LM5175 DC/DC Controller Design Tool

WIDE V_{IN} DC/DC Power Solutions — Reliable Power for Demanding Systems

About | = Input Box | TERMS OF USE | Industrial | Automotive

Step 1: Operating Specifications

Input Voltage - Min, $V_{IN(min)}$	**10**	**V**
Input Voltage - Nom, $V_{IN(nom)}$	**13**	**V**
Input Voltage - Max, $V_{IN(max)}$	**15**	**V**
Output Voltage, V_{OUT}	**12**	**V**
Full Load Output Current, $I_{OUT(max)}$	**4**	**A**
Switching Frequency	**400**	**kHz**
Frequency Set Resistor, R_T	61.9	kΩ

Step 2: Filter Inductor

Recommended Filter Inductance	2.3	µH
Inductance, L_F	**2.2**	**µH**
Inductor DCR	**17**	**mΩ**
Pk-to-Pk Ripple Current at $V_{IN(min)}$, ΔI_{L1}	2.0	A_{pk-pk}
Pk-to-Pk Ripple Current at $V_{IN(nom)}$, ΔI_{L2}	1.1	A_{pk-pk}
Pk-to-Pk Ripple Current at $V_{IN(max)}$, ΔI_{L3}	2.7	A_{pk-pk}
ΔI_L as a % at $V_{IN(min)}$	40	%
ΔI_L as a % at $V_{IN(nom)}$	26	%
ΔI_L as a % at $V_{IN(max)}$	69	%

Step 3: OCP, Sense Resistors, Slope Comp

Required $I_{OCP(MIN)}$ Setpoint at $V_{IN(nom)}$	**5**	**A**
Recommended Sense Resistance	17.9	mΩ
Sense Resistance, R_S	**18**	**mΩ**
Peak Inductor Current, I_{LPK}	8.9	A
Power Loss in Rs at Full Load (Min VIN)	0.08	W
Recommended SLOPE Capacitance	33	pF
SLOPE Capacitance, C_{SLOPE}	**33**	**pF**
$I_{OUT(typ)}$ at OCP Inception: $V_{IN(min)}$	6.5	A
$V_{IN(nom)}$	5.0	A
$V_{IN(max)}$	5.8	A
Required Const Current Loop Setpoint	**N/A**	**A**
Output Leg Shunt Resistance, $R_{CS(out)}$	0	mΩ

Step 4: Output Capacitor

Output Voltage Ripple Spec	**120**	**mV_{pk-pk}**
Minimum Output Capacitance	22.0	µF
Output Capacitance, C_{OUT}	**88**	**µF**
Maximum Permitted ESR	25.0	mΩ
Output Capacitor ESR	**4**	**mΩ**
Resulting Output Voltage Ripple (max)	36	mV_{pk-pk}
Output Capacitor RMS Current (max)	1.8	A (rms)

Step 5: Input Capacitor

Input Voltage Ripple Spec	**180**	**mV_{pk-pk}**
Minimum Input Capacitance	10.0	µF
Input Capacitance, C_{IN}	**22**	**µF**
Maximum Permitted ESR	20.2	mΩ
Input Capacitor ESR	**4**	**mΩ**
Resulting Input Voltage Ripple (max)	93	mV_{pk-pk}
Input Capacitor RMS Current (max)	1.6	A (rms)

Step 6: Soft-start, Dither, UVLO

Soft-Start Time, t_{SS}	**8**	**ms**
Soft-Start Capacitance, C_{SS}	47	nF

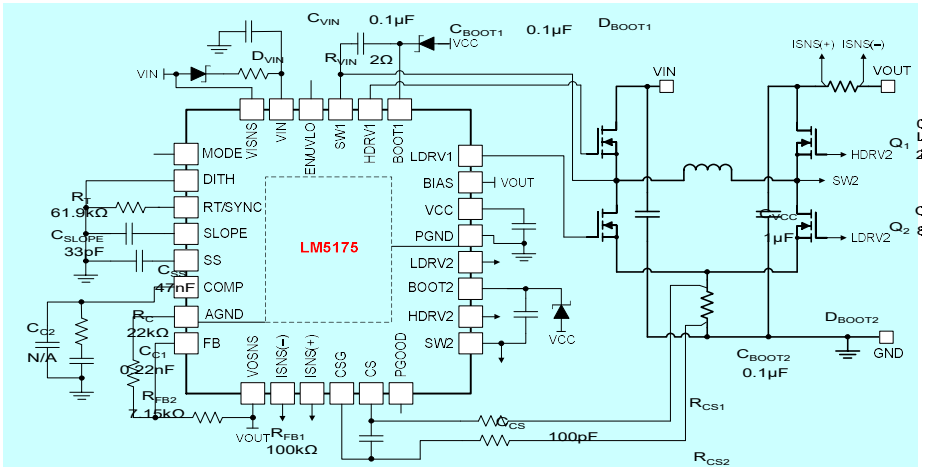
DITHER Disabled

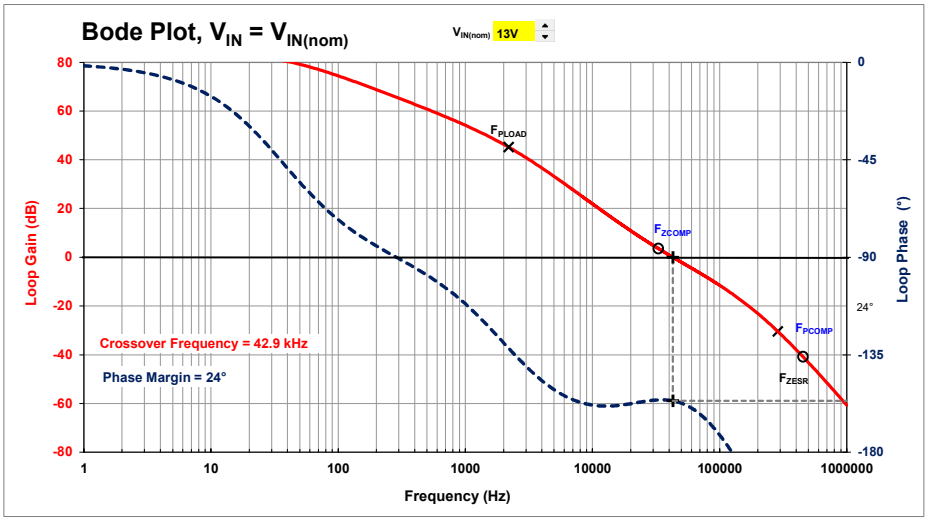
*Short DITH pin to GND

Required Input Voltage UVLO On	**5.5**	**V**
Input Voltage UVLO Off	4.84	V
Upper UVLO Resistor, R_{UV1}	**200**	**kΩ**
Lower UVLO Resistor, R_{UV2}	52.3	kΩ

Step 7: Compensation Design

Load Pole Frequency	2191	Hz
C_{OUT} ESR Zero Frequency	452	kHz
Boost RHP Zero Frequency	1	kHz
Desired Crossover Frequency	**50**	**kHz**
Error Amp Pole Frequency	36	Hz
Upper Feedback Resistor, R_{FB1}	**100**	**kΩ**
Lower Feedback Resistor, R_{FB2}	7.15	kΩ





Compensation Components

	Calculated /	Std Values	Selected		Actual P/Z Frequencies
R_C	29.4	29.4	**22**	**kΩ**	36 Hz (F_{PEA})
C_{C1}	0.2	0.22	**0.22**	**nF**	32.9 kHz (F_{ZCOMP})
C_{C2}	0	0	**0**	**pF**	286 kHz (F_{PCOMP})

Min COMP Voltage **1.33V**
Max COMP Voltage **2.25V**

Efficiency / Power Loss Analyzer

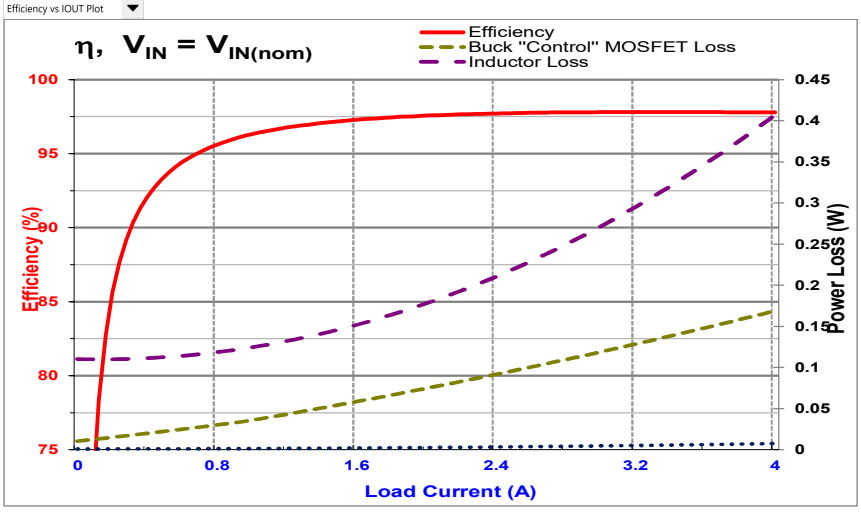
Step 8: Efficiency

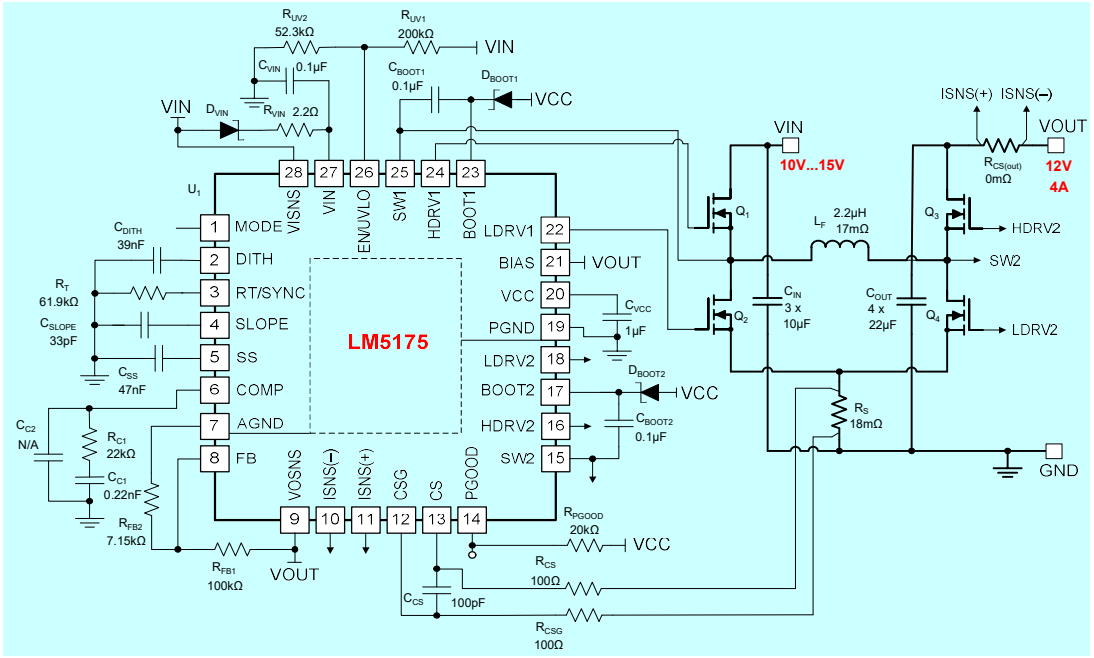
Buck-Leg Power MOSFETs (Q_1, Q_2) BSC0702LS	Hi-side	Low-side	
On-State Resistance, $R_{DS(on)}$	**2.7**	**2.7**	mΩ
Total Gate Charge, Q_G	**24**	**24**	nC
Gate-Drain Charge, Q_{GD}	**8**	**8**	nC
Gate-Source Charge, Q_{GS}	**10**	**10**	nC
Gate Resistance, R_G	**1.3**	**1.3**	Ω
Transconductance, g_{FS}	**120**	**120**	S
Gate-Source Threshold Voltage, V_{TH}	**1.7**	**1.7**	V
Body Diode Forward Voltage, V_{BD}	**0.8**	**0.8**	V
Body Diode Rev Recovery Charge, Q_{RR}		**36**	nC
Thermal Resistance, θ_{JA}	**50**	**50**	°C/W

Boost-Leg Power MOSFETs (Q_3, Q_4) RU3040M2	Hi-side	Low-side	
On-State Resistance, $R_{DS(on)}$	**5.8**	**8.2**	mΩ
Total Gate Charge, Q_G	**13**	**13**	nC
Gate-Drain Charge, Q_{GD}	**5.5**	**5.5**	nC
Gate-Source Charge, Q_{GS}	**3.8**	**3.8**	nC
Gate Resistance, R_G	**1**	**1**	Ω
Transconductance, g_{FS}	**125**	**125**	S
Gate-Source Threshold Voltage, V_{TH}	**1.8**	**1.8**	V
Body Diode Forward Voltage, V_{BD}	**1.2**	**1.2**	V
Body Diode Rev Recovery Charge, Q_{RR}	**9**		nC
Thermal Resistance, θ_{JA}	**35**	**35**	°C/W

External Schottky Diode (if applicable)	*Buck* Leg	*Boost* Leg	
Schottky Fwd Voltage, V_{FWDsch}	**0.35**	**0.35**	V
Schottky Rev Recovery Charge, Q_{RRsch}	**0.6**	**0.6**	nC

Efficiency vs IOUT Plot





** Tie MODE to VCC (or voltage > 2.4V) for CCM, GND for DCM **

VIN = 10 V to 15 V, VOUT = 12 V, IOUT = 4 A, Fsw = 400 kHz, Current Limit = 5 A

High Efficiency Synchronous Buck-Boost Regulator BOM

Count	Ref Des	Value	Description	Size	Part Number	MFR
2	C_{BOOT1}, C_{BOOT2}	0.1µF	Capacitor, Ceramic, 0.1-µF, 50V, X7R, 20%	0603	Std	Std
1	C_{C1}	0.22nF	Capacitor, Ceramic, 0.22-nF, 16V, X7R, 10%	0603	Std	Std
1	C_{C2}	0pF	Capacitor, Ceramic, 0-pF, 50V, NP0, 5%	0603	Std	Std
1	C_{SLOPE}	33pF	Capacitor, Ceramic, 33-pF, 50V, NP0, 5%	0603	Std	Std
1	C_{CS}	100pF	Capacitor, Ceramic, 100-pF, 16V, X7R, 10%	0603	Std	Std
1	C_{DITH}	39nF	Capacitor, Ceramic, 39-nF, 16V, X7R, 10%	0603	Std	Std
3	C_{IN}	10µF	Capacitor, Ceramic, 10-µF, 50V, X7R, 20%	1210	Std	Std
4	C_{OUT}	22µF	Capacitor, Ceramic, 22-µF, 25V, X5R, 20%	1210	Std	Std
1	C_{SS}	47nF	Capacitor, Ceramic, 47-nF, 16V, X7R, 10%	0603	Std	Std
1	C_{VCC}	1µF	Capacitor, Ceramic, 1-µF, 25V, X7R, 20%	0603	Std	Std
1	C_{VIN}	0.1µF	Capacitor, Ceramic, 0.1-µF, 100V, X7R, 20%	0603	Std	Std
3	D_{BOOT1}, D_{BOOT2}, D_{VIN}	See description	Schottky Diode, 200mA	-	-	Various
1	L_F	2.2µH	Inductor, 2.2µH, 17mΩ, >10A	-	-	Various
2	Q_1, Q_2	See description	MOSFET, N-CH, 60V, 2.7mΩ	Std	BSC0702LS	-
2	Q_3, Q_4	See description	MOSFET, N-CH, 60V, 5.8mΩ	Std	RU3040M2	-
1	R_{C1}	22k	Resistor, Chip, 22-kΩ, 1/16W, 1%	0603	Std	Std
1	R_S	18m	Resistor, Chip, 18-mΩ, 2W, 1%	2512	Std	Std
1	$R_{CS(out)}$	0m	Resistor, Chip, 0-mΩ, 2W, 1%	2512	Std	Std
1	R_T	61.9k	Resistor, Chip, 61.9-kΩ, 1/16W, 1%	0603	Std	Std
1	R_{FB1}	100k	Resistor, Chip, 100-kΩ, 1/16W, 1%	0603	Std	Std
1	R_{FB2}	7.15k	Resistor, Chip, 7.15-kΩ, 1/16W, 1%	0603	Std	Std
1	R_{PGOOD}	20k	Resistor, Chip, 20-kΩ, 1/16W, 1%	0603	Std	Std
2	R_{CS}, R_{CSG}	100	Resistor, Chip, 100-Ω, 1/16W, 1%	0603	Std	Std
1	R_{UV1}	200k	Resistor, Chip, 200-kΩ, 1/16W, 1%	0603	Std	Std
1	R_{UV2}	52.3k	Resistor, Chip, 52.3-kΩ, 1/16W, 1%	0603	Std	Std
1	R_{VIN}	2.2	Resistor, Chip, 2.2-Ω, 1/16W, 1%	0603	Std	Std
1	**U_1**	**LM5175**	**IC, LM5175, Buck-Boost PWM Controller, 3.5V–42V Input**	**QFN-28**	**LM5175RHF**	**TI**
				TSSOP-28	**LM5175PWP**	

NOTES:

** For information on TI NexFET™ MOSFETs, see ** http://www.ti.com/nexfet **

** Inductor saturation current should be higher than the peak inductor current at the OCP setpoint for all input voltages and operating temperatures **

** Effective input and output capacitances should be appropriately derated for applied voltage and temperature, particularly with ceramics **