LM5176 DC/DC Controller Design Tool

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

About | = Input Box

http://www.ti.com/product/lm5176

TERMS OF USE

V 1.0.1 October 2022

Step 1: Operating Specifications

Input Voltage - Min, $V_{IN(min)}$	**12**	**V**
Input Voltage - Nom, $V_{IN(nom)}$	**20**	**V**
Input Voltage - Max, $V_{IN(max)}$	**24**	**V**
Output Voltage, V_{OUT}	**21**	**V**
Full Load Output Current, $I_{OUT(max)}$	**1.8**	**A**
Switching Frequency	**520**	**kHz**
Frequency Set Resistor, R_T	15	kΩ

Step 2: Filter Inductor

Recommended Filter Inductance	6.5	µH
Inductance, L_F	**6.8**	**µH**
Inductor DCR	**18.5**	**mΩ**
Pk-to-Pk Ripple Current at $V_{IN(min)}$, ΔI_{L1}	1.5	A_{pk-pk}
Pk-to-Pk Ripple Current at $V_{IN(nom)}$, ΔI_{L2}	0.3	A_{pk-pk}
Pk-to-Pk Ripple Current at $V_{IN(max)}$, ΔI_{L3}	0.7	A_{pk-pk}
ΔI_L as a % at $V_{IN(min)}$	42	%
ΔI_L as a % at $V_{IN(nom)}$	13	%
ΔI_L as a % at $V_{IN(max)}$	41	%

Step 3: OCP, Sense Resistors, Slope Comp

Required $I_{OCP(MIN)}$ Setpoint at $V_{IN(nom)}$	**2.2**	**A**
Recommended Sense Resistance	23.9	mΩ
Sense Resistance, R_S	**24**	**mΩ**
Peak Inductor Current, I_{LPK}	5.0	A
Power Loss in Rs at Full Load (Min VIN)	0.13	W
Recommended SLOPE Capacitance	120	pF
SLOPE Capacitance, C_{SLOPE}	**120**	**pF**
$I_{OUT(typ)}$ at OCP Inception: $V_{IN(min)}$	2.4	A
$V_{IN(nom)}$	3.0	A
$V_{IN(max)}$	3.7	A
Set Const Current Loop Setpoint (?)	**1.8**	**A**
Output Leg Shunt Resistance, $R_{CS(out)}$	28	mΩ

Step 4: Output Capacitor

Output Voltage Ripple Spec	**100**	**mV_{pk-pk}**
Minimum Output Capacitance	22.0	µF
Output Capacitance, C_{OUT}	**170**	**µF**
Maximum Permitted ESR	50.7	mΩ
Output Capacitor ESR	**28**	**mΩ**
Resulting Output Voltage Ripple (max)	59	mV_{pk-pk}
Output Capacitor RMS Current (max)	1.6	A (rms)

Step 5: Input Capacitor

Input Voltage Ripple Spec	**200**	**mV_{pk-pk}**
Minimum Input Capacitance	10.0	µF
Input Capacitance, C_{IN}	**40**	**µF**
Maximum Permitted ESR	87.8	mΩ
Input Capacitor ESR	**0.1**	**mΩ**
Resulting Input Voltage Ripple (max)	10	mV_{pk-pk}
Input Capacitor RMS Current (max)	0.6	A (rms)

Step 6: Soft-start, Dither, UVLO

Soft-Start Time, t_{SS}	**50**	**ms**
Soft-Start Capacitance, C_{SS}	330	nF

DITHER Disabled

*Short DITH pin to GND

Required Input Voltage UVLO On	**10**	**V**
Input Voltage UVLO Off	9.14	V
Upper UVLO Resistor, R_{UV1}	**250**	**kΩ**
Lower UVLO Resistor, R_{UV2}	33.2	kΩ

Step 7: Compensation Design

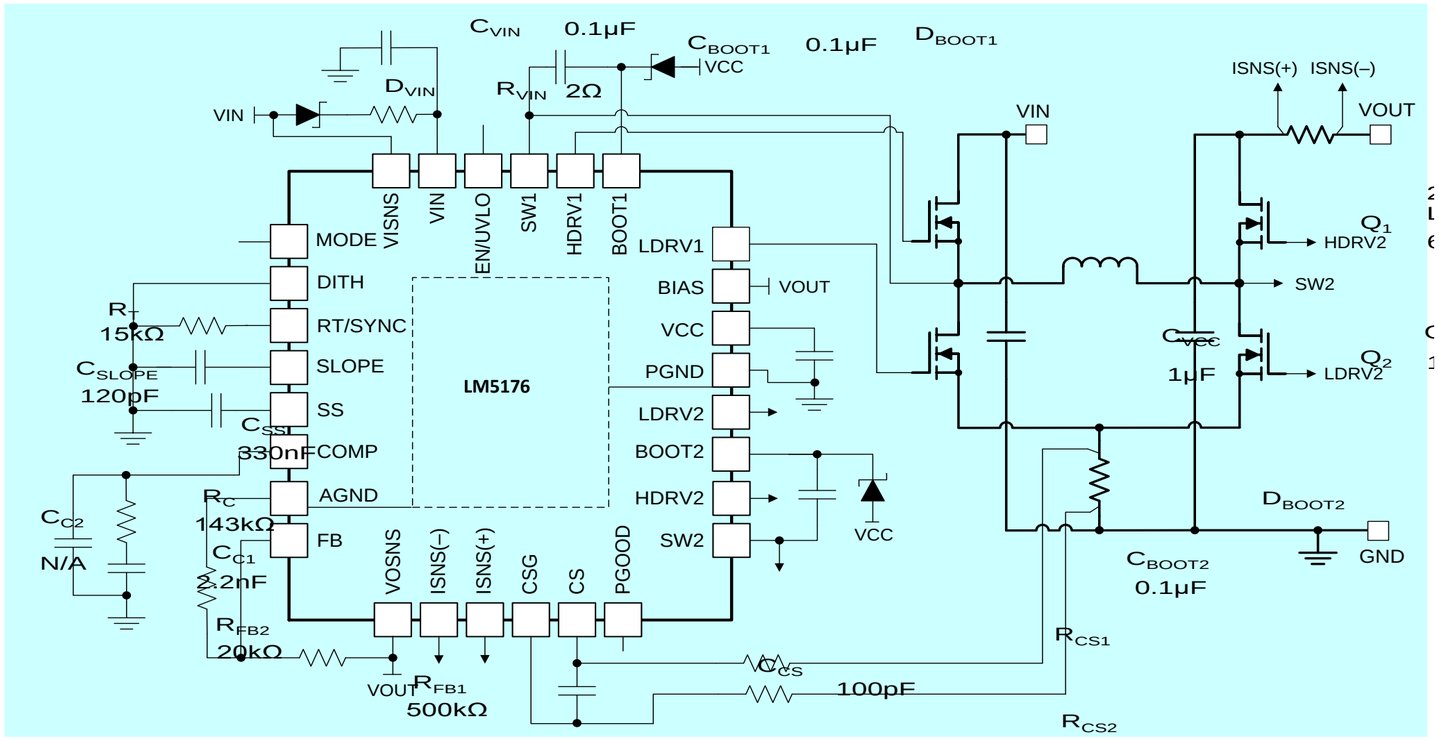
Load Pole Frequency	307	Hz
C_{OUT} ESR Zero Frequency	33	kHz
Boost RHP Zero Frequency	247	kHz
Desired Crossover Frequency	**52**	**kHz**
Error Amp Pole Frequency	4	Hz
Upper Feedback Resistor, R_{FB1}	**500**	**kΩ**
Lower Feedback Resistor, R_{FB2}	20	kΩ

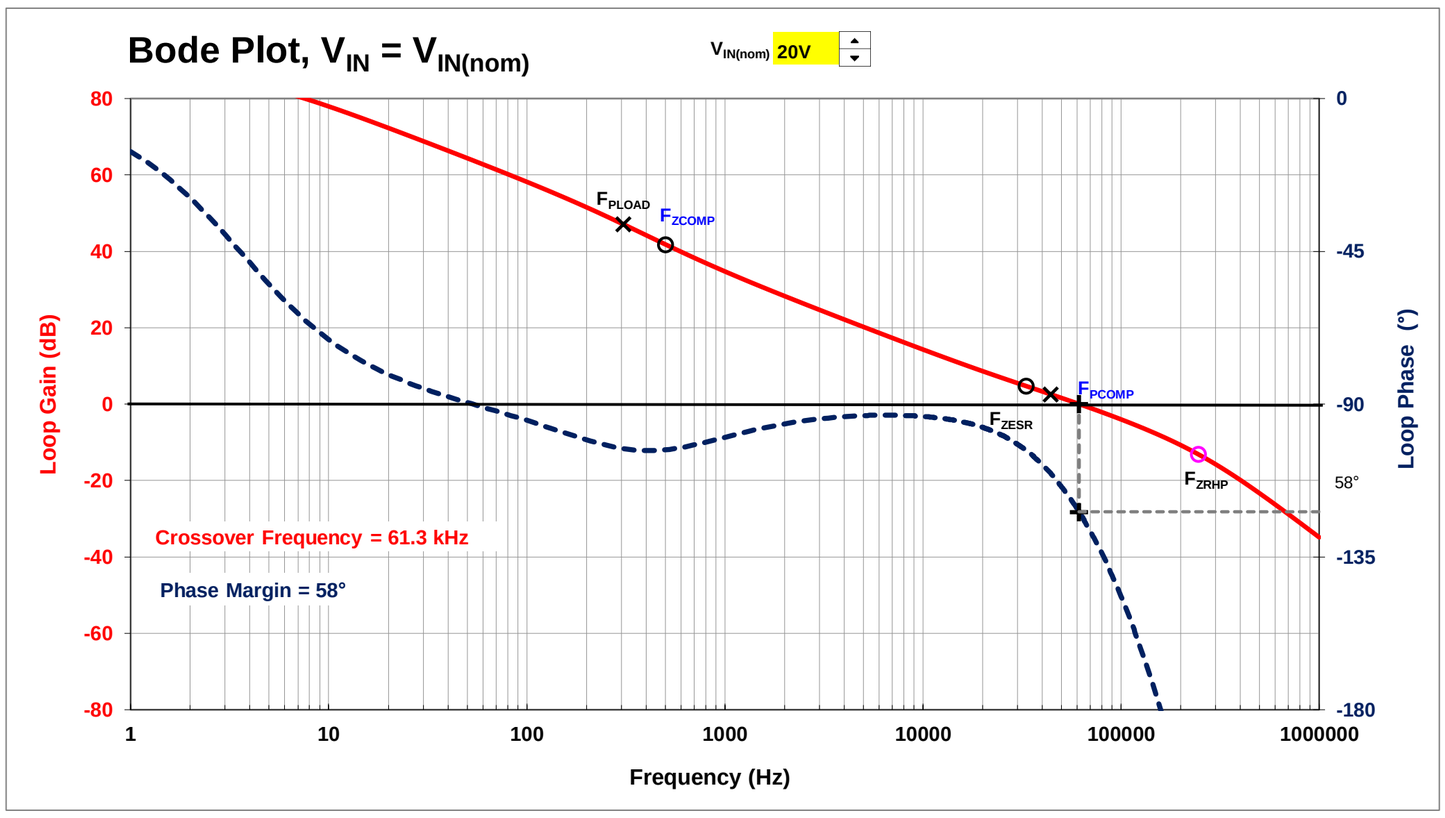
Compensation Components

	Calculated / Std Values		Selected		Actual P/Z Frequencies	
R_C	141.8	143	**143**	**kΩ**	4	Hz (F_{PEA})
C_{C1}	2.4	2.2	**2.2**	**nF**	0.5	kHz (F_{ZCOMP})
C_{C2}	0	0	**0**	**pF**	44	kHz (F_{PCOMP})

Min COMP Voltage **1.54V**

Max COMP Voltage **2.26V**

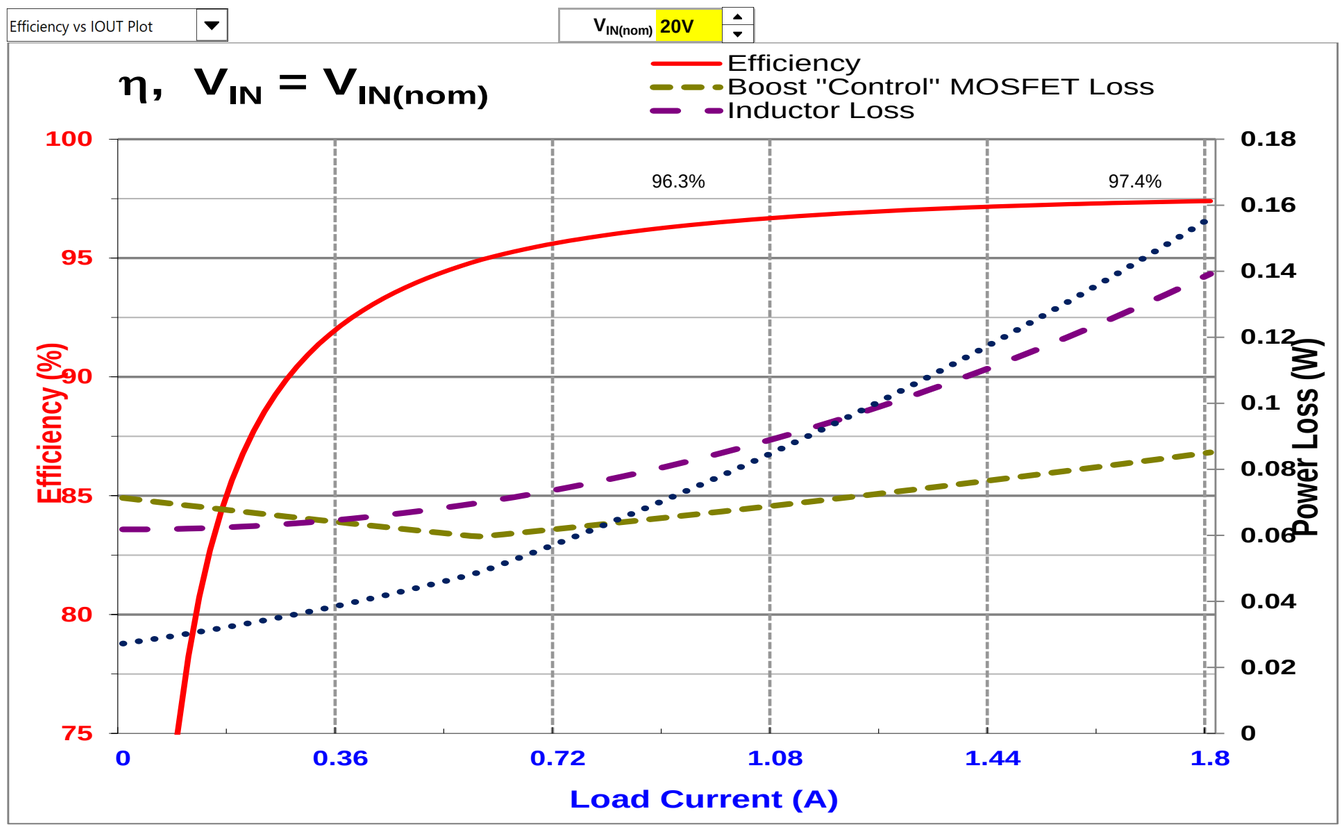




Efficiency / Power Loss Analyzer

Step 8: Efficiency

Efficiency vs IOUT Plot | $V_{IN(nom)}$ 20V



***Buck*-Leg Power MOSFETs (Q_1, Q_2)** CSD18563Q5A

	Hi-side	Low-side	
On-State Resistance, $R_{DS(on)}$	16.0	16.0	mΩ
Total Gate Charge, Q_G	13.2	13.2	nC
Gate-Drain Charge, Q_{GD}	1.8	1.8	nC
Gate-Source Charge, Q_{GS}	2.2	2.2	nC
Gate Resistance, R_G	1.47	1.47	Ω
Transconductance, g_{FS}	8.3	8.3	S
Gate-Source Threshold Voltage, V_{TH}	1.7	1.7	V
Body Diode Forward Voltage, V_{BD}	1.2	1.2	V
Body Diode Rev Recovery Charge, Q_{RR}		7.9	nC
Thermal Resistance, θ_{JA}	50	50	°C/W

***Boost*-Leg Power MOSFETs (Q_3, Q_4)** CSD16321Q5

	Hi-side	Low-side	
On-State Resistance, $R_{DS(on)}$	16	16	mΩ
Total Gate Charge, Q_G	13.2	13.2	nC
Gate-Drain Charge, Q_{GD}	1.8	1.8	nC
Gate-Source Charge, Q_{GS}	2.2	2.2	nC
Gate Resistance, R_G	1.47	1.47	Ω
Transconductance, g_{FS}	8.3	8.3	S
Gate-Source Threshold Voltage, V_{TH}	1.7	1.7	V
Body Diode Forward Voltage, V_{BD}	1.2	1.2	V
Body Diode Rev Recovery Charge, Q_{RR}	7.9		nC
Thermal Resistance, θ_{JA}	50	50	°C/W

External Schottky Diode (if applicable)	*Buck* Leg	*Boost* Leg	
Schottky Fwd Voltage, V_{FWDsch}	0	0	V
Schottky Rev Recovery Charge, Q_{RRsch}	0	0	nC