LM(2)5117 Wide Input Range Synchronous Buck Controller with Analog Current Monitor

Revision: 09/20/2013 ver 1.5 by Eric Lee

Note: The components calculated in this worksheet are reasonable starting values for a design using the LM(2)5117. They are not optimized for any particular performance attribute. The most recent version of this excel file can be found in the product folder of the part at national.com. Make sure to input or select values in all of the blue shaded cells even if a value already exists in that cell. Blue shaded cells require input from user. Do not over write equations in cells, as this may result in calculation errors.
To activate all functions, **Macro should be enabled and Analysis Toolpak should be added in.**

Step 1 - General Requirements

Max input voltage, $V_{IN(MAX)}$ [V]	55
Min input voltage, $V_{IN(MIN)}$ [V]	35
Target output voltage, V_{OUT} [V]	30
Full load current , I_{OUT} [A]	5
Recommended IC	LM5117

Step 2 - Switching Frequency

Switching frequency, F_{SW} [kHz]	80
Max duty cycle, D_{MAX}	0.86
Min duty cycle, D_{MIN}	0.55
RT resistor, R_T [kΩ]	64.2

Step 3 - Inductor Value

Max ripple current % of full load current [%]	30
Recommended output inductor, L_O [uH]	113.6
User selection, L_O [uH]	100.0
Min load current in CCM @$V_{IN(MAX)}$ [A]	0.9
Min load current in CCM @$V_{IN(MIN)}$ [A]	0.3

Step 4 - Current Limit

Target (% beyond full load @$V_{IN(MIN)}$)	30
K Factor	1
Recommended current sense resistor , R_S [Ω]	0.0120
User selection , R_S [Ω]	0.01
Max output current @$V_{IN(MIN)}$ [A]	8.5
Max output current @$V_{IN(MAX)}$ [A]	9.1
Peak inductor current with output hard short [A]	12.1
Full load power dissipation of R_S @$V_{IN(MAX)}$, P_{RS} [W]	0.11

Step 5 - Ramp Configuration

Ramp capacitor, C_{RAMP} [pF]	1000
Ramp resistor, R_{RAMP} [kΩ]	1000.0

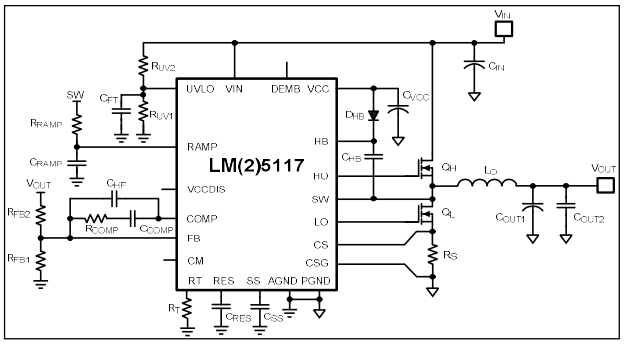
Step 6 -VIN UV Shutdown

Desired minimum start-up voltage, $V_{IN(STARTUP)}$ [V]	9.5
Desired UV hysteresis, V_{HYS} [V]	2
R_{UV2} [kΩ]	100
R_{UV1} [kΩ]	15.15
Max C_{FT} (optional) [pF]	238

Step 7 -NMOS gate charge

High-side MOSFET Qg @V_{VCC} (nC)	4.3
Low-side MOSFET Qg @V_{VCC} (nC)	108
Gate charging current [mA]	9

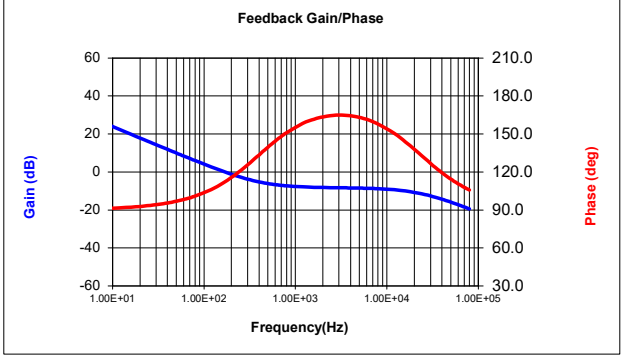
TYPICAL APPLICATION CIRCUIT



LIST OF COMPONENTS AND PARAMETERS

Components	Description	Value	Min Rating
IC	Buck controller	LM5117	
C_{IN}	Input capacitor	2µF	55V
C_{OUT1}	Output capacitor	220µF	30V
C_{OUT2}	Output capacitor	2µF	30V
C_{VCC}	VCC capacitor	0.75µF Min	10V
C_{HB}	Bootstrap capacitor	0.03µF Min	9V
C_{SS}	Softstart capacitor	0.13µF	6V
C_{RES}	Restart capacitor	2.00µF	6V
C_{RAMP}	RAMP capacitor	1000pF	16V
C_{COMP}	Compensation Capacitor	10.00nF	6V
C_{HF}	Compensation Capacitor	180pF	6V
C_{FT}	Optional filter capacitor	238pF Max	16V
R_{UV1}	UVLO divider resistor	15.15kΩ	1/16W
R_{UV2}	UVLO divider resistor	100.0kΩ	1/8W
R_{FB1}	Feedback divider resistor	2740Ω	1/16W
R_{FB2}	Feedback divider resistor	100000Ω	1/16W
R_S	Current sense resistor	0.0100Ω	0.11W
R_T	Oscillator timing resistor	64.2kΩ	1/16W
R_{RAMP}	RAMP resistor	1000kΩ	1/8W
R_{COMP}	Compensation Resistor	39.00kΩ	1/16W
L_O	Output inductor	100.0µH	9A~12A
D_{HB}	Bootstrap diode	1A	25V
Q_H and Q_L	NMOS		55V

FREQUENCY RESPONSE



Step 8 -Bootstrap capacitor and VCC capacitor

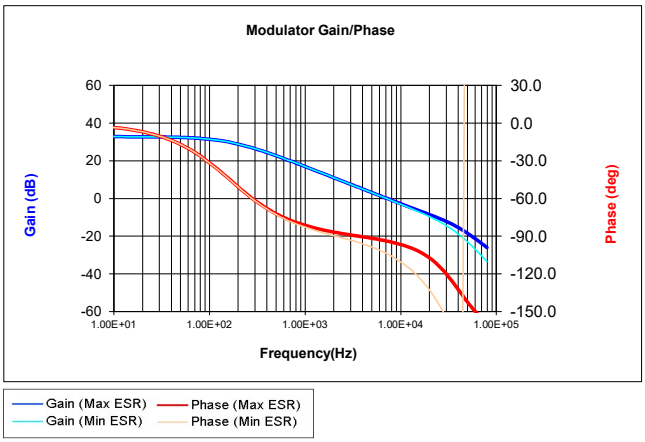
Min C_{HB} [µF]	0.03
Min C_{VCC} [µF]	0.75

Step 9 -Output Capacitors

Output capacitor with ESR, C_{OUT1} [µF]	220
Ceramic output capacitor, C_{OUT2} [µF]	2
Max ESR of C_{OUT1}, R_{ESR} [Ω]	0.02
Effective total C_{OUT} [µF]	222
Peak-Peak output voltage ripple @VIN(MAX) [mV]	36
RMS output current ripple [A]	0.5

Step 10 -Input Capacitors

Input capacitor(ceramic), C_{IN} [µF]	2
Peak-Peak input voltage ripple [V]	7.81
RMS input current ripple [A]	2.5



Step 11 -Soft Start

Desired soft-start time, T_{SS} [ms]	10
Soft-start capacitor, C_{SS} [µF]	0.125

Step 12 - Hiccup mode restart time

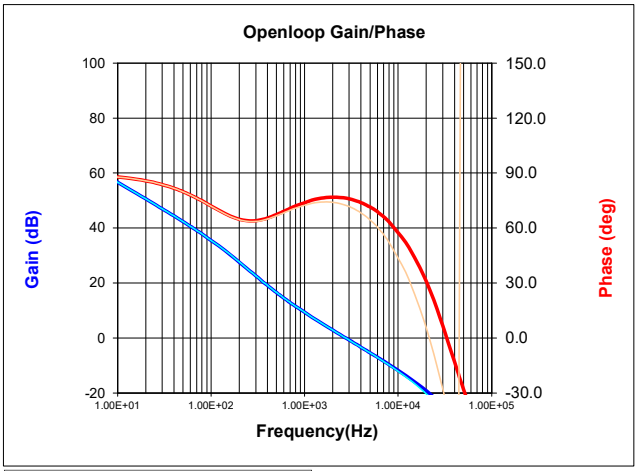
Desired restart time, T_{RES} [ms]	250
Restart capacitor, C_{RES} [µF]	2.00

Step 13 - Feedback Resistors

R_{FB2} [Ω]	100000
R_{FB1} [Ω]	2740

Step 14 - Compensation Network

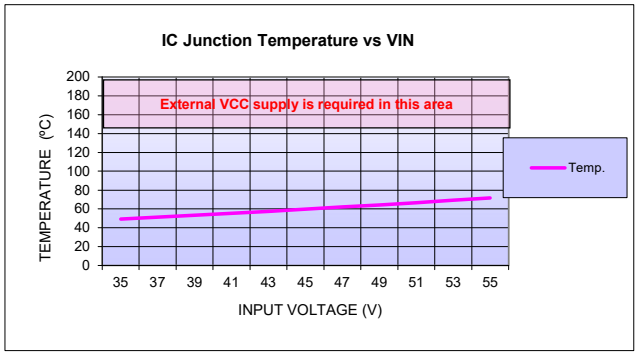
Openloop crossover frequency, F_{CROSS} [kHz]	2.8
R_{COMP} [Ω]	39036
User selection, R_{COMP} [Ω]	39000
C_{COMP} [pF]	12000
User selection, C_{COMP} [pF]	10000
User selection, C_{HF} [pF]	180



Step 14 - Controller Power Dissipation

Ambient temperature [ºC]	25
External VCC Select "**Yes**" or "**No**"	No
Typical High-side MOSFET Cgs (pF)	7920
Typical High-side MOSFET Cgd (pF)	2090
Typical Low-side MOSFET Cgs (pF)	1600
Typical Low-side MOSFET Cgd (pF)	360
Total power loss @$V_{IN(MAX)}$ [W]	1.2
IC temperature @$V_{IN(MAX)}$ [ºC]	72

IC TEMPERATURE



PRINT

Simulate This Design Using WEBENCH® Tools

To further optimize the design, please visit:
http://webench.national.com/
Optimization graphs, charts, and electrical/thermal simulation capabilites are available.
Note: The WEBENCH recommended BOM may be different than what is recommended in this spreadsheet.