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

LM5146

Input Voltage – Min, $V_{IN(min)}$	**46**	V
Input Voltage – Nom, $V_{IN(nom)}$	**48**	V
Input Voltage – Max, $V_{IN(max)}$	**50**	V
Output Voltage, V_{OUT}	**24**	V
Maximum Output Current, I_{OUT}	**16**	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	8.8	µH
Inductance, L_O	**10**	**µH**
Inductor DCR	**16.5**	**mΩ**
Pk-to-Pk Ripple Current at $V_{IN(nom)}$, ΔI_L	4.8	A_{PK-PK}
Inductor Ripple Current as a % of Max I_{OUT}	30	%
Estimate Core Loss at $V_{IN(nom)}$	**0.2**	**W**

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

RDS(on) sensing

Required Current Limit Setpoint	**30**	**A**
Current Limit Set Resistor, R_{ILIM}	453	Ω
Min Inductor Sat Current, $I_{L(SAT)}$	38.4	A

Step 4: Output Capacitance

Output Voltage Ripple Specification	**200**	mV_{PK-PK}
Minimum Ideal Output Capacitance	12	µF
Total Output Capacitance (Derated), C_{OUT}	**480**	**µF**
Maximum Permitted ESR	42	mΩ
Output Capacitor ESR	**37**	**mΩ**
Resulting Output Voltage Ripple	176	mV_{PK-PK}
Output Capacitor Ripple Current	1.4	A_{RMS}

Step 5: Input Capacitance

Input Voltage Ripple Specification	**480**	mV_{PK-PK}
Minimum Ideal Input Capacitance	33	µF
Total Input Capacitance (Derated), C_{IN}	**440**	**µF**
Maximum Permitted ESR	24	mΩ
Input Capacitor ESR	**3**	**mΩ**
Resulting Input Voltage Ripple	91	mV_{PK-PK}
Input Capacitor Ripple Current	8.0	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	**15**	**V**
Input Voltage UVLO Turn-Off	**14**	**V**
UVLO Upper Resistor, R_{UV1}	100	kΩ
UVLO Lower Resistor, R_{UV2}	8.66	kΩ

If the SYNC feature is not required, connect SYNCIN to GND or VCC for diode emulation or FPWM modes, respectively

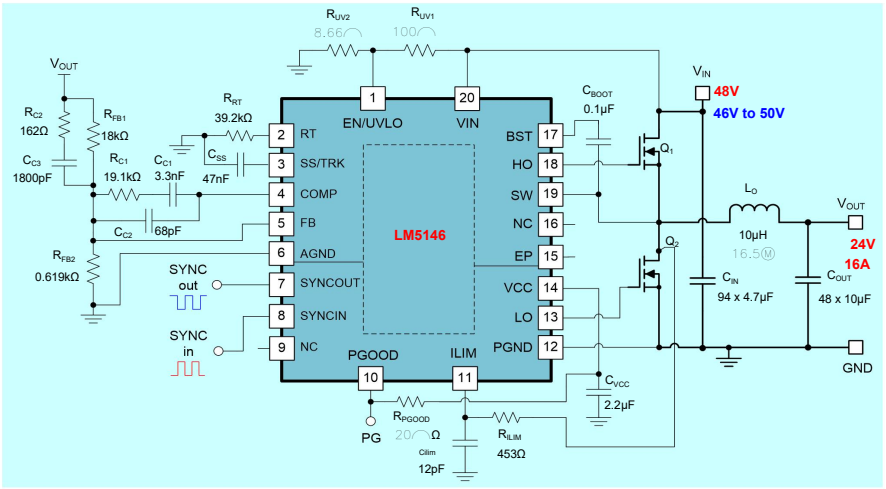
Step 7: Compensation Design

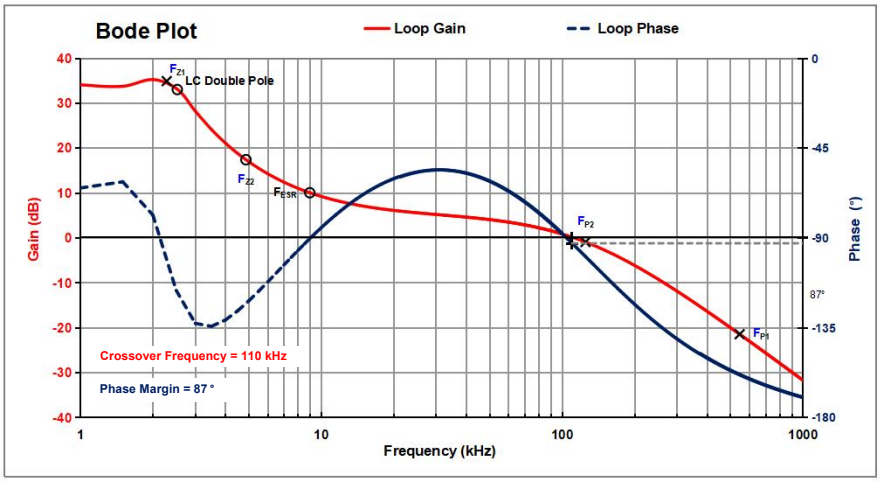
LC Complex Pole Frequency	2.3	kHz
ESR Zero Frequency	9	kHz
Desired Crossover Frequency	**36**	kHz
Appropriate Midband Gain	1.05	V/V
Upper Feedback Resistor, R_{FB1}	**18**	**kΩ**
Lower Feedback Resistor, R_{FB2}	0.619	kΩ
Actual Output Voltage, V_{OUT}	24.063	V

Pole & Zero Placement	F_{Z1}	**2.5**	kHz
Baseline P/Z Frequencies:	F_{Z2}	**4.8**	kHz
	F_{P1}	**536**	kHz
	F_{P2}	**128**	kHz

Compensation Components

	Calculated / Std Values		Selected	Actual P/Z Frequencies
R_{C1}	18.9	19.1	**19.1 kΩ**	**2.5 kHz (F_{Z1})**
C_{C1}	3363	3300	**3300 pF**	**4.9 kHz (F_{Z2})**
C_{C2}	67	68	**68 pF**	**546 kHz (F_{P1})**
R_{C2}	163	162	**162 Ω**	**125 kHz (F_{P2})**
C_{C3}	1826	1800	**1800 pF**	





Efficiency / Power Loss Analyzer

Step 8: Efficiency

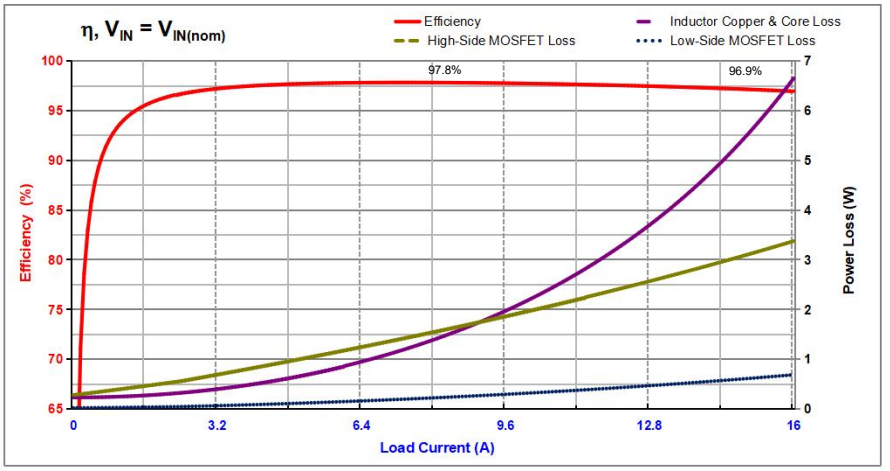
High-Side MOSFET (Q_1) Specifications	TPH4R008NH	
On-State Resistance, $R_{DS(on)}$	**3.3**	mΩ
Total Gate Charge, Q_G	**59**	nC
Gate-Drain Charge, Q_{GD}	**12**	nC
Gate-Source Charge, Q_{GS}	**18**	nC
Output Capacitance, C_{OSS}	**890**	pF
Gate Resistance, R_G	**1.2**	Ω
Transconductance, g_{FS}	**45**	S
Gate-Source Plateau Voltage, $V_{GS(MP)}$	**3**	V
Body Diode Forward Voltage, V_{BD1}	**0.8**	V
Thermal Resistance, θ_{JA}	**55**	°C/W

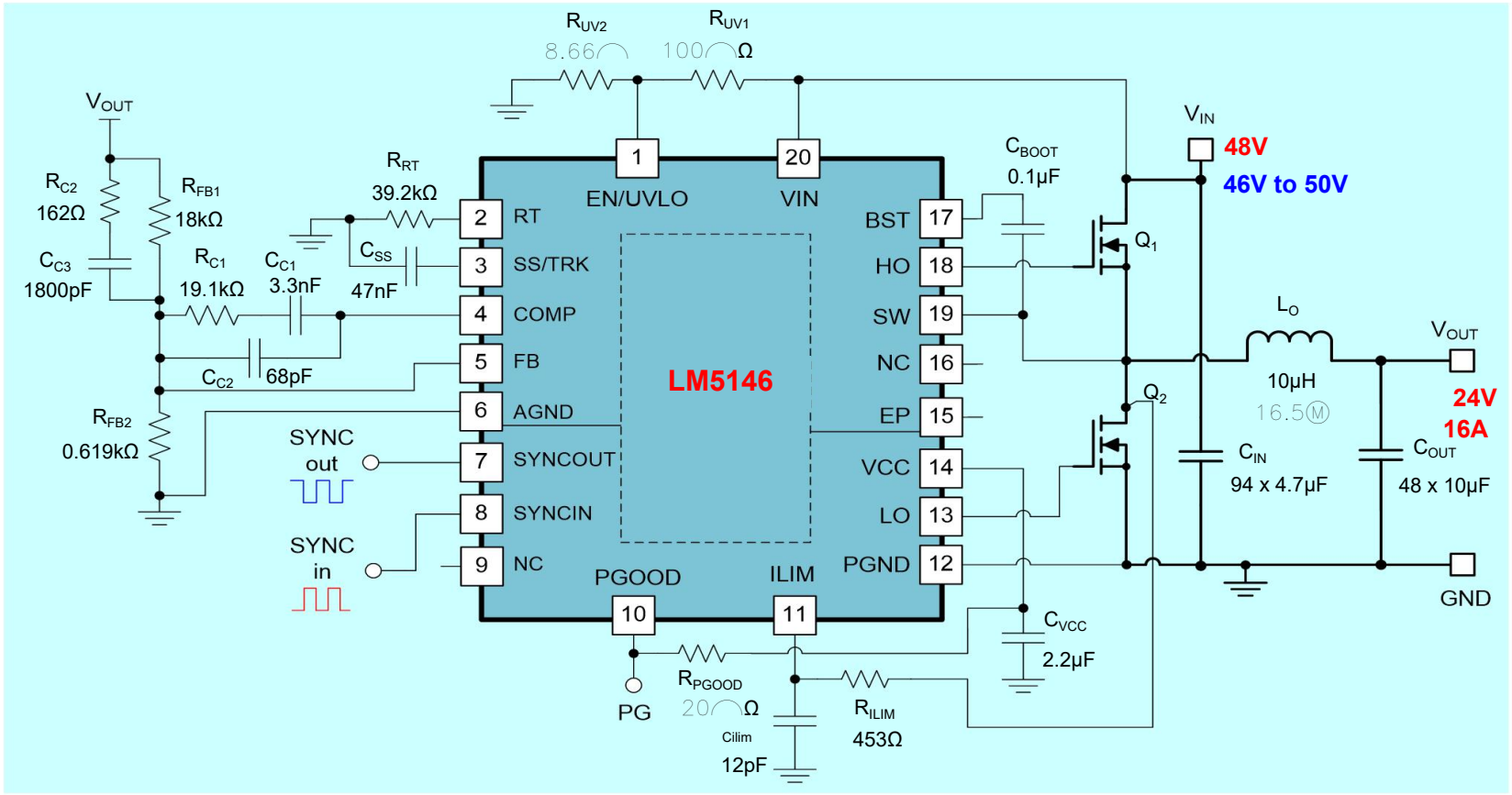
Low-Side MOSFET (Q_2) Specifications	TPH4R008NH	
On-State Resistance, $R_{DS(on)}$	**3.3**	mΩ
Total Gate Charge, Q_G	**59**	nC
Output Charge, Q_{OSS}	**12**	nC
Output Capacitance, C_{OSS}	**890**	pF
Body Diode Forward Voltage, V_{BD2}	**0.9**	V
Body Diode Recovery Charge, Q_{RR}	**50**	nC
Thermal Resistance, θ_{JA}	**40**	°C/W

Step 9: IC Power Loss

External VCC Appli

IC Power Dissipation	0.32	W
IC Junction Temperature Rise (est)	16.1	°C





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

VIN = 48V, VOUT = 24V, IOUT = 16A, Fsw = 255kHz, Current Limit = 30A

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}	3300pF	Capacitor, Ceramic, 3300pF, 16V, X7R, 10%	0402	Std	Std
1	C_{C2}	68pF	Capacitor, Ceramic, 68pF, 50V, NP0, 5%	0402	Std	Std
1	C_{C3}	1800pF	Capacitor, Ceramic, 1800pF, 50V, NP0, 5%	0402	Std	Std
1	C_S	12pF	Capacitor, Ceramic, 12pF, 100V, X7R, 20%	0603	Std	Std
44	C_{IN}	4.7µF	Capacitor, Ceramic, 4.7µF, 100V, X7S, 10%	1210	Std	Std
48	C_{OUT}	10µF	Capacitor, Ceramic, 10µF, 50V, 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_O	10µH	Inductor, 10µH, 16.5mΩ, >39A	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}	19.1k	Resistor, Chip, 19.1kΩ, 1/16W, 1%	0402	Std	Std
1	R_{C2}	162	Resistor, Chip, 162Ω, 1/16W, 1%	0402	Std	Std
1	R_{ILIM}	453	Resistor, Chip, 453Ω, 1/16W, 1%	0805	Std	Std
1	R_{RT}	39.2k	Resistor, Chip, 39.2kΩ, 1/16W, 1%	0402	Std	Std
1	R_{FB1}	18k	Resistor, Chip, 18kΩ, 1/16W, 1%	0402	Std	Std
1	R_{FB2}	0.619k	Resistor, Chip, 0.619kΩ, 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}	8.66k	Resistor, Chip, 8.66kΩ, 1/16W, 1%	0402	Std	Std
1	R_{VIN}	2.2	Resistor, Chip, 2.2Ω, 1/16W, 1%	0402	Std	Std
1	**U_1**	**LM5146**	**IC, LM5146 PWM Controller, 5.5V-100V Input**	**VQFN-20**	**LM5146RGYR**	**TI**

Total Solution Size (I

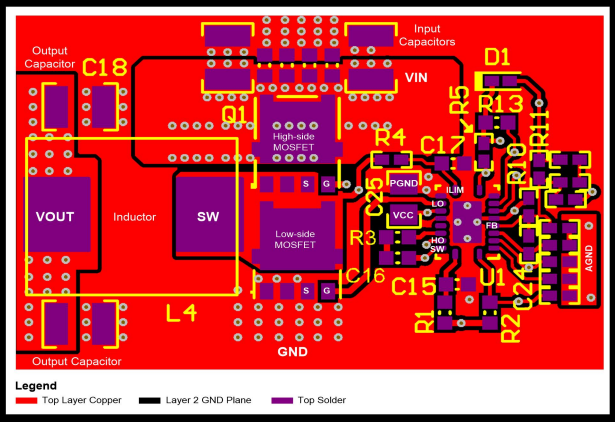
NOTES:

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

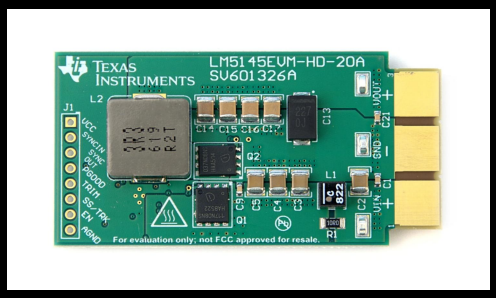
** Effective output capacitance should be appropriately **derated** for applied voltage and temperature, particularly with **ceramics** **

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

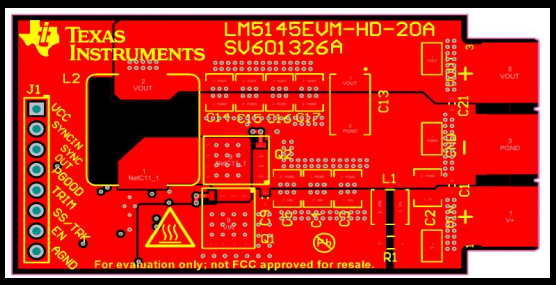
LM5146-Q1-EVM12V

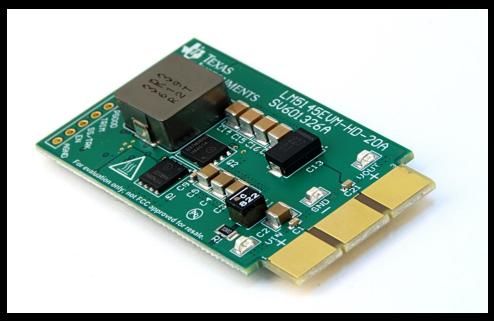


LM5145EVM-HD-20A PCB Layout



Top Layer





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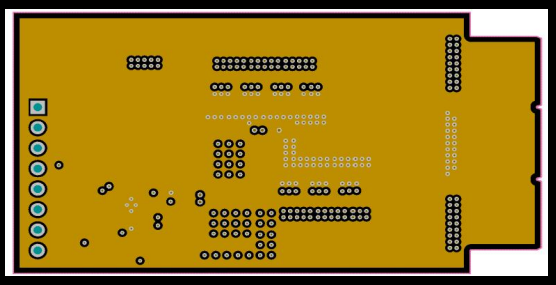

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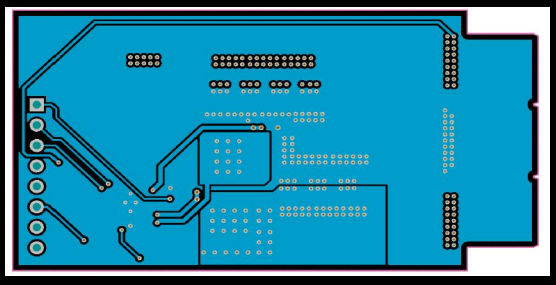

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