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

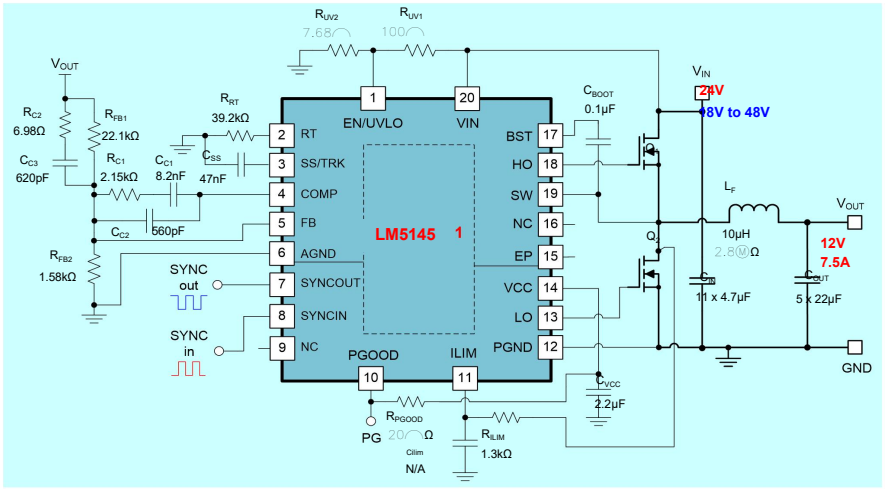
LM(2)5145/46-Q1 DC-DC Controller Design Tool

About | = Input Box | TERMS OF USE

Step 1: Operating Specifications

LM5145

Input Voltage – Min, $V_{IN(min)}$	18	V
Input Voltage – Nom, $V_{IN(nom)}$	24	V
Input Voltage – Max, $V_{IN(max)}$	48	V
Output Voltage, V_{OUT}	12	V
Maximum Output Current, I_{OUT}	7.5	A
Free-running Switching Frequency, F_{SW}	255	kHz
SYNC Frequency (if used), $F_{SW-SYNC}$	255	kHz
Frequency Set Resistor, R_{RT}	39.2	kΩ



Step 2: Filter Inductor

Recommended Filter Inductance	9.4	µH
Inductance, L_F	10	µH
Inductor DCR	2.8	mΩ
Pk-to-Pk Ripple Current at $V_{IN(nom)}$, ΔI_L	2.4	A_{PK-PK}
Inductor Ripple Current as a % of Max I_{OUT}	31	%
Estimate Core Loss at $V_{IN(nom)}$	0.4	W

Step 3: $R_{DS(on)}$ or Shunt-Based Current Limit

RDS(on) sensing

Required Current Limit Setpoint	80	A
Current Limit Set Resistor, R_{ILIM}	1300	Ω
Min Inductor Sat Current, $I_{L(SAT)}$	97.2	A

Step 4: Output Capacitance

Output Voltage Ripple Specification	100	mV_{PK-PK}
Minimum Ideal Output Capacitance	12	µF
Total Output Capacitance (Derated), C_{OUT}	110	µF
Maximum Permitted ESR	42	mΩ
Output Capacitor ESR	1	mΩ
Resulting Output Voltage Ripple	11	mV_{PK-PK}
Output Capacitor Ripple Current	0.7	A_{RMS}

Step 5: Input Capacitance

Input Voltage Ripple Specification	500	mV_{PK-PK}
Minimum Ideal Input Capacitance	15	µF
Total Input Capacitance (Derated), C_{IN}	50	µF
Maximum Permitted ESR	41	mΩ
Input Capacitor ESR	2	mΩ
Resulting Input Voltage Ripple	164	mV_{PK-PK}
Input Capacitor Ripple Current	3.7	A_{RMS}

Step 6: Soft-start, UVLO

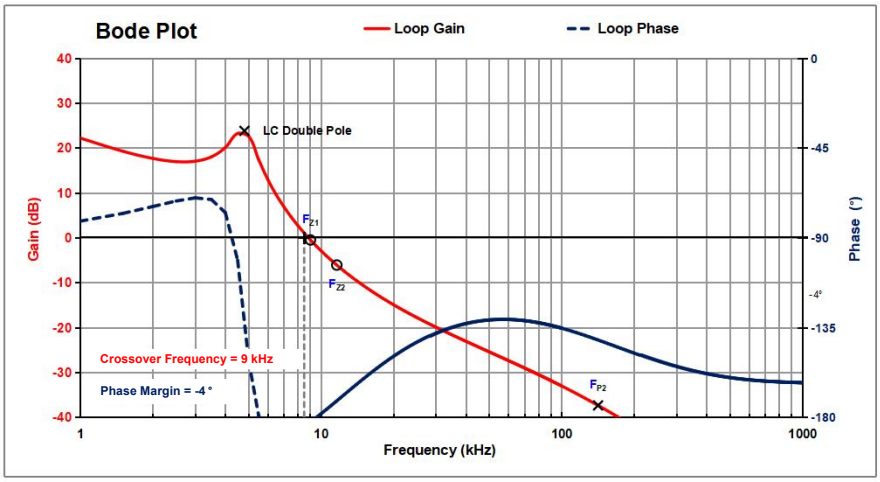
Soft-Start Time, t_{SS}	4	ms
Soft-Start Capacitance, C_{SS}	47	nF
Input Voltage UVLO Turn-On	17	V
Input Voltage UVLO Turn-Off	16	V
UVLO Upper Resistor, R_{UV1}	100	kΩ
UVLO Lower Resistor, R_{UV2}	7.68	kΩ

If the SYNC feature is not required, connect SYNCIN to GND or VCC for DCM or CCM operation, respectively

Step 7: Compensation Design

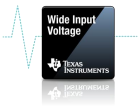
LC Complex Pole Frequency	4.8	kHz
ESR Zero Frequency	1447	kHz
Desired Crossover Frequency	30	kHz
Appropriate Midband Gain	0.42	V/V
Upper Feedback Resistor, R_{FB1}	22.1	kΩ
Lower Feedback Resistor, R_{FB2}	1.58	kΩ
Actual Output Voltage, V_{OUT}	11.990	V

Pole & Zero Placement	F_{Z1}	3.4 kHz
Baseline P/Z Frequencies:	F_{Z2}	4.3 kHz
	F_{P1}	1447 kHz
	F_{P2}	128 kHz



Compensation Components

	Calculated	Std Values	Selected	Actual P/Z Frequencies
R_{C1}	9.2	9.31	2.15 kΩ	9.0 kHz (F_{Z1})
C_{C1}	5144	4700	8200 pF	11.6 kHz (F_{Z2})
C_{C2}	139	150	560 pF	36777 kHz (F_{P1})
R_{C2}	66	66.5	6.98 Ω	141 kHz (F_{P2})
C_{C3}	1662	1800	620 pF	

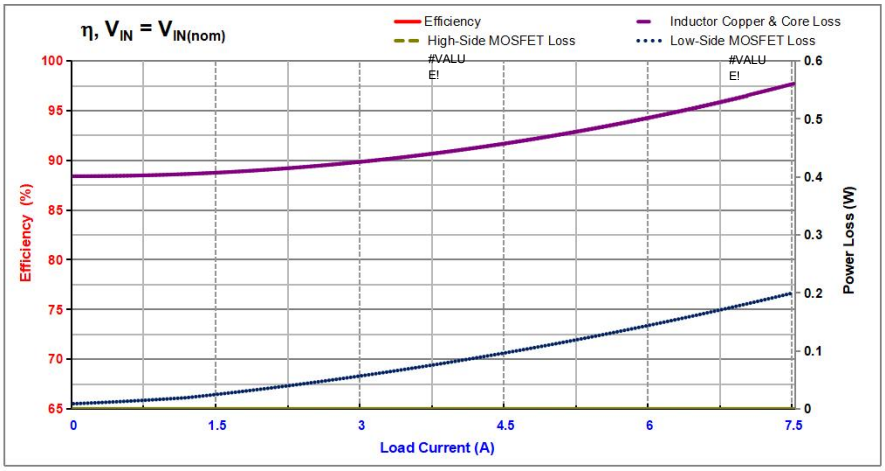


Efficiency / Power Loss Analyzer

Step 8: Efficiency

High-Side MOSFET (Q_1) Specifications	TPH4R008NH	
On-State Resistance, $R_{DS(on)}$	3.3	mΩ
Total Gate Charge, Q_G	59	nC
Gate-Drain Charge, Q_{GD}	12	nC
Gate-Source Charge, Q_{GS}	18	nC
Output Capacitance, C_{OSS}	890	pF
Gate Resistance, R_G	1.2	Ω
Transconductance, g_{FS}	100	S
Gate-Source Plateau Voltage, $V_{GS(MP)}$	2.0-4.0	V
Body Diode Forward Voltage, V_{BD1}	0.8	V
Thermal Resistance, θ_{JA}	50	°C/W

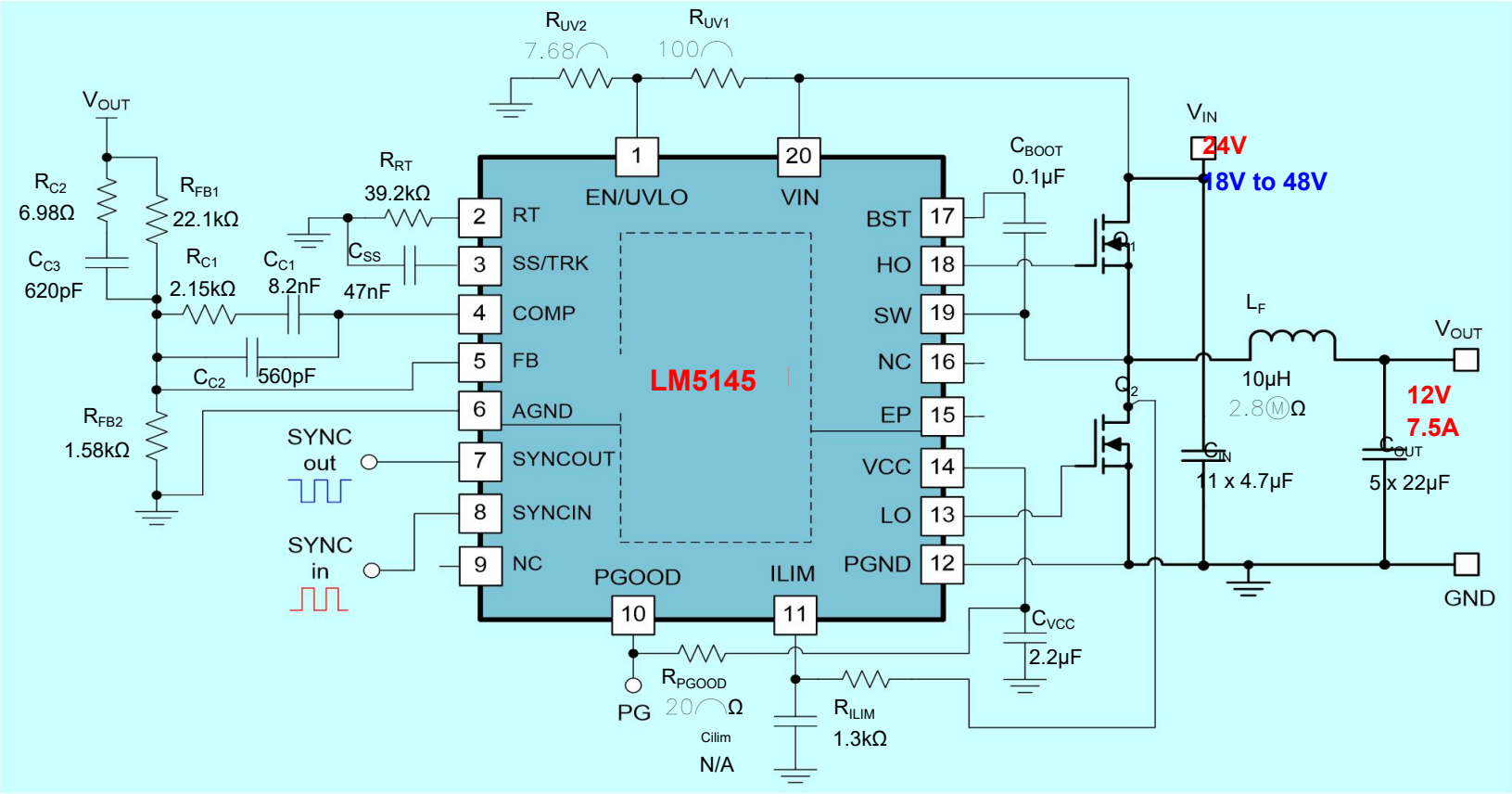
Low-Side MOSFET (Q_2) Specifications	TPH4R008NH	
On-State Resistance, $R_{DS(on)}$	3.3	mΩ
Total Gate Charge, Q_G	59	nC
Output Charge, Q_{OSS}	12	nC
Output Capacitance, C_{OSS}	890	pF
Body Diode Forward Voltage, V_{BD2}	0.9	V
Body Diode Recovery Charge, Q_{RR}	111	nC
Thermal Resistance, θ_{JA}	50	°C/W
Antiparallel Schottky Diode (if applicable)		
Schottky Diode Forward Voltage, V_{SD}	0	V
Schottky Diode Recovery Charge, Q_{RR2}	0	nC



Step 9: IC Power Loss

No External VCC

IC Power Dissipation	0.77	W
IC Junction Temperature Rise (est)	38.5	°C



** Tie SYNCIN to VCC and GND for CCM and DCM operation, respectively **

VIN = 24 V, VOUT = 12 V, IOUT = 7.5 A, Fsw = 255 kHz, Current Limit = 80 A

Wide V_{IN}, High Efficiency Synchronous Buck Regulator BOM

Count	Ref Des	Value	Description	Size	Part Number	MFR
1	C_{BOOT}	0.1µF	Capacitor, Ceramic, 0.1µF, 25V, X7R, 20%	0603	Std	Std
1	C_{C1}	8200pF	Capacitor, Ceramic, 8200pF, 16V, X7R, 10%	0402	Std	Std
1	C_{C2}	560pF	Capacitor, Ceramic, 560pF, 50V, NP0, 5%	0402	Std	Std
1	C_{C3}	620pF	Capacitor, Ceramic, 620pF, 50V, NP0, 5%	0402	Std	Std
1	C_S	N/A	Capacitor, Ceramic, N/A, 100V, X7R, 20%	0603	Std	Std
5	C_{IN}	4.7µF	Capacitor, Ceramic, 4.7µF, 100V, X7S, 10%	1210	Std	Std
5	C_{OUT}	22µF	Capacitor, Ceramic, 22µF, 16V, X7R, 10%	1210	Std	Std
1	C_{SS}	47nF	Capacitor, Ceramic, 47nF, 16V, X7R, 10%	0603	Std	Std
1	C_{VCC}	2.2µF	Capacitor, Ceramic, 2.2µF, 25V, X7R, 20%	0805	Std	Std
1	C_{VIN}	0.1µF	Capacitor, Ceramic, 0.1µF, 50V, X7R, 20%	0603	Std	Std
1	L_F	10µH	Inductor, 10µH, 2.8mΩ, >98A	10mm x 10mm	Various	Various
1	Q_1	See description	MOSFET, N-CH, 80V/100V, 3.3mΩ Quantity: 1	SON 5 x 6	TPH4R008NH	TI
1	Q_2	See description	MOSFET, N-CH, 80V/100V, 3.3mΩ Quantity: 1	SON 5 x 6	TPH4R008NH	TI
1	R_{C1}	2.15k	Resistor, Chip, 2.15kΩ, 1/16W, 1%	0402	Std	Std
1	R_{C2}	6.98	Resistor, Chip, 6.98Ω, 1/16W, 1%	0402	Std	Std
1	R_{ILIM}	1300	Resistor, Chip, 1300Ω, 1/16W, 1%	0805	Std	Std
1	R_{RT}	39.2k	Resistor, Chip, 39.2kΩ, 1/16W, 1%	0402	Std	Std
1	R_{FB1}	22.1k	Resistor, Chip, 22.1kΩ, 1/16W, 1%	0402	Std	Std
1	R_{FB2}	1.58k	Resistor, Chip, 1.58kΩ, 1/16W, 1%	0402	Std	Std
1	R_{PGOOD}	20k	Resistor, Chip, 20kΩ, 1/16W, 1%	0402	Std	Std
1	R_{UV1}	100k	Resistor, Chip, 100kΩ, 1/16W, 1%	0603	Std	Std
1	R_{UV2}	7.68k	Resistor, Chip, 7.68kΩ, 1/16W, 1%	0402	Std	Std
1	R_{VIN}	2.2	Resistor, Chip, 2.2Ω, 1/16W, 1%	0402	Std	Std
1	**U_1**	**LM5145**	**IC, LM5145, PWM Controller, 6V-75V Input**	**VQFN-20**	**LM5145RGYR**	**TI**

Total Solution Size (

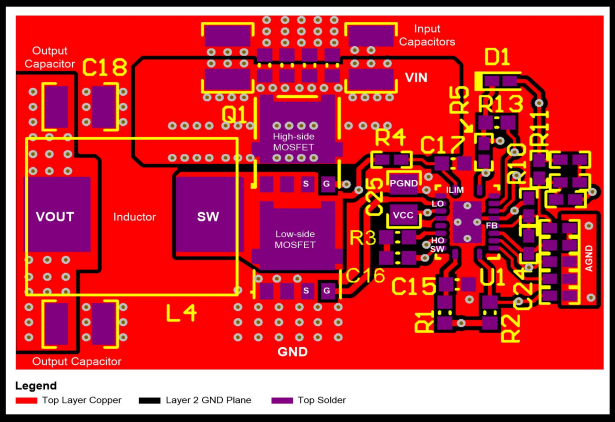
NOTES:

** Inductor saturation current should be higher than the current limit setpoint at all operating temperatures **

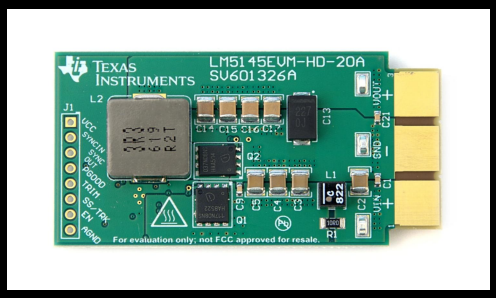
** Effective output capacitance should be appropriately **derated** for applied voltage and temperature, particularly with **ceramics** **

LM(2)5145/6/ -Q1 Quickstart Calculator

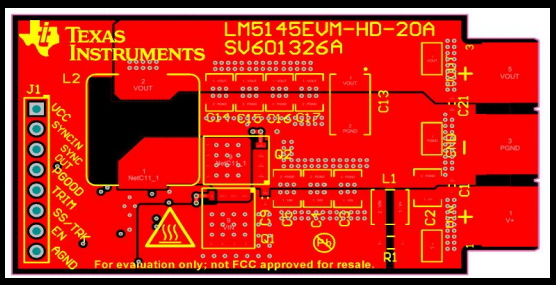
LM5146-Q1-EVM12V

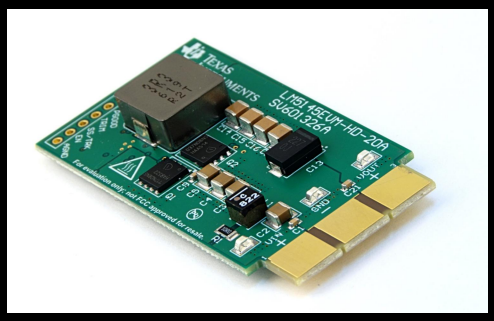


LM5145EVM-HD-20A PCB Layout

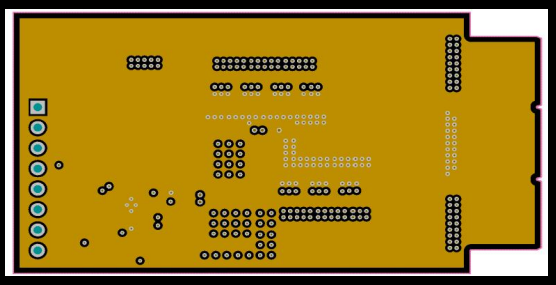


Top Layer





Layer 2



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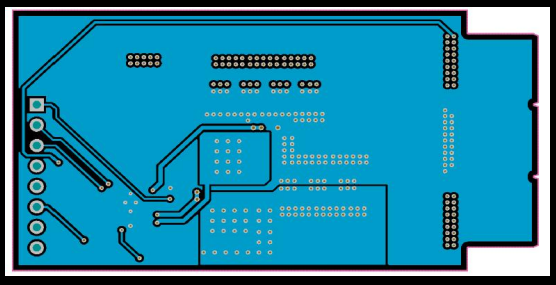

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