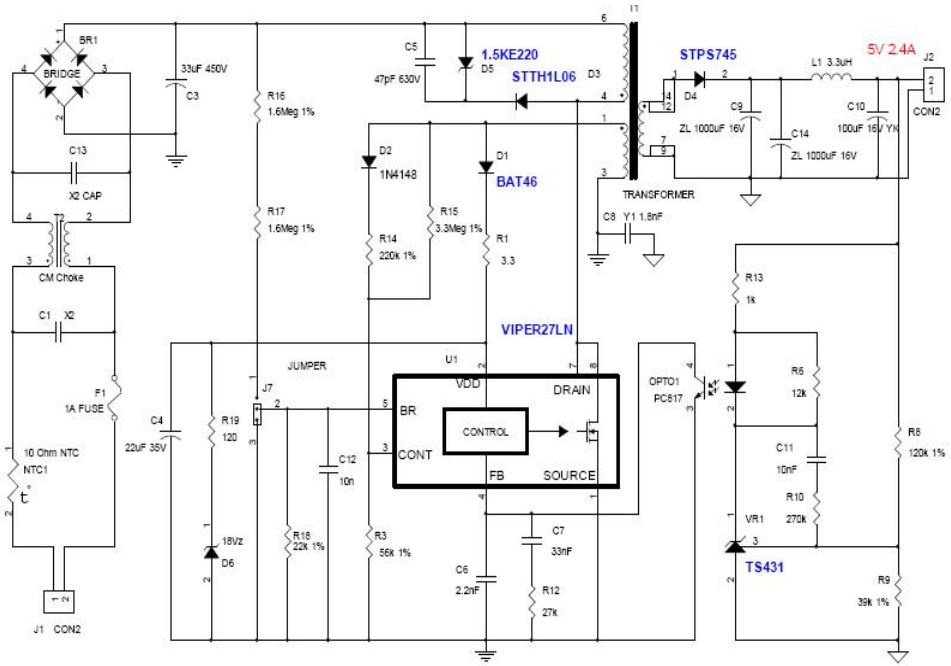


Table 11 No Load input Power

Vin AC (V_{RMS})	Pin (mW)
90	13.50
115	13.70
230	21.20
265	25.00

Wide range [90 - 265] input, 5V-12W output VIPER27LN

Demo Board with improved stand-by performance



No load Condition

No load Input Power	
Vinac (VRMS)	**Pin (mW)**
90	15
115	16
230	24
265	29

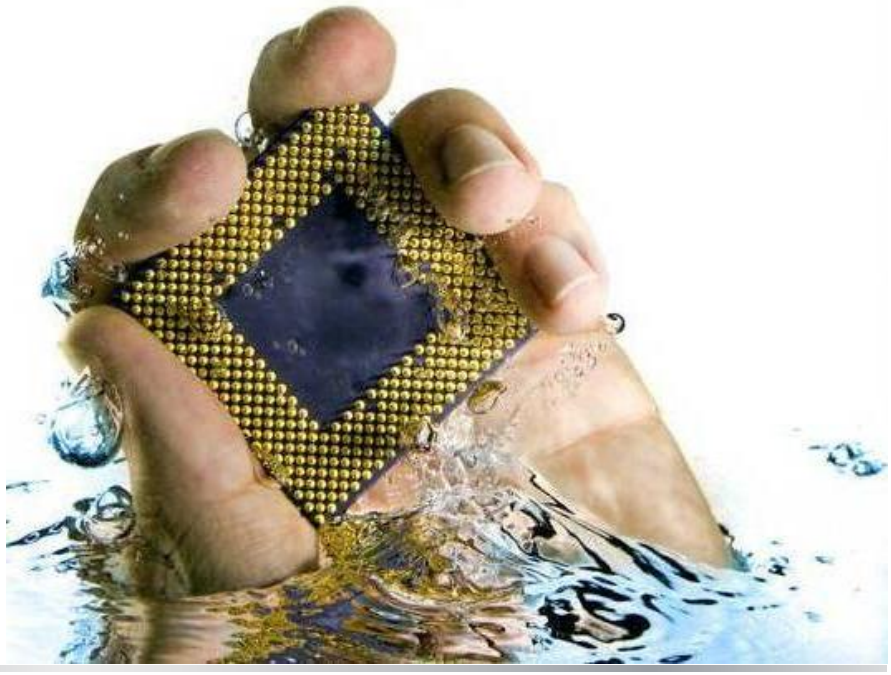
w/o Brown out and in feature

In case of Brown out and in feature is implemented additional 10mW must be considered

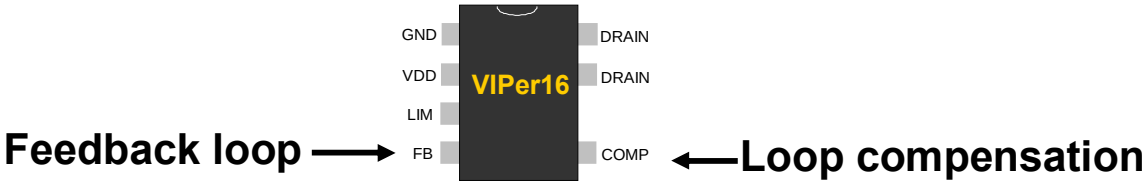
Table 1. Electrical specification

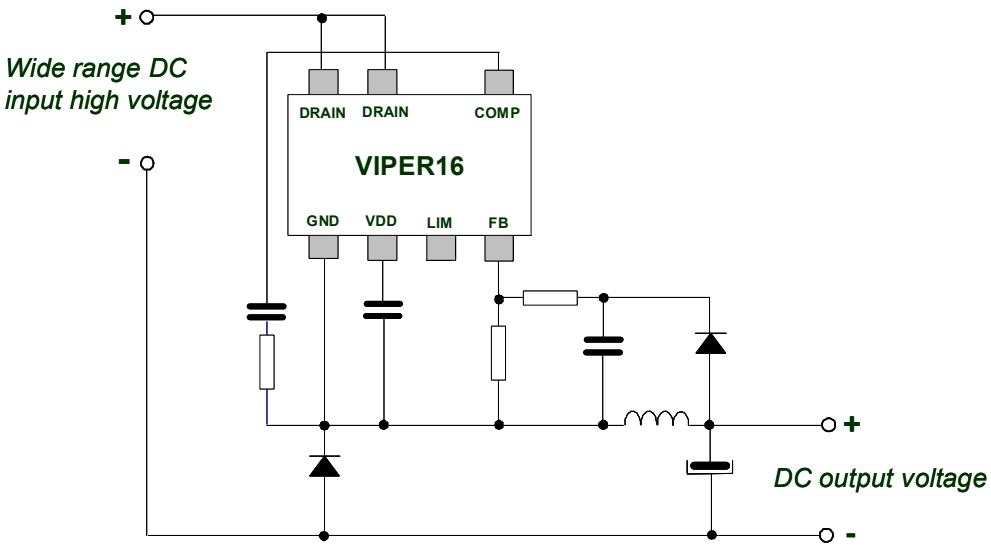
Parameter	Symbol	Value
Input Voltage range	V_{IN}	[$90V_{RMS}$; $265V_{RMS}$]
Output Voltage	V_{OUT}	5V
Max Output Current	I_{OUT}	2.4A
Precision of output regulation	Δ_{VOUT_LF}	±5%
High Frequency output Voltage ripple	Δ_{VOUT_HF}	50mV
Max ambient operating temperature	T_A	60 °C

Solution for ultra wide input voltage auxiliary supply based on Viper16



Buck converter

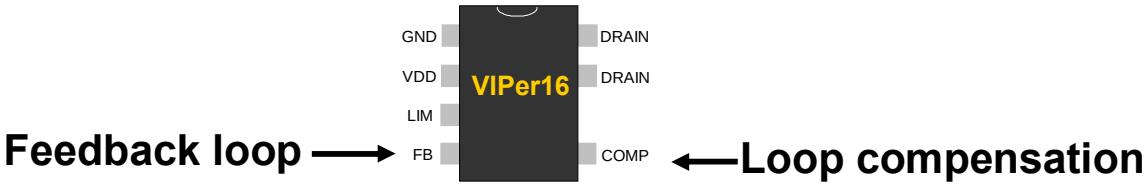


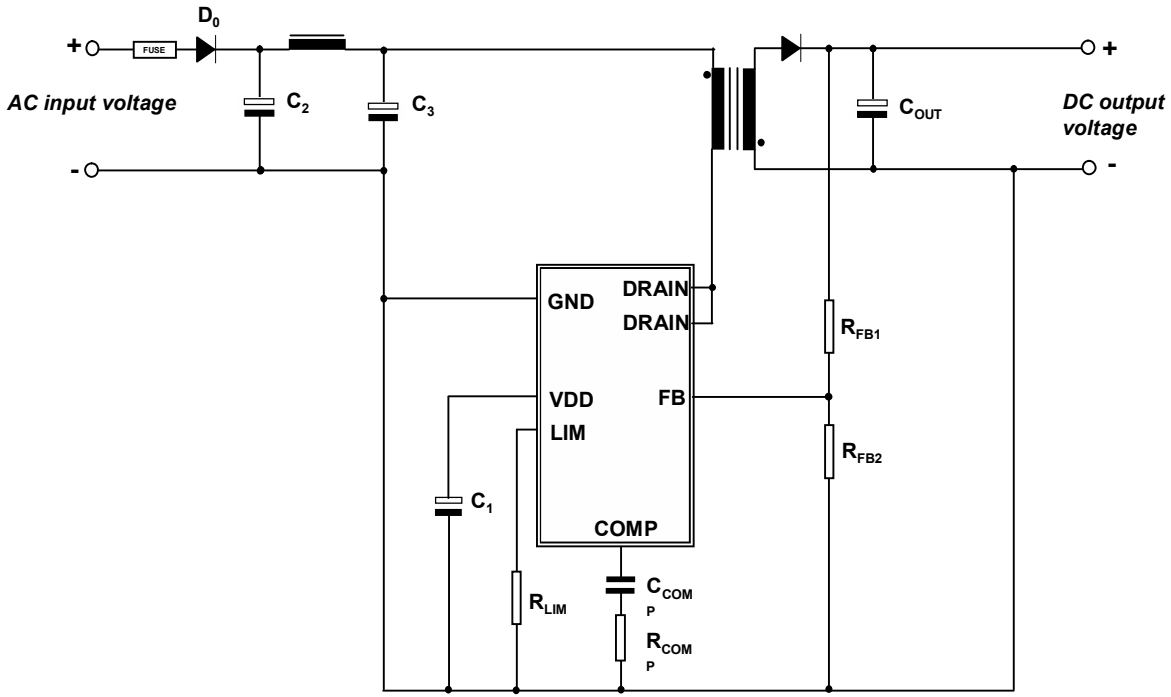


Solutions for replacement of capacitive power supply

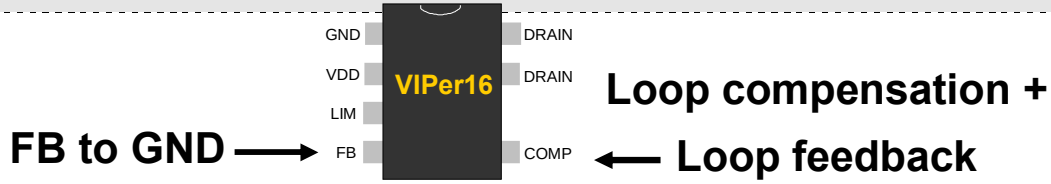
Auxiliary power supply for: Home appliances, Power metering, LED drivers

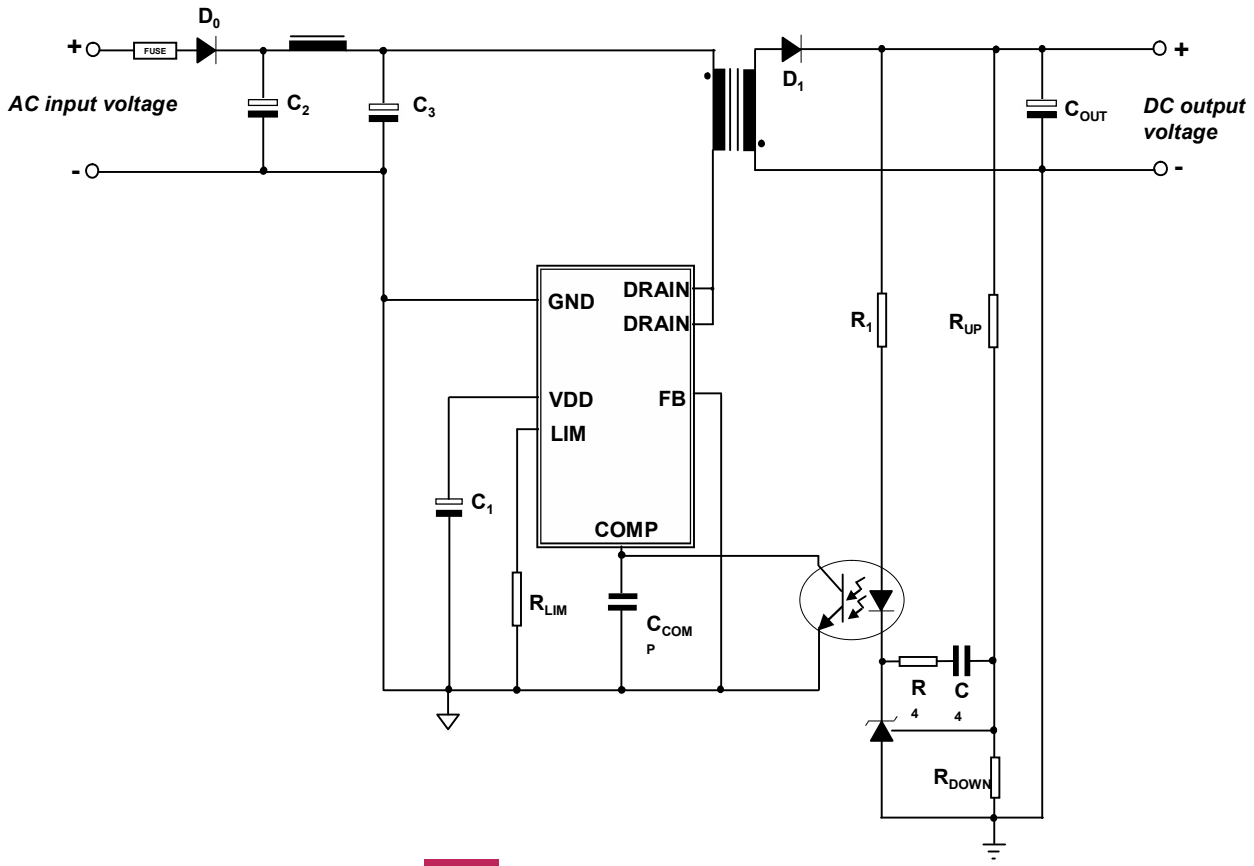
Fly-back converter, nonisolated





Fly-back converter, isolated





Main applications focus

Not-isolated SMPS up to *1.8W* output power, addressing following applications:

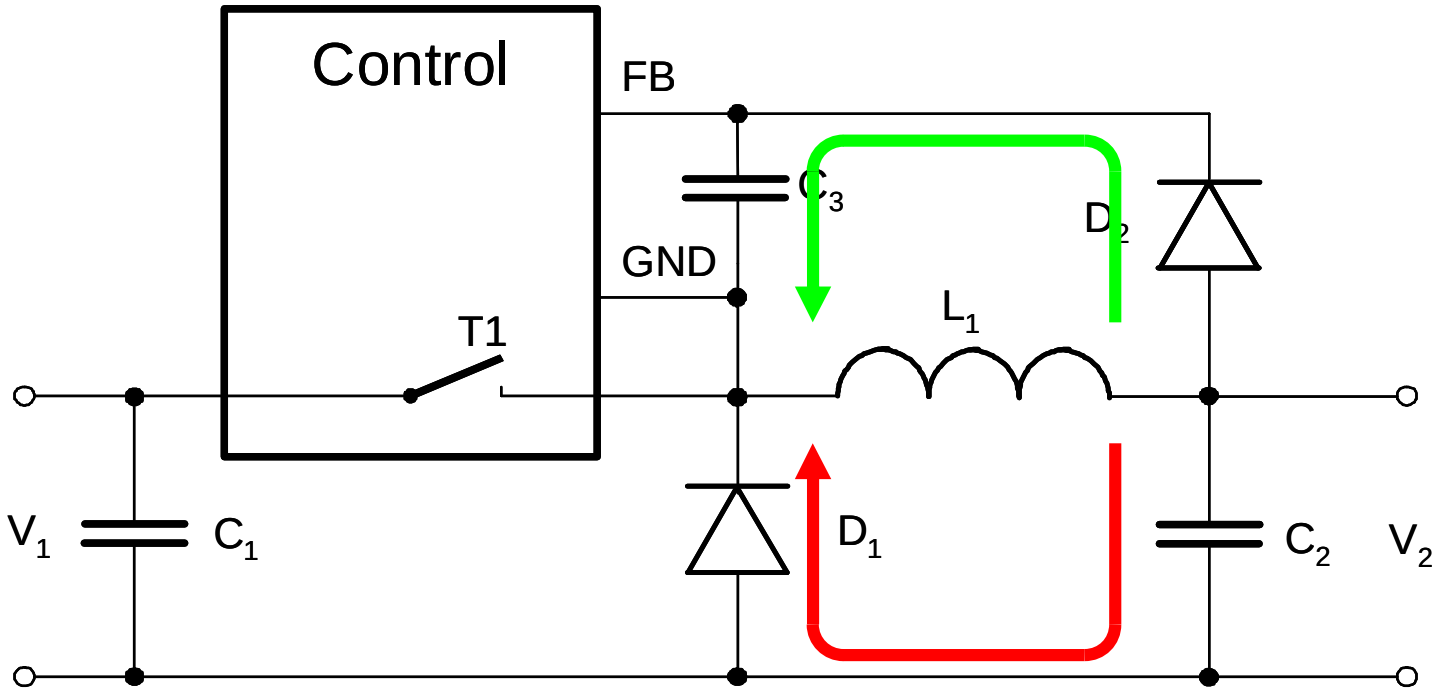
- **Metering**
  - Small metering applications for single of three phase wide range applications

- **Home Appliances**
  - Auxiliary power supply
    - Able to operate at phase to phase input
    - Able to survive misconnection of the input
  - Motor control
    - Auxiliary supply for motor control applications

- **Lighting**
  - Auxiliary supply for HID and microcontrolled ballast for fluorescent

- **General replacement of capacitive power supply driven by low standby requirements**

Feedback



During OFF time – the inductor charges output capacitor and auxiliary capacitor (Viper16 supply voltage)

STEVAL-ISA010V1

Super Wide Input Range Viper16 Buck Converter

Documentation: AN2872 soon to be published

- Buck topology
- Common Neutral
- Input voltage range 85 – 500VAC
- Output voltages 12V and 5V
- Output current – max 150mA (total for both outputs)
- Conductive EMI EN55022 Class B
- Stand by below 100mW at 230VAC

Key Product:
- ✓ VIPer16L
- ✓ STTH108
- ✓ L78L05

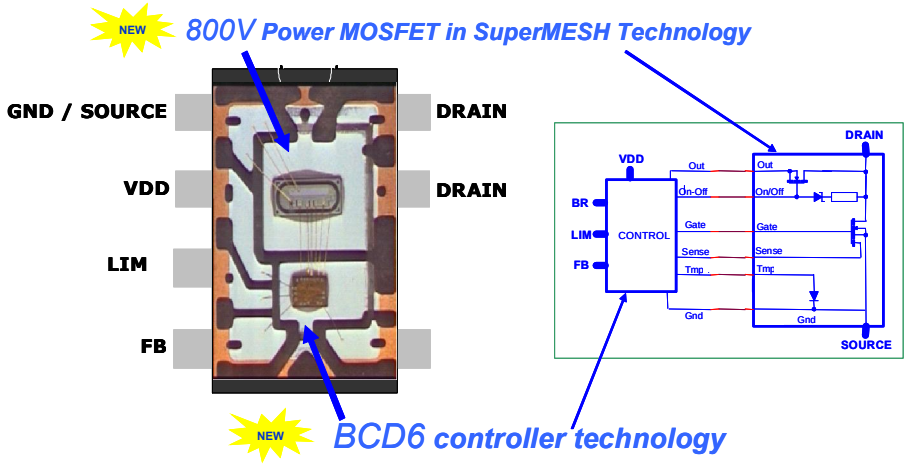
Typical Applications:
- ✓ Metering
- ✓ Home Appliances
- ✓ Motor Control

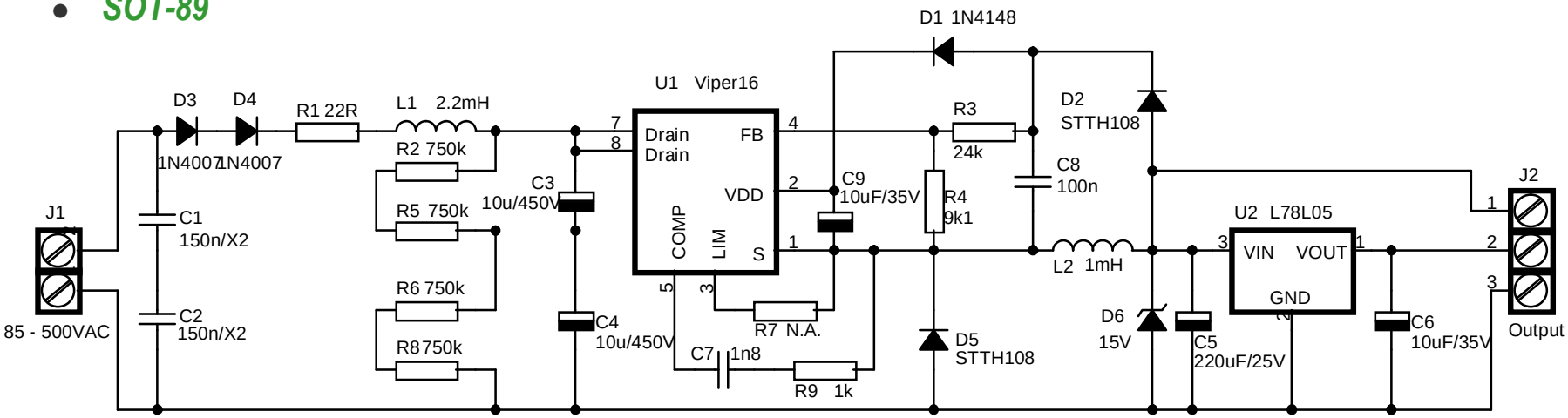
Board Purpose:
It addresses customers working on applications which would like to have single universal auxiliary supply which can be supplied from standard mains, but also either accidentally as misconnection or standardly from phase to phase voltage with focus to extremely low standby power

STEVAL-ISA010V1 – short description

ST components on the board

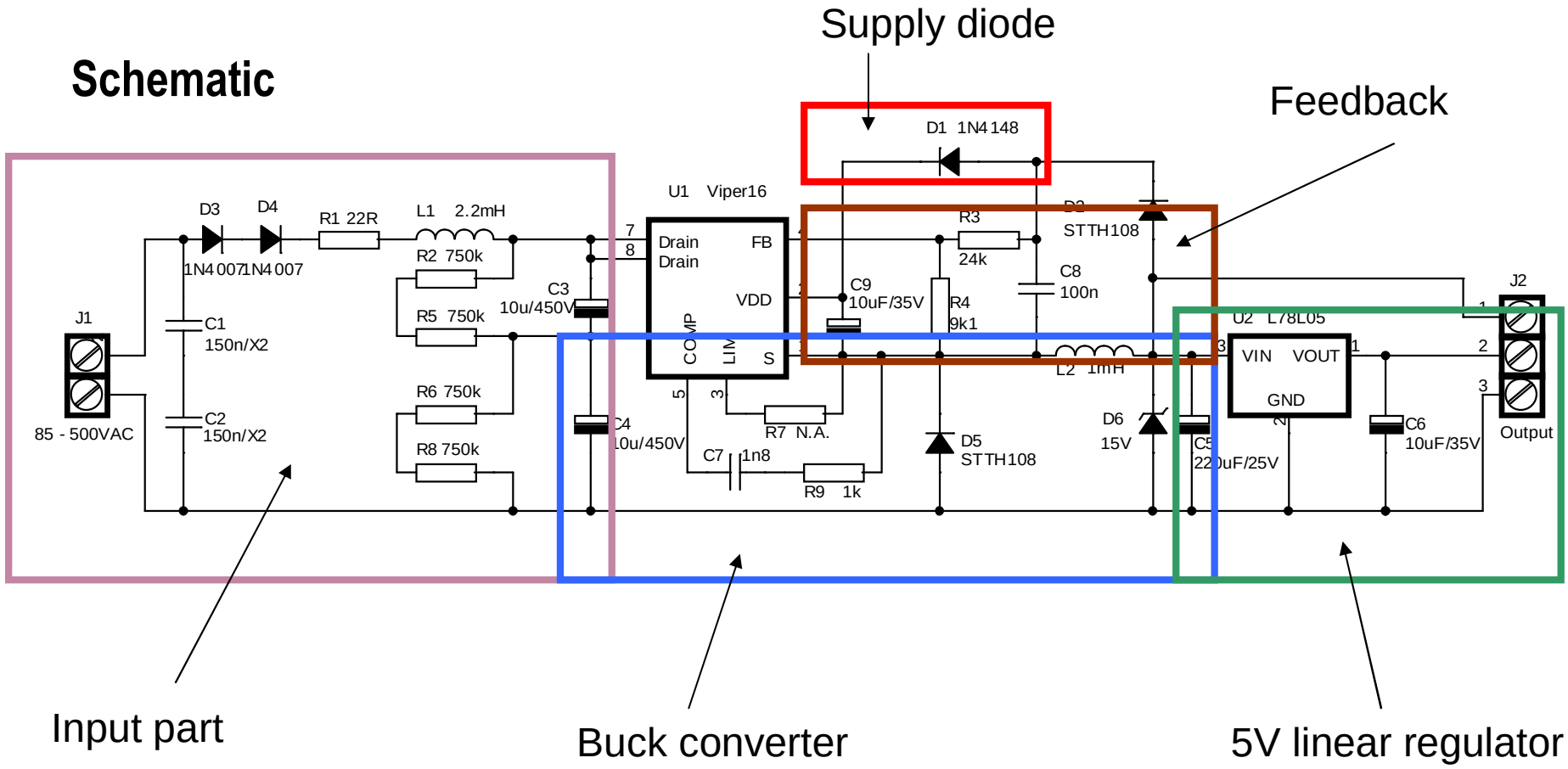
- **Viper16L**
  - One package converter
  - 60kHz
  - DIP-7
- **STTH108**
  - Ultrafast diode 800V/1A
  - SMA
- **L78L05**
  - Standard linear regulator
  - SOT-89



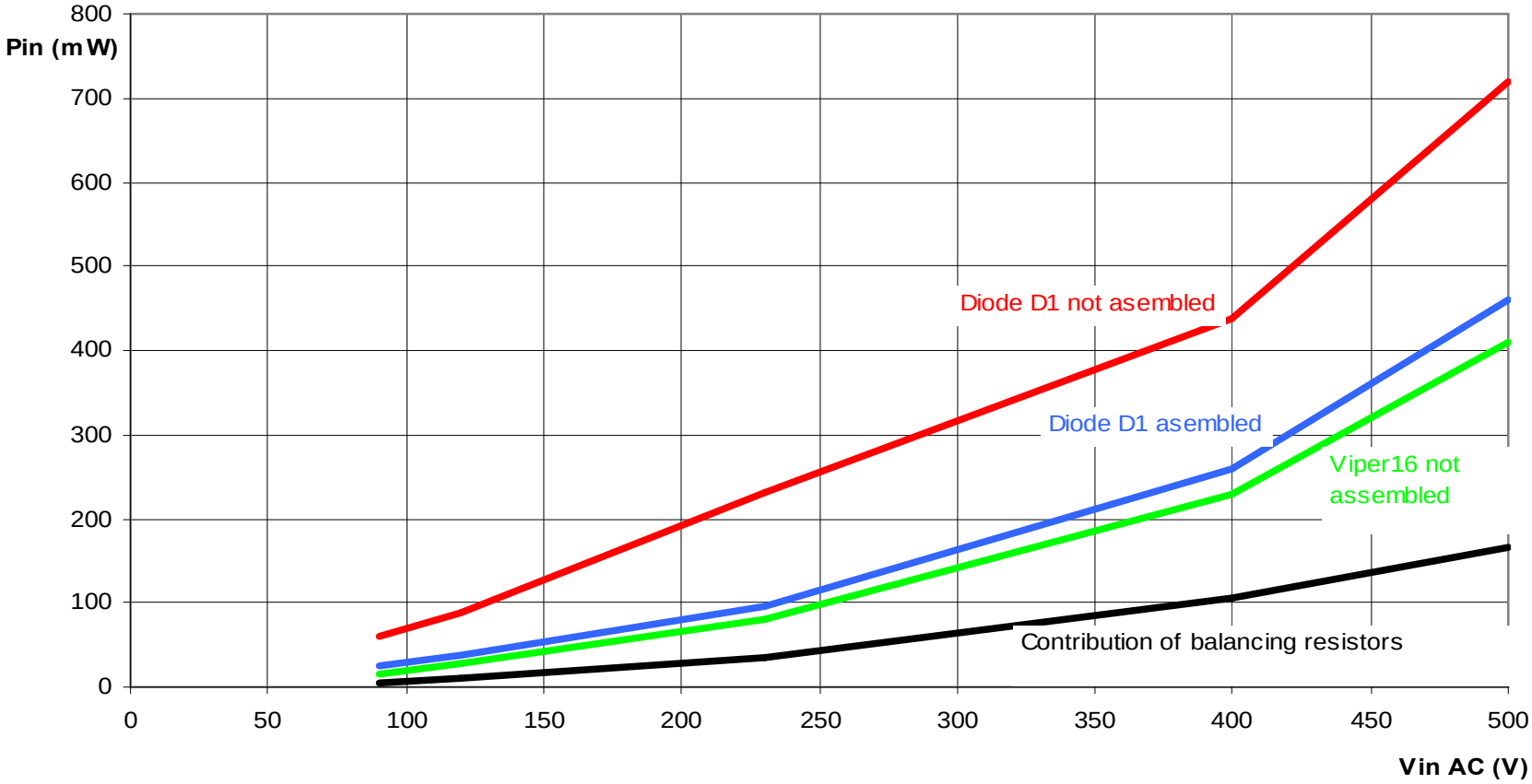


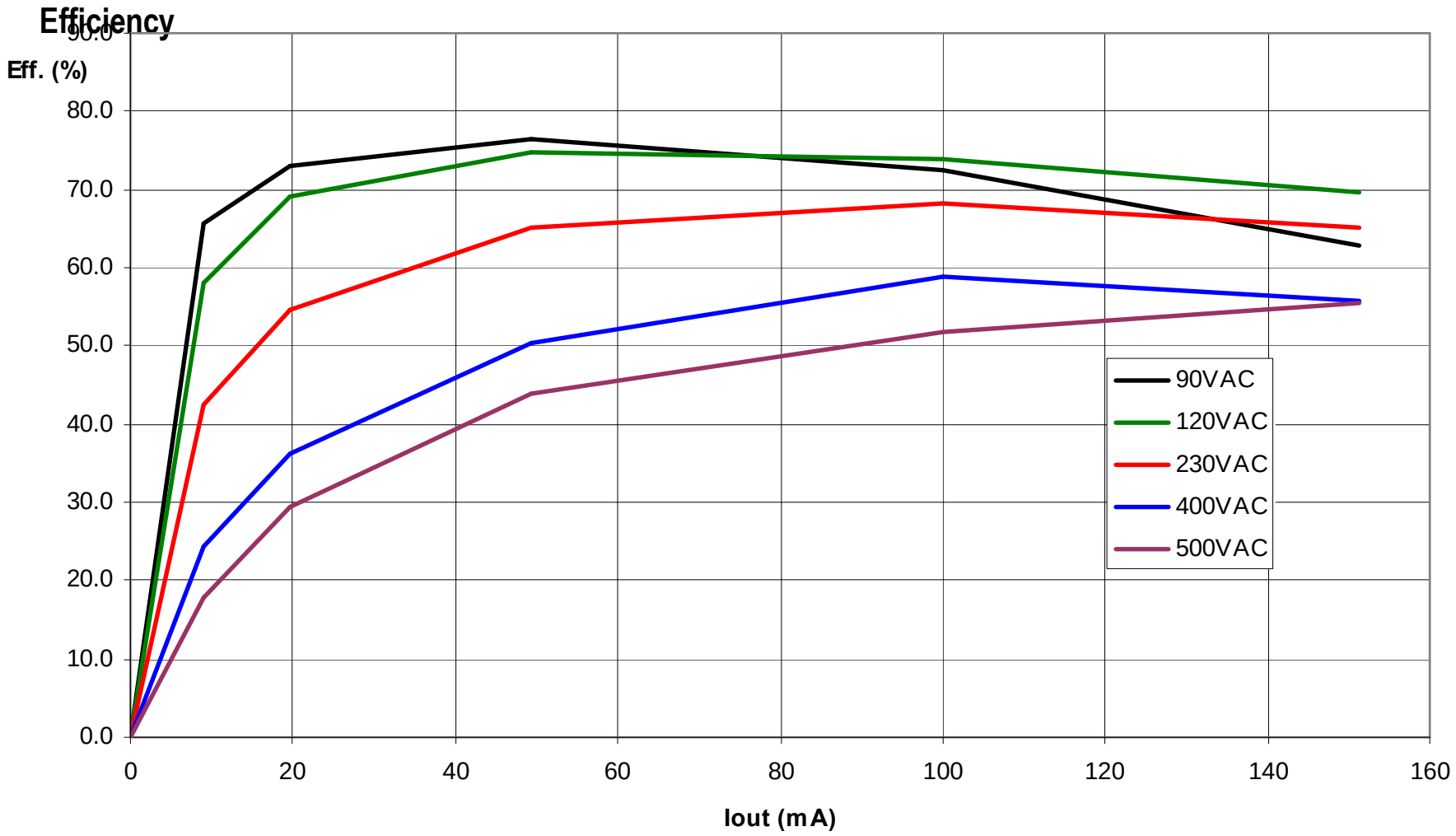
STEVAL-ISA010V1 – detail description

Schematic

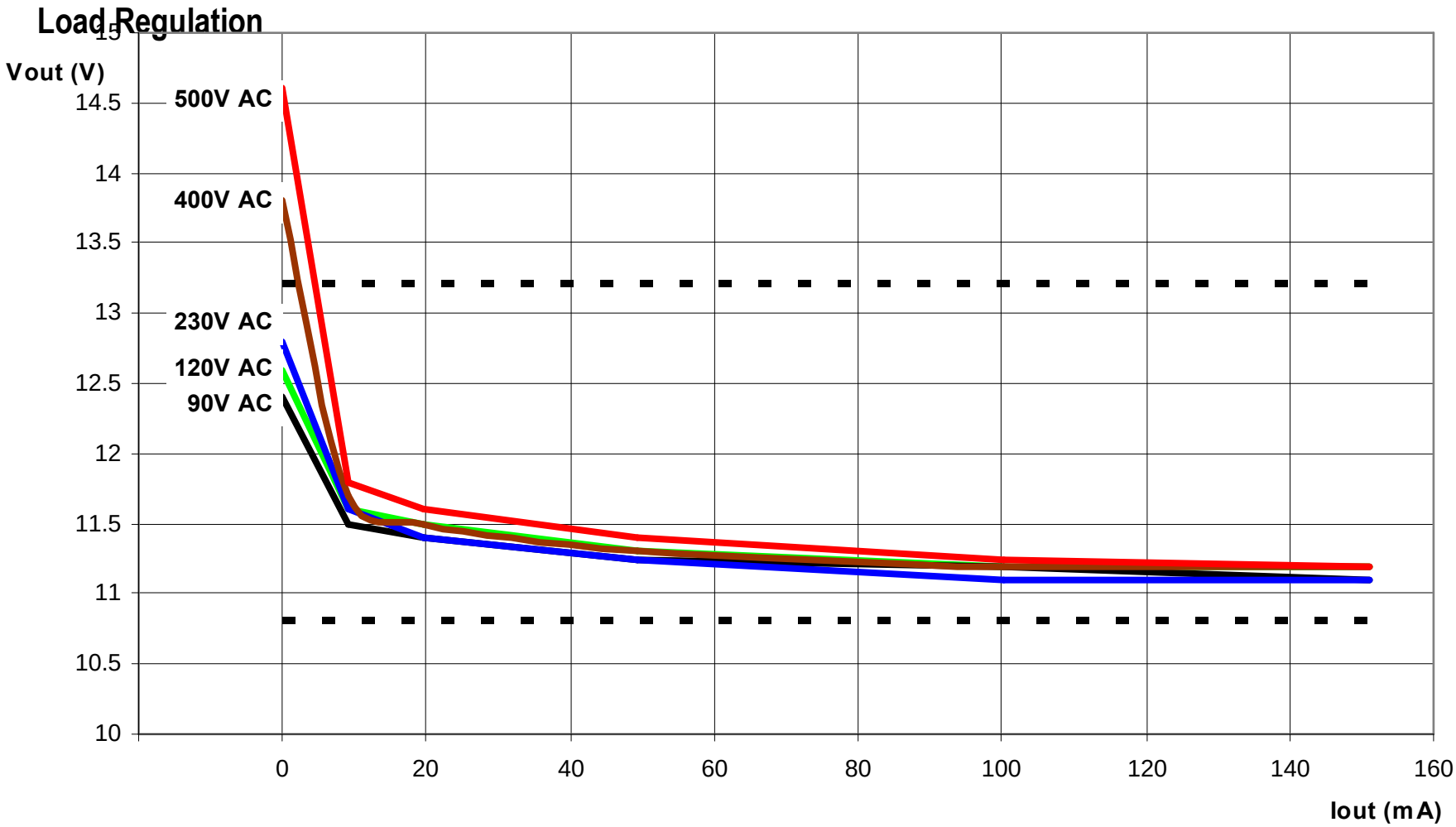


Stand-by


800
Pin (mW)
700
600
500
400
300
200
100
0
0
50
100
150
200
250
300
350
400
450
500
Vin AC (V)
Diode D1 not asembled
Diode D1 asembled
Viper16 not assembled
Contribution of balancing resistors


Efficiency
Eff. (%)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
20
40
60
80
100
120
140
160
Iout (mA)
90VAC
120VAC
230VAC
400VAC
500VAC

STEVAL-ISA010V1 – performance



STEVAL-ISA010V1 – performance

Thermal behavior and EMC

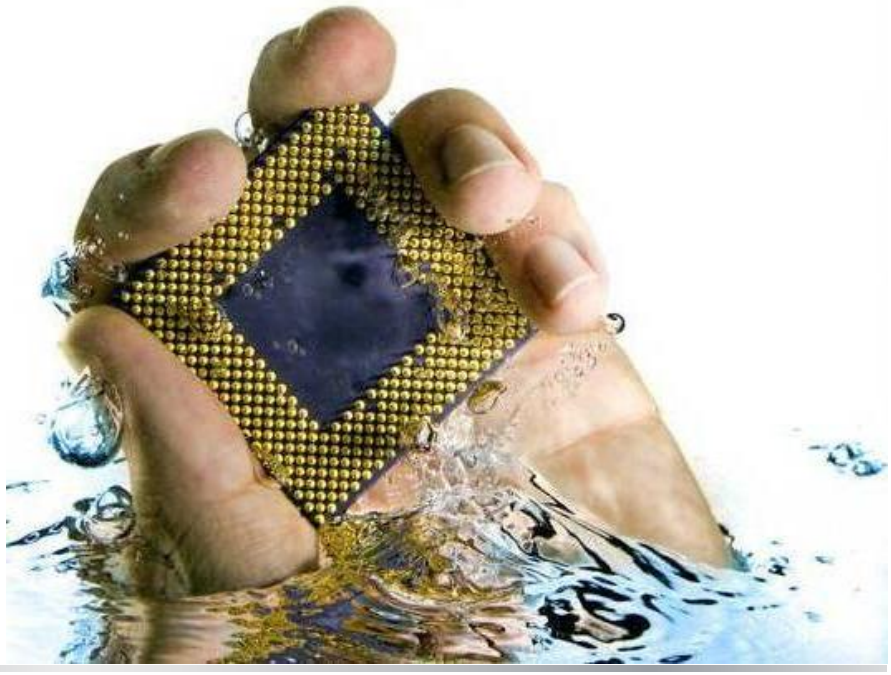
Tamb 25°C

Vin (V AC)	T (°C)	ΔT (°C)
90	52	27
120	49	24
230	60	35
400	89	64
500	77	52

EMC

- ***Meets***
- ***Surge – IEC 61000-4-5 – 2kV***
- ***Burst – IEC 61000-4-4 – 8kV***

VIPer16 schematics list



Converter Specifications

Topology:

Buck Converter

Input:

230VAC ± 20%

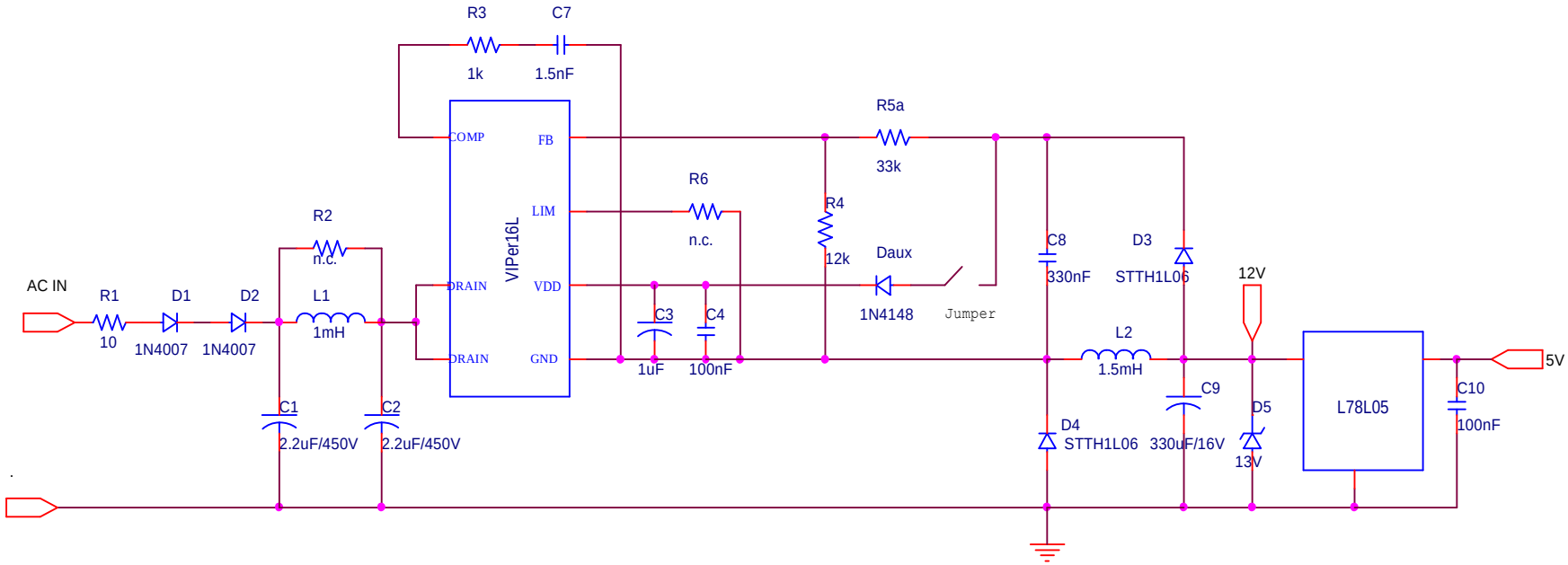
Output:

V_{OUT1} = 12V I_{OUT1} = 100mA
V_{OUT2} = 5V I_{OUT2}= 100mA

Stand-by:

P_{IN} < 0.3W at no load

Schematic & Layout



POUT = 0 → PIN_{230Vac} = 0.22W

Converter Specifications

Topology:

Buck Boost Converter

Input:

230VAC ± 20%

Output:

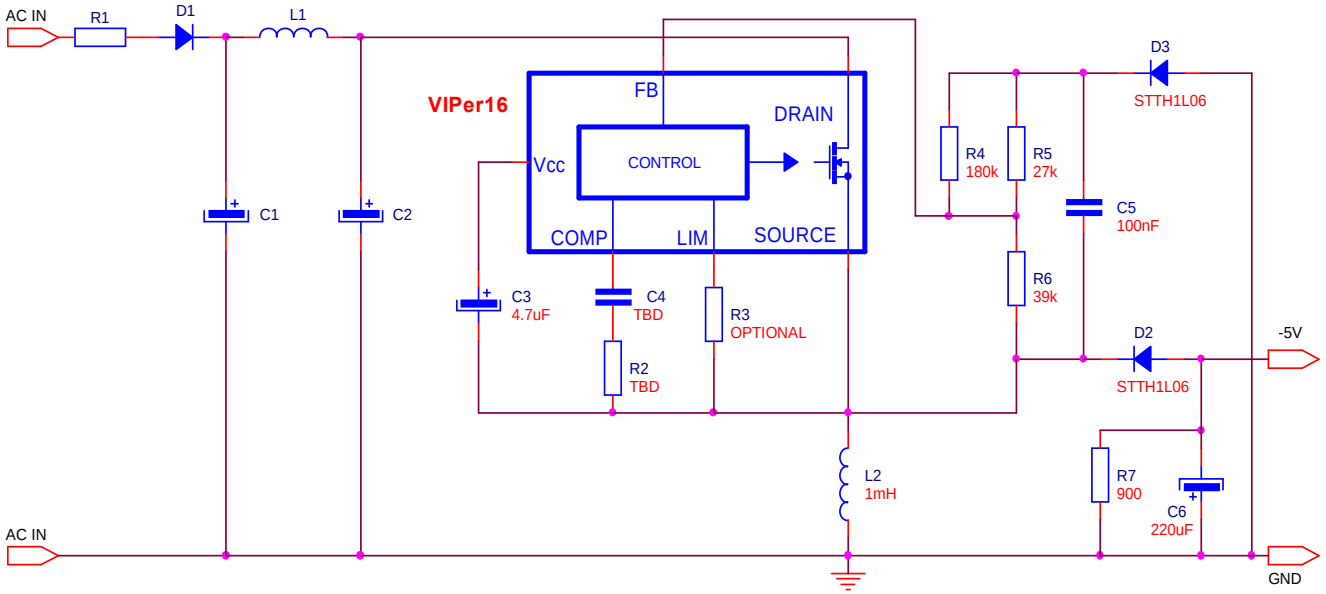
V_{OUT}= -5V I_{OUT} = 100mA

(max) 5.2V max ripple might go down to min 4.5V

Stand-by:

P_{IN} < 0.2W at no load

Buck Boost Converter , V_{OUT}= -5V (option 1)



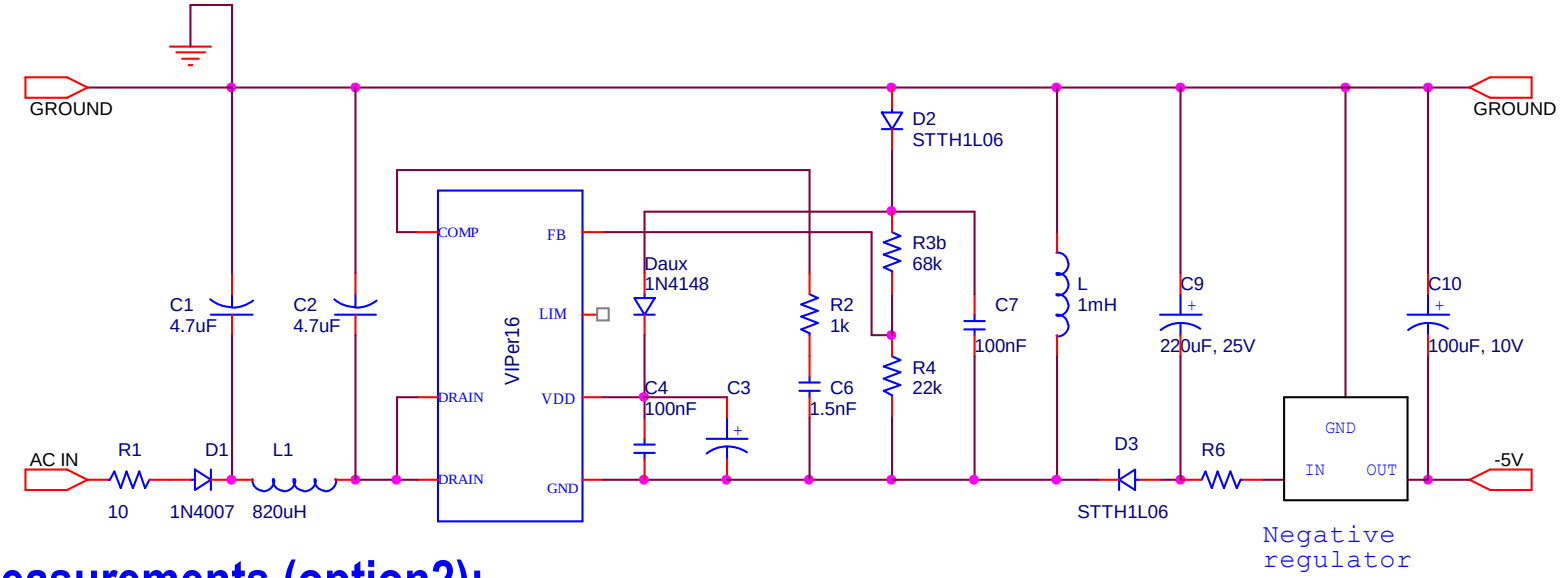
Measurements (option1):

Iout=100mA

- **Load regulation: 5.2V – 4.71V (90 – 264Vac)**
- **Standby: 190mW@230Vac e 120mW@110Vac**
- **Efficiency:**
  - **54% @100mA**
  - **49% @50mA**

Buck Boost Converter , V_{OUT} = -5V (option 2)

From -12V to -5V by negative linear regulator



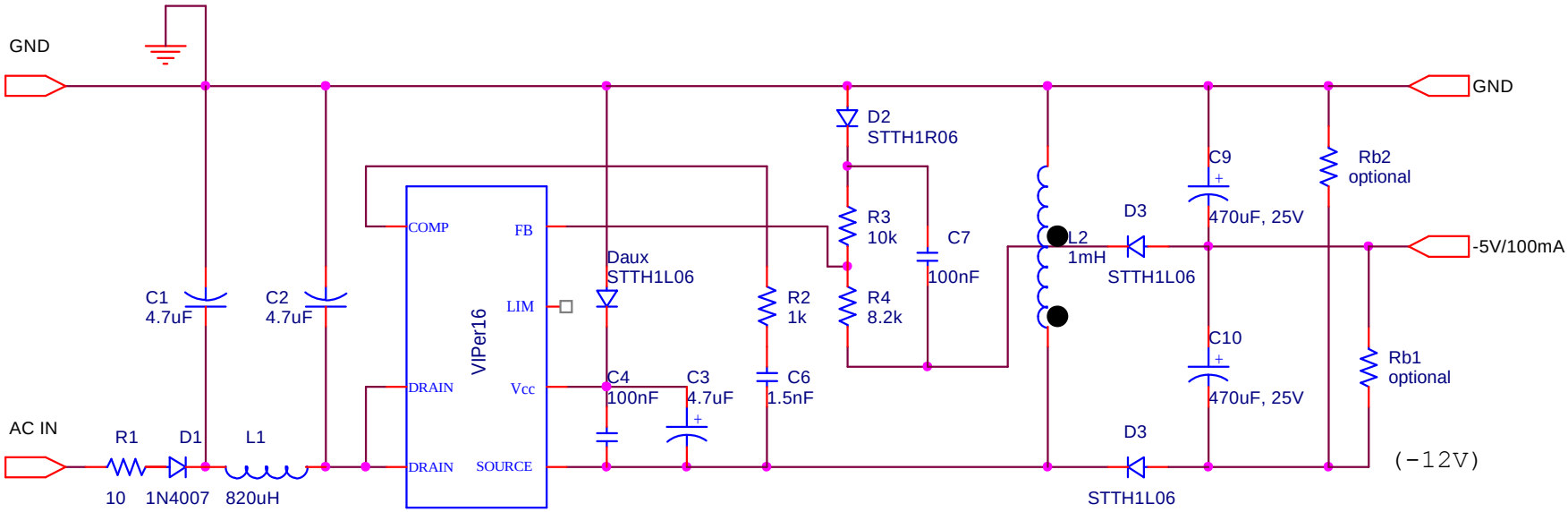
Measurements (option2):

Iout=100mA

- **Load regulation: 5V (90 – 264Vac)**
- **Standby: 60mW@230Vac e 50mW@110Vac**
- **Efficiency:**
  - **30% @100mA**
  - **28% @50mA**

From -12V to -5V by double inductor

Option 3: -5V with Central Tap Inductor



Converter Specifications

ORDER CODES:
EVLVIPER16H-4WFL
EVLVIPER16L-4WFL

Topology:
Non isolated fly-back

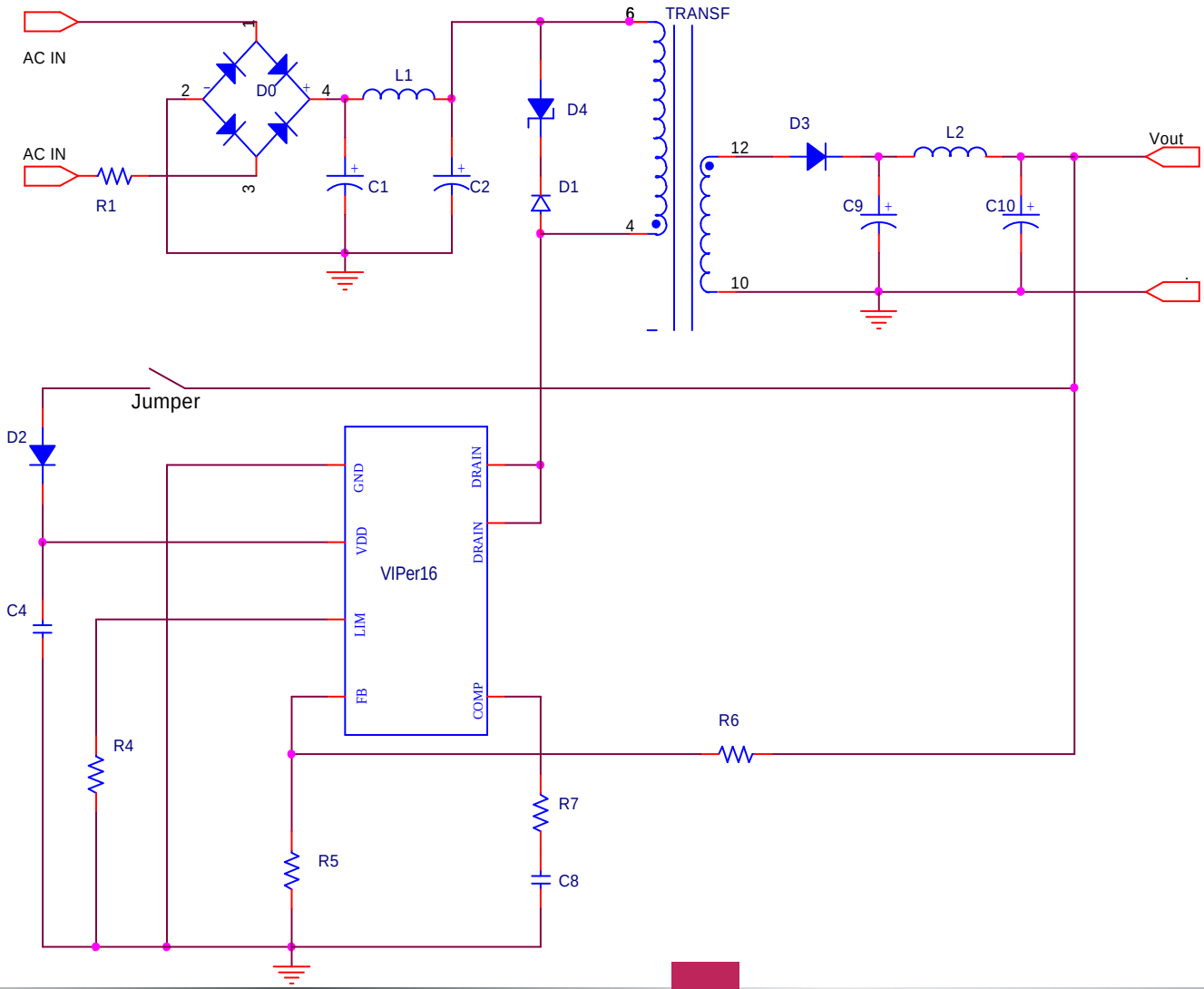
Input:
90-264V_{AC}

Output:
V_{OUT}= 16V I_{OUT} = 250mA

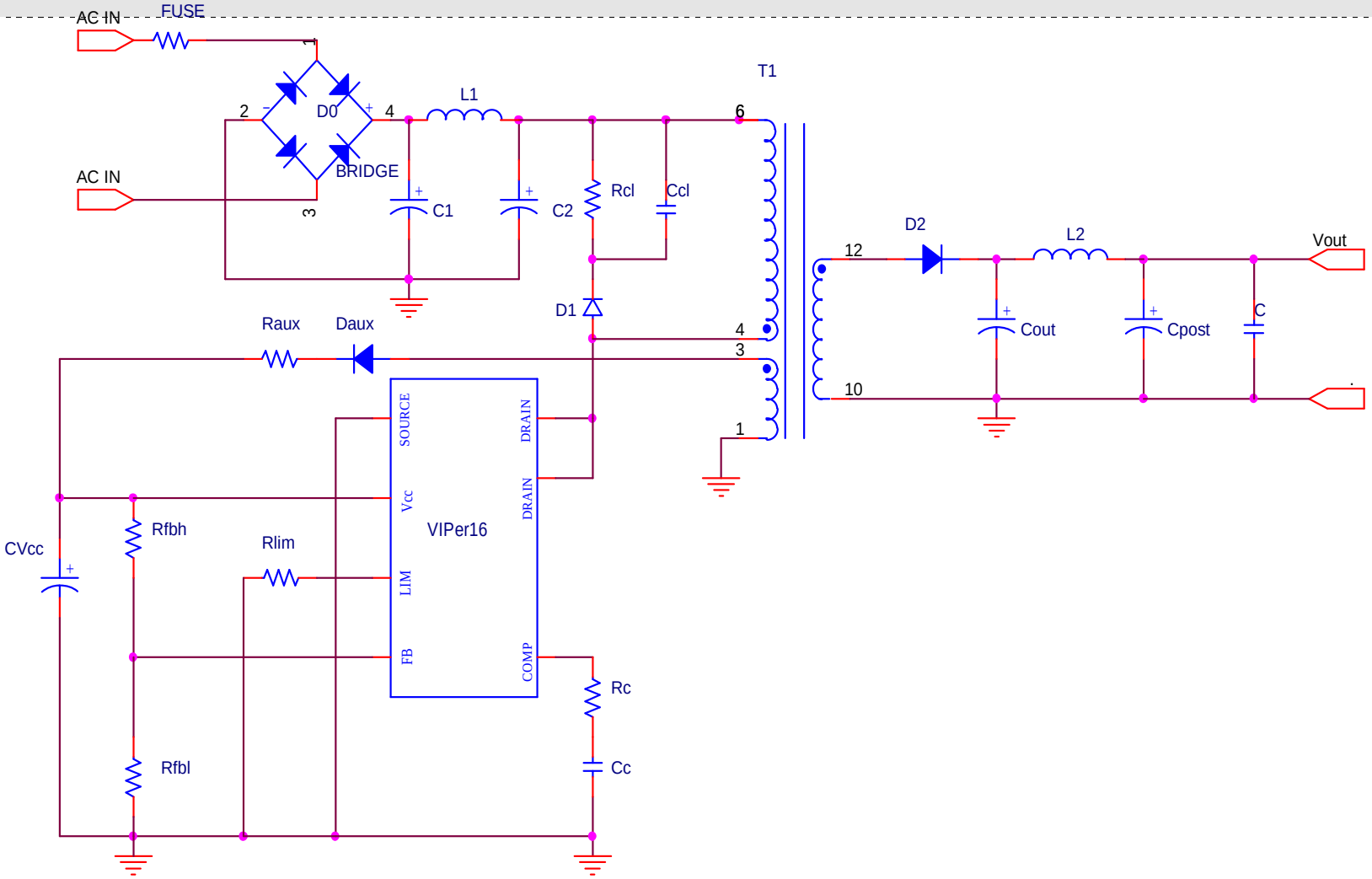
Stand-by:
P_{IN} < 0.1W at no load

Efficiency:
> 70% @ (Io=10%-100%loading & V_{INAC}=90-264Vac)

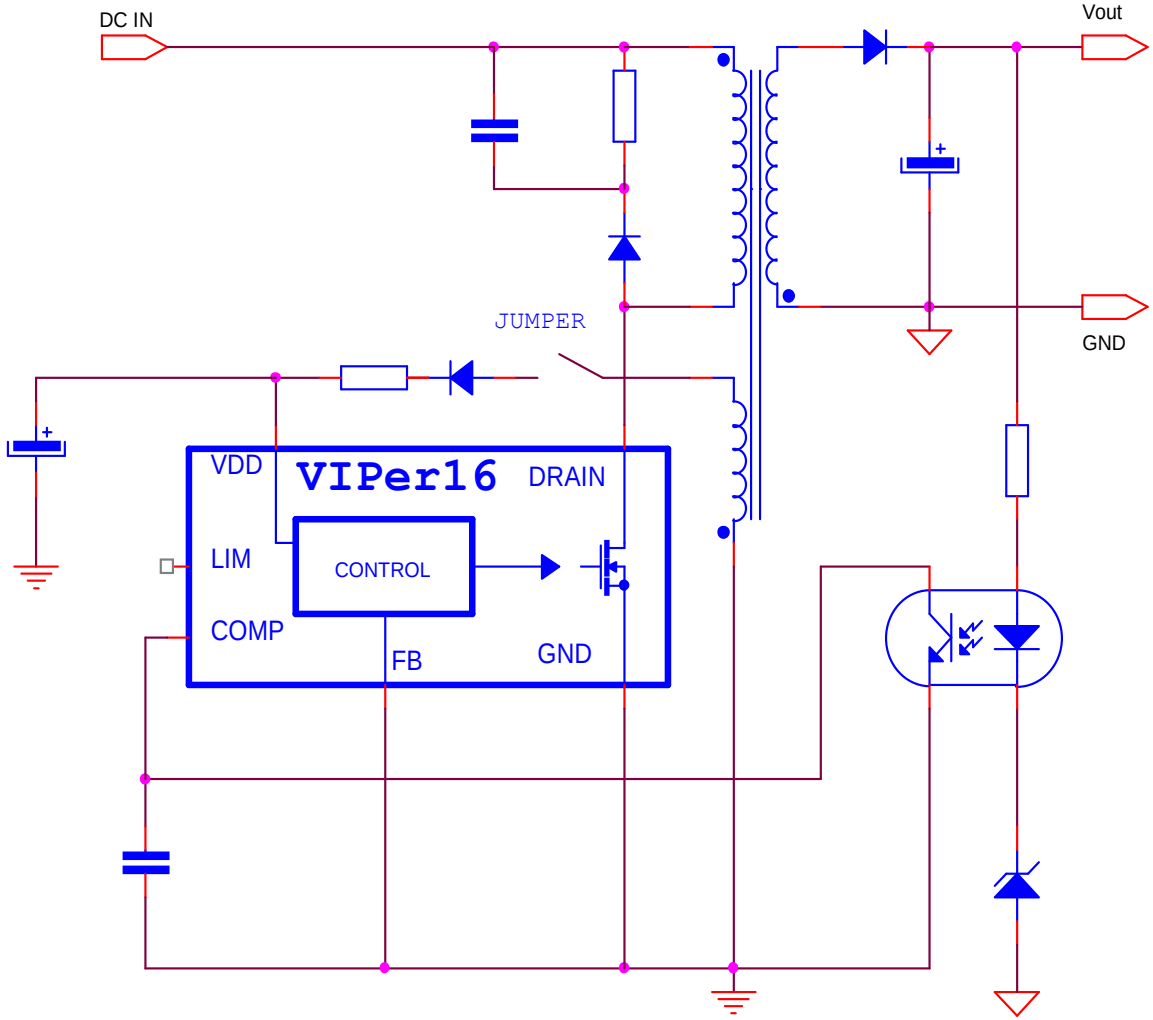
Non Isolated fly-back , V_{OUT} = 16V



Fly-back with Primary Regulation



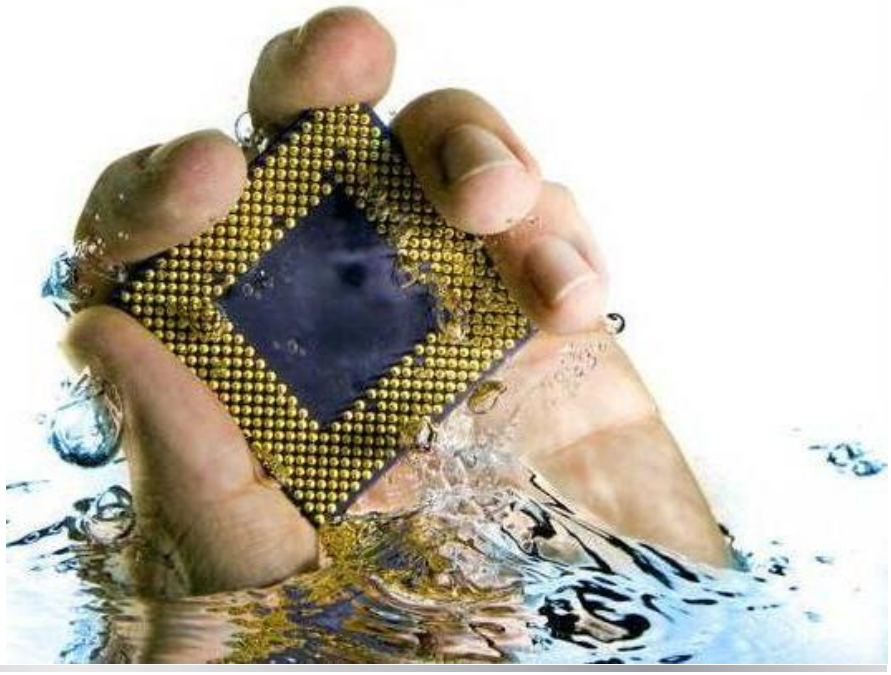
Isolated Fly-back with Secondary Regulation



VIPer Plus

PI vs. ST easy cross-reference

AC-DC Products



PI easy cross-reference

New VIPer Plus family is the right competitor of Power Integrations TinySwitch.

Customer what offline converter are they using? In most cases the answer is: PI!

In case that we have the right replacement we can offer ST part with all the nice features on bottom:

- ❑ **avalanche rugged 800V MOSFET**
- ❑ **two fixed frequency with jittering or quasi-resonant**
- ❑ **<50mW stand-by power (30mW already achieved)**
- ❑ **Soft-start-up**
- ❑ **Current limitation, overvoltage & -current protection, temperature protected etc…**

Easy cross-reference vs TinySwitch 1/3

Very Low AC-DC, Non-Isolated Linear/Passive Supply Replacement (≤360 mA)

Original Data from PI product selector

Product	Output Current		Output Current		ST cross
	MDCM2	CCM3	MDM2	CCm3	
LinkSwitch-TN	230 VAC ± 15%		85 - 265 VAC		
LNK302 PN/GN/DN	63 mA	80 mA	63 mA	80 mA	VIPER16 xN/xD
LNK304 PN/GN/DN	120 mA	170 mA	120 mA	170 mA	VIPER16 xN/xD
LNK305 PN/GN/DN	175 mA	280 mA	175 mA	280 mA	VIPER26 xN/xD
LNK306 PN/GN/DN	225 mA	360 mA	225 mA	360 mA	VIPER26 xN/xD

VIPER26 within 2009

Low Power AC-DC Power Conversion (Up to 36.5 W)

Original Data from PI product selector

Product	Continuous Output Power		Continuous Output Power		ST cross
	Adapter	Open Frame	Adapter	Open Frame	
TinySwitch - III	230 VAC ± 15 %		85 - 265 VAC		
TNY274 PN/GN	6 W	11 W	5 W	8.5 W	VIPER17 / VIPER15
TNY275 PN/GN	8.5 W	15 W	6 W	11.5 W	VIPER17 / VIPER15
TNY276 PN/GN	10 W	19 W	7 W	15 W	VIPER27 / VIPER25
TNY277 PN/GN	13W	23.5 W	8 W	18 W	VIPER27 / VIPER25
TNY278 PN/GN	16 W	28 W	10 W	21.5 W	VIPER37 / VIPER35
TNY279 PN/GN	18 W	32 W	12 W	25 W	VIPER37 / VIPER35
TNY280 PN/GN	20 W	36.5 W	14 W	28.5 W	VIPER37 / VIPER35

VIPER37 and VIPER35 within 2009

Easy cross-reference vs TinySwitch 2/3

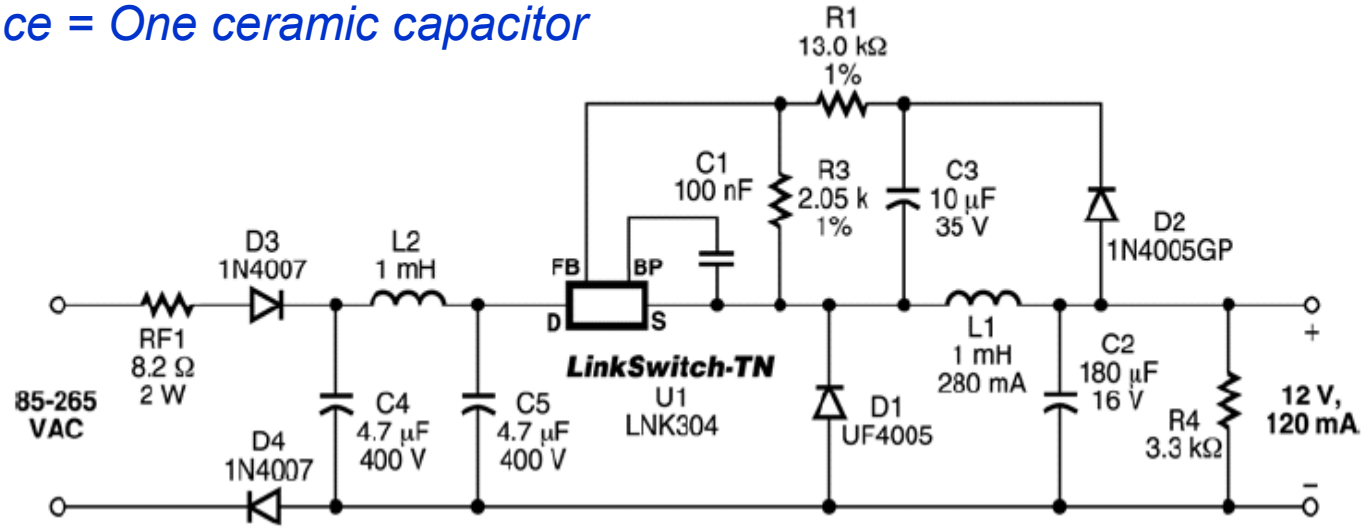
Very Low Power AC-DC Power Conversion (Up to 17 W)

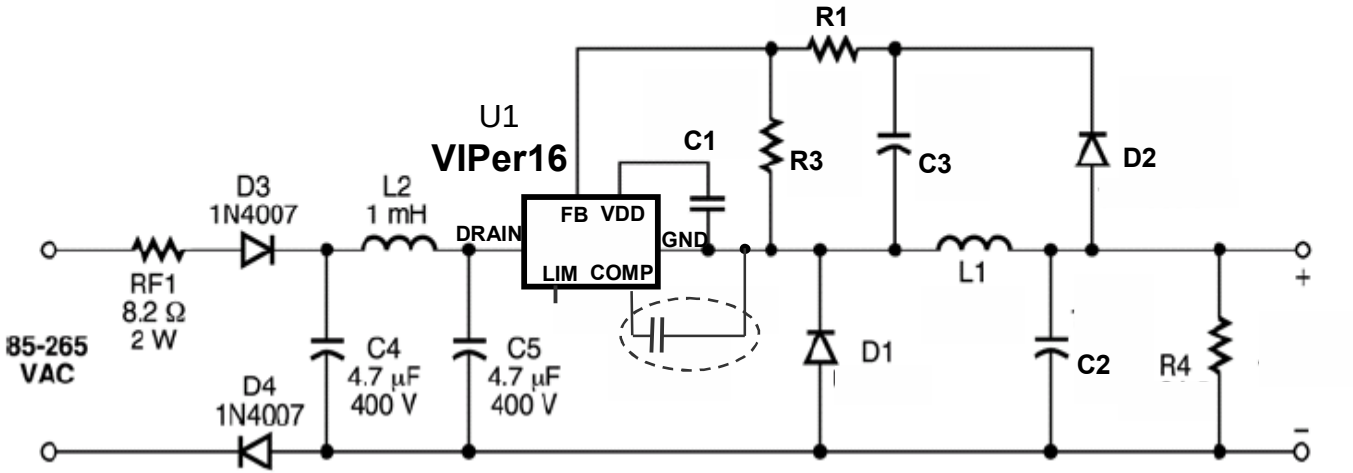
Original Data from PI product selector

Product	Continuous Output Power			Continuous Output Power			
	Adapter	Open Frame		Adapter	Open Frame		ST cross
LinkSwitch - CV	230 VAC ± 15%			85 - 265 VAC			
LNK623 PG/DG	6.5 W	9 W		5.0 W	6 W		**VIPER16 xN/xD**
LNK624 PG/DG	7 W	11 W		5.5 W	6.5 W		**VIPER16 xN/xD**
LNK625 PG/DG	8 W	13.5 W		6.5 W	8 W		**VIPER26 xN/xD**
LNK626 PG	10.5 W	17 W		8.5 W	10 W		**VIPER26 xN/xD**
LinkSwitch - II	230 VAC ± 15%			85 - 265 VAC			
LNK603/613 PG/DG	2.5 W	3.3 W		2.5 W	3.3 W		**VIPER16 xN/xD**
LNK604/614 PG/DG	3.5 W	4.1 W		3.5 W	4.1 W		**VIPER16 xN/xD**
LNK605/615 PG/DG	4.5 W	5.1 W		4.5 W	5.1 W		**VIPER26 xN/xD**
LNK606/616 PG/GG	5.5 W	6.1 W		5.5 W	6.1 W		**VIPER26 xN/xD**
LinkSwitch - LP	230 VAC ± 15%			85 - 265 VAC			
LNK562 PN/GN/DN	1.9 W	1.9 W		1.9 W	1.9 W		**VIPER16 xN/xD**
LNK563 PN/GN/DN	2.5 W	2.5 W		2.5 W	2.5 W		**VIPER16 xN/xD**
LNK564 PN/GN/DN	3 W	3 W		3 W	3 W		**VIPER16 xN/xD**
LinkSwitch - XT	230 VAC ± 15%			85 - 265 VAC			
LNK362 PN/GN/DN	2.8 W	2.8 W		2.6 W	2.6 W		**VIPER16 xN/xD**
LNK363 PN/GN/DN	5 W	7.5 W		3.7 W	4.7 W		**VIPER16 xN/xD**
LNK364 PN/GN/DN	5.5 W	9 W		4 W	6 W		**VIPER16 xN/xD**

Buck Converter comparison

BOM difference = One ceramic capacitor





VIPer16 / LNK304 comparison

In line with LNK304	Strength	Weakness
Stand-by performance	800V, Avalanche Rugged Advantage: Reliability and Robustness	BOM with One capacitor more
Fixed Frequency	Adjustable I_{Dlim} (LIM pin) Advantages: 1- Optimization of the secondary side components limiting the max output power to the needed one 2- Same device for different output power helps in stock optimization.	SMD-8 (DIP-8 gull-wing)
Jittering for EMI reduction	Soft start Advantage: Reliability and Robustness	Tools…we are coming with Eval Boards and Application Note.
Over Load protection	Burst Mode with dedicated low load management circuit Advantage: Drastic reduction of the VIPer's consumption	
Autorestart after over load		
Thermal Protection with Hyst.		

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Thanks for your attention