

A collage background for the title section. On the left, a group of men in business suits are sitting and talking. In the center, there is a close-up of a microchip with a fan-like structure. On the right, there is an outdoor air conditioning unit with white pipes. On the far right, a woman with glasses is smiling and talking on a mobile phone.

HIGH PERFORMANCE DC-DC BUCK CONVERTERS

Low Voltage Applications

Yongmin Seong

April 21, 2014



Typical DC-DC Application Requirements

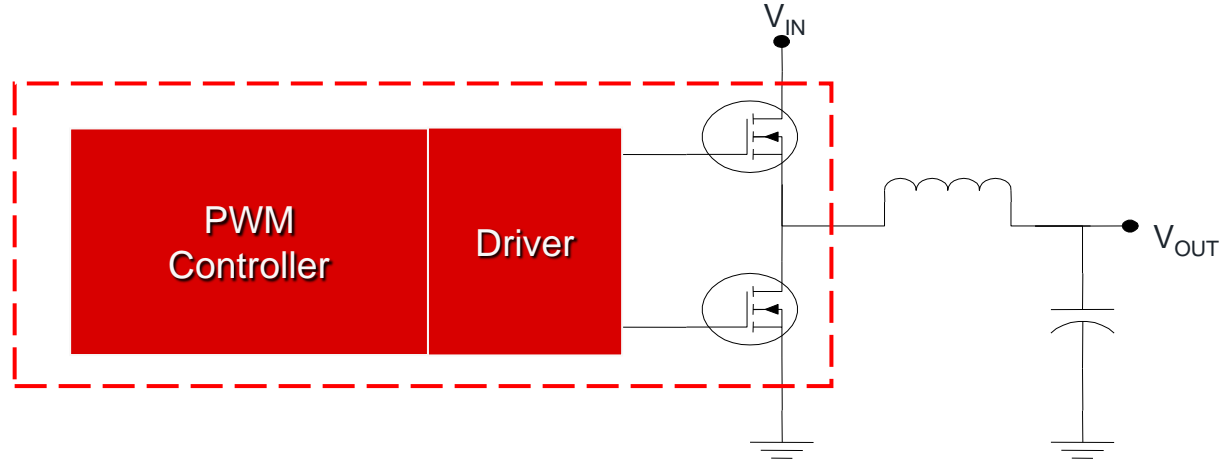
- High Efficiency
- Small Size
- Fast Transient Response
- Small Part Count
- Low Cost
- Ease of Design



Next Generation TinyBuck[®] Family

Family of Controller/Driver + FETs in a Multi-Chip Module

- TinyBuck[®] FAN23xx family is our second generation of fully-integrated synchronous buck regulators
- Device integrates controller, driver IC, a high-side MOSFET and a low-side MOSFET in a space efficient 5.5x5 mm PQFN package



Key Benefits:

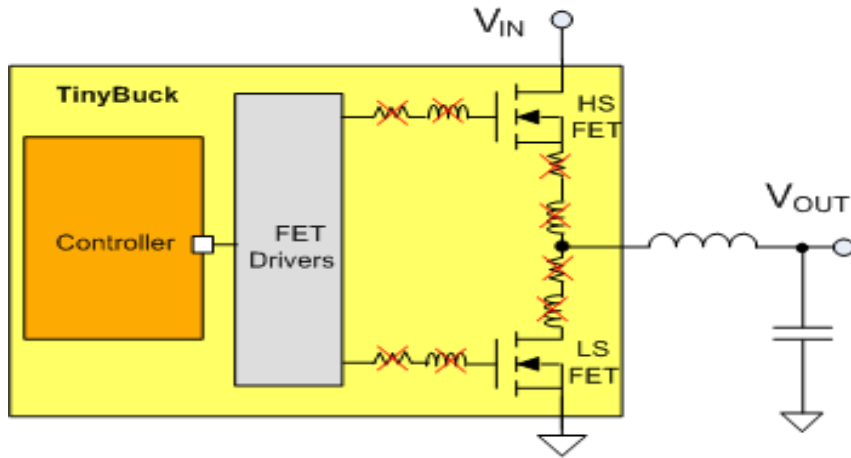
- Delivers up to 96% peak efficiency, compared to conventional and competitive solutions
- Critical space savings and BOM cost advantages versus conventional discrete solutions
- Easier, faster and more flexible designs for quicker time to market



Next Generation TinyBuck® POL Regulators Value Proposition

VALUE PROPOSITION:

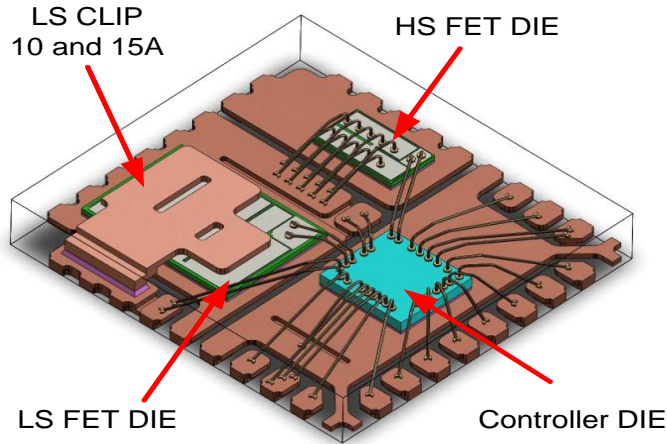
Superior efficiency over a wide load range with excellent thermal performance.



- Total board area reduced compared to discrete designs.
- Common package footprint facilitates easy migration path for next gen design.
- FET selection optimization greatly simplifies design.
- Reduced parasitics decrease switching ringing and switching losses.
- Reduced parasitics offer ability to operate at high frequency.



Next Generation TinyBuck[®] Regulators



- Superior efficiency over a wide load range with excellent thermal performance.
- 4A, 6A, 10A, and 15A devices
- $V_{IN} = 4.5V - 24V$
- Achieves 90-92% efficiency at rated load current with $V_{IN} = 12V$, $V_{OUT} = 1.2V$, $F_{sw} = 500KHz$
- Minimizes external component count for reduced BOM cost
- Constant on-time controller with PFM mode
- Single footprint compatibility for all devices
- Online simulation tool available



FAN23xx Device Optimization and Benefits

High Performance Integrated MCM Solution

- Optimized gate drive circuitry optimized for each pair of power MOSFETs
- Constant on-time architecture with PFM for highest light load efficiency and fast transient response
- Advanced MLP packaging for best thermal performance; 10A & 15A device utilizes Cu clip technology
- Leverages Fairchild's PowerTrench MOSFETs with shielded gate technology which reduces switch node ringing

Greater Space & Component Cost Savings

- Reduce size and cost of magnetics and capacitors, running 1.5MHz switching frequency
- Reduced component count with PWM controller and power MOSFETs integrated
- Constant on-time eliminates need for external compensation components

Product Flexibility & Re-use

- TinyBuck® family covers a wide V_{in} range and output currents up to 15A
- Compatible with MLCC & POSCAP
- Single footprint for all devices



TinyBuck® Portfolio and Feature Overview

FSID	Current Rating	VIN Rating	Additional Vin Rating with Vin/Pvin/Pvcc Connected to Bypass Internal Reg	Linear Regulator	FET Rating	PFM Enabled	Minimum Frequency Clamp	Tracking
FAN23SV04T	4A	7 - 15V	4.5-5.5V	Yes	25V	No	Yes	Yes
FAN2306	6A	4.5 - 15V	N/A	No	25V	Yes	Yes	No
FAN2306M	6A	4.5 - 15V	N/A	No	25V	Yes	No	No
FAN23SV06	6A	7 - 15V	4.5-5.5V	Yes	25V	Yes	Yes	No
FAN23SV06P	6A	7 - 15V	4.5-5.5V	Yes	25V	No	Yes	No
FAN2310	10A	4.5 - 15V	N/A	No	25V	Yes	Yes	No
FAN23SV10M	10A	7 - 15V	4.5-5.5V	Yes	25V	Yes	No	No
FAN2315	15A	4.5 - 15V	N/A	No	25V	Yes	Yes	No
FAN23SV15M	15A	7 - 15V	4.5-5.5V	Yes	25V	Yes	No	No
Separator Row								
FAN2356	6A	4.5 - 24V	N/A	No	30V	Yes	Yes	No
FAN23SV56	6A	7 - 24V	4.5-5.5V	Yes	30V	Yes	Yes	No
FAN2360	10A	4.5 - 24V	N/A	No	30V	Yes	Yes	No
FAN23SV60	10A	7 - 24V	4.5-5.5V	Yes	30V	Yes	Yes	No
FAN2365	15A	4.5 - 24V	N/A	No	30V	Yes	Yes	No
FAN23SV65	15A	7 - 24V	4.5-5.5V	Yes	30V	Yes	Yes	No

*Additional parts are available upon request based on load current, PFM, forced PWM, ultrasonic mode and tracking options.

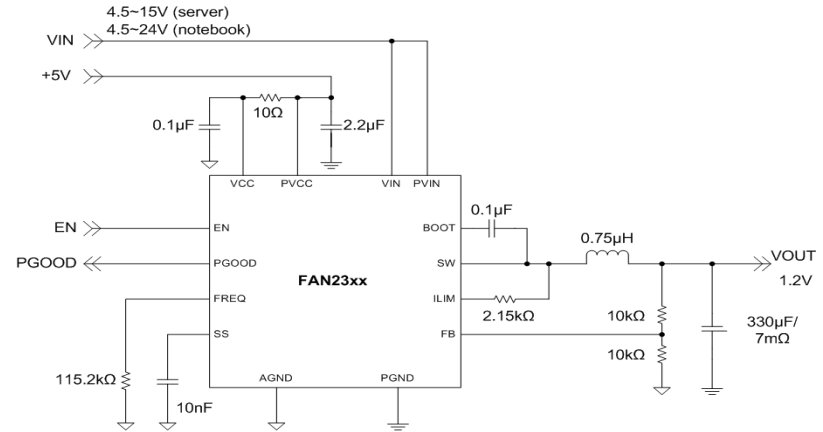
*Please contact your local Fairchild representative for further information.



TinyBuck[®] Portfolio Features:

FAN2306/10/15, FAN2356/60/65, FAN23SV06/10/15, FAN23SV56/60/65

- Operates between 4.5V - 5.5V input when Pvin/Vin/Pvcc are tied together
- Continuous output current of 6A, 10A or 15A
- PFM mode for light load efficiency
- Forced PWM or ultrasonic mode options
- Adjustable soft-start
- Precision reference, $\pm 1\%$ over temp
- Output voltage range from 0.6 to 5.5V
- Programmable frequency 200kHz – 1MHz (15A), up to 1.5MHz for 6A and 10A devices
- Low shutdown current





TinyBuck® Portfolio Features:

FAN2306/10/15, FAN2356/60/65, FAN23SV06/10/15, FAN23SV56/60/65

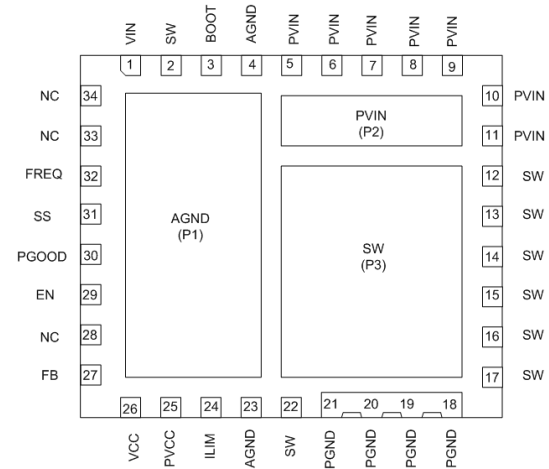
- Adjustable sourcing current limit
- Internal boot diode
- Thermal shutdown
- Ambient temperature range of -40°C to +85°C
- Halogen and lead free, RoHS compliant
- 5.5mm x 5mm 34L PQFN package

Single Voltage (SV)

- Vin range: 7V -15V or up to 24V
- **No external bias required**

Non Single Voltage

- Vin range: 4.5V - 15V or 24V
- **External 5V bias required (shown)**



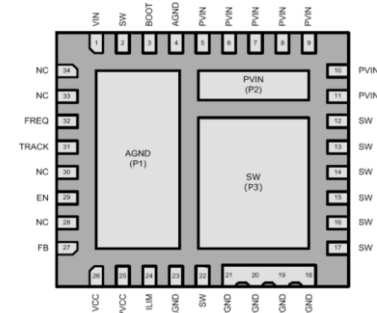
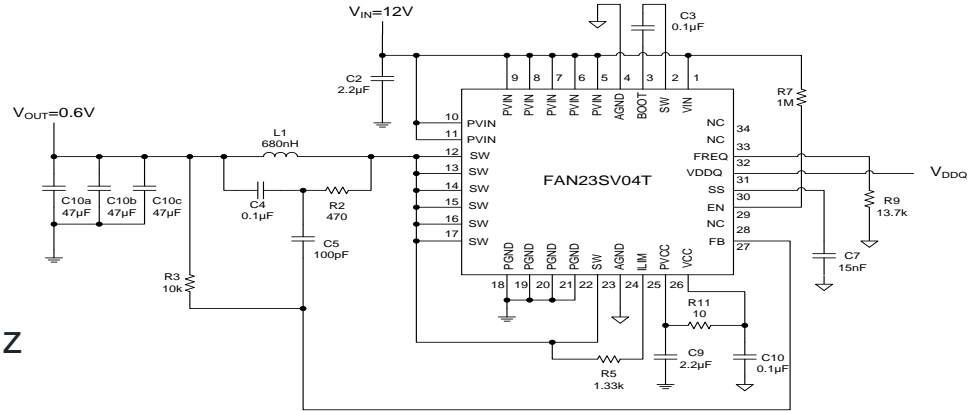
Bottom
view



FAN23SV04T for DDR Tracking Applications

Minimizes external components! Higher Efficiency!

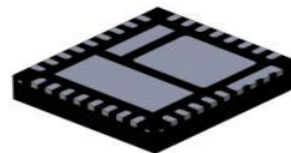
- Continuous output current of 4A, Max
- Current up to 6A
- Constant On Time controller provides line and load transient response
- Programmable frequency 200kHz – 1.5MHz
- Low 10 μ A Shutdown Current
- Adjustable current limit
- Internal boot diode
- Internal Linear Bias Regulator
- Internal V_{DDQ} Resistor Divider
- Thermal shutdown
- Ambient temperature range of -40 to +85C



PQFN 5.5x5mm 34L Package



Target Market Applications



Server & Storage



Server
System Rails
DDR Vtt



Blade Server
System Rails
Non V_{CORE} Sockets
DDR Vtt

Computing



Workstations
System Rails



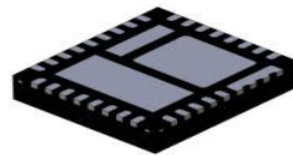
Embedded Computers
System Rails



All-in-one Desktop
System Rails
Memory Voltage Rail



Target Market Applications



Communication, Telecom & Industrial



FPGA Core
Core Power



Factory Automation
12V System Rails



Telecom and Datacom
System Rails

Consumer



Gaming
System Rails

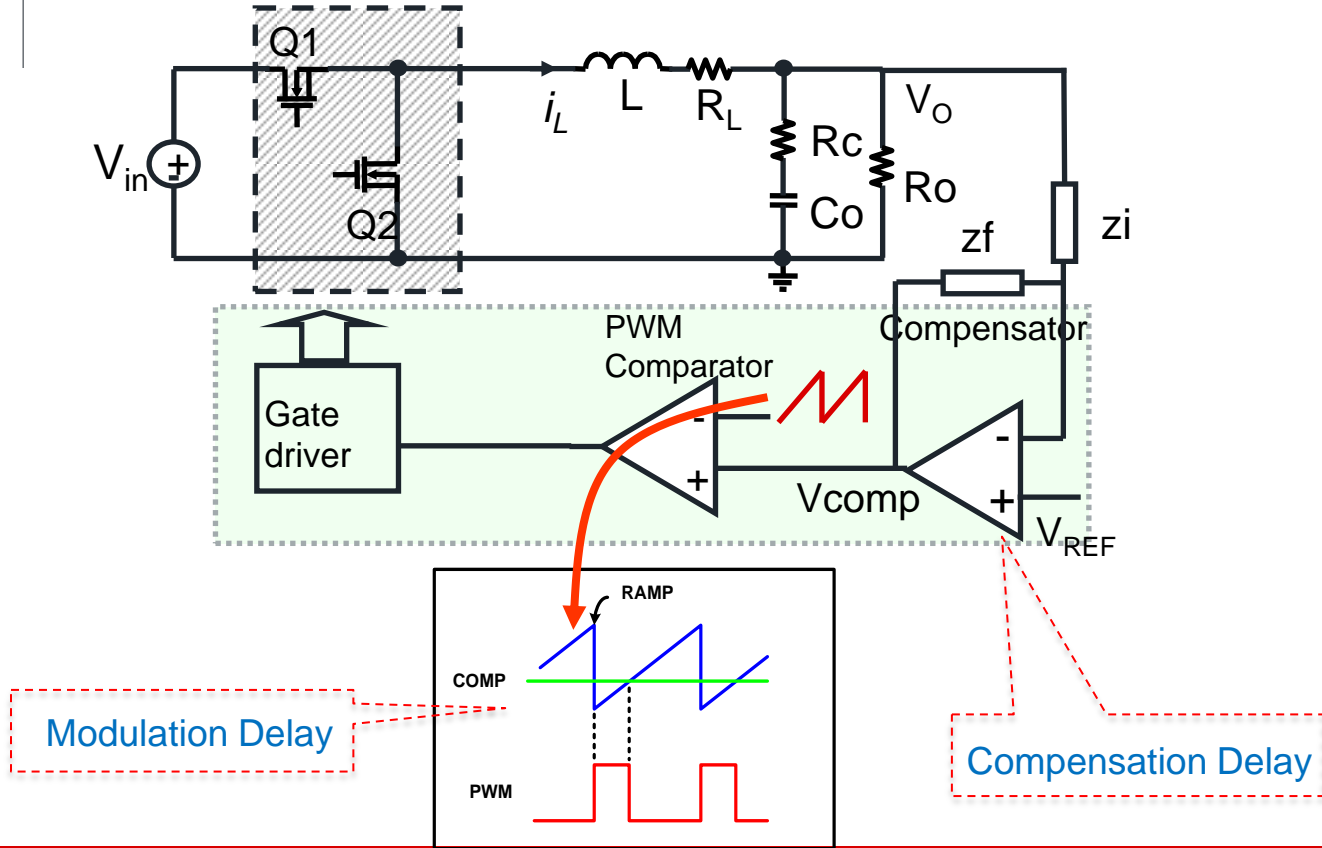


Casino Gaming
System Rails

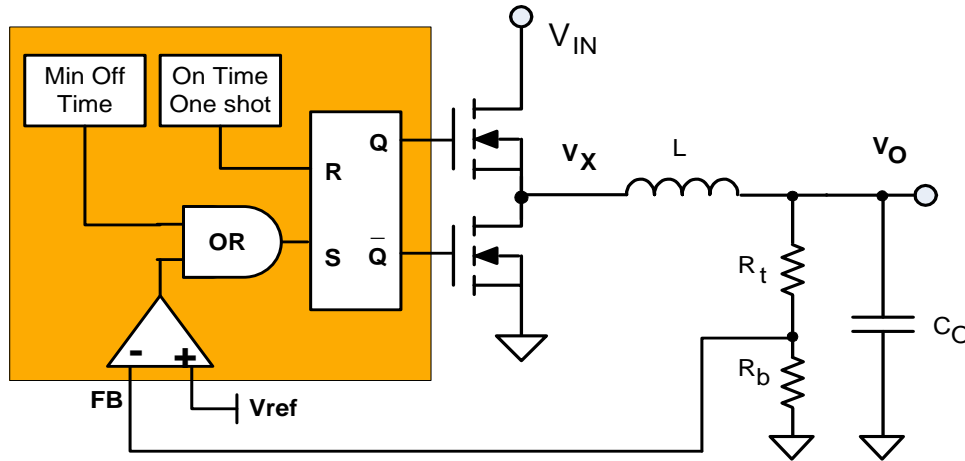


Set-top Boxes
Core Power
System Rails

Voltage Mode Control



Constant On Time (COT) Control

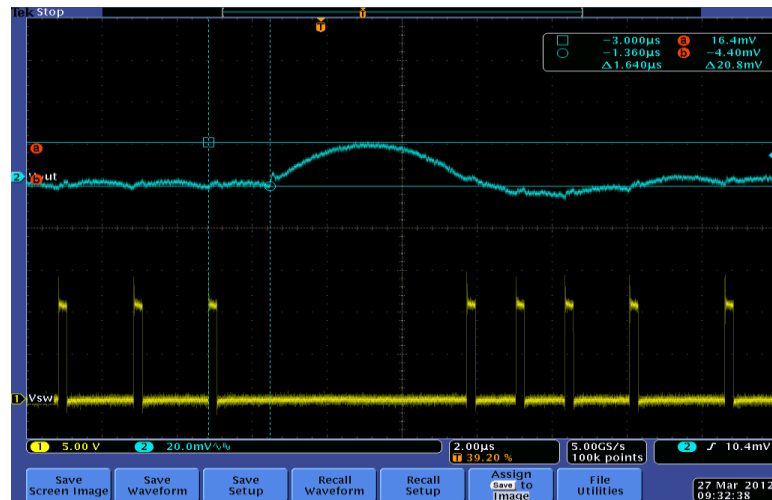
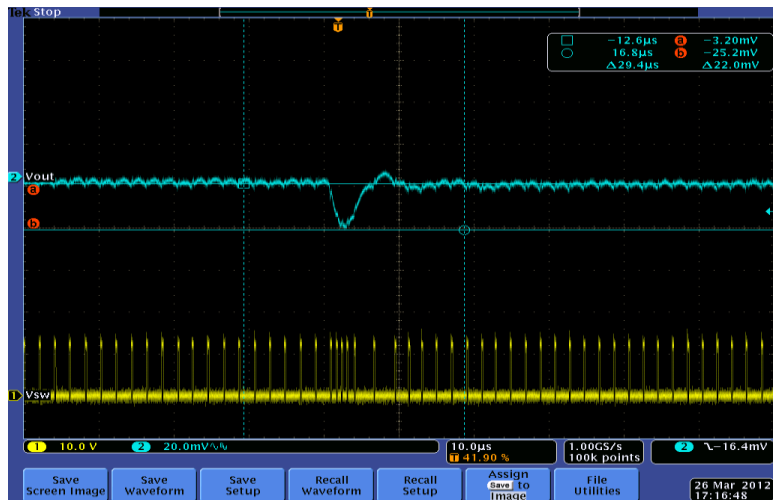


- No error amplifier & compensation components
- Fast line and load transient response
- Uses ripple current information for PWM generation
- Automatic transition in/out of Pulse Frequency Mode (PFM)



FAN2306 Transient Response

Load step from 2A to 4A; then 4A to 2A



- $V_{in}=12V$; $V_{out}=1.2V$; $F_{sw}=500kHz$
- $L=2.2\mu H$; $C_{out}=6 \times 22\mu F$
- Left: $V_{dip} = 22mV$ (Note that V_{sw} shows F_{sw} increase during transient)
- Right $V_{soar}=20.8mV$ (Note that COT controller prevents pulses during transient)



Buck Converter Equations for COT

- Fundamental buck relationship between V_{IN} , V_{OUT} , and duty cycle
 - steady state operation with inductor in CCM (Continuous Conduction Mode)
 - applies to all control methods (VMC, CMC, COT, etc)

$$V_{OUT} = D \cdot V_{IN} = \left(\frac{T_{ON}}{T_{SW}} \right) \cdot V_{IN}$$

- Substituting $F_{SW} = 1/T_{SW}$ and rearranging yields the relationship for programming T_{ON} for COT operation:

$$T_{ON} = \frac{V_{OUT}}{V_{IN} \cdot F_{SW}}$$

- T_{ON} is programmed for desired F_{SW}
- T_{ON} is inversely proportional to V_{IN}
- V_{IN} feed-forward varies T_{ON} as V_{IN} changes to maintain F_{SW} approximately constant (see next slide)



V_{IN} Feed Forward is Incorporated in TON Programming

- R_{FREQ} programs I_{tON} which is a current proportional to V_{IN} :

$$I_{tON} = \frac{1}{10} \cdot \frac{V_{IN}}{R_{FREQ}}$$

- T_{ON} interval is generated internally by charging internal C_{tON} to 2V using I_{tON} . C_{tON} is an internal 2.2 pF capacitor.

$$T_{ON} = \frac{C_{tON} \cdot 2V}{I_{tON}}$$

- Substitute for I_{tON} , solve for R_{FREQ} as indicated, and incorporate buck relationship to reach RFREQ equation above.

$$R_{FREQ} = \frac{V_{IN} \cdot T_{ON}}{2V \cdot 10 \cdot C_{tON}}$$

On following page, substitute:

$$V_{IN} \cdot T_{ON} = \frac{V_{OUT}}{f_{SW}}$$



FREQ Pin: Programming T_{ON} Determines F_{SW}

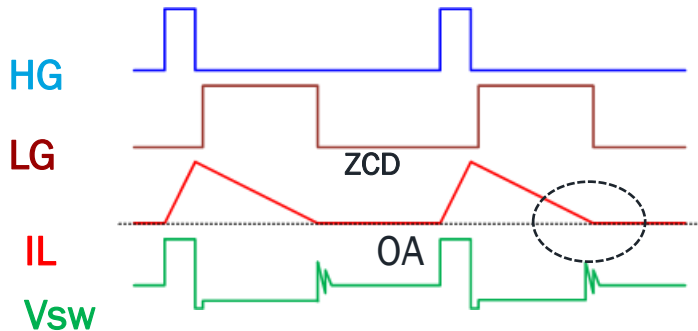
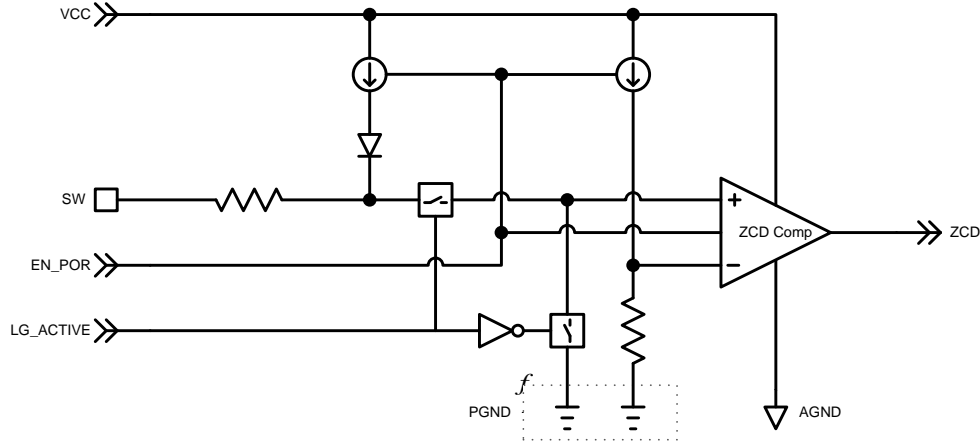
- Datasheet equation

$$R_{FREQ} = \frac{V_{OUT}}{20 \cdot C_{TON} \cdot f_{SW}}$$

- T_{ON} is programmed for chosen f_{SW} by RFREQ.
 - $C_{ton} = 2.2\text{pF}$ internal capacitor
 - V_{OUT} = desired output voltage
 - F_{SW} = desired switching frequency



Pulse Frequency Modulation (PFM) Operation



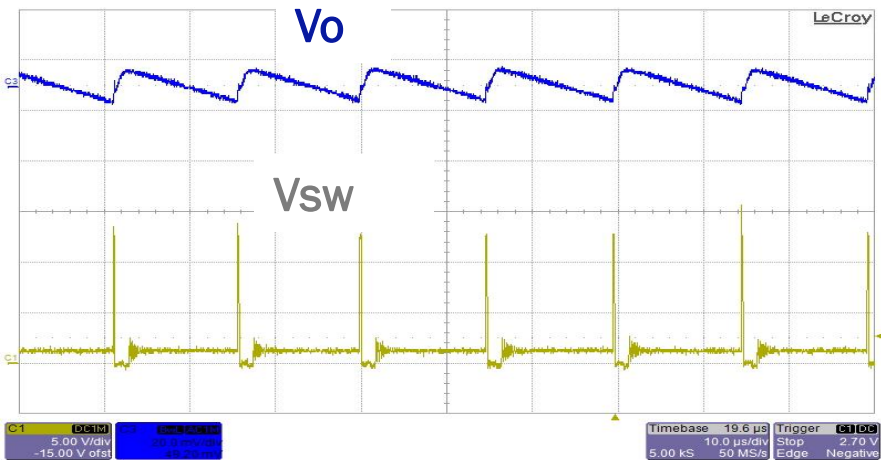
In PFM mode, the frequency can be expressed as:

$$f_{SW} = \frac{2 \cdot L \cdot I_{OUT}}{t_{ON}^2 \cdot (V_{IN} - V_{OUT})} \cdot \frac{V_{OUT}}{V_{IN}}$$

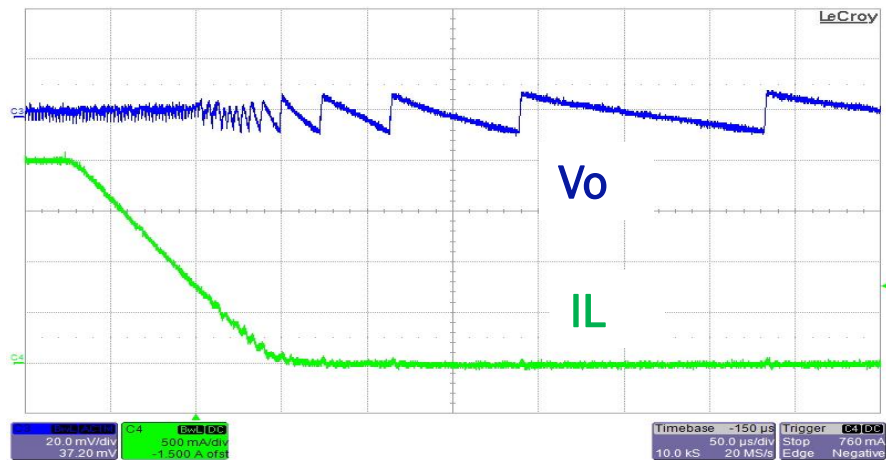


PFM Operation

DCM Operation



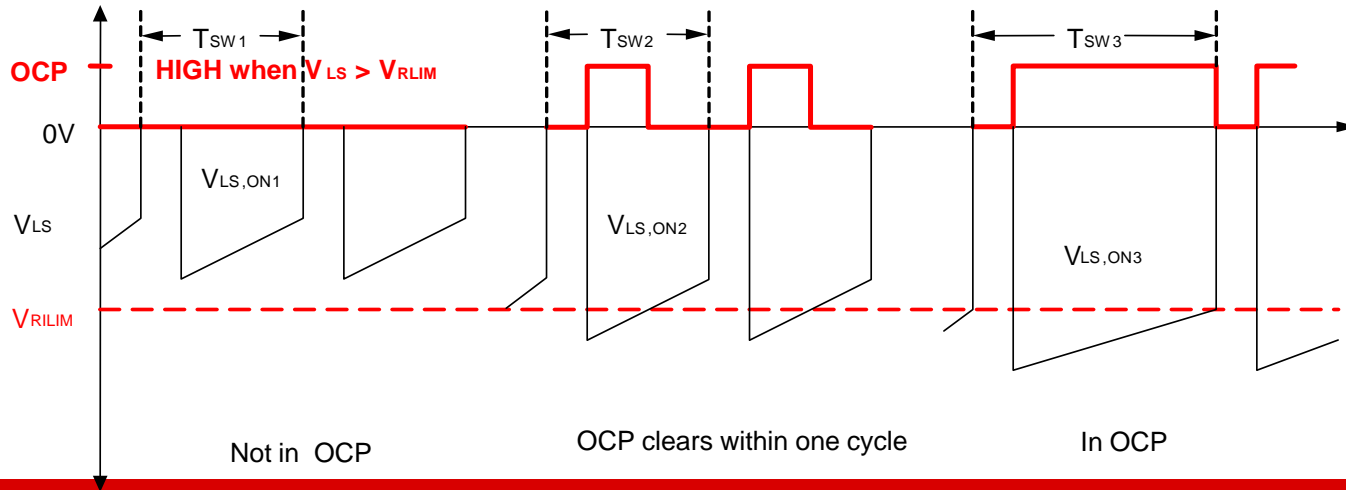
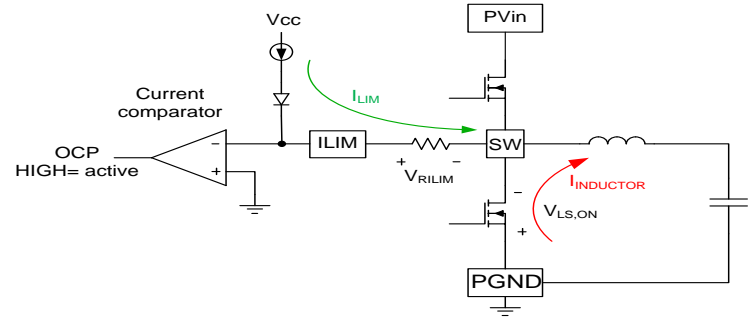
CCM - DCM



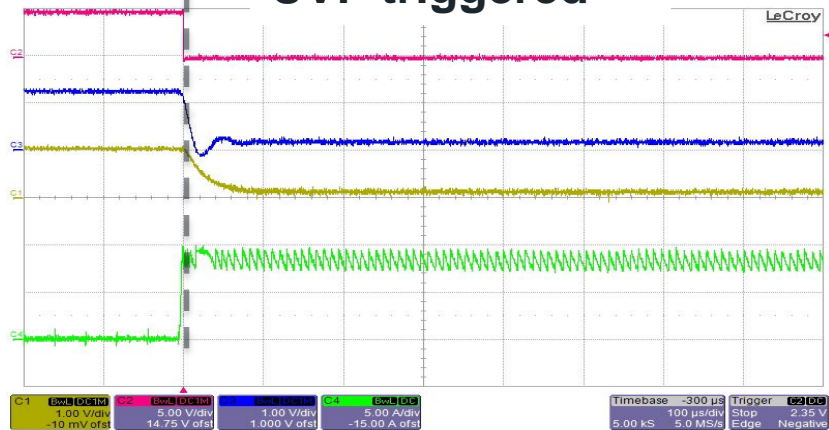


Over Current Protection

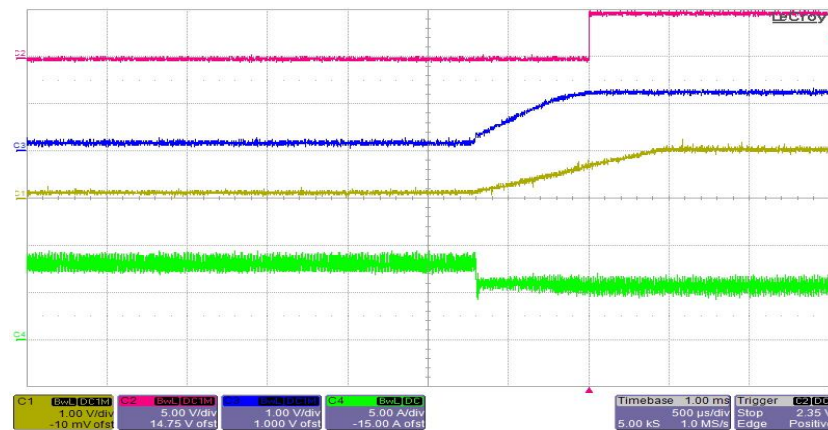
- Valley current limit with current sensed during calm interval when LS FET is ON
- Current sensed across LS MOSFET $R_{ds,on}$. No external R_{sense} required



OCP Apply & UVP triggered



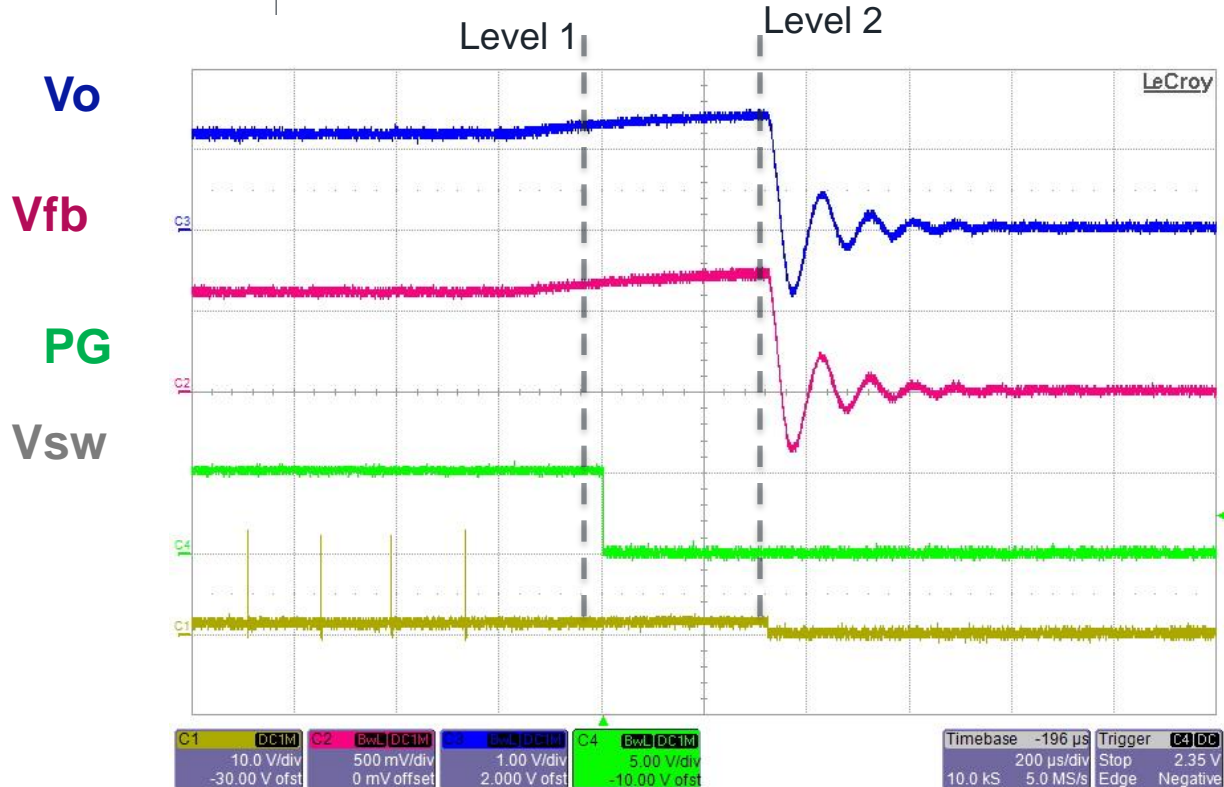
OCP Removal



- During an OC event, V_o may drop below the UV threshold. An overload condition is triggered.
- SS clamp voltage is reduced in an overload condition. F_{SW} is reduced due to lower inductor decay slew rate.



Over Voltage Protection



- When level 1 is triggered, both HS and LS turn off.
- When level 2 is triggered, HS turns off but LS is forced on until a VCC power cycle.



Design Flow: Specifications

- Inputs required for component calculations
 - V_{in} range
 - V_{out}
 - I_{out}
 - Target switching frequency
 - OCP trip point
 - Output ripple spec
 - Transient spec
- Component preferences



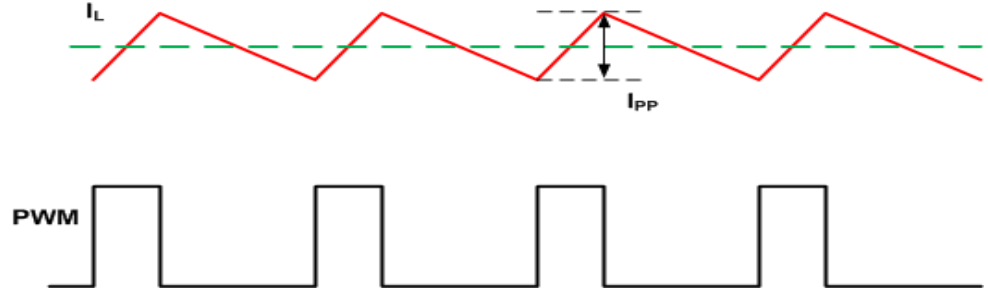
Design Flow: Power Circuit & Control Circuit

- Power circuit
 - Choose Next Generation TinyBuck[®] based on current requirements, bias availability, options
 - Specify inductor ripple current and calculate L value
 - Determine output capacitor C value
 - Calculate input capacitor value
- Control circuit
 - Calculate feedback divider resistors
 - Calculate FREQ resistor to program Ton
 - Calculate ripple injection components
 - Calculate Rilim
 - Calculate soft start capacitor
 - Configure EN operation
 - Configure PGOOD
 - Select boot capacitor, PVcc/Vcc capacitor, filter resistor



Inductor Selection

- Smaller inductor value increases ripple current
 - Inductor physical size is smaller
 - lower winding (DC) losses in general
 - Conduction losses increase in FETs
 - Faster transient response
- Bigger inductor value reduces ripple current
 - Inductor physical size is increased
 - higher winding losses in general.
 - Slower transient response



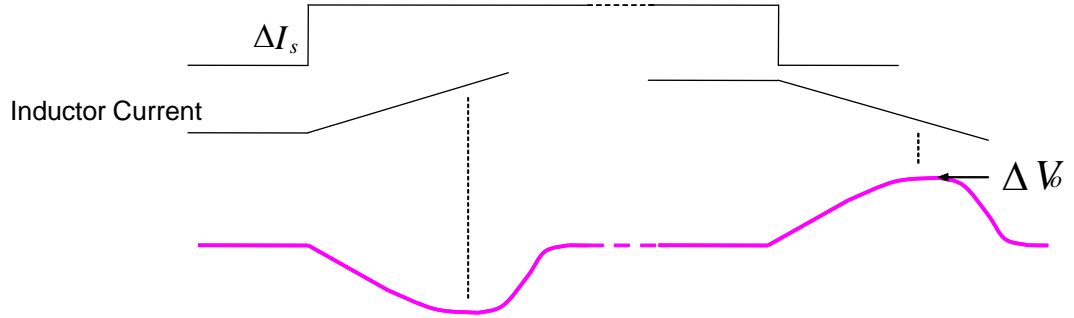
$$I_{pp} = \frac{V_{in} - V_o}{L \cdot F_{sw}} \cdot \frac{V_o}{V_{in}}$$



Output Capacitor Considerations

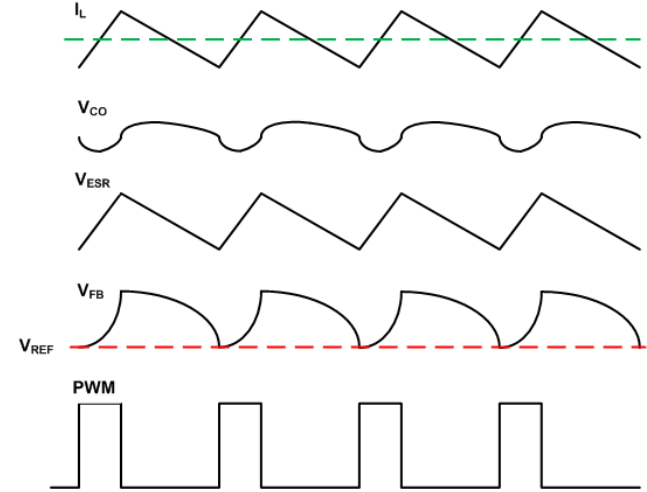
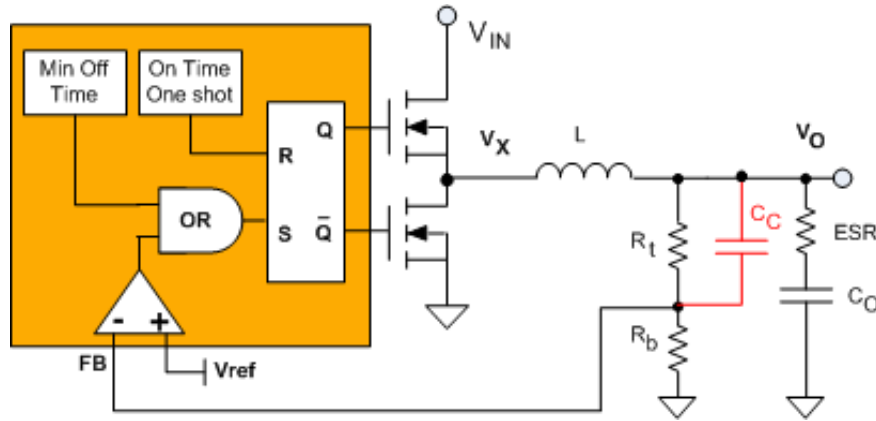
$$C_{o,min} = \frac{I_{pp}}{8 \cdot V_o,pp \cdot F_{sw}}$$

$$C_o = L \cdot \frac{I_{MAX}^2 - I_{MIN}^2}{(V_o + \Delta V_o)^2 - V_o^2}$$



- Output capacitor selection is mainly determined by steady state and transient ripple requirements.
- Bulk capacitors
 - Bulk implies technology for increased capacitance/volume
 - Bulk capacitor ESR is significant contributor to ripple
 - POSCAP, Oscon, ALEL: Polymer
- Multi Layer Ceramic capacitors (MLCC)
 - MLCC can offer small size with extremely small ESR
 - C_{OUT} value calculation and component selection must include
 - DC bias effects
 - Package size

COT w/ Bulk Output Capacitors

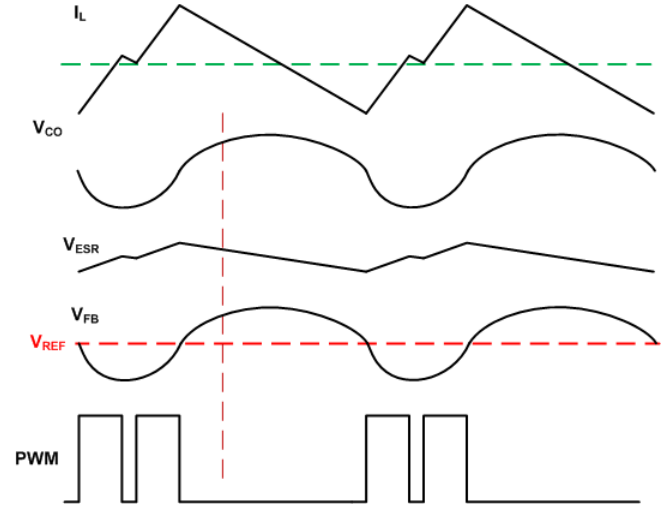
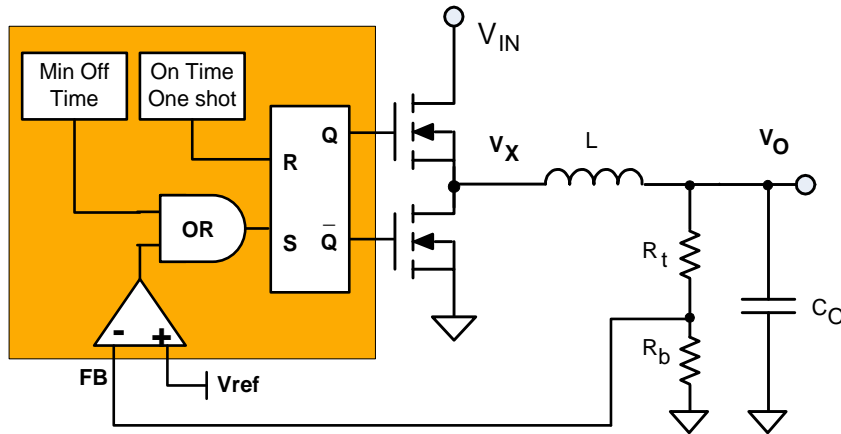


- For bulk caps, the ripple may be generated by ESR of C_{OUT}
- Ripple is in phase with inductor current
- Circuit is typically stable when pk-pk ripple on FB is $\geq 12\text{mV}$
- A feed forward cap C_c could be added if ripple is not enough.

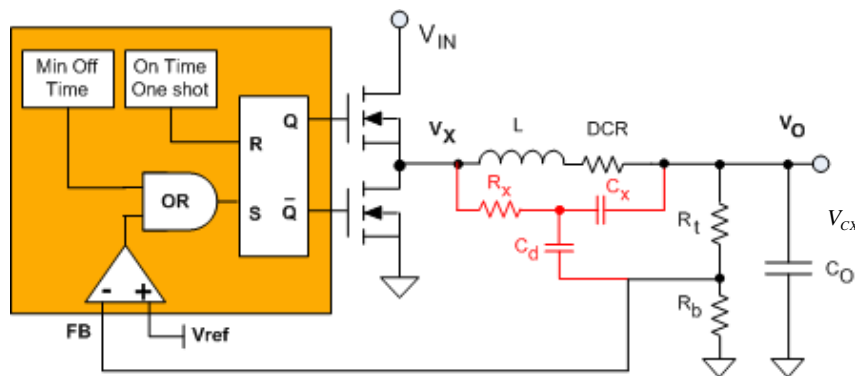


COT w/ Ceramic Output Capacitors - Instability

- For ceramic caps, the ripple may not be enough and instability can occur.



COT w/ Ceramic Output Capacitors – Ripple Injection

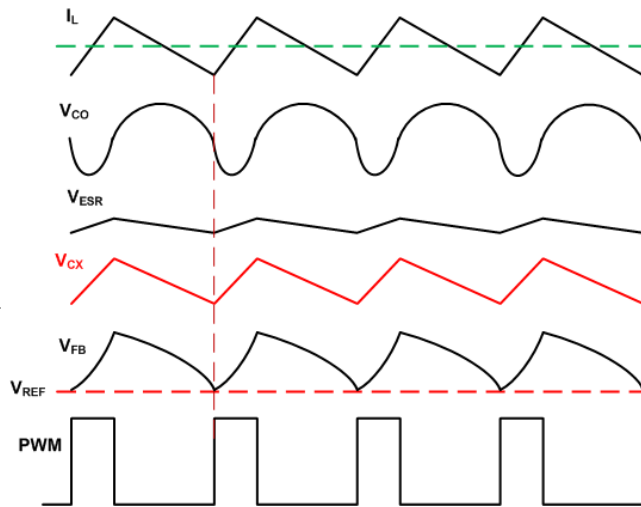


$$C_d = \frac{8L_o \cdot C_o \cdot F_{sw} \cdot (R_t + R_b) - R_b \cdot R_x \cdot C_x}{8F_{sw} \cdot R_x \cdot C_x \cdot R_t \cdot R_b}$$



$$C_d = \frac{L_o \cdot C_o \cdot (R_t + R_b)}{R_x \cdot C_x \cdot R_t \cdot R_b}$$

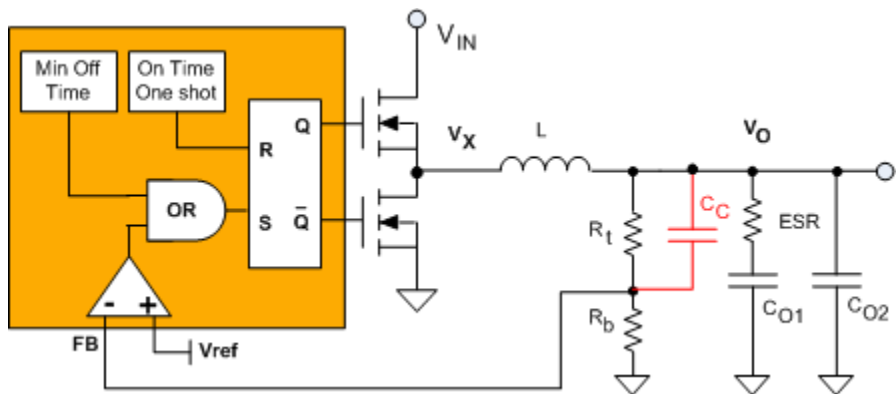
$$V_{CX(pp)} = \frac{I_{L(pp)} \cdot L}{R_x \cdot C_x}$$



- For ceramic caps, RCC network is needed to generate ripple voltage to Vfb

Shangyang Xiao, "On the Ripple Generating Circuit of COT Controlled Buck Converters", Power Electronics Technology 2013
<http://powerelectronics.com/regulators/ripple-generation-circuit-constant-time-controlled-buck-converters>

COT w/Bulk + Ceramic Output Capacitors



- For bulk + ceramic caps, stability may be achieved by adding a feed-forward cap
- The cap is used to cancel a pole formed by bulk & ceramic caps.

Without compensation

$$Z(C_o) = \frac{1}{S} \cdot \frac{s \cdot ESR \cdot C_{O1} + 1}{s \cdot ESR \cdot \frac{C_{O1} \cdot C_{O2}}{C_{O1} + C_{O2}} + 1} \cdot \frac{1}{C_{O1} + C_{O2}}$$



$$C_c = \frac{ESR \cdot C_{O1} \cdot C_{O2}}{R_t \cdot (C_{O1} + C_{O2})}$$

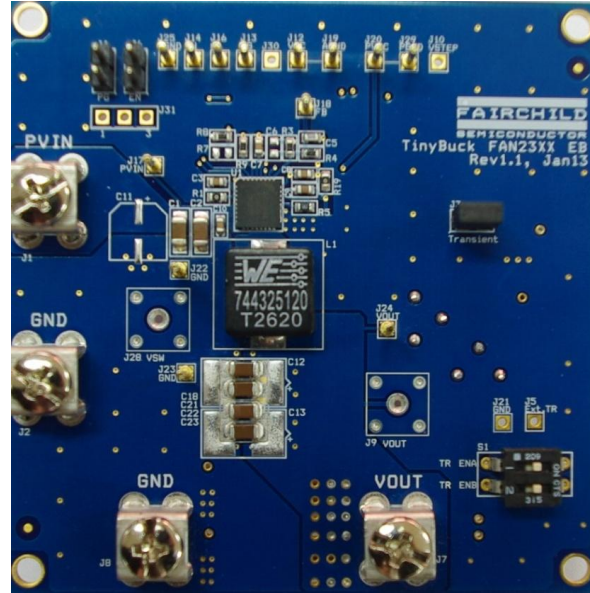
Ting Qian, et, al, "Effect of Combined Output Capacitors for Stability of Buck Converters with Constant On Time Control", IEEE Transactions on Power Electronics, 2012.



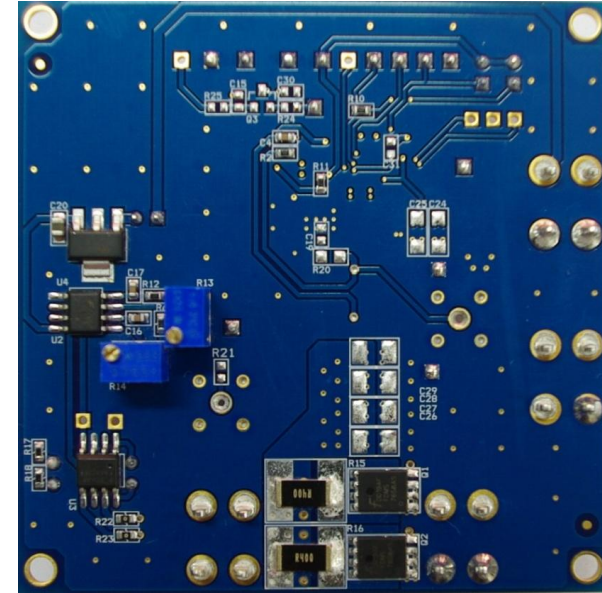
Evaluation Board

Top

- PCB has 4 layers
- SW routed on top only
- All 1 oz copper (top and bottom layers are 0.5oz with plating)
- Single point connection AGND to PGND

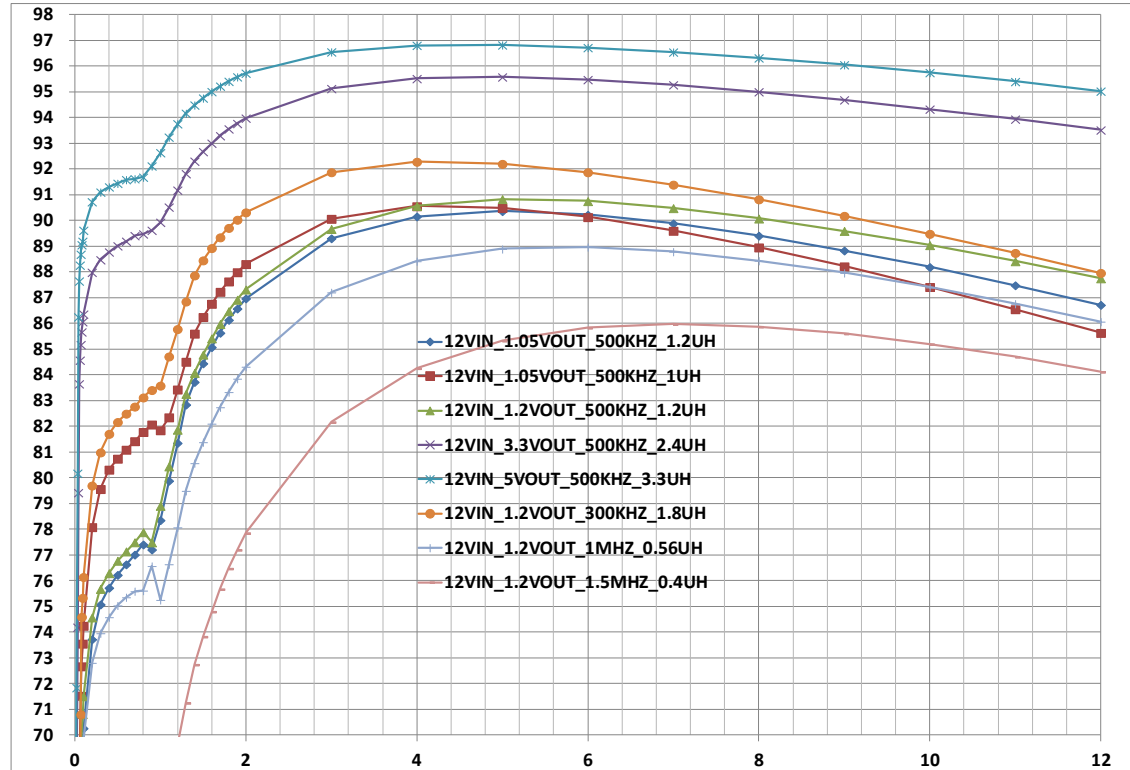


Bottom



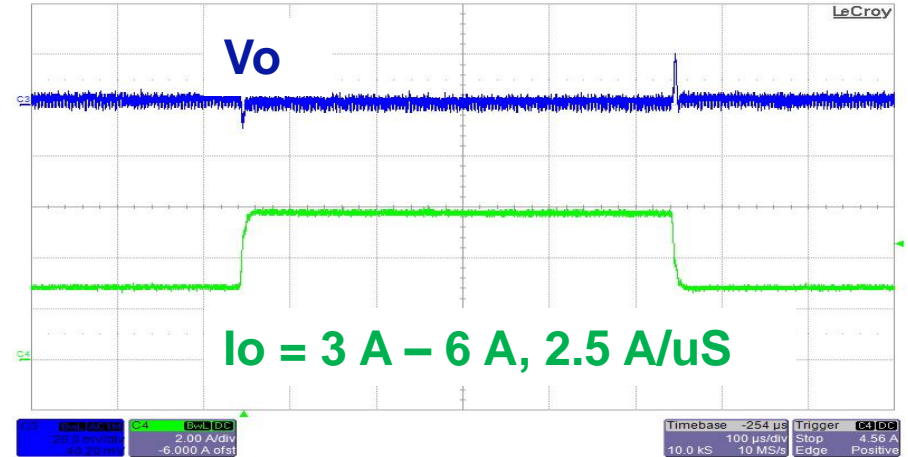
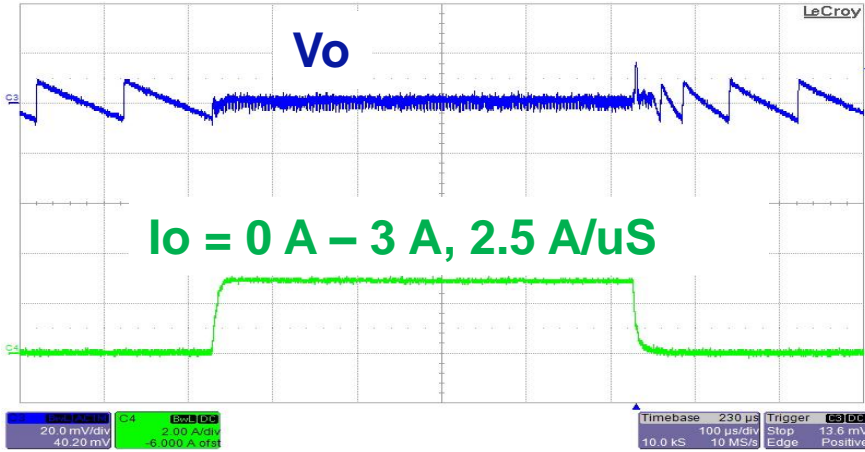


Efficiency Chart for FAN2306





Transient Response – FAN2306

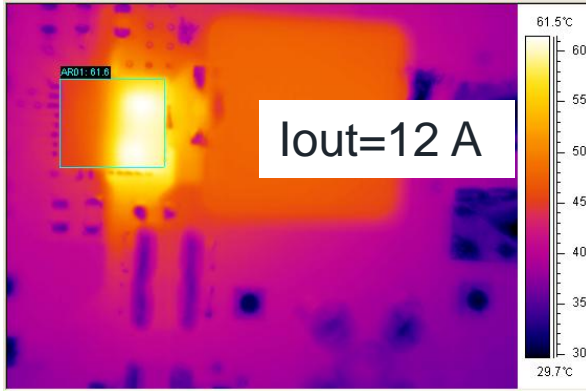


- 12Vin/1.2Vout/500kHz
- 1.2 μ H/1.8m Ω , Co=4 x 47 μ F
- 25[C] room temperature
- No cooling & natural convection

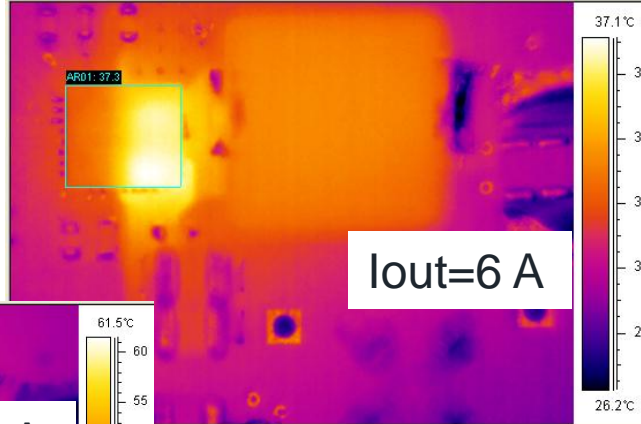


Thermal – FAN2306

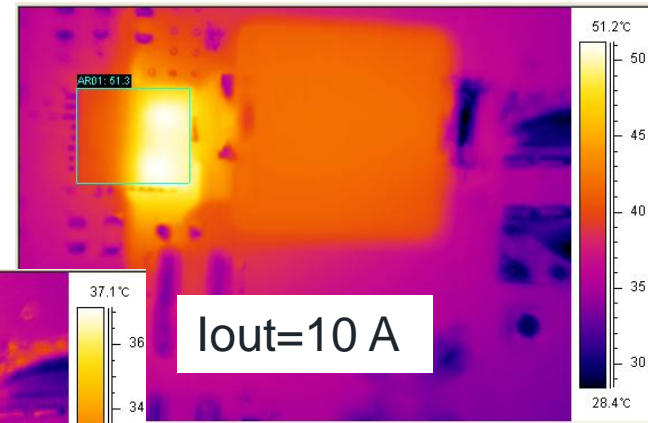
- 12 Vin/1.2 Vout/500 kHz
- Load=6 A,10 A,12 A
- 1.2 uH/1.8 mΩ, Co=4 x 47 uF
- 25[C] room temperature
- No cooling & natural convection



Case top Max. Temp. is 61.6[C]



Case top Max. Temp. is 37.3[C]

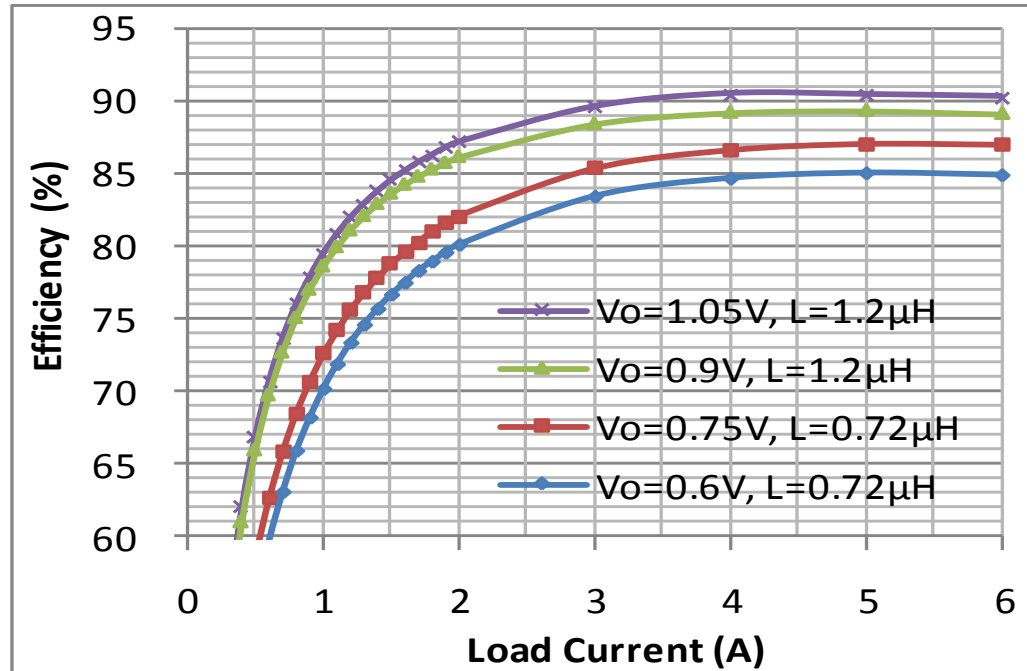


Case top Max. Temp. is 51.3[C]



FAN23SV04T for DDR Tracking Applications – Cont.

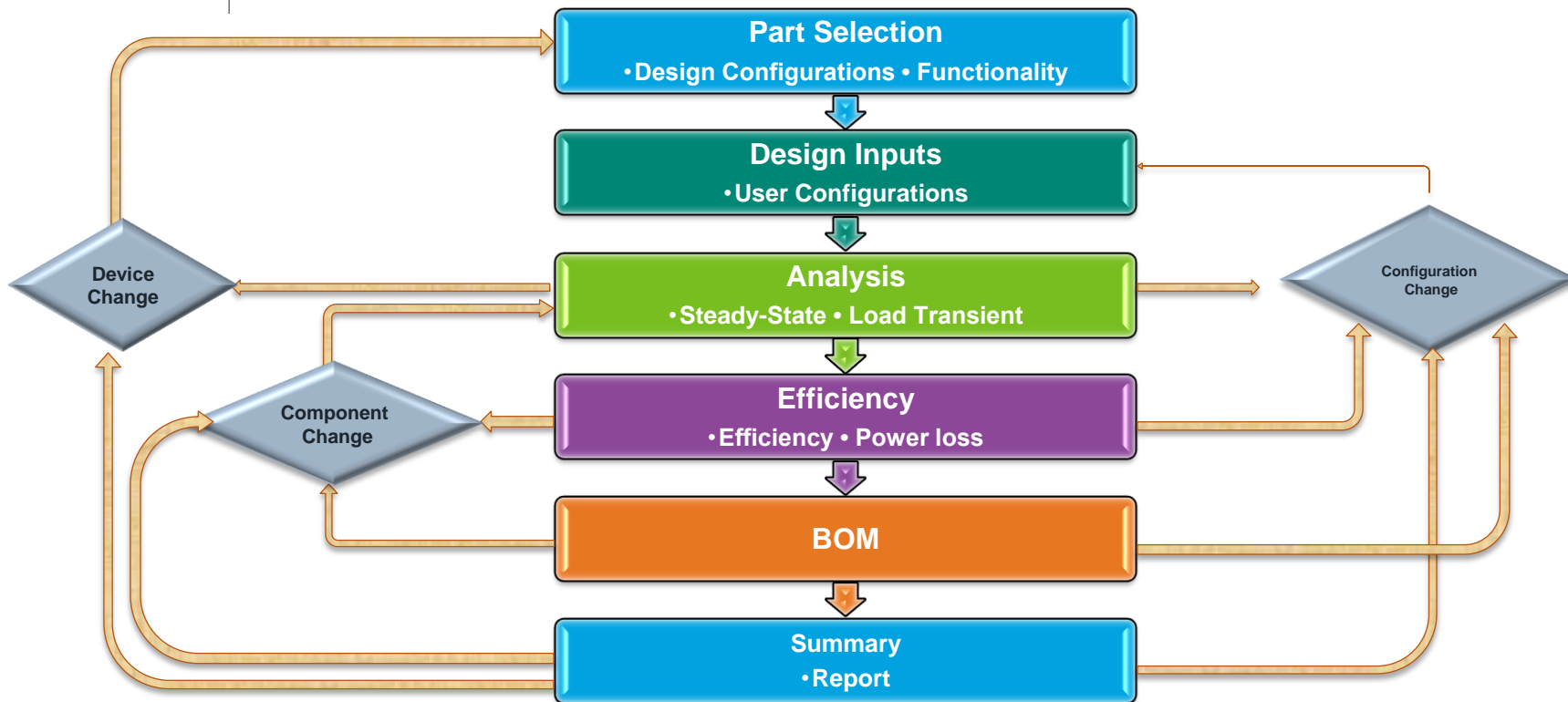
Minimizes external components! Higher Efficiency!



Efficiency vs. Load Current $V_{IN}=12\text{ V}$ and $f_{SW}=500\text{ kHz}$

Design Flow

<http://www.fairchildsemi.com/ShoppingExperience/action/redirect?type=icdesigner>





Part Selection

- Enter user configuration
- PFM and Ultrasonic Mode selection(Optional)
- Click 'Select' in "Filtered Part List"

Part Selection | Design Inputs | Analysis | Efficiency | BOM | Summary

Online simulation tool for TinyBuck™

Configuration

Vin: 12 V

Vout: 1.2 V

Iout: 6 A

Fsw: 500 kHz

Functionality

PFM

Ultrasonic Mode (Minimum Frequency Stamp: 250 kHz)

DDR Tracking

Integrated Bias Linear Regulator

Common Features

Pre-Bias Start-up

Output Over Current Protection

Enable

Power Good

Programmable Soft-start

Internal Boot Diode

Thermal Shut-down Protection

1st & 2nd Output Over Voltage Protection

VCC UVLO Protection

Programmable Frequency

Input Voltage Feed-forward

*Setting sliders to 0 will disable their filter.

FILTERED PARTS | SHOW ALL

FILTERED PART LIST

	Part Number	Info	Description	Vin Min (V)	Vin Max (V)	Vout Min (V)	Vout Max (V)	Iout Max (A)	Min. Switch Freq (kHz)	Max. Switch Freq (kHz)	Package (mm ²)
Select	FAN23SV65		15A integrated synchronous buck regulator with ultrasonic mode, internal linear regulator and wide input range	7	24	0.6	5.5	15	200	1000	5.5 x 5.0
Select	FAN23SV60		10A integrated synchronous buck regulator with ultrasonic mode, internal linear regulator and wide input range	7	24	0.6	5.5	10	200	1500	5.5 x 5.0
Select	FAN23SV56		6A integrated synchronous buck regulator with ultrasonic mode, internal linear regulator and wide input range	7	24	0.6	5.5	6	200	1500	5.5 x 5.0
Select	FAN23SV06		6A integrated synchronous buck regulator with ultrasonic mode and internal linear regulator	7	15	0.6	5.5	6	200	1500	5.5 x 5.0
Select	FAN2365		15A integrated synchronous buck regulator with ultrasonic mode and wide input range	4.5	24	0.6	5.5	15	200	1000	5.5 x 5.0
Select	FAN2360		10A integrated synchronous buck regulator with ultrasonic mode and wide input range	4.5	24	0.6	5.5	10	200	1500	5.5 x 5.0
Select	FAN2356		6A integrated synchronous buck regulator with ultrasonic mode and wide input range	4.5	24	0.6	5.5	6	200	1500	5.5 x 5.0
Select	FAN2315		15A integrated synchronous buck regulator with ultrasonic mode	4.5	15	0.6	5.5	15	200	1000	5.5 x 5.0
Select	FAN2310		10A integrated synchronous buck regulator with ultrasonic mode	4.5	15	0.6	5.5	10	200	1500	5.5 x 5.0
Select	FAN2306		6A integrated synchronous buck regulator with ultrasonic mode	4.5	15	0.6	5.5	6	200	1500	5.5 x 5.0



Design Inputs

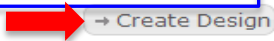
- Enter design requirements
- Create design



Design Requirements: FAN2306

Operational Conditions

Vin	<input type="text" value="12"/>	V
Vout	<input type="text" value="1.2"/>	V
Iout	<input type="text" value="6"/>	A
Frequency	<input type="text" value="500"/>	KHz
Output Inductor Current Ripple	<input type="text" value="30"/>	%
Max Output Voltage Ripple	<input type="text" value="5"/>	%
Type of Output Capacitor	<input checked="" type="radio"/> MLCC <input type="radio"/> Bulk	



Description

The FAN2306 / FAN2306M are highly efficient integrated TinyBuck™ synchronous buck regulator. They are capable of operatin with an input range from 4.5 V to 15 V, supporting 6 A continuous load currents.

These devices utilize Fairchild's constant on-time control architecture to provide excellent transient response and to maintain a relatively constant switching frequency. The FAN2306 /FAN2306M utilize Pulse Frequency Modulation (PFM) mode to maximize light-load efficiency by reducing switching frequency when the inductor is operating in discontinuous conduction mode at light loads. The FAN2306 includes an ultrasonic mode with minimum frequency clamp to keep the switching frequency above the audible range, while the FAN2306M does not include the minimum frequency clamp to maximize efficiency to extremely light loads.

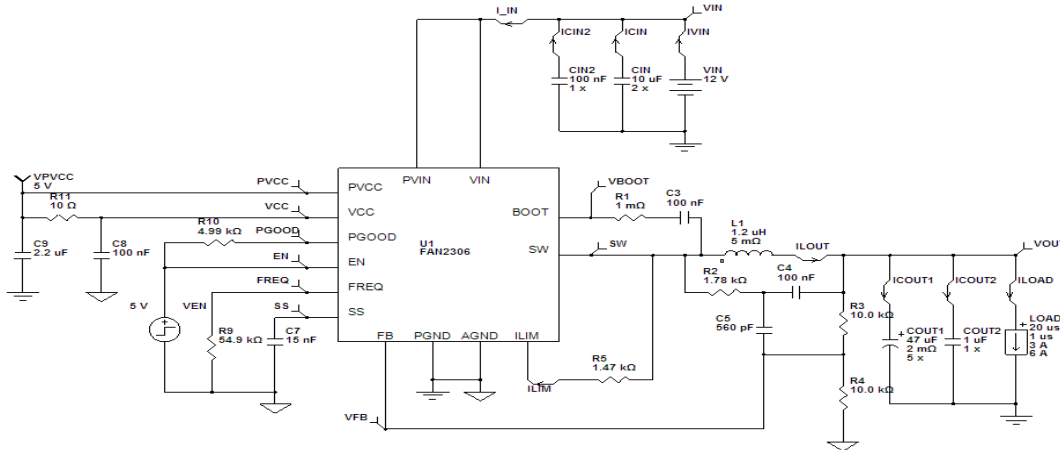
Switching frequency and over-current protection can be programmed to provide a flexible solution for various applications. Output over-voltage, undervoltage, over-current, and thermal shutdown protections help prevent damage to the device during fault conditions. After thermal shutdown is activated, a hysteresis feature restarts the device when normal operating temperature is reached.



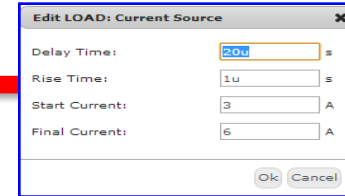
Analysis – Schematic



TinyBuck: FAN2306



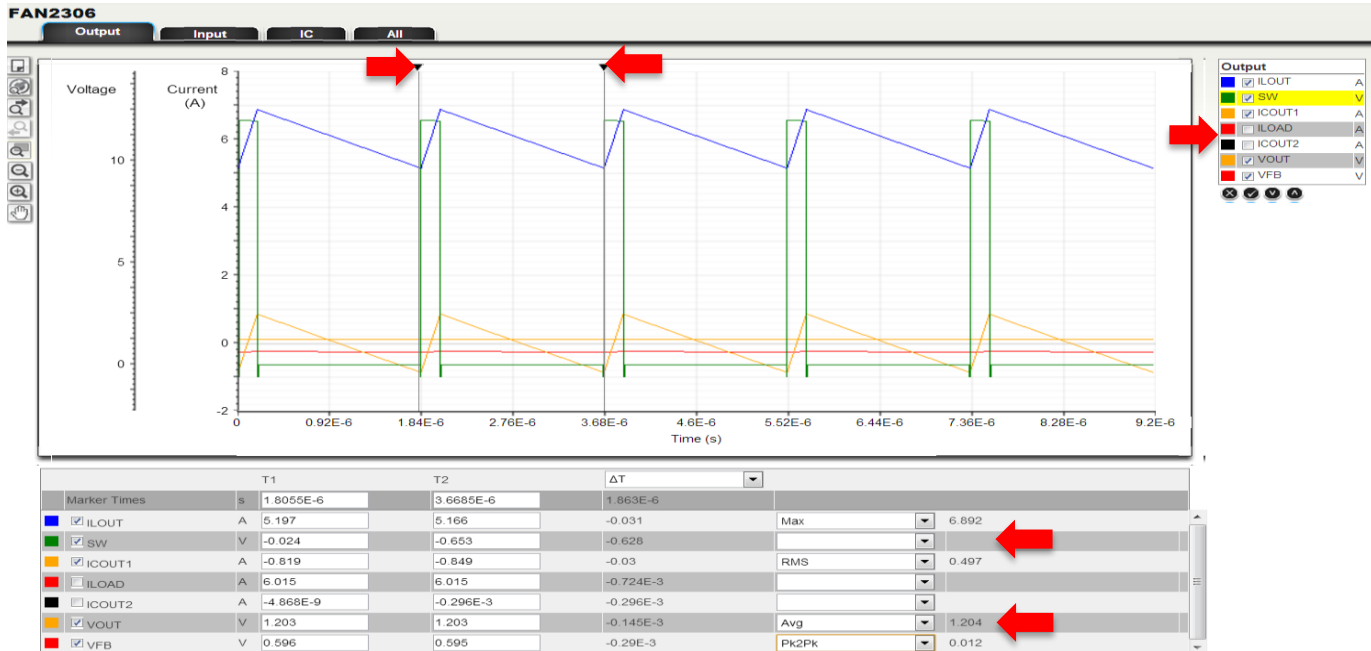
- Component values can be changed
- For Steady-State analysis, set 'Final Current' by clicking Load box
- For Transient Analysis, set 'Start Current' & 'Final Current' by clicking Load box





Example – Steady State Waveform(CCM)

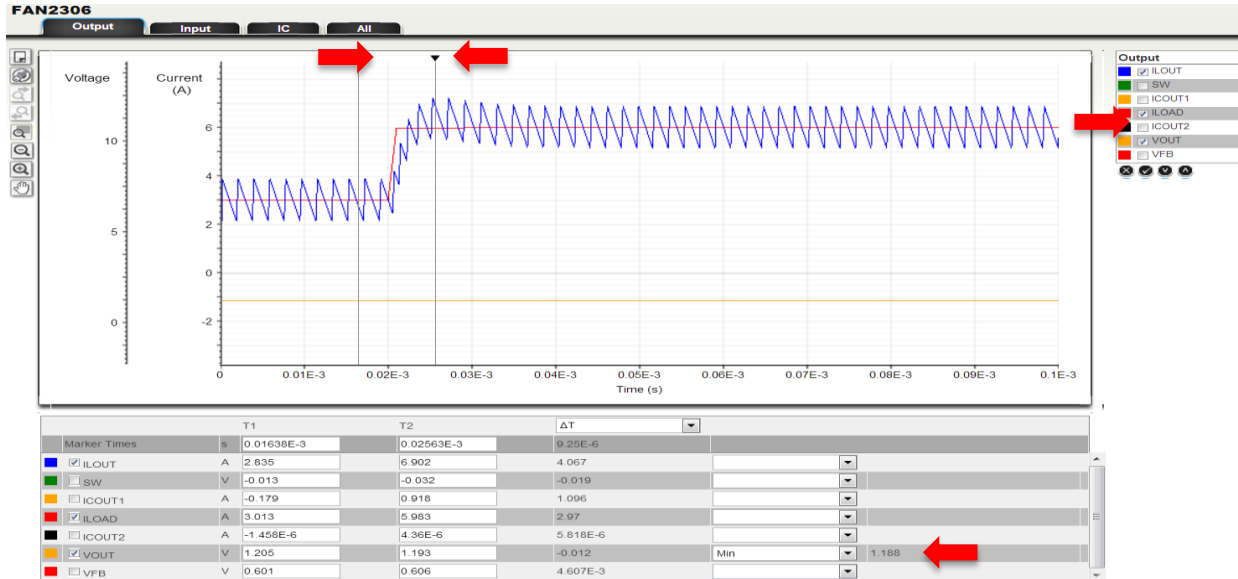
- Click 'View Results' to see steady-state waveforms





Example – Transient Waveforms

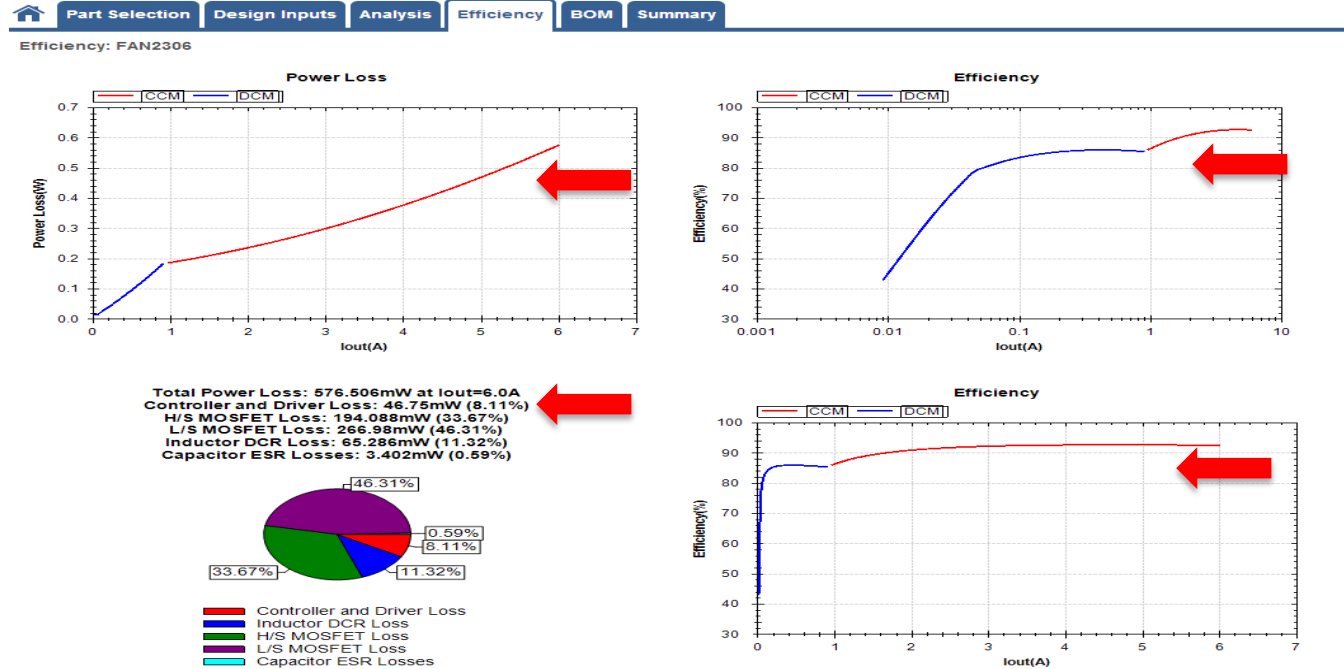
- Set 'Start Current' & 'Final Current' in Load box
- Click 'Transient Analysis' and click 'View Results'





Efficiency

- Click 'Efficiency' tab
- Each image can be copied or saved





BOM

- Click 'BOM' tab to see recommended part number
- Click each part number to see product specification and datasheet
- Click vendor name to see inventory, price and alternative part
- Click a image of 'Download Excel BOM' to see BOM in Excel

Navigation tabs: Home, Part Selection, Design Inputs, Analysis, Efficiency, **BOM**, Summary

BOM POWERED BY Transim

Generic

Download Excel BOM (indicated by red arrow)

Arrow (indicated by red arrow)

Ref	Qty	Find	Part Number	Manufacturer	Description
U1	1		FAN2306MPX (indicated by red arrow)	Fairchild Semiconductor	6A integrated synchronous bi
C3	1		06036C104JAT2A	AVX	Cap Ceramic 0.1uF 6.3VDC X7R 5% SMD 0603 T/R
C4	1		06035C104KAT2A	AVX	Cap Ceramic 0.1uF 50VDC X7R 10% SMD 0603 Paper T/R
C5	1		C0803C561J8GACTU	Kemet	Cap Ceramic 560pF 10VDC COG 5% SMD 0603 Paper T/R
C7	1		0603YC153JAT2A	AVX	Cap Ceramic 0.015uF 16VDC X7R 5% SMD 0603 T/R
C8	1		06036C104JAT2A	AVX	Cap Ceramic 0.1uF 6.3VDC X7R 5% SMD 0603 T/R
C9	1		06036C225KAT2A	AVX	Cap Ceramic 2.2uF 6.3VDC X7R 10% SMD 0603 Paper T/R
CIN	1		GRM32ER7YA106KA12L	Murata	CAP CER 10UF 35V X7R 10% 1210
CIN2	1		06035C104KAT2A	AVX	Cap Ceramic 0.1uF 50VDC X7R 10% SMD 0603 Paper T/R
COUT1	3		C0805C476M7PAC	Kemet	Cap Ceramic 47uF 4VDC X5R 20% SMD 0805 Bulk
COUT2	1		User Selection Required		Capacitor 1uF, 1.2V
L1	1		2256-05L	API Delevan	POWER CHOKE 2.2UH MOLDED AXIAL



Summary

- Click 'Summary' tab to see all results
- Click 'PDF' image to open them in PDF file

Part Selection Design Inputs Analysis Efficiency BOM Summary

Summary Report: FAN2306



Part Number	Info	Description	Vin Min (V)	Vin Max (V)	Vout Min (V)	Vout Max (V)	Iout Max (A)	Min. Switch Freq (kHz)	Max. Switch Freq (kHz)	Package (mm ²)
FAN2306		6A integrated synchronous buck regulator with ultrasonic mode	4.5	15	0.6	5.5	6	200	1500	5.5 x 5.0

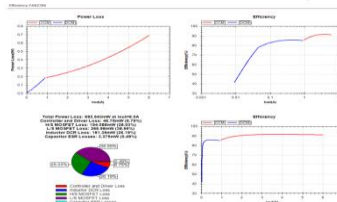
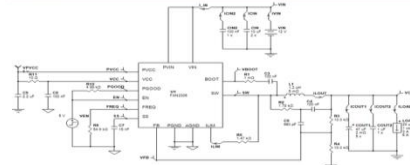
Operating Conditions

Vin	12
Vout	1.2
Iout	6
Frequency	500
Output Inductor Current Ripple	30
Max Output Voltage Ripple	5
Type of Output Capacitor	MLCC
Part Number	FAN2306

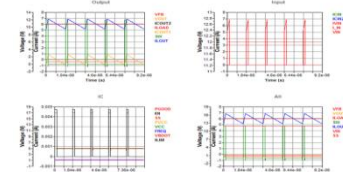
Bill of Materials

Ref	Qty	Description
ICs		
U1	1	IC FAN2306
Capacitors		
C3	1	Capacitor 100nF, 0.3V
C4	1	Capacitor 100nF, 30V
C5	1	Capacitor 880pF, 1.2V
C7	1	Capacitor 150nF, 0.3V
C8	1	Capacitor 100nF, 0.3V
C9	1	Capacitor 2.2uF, 0.3V
CIN	2	Capacitor 10uF, 30V
CIN2	1	Capacitor 100nF, 30V
COU1	8	Capacitor 47uF, 1.2V, 2mD
COU2	1	Capacitor 1uF, 1.2V
Inductors		
L1	1	Inductor 1.2uH, 5mD
Resistors		
R2	1	Resistor 1.7kD, 1
R3	1	Resistor 10 Ohm, 1
R4	1	Resistor 10 Ohm, 1
R5	1	Resistor 1.47kD, 1
R9	1	Resistor 0.4 Ohm, 1
R10	1	Resistor 4.99kD, 1
R11	1	Resistor 10D, 1

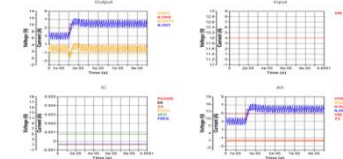
Configured Schematics



Steady State Results



Transient Results





THANK YOU