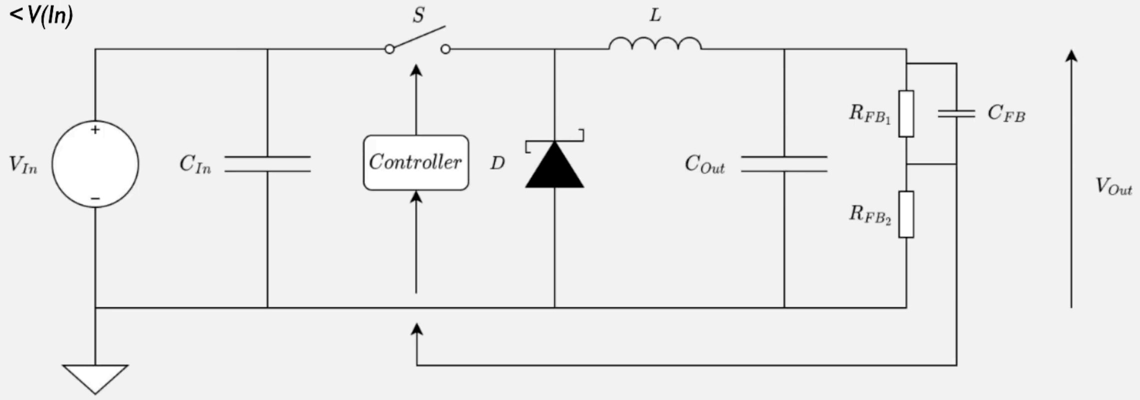
BUCK CONVERTER OVERVIEW

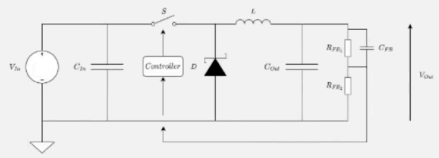
Buck (Step-Down Converter):
V(Out) < V(In)



$$V_{Out} \approx \delta \cdot \eta \cdot V_{In}$$

REQUIREMENTS SPECIFICATION

As a bare minimum, we require these parameters to be defined:



1. **Input voltage range:** $12V \leq V_{In} \leq 16.8V$
2. **Nominal output voltage:** $V_{Out,nom} = 3.3V$
3. **Maximum output (load) current:** $I_{Out,max} = 500mA$

Then we can choose a buck converter IC!

MAXIMUM SWITCHING CURRENT

Switch (typically in IC), diode (can be in IC), and inductor need to sustain currents larger than the load current!

1. ***Calculate duty cycle (efficiency ~80 to 90%):*** $\delta \approx \frac{V_{Out}}{V_{In,max} \cdot \eta} = 0.25$
2. ***Calculate inductor ripple current (using 'average' L value from datasheet):*** $\Delta I_L = \frac{(V_{In,max} - V_{Out}) \cdot D}{f_{sw} \cdot L_{avg}} = 325mA$
3. ***Check if IC can deliver required max. output current:*** $I_{IC,max} = I_{LIM,min} - \frac{\Delta I_L}{2} = 1.84A$
4. ***Calculate peak switch/diode/inductor current:*** $I_{SW,max} = I_{Out,max} + \frac{\Delta I_L}{2} = 660mA$

INDUCTOR SELECTION

L

$$L_{min} = \frac{V_{Out} \cdot (V_{In,max} - V_{Out})}{\Delta I_L \cdot f_{sw} \cdot V_{In,max}}$$

But how do we choose inductor ripple current if L isn't known yet? :(

Estimate ripple current is 20% to 40% of maximum output current! :)

$$L_{min} = \frac{3.3V \cdot (16.8V - 3.3V)}{0.3 \cdot 0.5A \cdot 800kHz \cdot 16.8V} = 22uH$$

calculating the value of our magnetic element

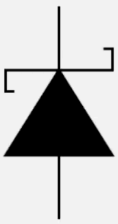
DIODE SELECTION

Diode is often included in IC.

However, if it isn't need to choose suitably Schottky diode, with current rating of at least (switch = off):

$$I_F = I_{Out} \cdot (1 - \delta) = 375mA$$

D



Also, check power dissipation of diode!

$$P_D = I_F \cdot V_F$$

need to choose a shotkey diode to minimize switching losses two

INPUT / OUTPUT CAPACITOR SELECTION

C_{In}

Input capacitor: typically given in datasheet! Use low-ESR caps, suitable dielectric/voltage rating.

E.g. from datasheet: small temperature coefficients. A 22μF ceramic capacitor for most applications is sufficient. Include a capacitor with a

Output capacitor: minimum and/or equations typically given in datasheet! Low-ESR + larger value to reduce output voltage ripple. Check dielectric/voltage rating.

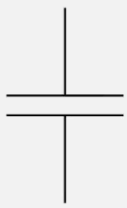
E.g. from datasheet:

$$\Delta V_{OUT} = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times f_{OSC} \times L} \times \left(R_{ESR} + \frac{1}{8 \times f_{OSC} \times C_{OUT}}\right)$$

and

The characteristics of the output capacitor also affect the stability of the regulation system, and a 10uF ceramic capacitor is recommended in typical application. The

C_{Out}

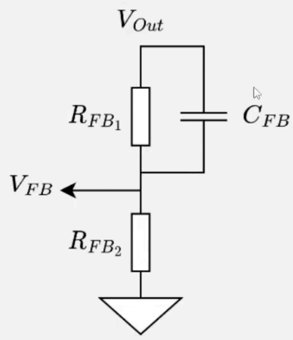


FEEDBACK NETWORK

Feedback voltage divider sets output voltage.

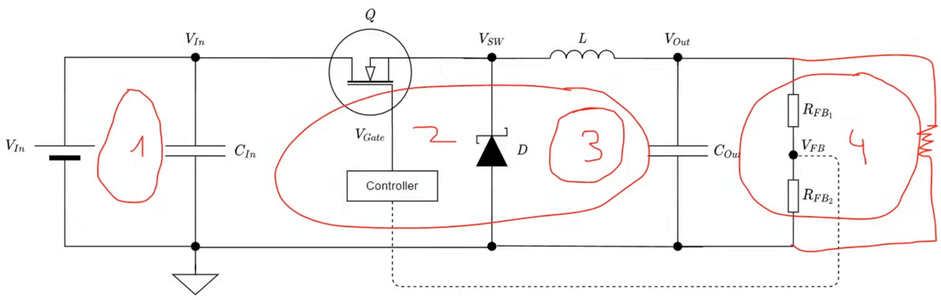
V(FB) typically fixed internally by (precision) voltage reference (typ. 0.8V).
(Given in datasheet)

$$V_{Out} = V_{FB} \cdot (1 + \frac{R_{FB_1}}{R_{FB_2}})$$



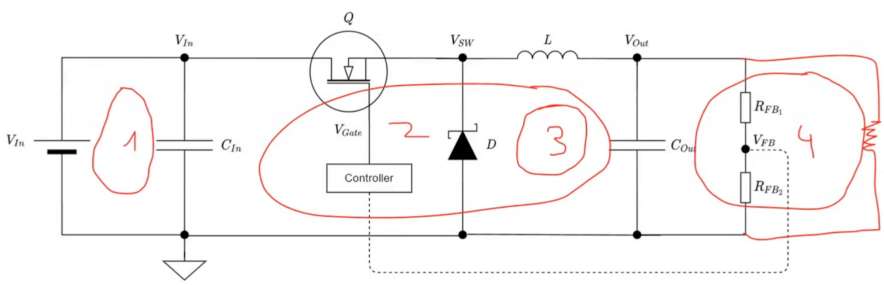
Datasheet will provide information on suitable order of magnitude of R(FB*), typically 10-100 kOhms. Check tolerance (typ. 1%)!

$$V_{Out} = 0.8V \cdot (1 + \frac{75k\Omega}{24k\Omega}) = 3.3V$$



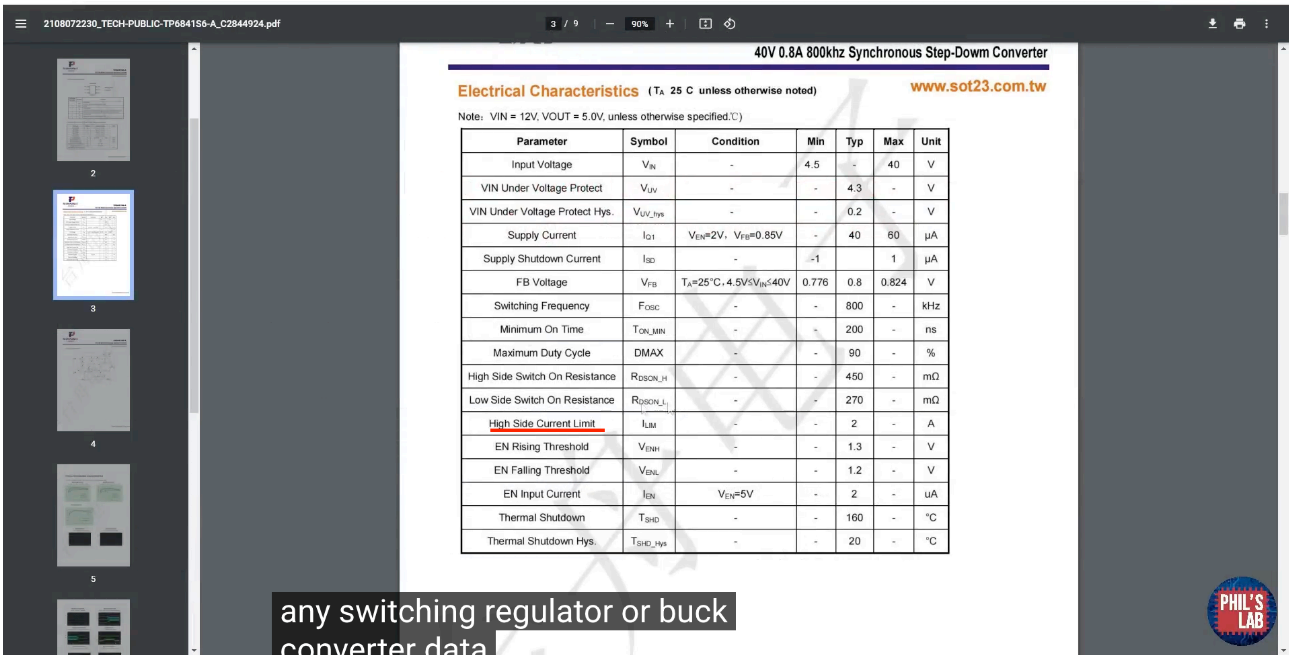
General Layout and Routing Rules 1:

- **Keep loops tight (small)!**
- **Start with critical (high-frequency, high-current) loops first.**
- **Finish with control circuitry (feedback, enables, etc.)**



General Layout and Routing Rules 2:

- **Keep all high-frequency, high-current components on same side as controller IC.**
- **Make traces as short and as wide as <u>reasonably</u> possible.**
- **Keep sensitive lines (feedback) away from areas of high energy (avoid coupling).**
- **Ground plane directly underneath switcher!**



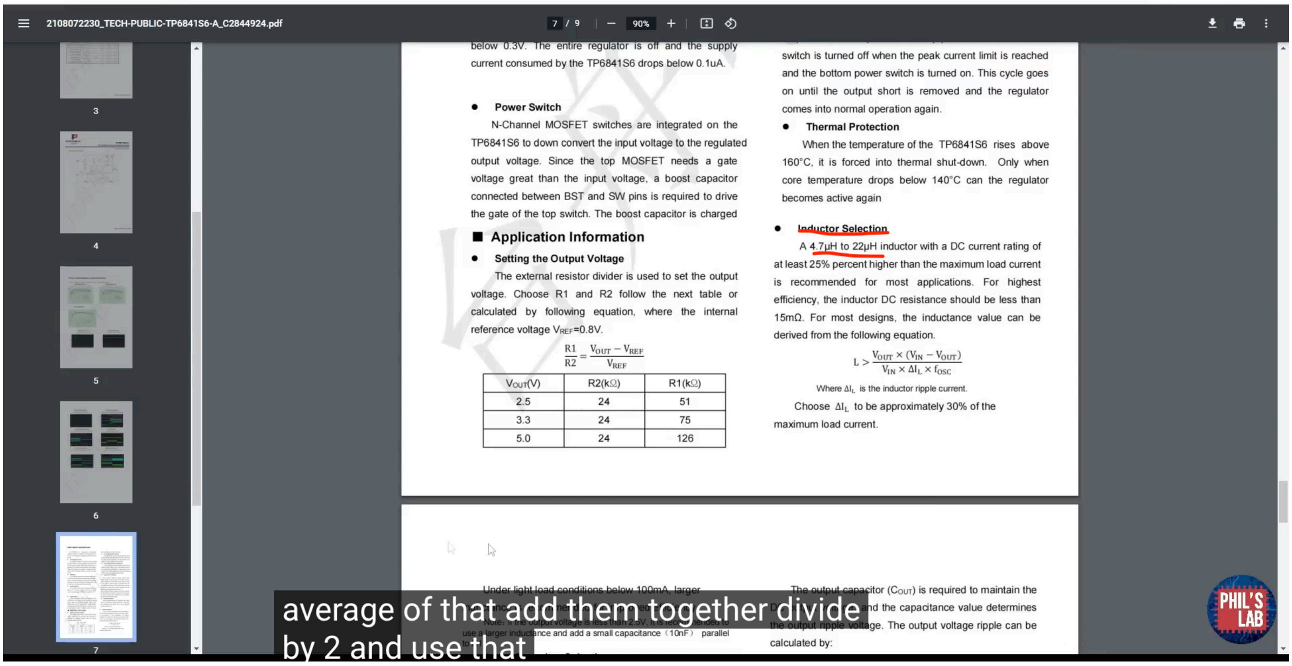
40V 0.8A 800khz Synchronous Step-Dowm Converter

www.sot23.com.tw

Electrical Characteristics (T_A 25 C unless otherwise noted)

Note：VIN = 12V, VOUT = 5.0V, unless otherwise specified.℃)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Input Voltage	V_{IN}	-	4.5	-	40	V
VIN Under Voltage Protect	V_{UV}	-	-	4.3	-	V
VIN Under Voltage Protect Hys.	V_{UV_hys}	-	-	0.2	-	V
Supply Current	I_{Q1}	V_{EN}=2V，V_{FB}=0.85V	-	40	60	μA
Supply Shutdown Current	I_{SD}	-	-1		1	μA
FB Voltage	V_{FB}	T_A=25°C，4.5V≤V_{IN}≤40V	0.776	0.8	0.824	V
Switching Frequency	F_{OSC}	-	-	800	-	kHz
Minimum On Time	T_{ON_MIN}	-	-	200	-	ns
Maximum Duty Cycle	DMAX	-	-	90	-	%
High Side Switch On Resistance	R_{DSON_H}	-	-	450	-	mΩ
Low Side Switch On Resistance	R_{DSON_L}	-	-	270	-	mΩ
High Side Current Limit	I_{LIM}	-	-	2	-	A
EN Rising Threshold	V_{ENH}	-	-	1.3	-	V
EN Falling Threshold	V_{ENL}	-	-	1.2	-	V
EN Input Current	I_{EN}	V_{EN}=5V	-	2	-	uA
Thermal Shutdown	T_{SHD}	-	-	160	-	°C
Thermal Shutdown Hys.	T_{SHD_Hys}	-	-	20	-	°C



below 0.3V. The entire regulator is off and the supply current consumed by the TP6841S6 drops below 0.1uA.

- **Power Switch**

N-Channel MOSFET switches are integrated on the TP6841S6 to down convert the input voltage to the regulated output voltage. Since the top MOSFET needs a gate voltage great than the input voltage, a boost capacitor connected between BST and SW pins is required to drive the gate of the top switch. The boost capacitor is charged

switch is turned off when the peak current limit is reached and the bottom power switch is turned on. This cycle goes on until the output short is removed and the regulator comes into normal operation again.

- **Thermal Protection**

When the temperature of the TP6841S6 rises above 160°C, it is forced into thermal shut-down. Only when core temperature drops below 140°C can the regulator becomes active again

Application Information

- **Setting the Output Voltage**

The external resistor divider is used to set the output voltage. Choose R1 and R2 follow the next table or calculated by following equation, where the internal reference voltage V_{REF}=0.8V.

$$\frac{R1}{R2} = \frac{V_{OUT} - V_{REF}}{V_{REF}}$$

V_{OUT}(V)	R2(kΩ)	R1(kΩ)
2.5	24	51
3.3	24	75
5.0	24	126

- **Inductor Selection**

A 4.7μH to 22μH inductor with a DC current rating of at least 25% percent higher than the maximum load current is recommended for most applications. For highest efficiency, the inductor DC resistance should be less than 15mΩ. For most designs, the inductance value can be derived from the following equation.

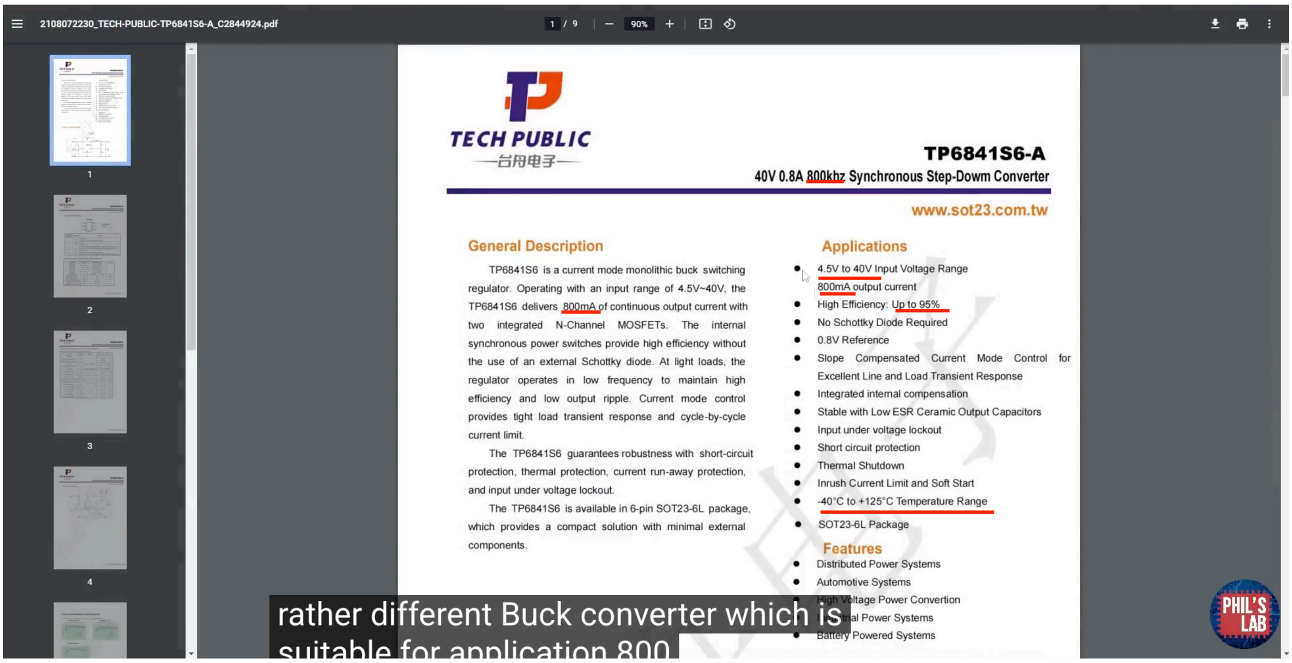
$$L > \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times f_{OSC}}$$

Where ΔI_L is the inductor ripple current.

Choose ΔI_L to be approximately 30% of the maximum load current.

Under light load conditions below 100mA, larger

The output capacitor (C_{OUT}) is required to maintain the ... and the capacitance value determines the output ripple voltage. The output voltage ripple can be calculated by:



TECH PUBLIC

台舟电子

TP6841S6-A

40V 0.8A 800khz Synchronous Step-Dowm Converter

www.sot23.com.tw

General Description

TP6841S6 is a current mode monolithic buck switching regulator. Operating with an input range of 4.5V~40V, the TP6841S6 delivers 800mA of continuous output current with two integrated N-Channel MOSFETs. The internal synchronous power switches provide high efficiency without the use of an external Schottky diode. At light loads, the regulator operates in low frequency to maintain high efficiency and low output ripple. Current mode control provides tight load transient response and cycle-by-cycle current limit.

The TP6841S6 guarantees robustness with short-circuit protection, thermal protection, current run-away protection, and input under voltage lockout.

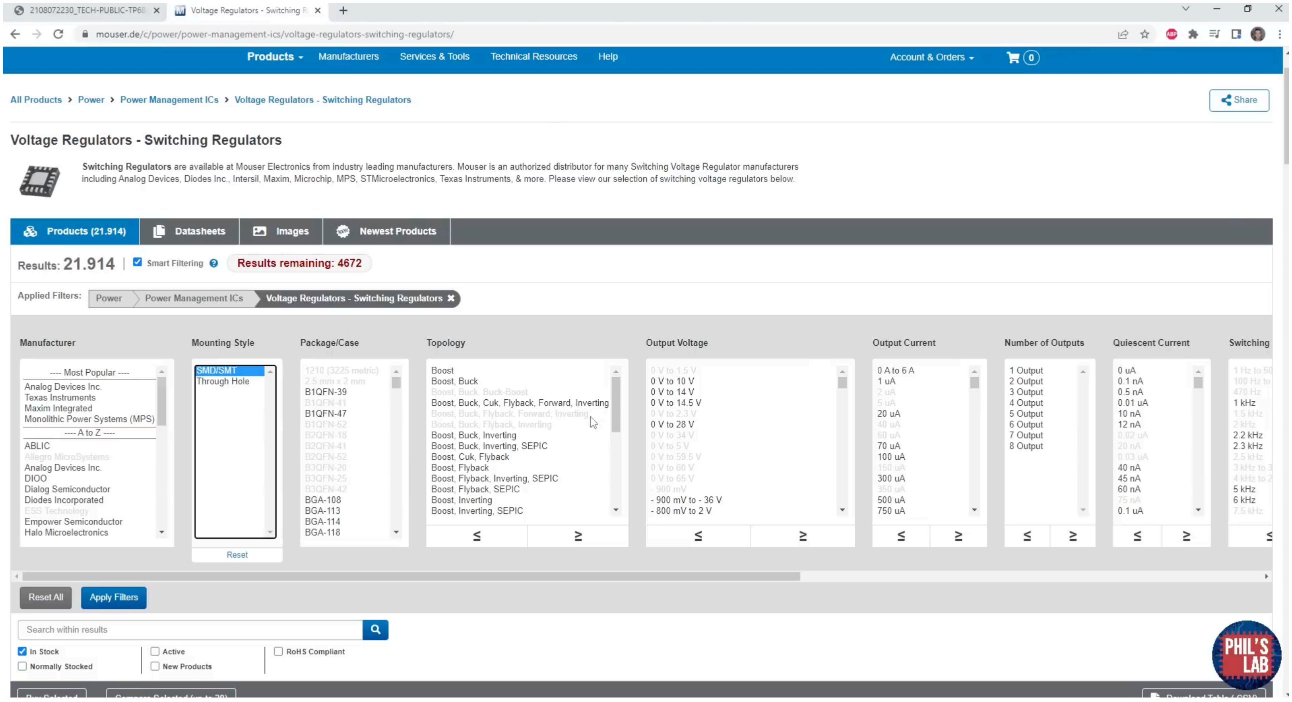
The TP6841S6 is available in 6-pin SOT23-6L package, which provides a compact solution with minimal external components.

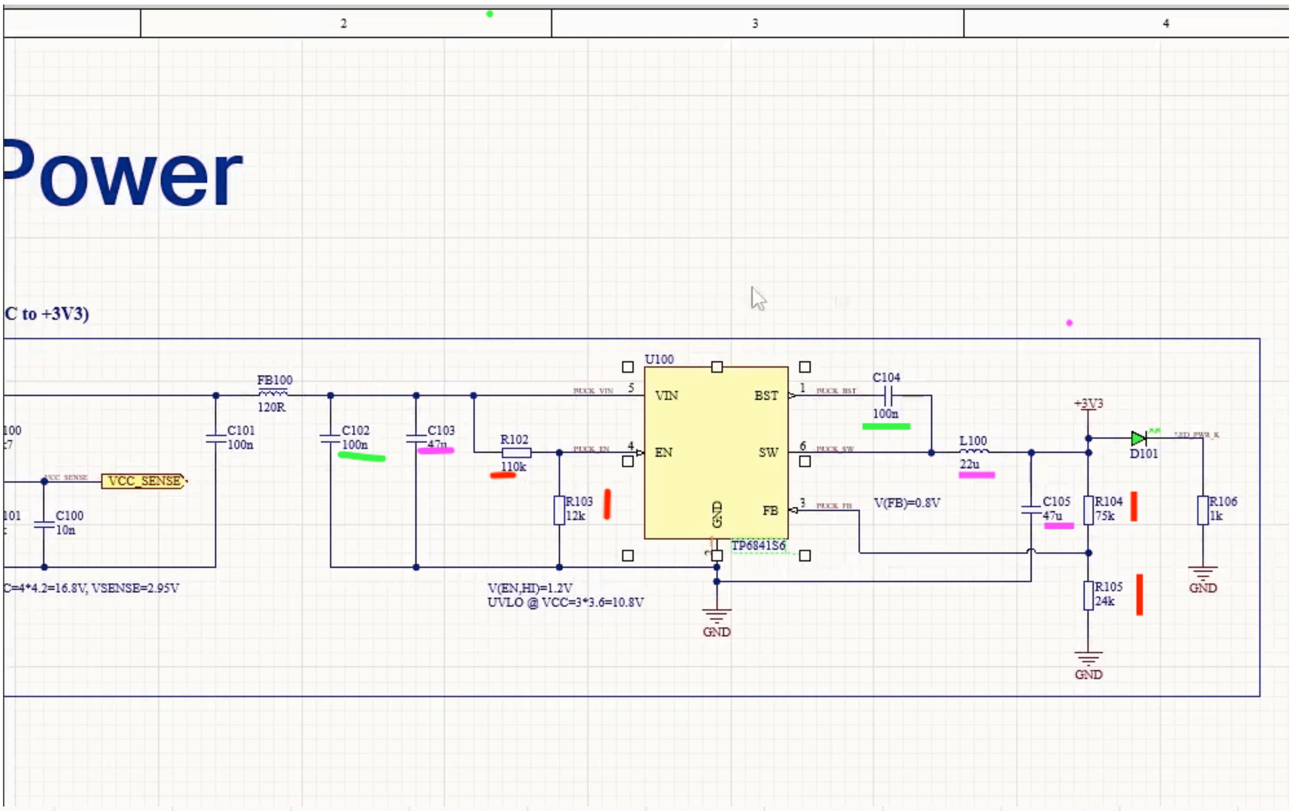
Applications

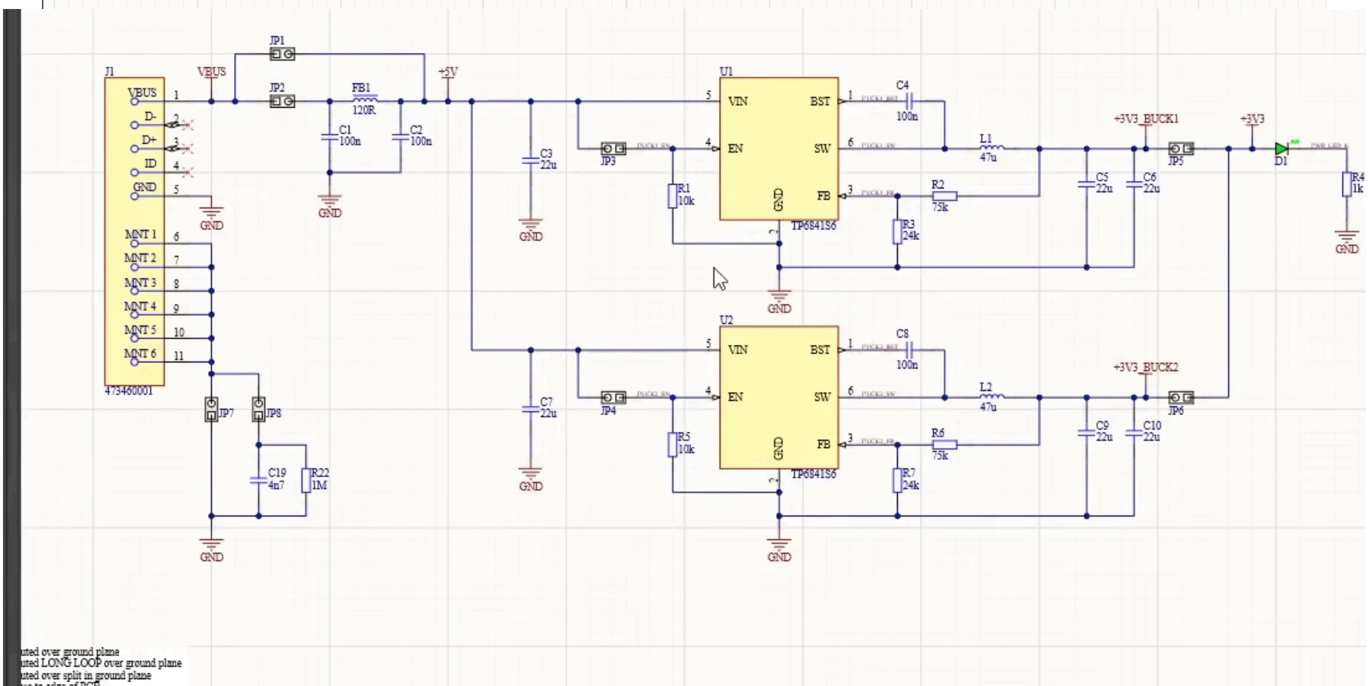
- 4.5V to 40V Input Voltage Range
  800mA output current
- High Efficiency: Up to 95%
- No Schottky Diode Required
- 0.8V Reference
- Slope Compensated Current Mode Control for Excellent Line and Load Transient Response
- Integrated internal compensation
- Stable with Low ESR Ceramic Output Capacitors
- Input under voltage lockout
- Short circuit protection
- Thermal Shutdown
- Inrush Current Limit and Soft Start
- -40°C to +125°C Temperature Range
- SOT23-6L Package

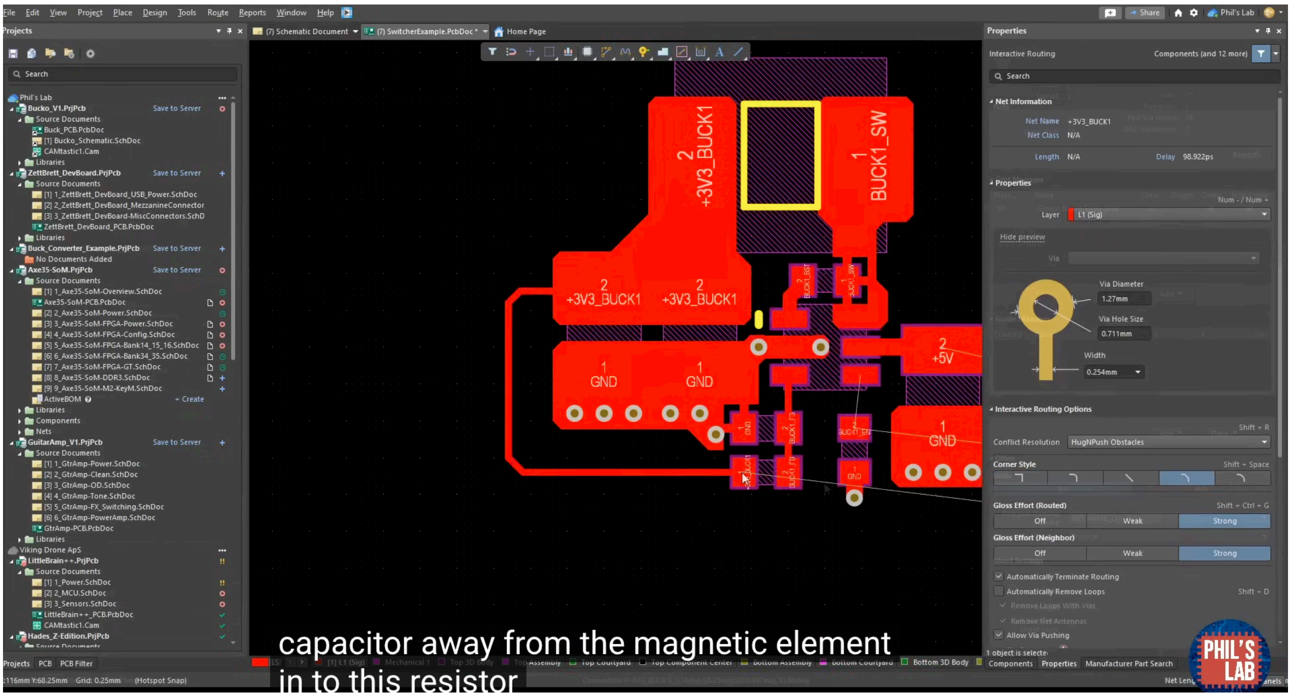
Features

- Distributed Power Systems
- Automotive Systems
- High Voltage Power Convertion
- ...trial Power Systems
- Battery Powered Systems


mouser.de/c/power/power-management-ics/voltage-regulators-switching-regulators/
Products
Manufacturers
Services & Tools
Technical Resources
Help
Account & Orders
All Products > Power > Power Management ICs > Voltage Regulators - Switching Regulators
Share
Voltage Regulators - Switching Regulators
Switching Regulators are available at Mouser Electronics from industry leading manufacturers. Mouser is an authorized distributor for many Switching Voltage Regulator manufacturers including Analog Devices, Diodes Inc., Intersil, Maxim, Microchip, MPS, STMicroelectronics, Texas Instruments, & more. Please view our selection of switching voltage regulators below.
Products (21.914)
Datasheets
Images
Newest Products
Results: 21.914
Smart Filtering
Results remaining: 4672
Applied Filters:
Power
Power Management ICs
Voltage Regulators - Switching Regulators
Manufacturer
Mounting Style
Package/Case
Topology
Output Voltage
Output Current
Number of Outputs
Quiescent Current
Switching
SMD/SMT
Through Hole
Reset
Reset All
Apply Filters
Search within results
In Stock
Normally Stocked
Active
New Products
RoHS Compliant
PHIL'S LAB


Power
C to +3V3)
FB100
120R
C101
100n
C102
100n
C103
47u
R102
110k
R103
12k
U100
VIN
BST
EN
SW
FB
TP6841S6
C104
100n
L100
22u
+3V3
D101
C105
47u
R104
75k
R105
24k
R106
1k
VCC_SENSE
C100
10n
V(FB)=0.8V
V(EN,HI)=1.2V
UVLO @ VCC=3*3.6=10.8V
C=4*4.2=16.8V, VSENSE=2.95V
GND


J1
VBUS
D-
D+
ID
GND
MNT 1
MNT 2
MNT 3
MNT 4
MNT 5
MNT 6
473460001
JP1
JP2
FB1
120R
C1
100n
C2
100n
+5V
C3
22u
JP3
R1
10k
U1
VIN
BST
EN
SW
FB
TP6841S6
C4
100n
L1
47u
R2
75k
R3
24k
C5
22u
C6
22u
+3V3_BUCK1
JP5
+3V3
D1
R4
1k
U2
C7
22u
JP4
R5
10k
C8
100n
L2
47u
R6
75k
R7
24k
C9
22u
C10
22u
+3V3_BUCK2
JP6
JP7
JP8
C19
4n7
R22
1M
GND



capacitor away from the magnetic element
in to this resistor
2
+3V3_BUCK1
1
BUCK1_SW
GND
+5V
Properties
Interactive Routing
Net Information
Net Name +3V3_BUCK1
Net Class N/A
Length N/A
Delay 98.922ps
Layer L1 (Sig)
Via Diameter 1.27mm
Via Hole Size 0.711mm
Width 0.254mm
Interactive Routing Options
Conflict Resolution HugNPush Obstacles
Corner Style
Gloss Effort (Routed)
Off Weak Strong
Gloss Effort (Neighbor)
Off Weak Strong
Automatically Terminate Routing
Automatically Remove Loops
Allow Via Pushing
PHIL'S LAB