$\frac{R_{uv1}}{R_{uv1} + R_{uv2}}$

MOSFET & Driver

Bootstrap Capacitor

MOSFET Total Gate Charge: $Q_G = 44{,}5\,nC$ (typ) $= 67\,nC$ (max) $\begin{bmatrix} V_{DS} = 40V \\ V_{GS} = 10V \\ I_D = 10A \end{bmatrix}$

$Q_G = 33{,}5\,nC$ (typ), $51\,nC$ (max) $\begin{bmatrix} V_{DS} = 40V \\ V_{GS} = 7{,}5V \\ I_D = 10A \end{bmatrix}$

$$C\,(F) = Q\,(C) \div U\,(V) = 47nC \div 12V = 3{,}91\overline{66}\,nF$$

$C_{Boot} = C \times 10$ (rule of thumb)
$= 39{,}1\overline{66}\,nF$
$\approx 39\,nF$ (next best value in E12 table)
$\approx 47\,nF$ (one size larger for when MOSFET is const. turned on in Buck-Boost mode)

Gate Resistor

IR2184 Output Rating:
$I_{O+} = 1{,}4A$ (typ)
$= 1{,}9A$ (max)
$I_{O-} = 1{,}8A$ (typ)
$= 2{,}3A$ (max)

$R = 5{,}6\,\Omega$

$I = 12V / 5{,}6\Omega = 2{,}1439\,A$ ⇒ in spec enough for me ¯_(ツ)_/¯

LM5161

~~Switching Frequency~~

~~Given:~~ $V_{in} =$ ~~ca.~~ $5V - 100V$
$F_{SW} =$ ~~ca.~~ $200kHz - 1MHz$ ~~is desirable~~
$R_{on} = 100k\Omega - 300k\Omega$ ~~as per datasheet examples~~
$V_{out} = 4V$

$F_{SW} = \frac{V_{OUT}}{1{,}008 \times 10^{-10} \times R_{ON}}$ $[R_{on} = 100\,k\Omega]$
$= 396{,}825\,kHz$

Feedback

$$V_{out} = \frac{V_{ref} \times (R_{FB2} + R_{FB1})}{R_{FB1}} \qquad \begin{bmatrix} V_{out} = 4V \\ V_{ref} = 2V \end{bmatrix}$$

$$\frac{R_{FB2}}{R_{FB1}} = \frac{V_{out}}{V_{ref}} - 1 = \frac{1}{1} \Rightarrow R_{FB1} = R_{FB2} = 5k\Omega$$

(just a random standard value I chose)

Switching Frequency

$$\cancel{F_{SW,max}(@V_{in,min}) = \frac{V_{out}}{V_{in,min} \times T_{OFF,min}(ns)} = \frac{4V}{5V \times 200ns} = 4\,MHz}$$??? WTF $\begin{bmatrix} T_{OFF,min} = 170\text{-}200ns \\ V_{in,min} = 5V \\ V_{out} = 4V \end{bmatrix}$

Datasheet might have wrong formula

$F_{SW,max} = 1 \div (\text{Period})$
$= 1 \div ((1 \div (1 - \frac{V_{out}}{V_{in,min}})) \times T_{off,min})$ } my own formula
$= 1\,MHz$

$F_{SW} = \frac{V_{OUT}}{1{,}008 \times 10^{-10} \times R_{ON}}$ $[R_{on} = 100\,k\Omega]$
$= 396{,}825\,kHz$

Inductor Selection

$$L_{min} = \frac{V_o \times (V_{in,max} - V_o)}{V_{in,max} \times F_{SW} \times I_{o,max} \times 0{,}4}$$

$V_o = 4V$
$V_{in,max} = 100V$
$I_{o,max} = 1A$

$= 24{,}1920\,\mu H$

! Allow for inductance tolerances & inductor saturation: choose a bit higher value !

$I_{L\,peak} = I_{o,max} + \frac{\Delta I_{L\,max}}{2}$
$= 1{,}2222\,A < 1{,}6A$ ✓

MOSFETs can only do 1,6A

$\Delta I_L = \frac{(V_{in,max} - V_{out}) \times D}{f_s \times L}$
$= 444{,}4\overline{44}8\,mA$

⇑ formula pulled from another TI datasheet

D = Dutycycle
f_s = Switching frequency
L = inductance
$\Delta I_{L,max}$ = peak to peak inductor current ripple at $V_{in,max}$ and $V_{in,min}$

$D = \frac{V_{out}}{V_{in,max} \times \eta}$ η = efficiency ≈ 90%
$= 4{,}\overline{44}\,\%$

Output Capacitor

$C_{out} = \frac{\Delta I_{L,max}}{8 \times F_{SW} \times \Delta V_{o,ripple}}$
$= 34{,}0299\,mF$?WTF???
$= 14{,}0001\,\mu F$ $[\Delta V_{ripple} = 10mV]$

!!! use X7R with high enoug voltage rating

$\Delta V_{o,ripple} = (I_{L\,peak} \times R_L \times T_s)/2$
$= 155{,}5402\,nV$? frfr???

I_L = Inductorstrom
R_L = Inductor resistance = $101m\Omega$ (max)
T_s = Period = $1/f_{SW}$

⇑ formula from Gemini AI

Series Ripple Resistor

Only neccesary when FPWM pin is pulled high and I'm not gonna do that cuz I'm lazy B)

VCC & Bootstrap Capacitor

$C_{BST} = 10nF$
$C_{VCC} = 1\mu F$

!!! It's recommended to add a resistor (>3Ω) to C_{BST} to protect the VCC-BST diode during full load transient operation !!!

Input Capacitor

$$C_{IN} = \frac{I_{o,max} \times D \times (1-D)}{\Delta V_{in,ripple} \times F_{SW}} = 2{,}1\,\mu F \qquad \begin{bmatrix} D = 0{,}5 \\ \Delta V_{ripple} = 300mV \end{bmatrix}$$

⇒ just use 2x 2.2µF Caps bro

!!! divide Cin into 2 caps & add a third 0,1µF to filter out any noise as close to PGND & VIN as possible !!!

Soft Start Capacitor

SS won't be needed
a minimun of $C_{SS} = 1nF$ is required
to stabilize the trans-conductance error amplifier

EN/ UVLO Resistor

$V_{IN(HYS)} = I_{UVLO(HYS)} \times R_{UV2}$
$R_{UV2} = V_{IN(HYS)} \div I_{UVLO(HYS)}$
$= 0{,}5V \div 20\mu A$ (typ)
$= 25\,k\Omega$

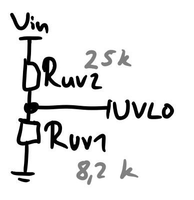
$V_{in(HYS)} = 0{,}5V$

$V_{in,UVLO(rising)} = V_{UVLO(TH)} \times (1 + \frac{R_{UV2}}{R_{UV1}})$
$= 5{,}0205\,V$

$V_{in,UVLO(rising)}$ = rising threshhold ≈ 5V

$V_{UVLO(TH)}$ = UVLO Threshhold = 1,24V

Example:



simple voltage divider formula:

$$V_{out} = \frac{R_{uv1}}{R_{uv1} + R_{uv2}} \times V_{in}$$

$$\frac{V_{out}}{V_{in}} = \frac{R_{uv1}}{R_{uv1} + R_{uv2}}$$

$$\frac{1{,}24V}{5} = \frac{x}{x + 25k\Omega}$$

$$\Rightarrow x = R_{uv1} = 8244{,}681\,\Omega \approx 8{,}2\,k\Omega$$