FAIRCHILD

SEMICONDUCTOR ™

RC5051 Converter Design Template

Version 3.0 of 3/5/'98

RC5051 Design Template

The RC5051 Design Template is a design tool that enables you to calculate the input and output capacitor requirements for Pentium converters based on Fairchild's RC5051 controller.

The only inputs required to use this tool appear on the "Input" page. All of these parameters are determined either by the system parameters or by the type of processor being used.

On the "OutCaps" page, the worst case transient is calculated, based on the data entered on the "Input" page; this information is then used to determine the ESR required of the output capacitors. The number of capacitors using a common style is calculated as a suggestion.

On the "GraphTrans" page, a graphical representation of the transient response of the converter is shown.

On the "InCaps" page, the maximum input ripple current is calculated, based again on the input data. This information is used to calculate the RMS ripple current required to be supported by the input caps. The number of capacitors using a common style is calculated as a suggestion.

On the "Inductor" page, the approximate inductor value is calculated, based on allowing a peak ripple current of one-tenth the output current.

On the "SenseRes" page, the maximum value of the sense resistor is selected; using a value larger than this may cause the converter to turn off inappropriately, while a smaller value will allow a higher output current in the event of a fault.

On the "MOSFETs" page, the power dissipation in the MOSFETs is estimated, based on continuous operation at maximum current. This number is then used to calculate the required thermal resistance of a heatsink, and a typical heatsink is suggested. Note that the calculation is very approximate, and a smaller heatsink may work very well!

On the "Summary" page, the calculated components are summarized.

User Inputs

Input Voltage	5	V
Output Voltage	2.000	V
Maximum Load Current	12.6	A
Switching Frequency	300	kHz
Maximum Ambient Temperature	70	C
ESR of Output Caps, Each	44	mΩ
Ripple Rating of Input Caps, Each	2	A	(at 40°C)
Tolerance of Sense Resistor	5	%
Maximum Ambient Temperature	40	°C

Output Capacitor Calculation

Positive Transient Limit (Current Changes from Max to Min)

Transient Limit	100 mV
Initial Setpoint Tolerance	20 mV
Factory Trim Offset	20 mV
Load Regulation	-30 mV
Temp. Co.	11 mV
TOTAL	79 mV

Negative Transient Limit (Current Changes from Min to Max)

Transient Limit	-100 mV
Initial Setpoint Tolerance	-20 mV
Factory Trim Offset	20 mV
Load Regulation	0 mV
Temp. Co.	0 mV
TOTAL	-100 mV
ESR Required	6.27 mΩ
No. of Output Capacitors	7

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ESR Transient
(Vin=5V, L=1uH, C=9000uF)

Vin=5V

(3A/us)*t

L

Vout=2V

C

15A=I

Vout=2V

ESL*dI/dt

ESR*I

(3V/1uH)*t

1900mV

ESR*I

T2   T3

dT=10us

I=15A

dI/dt=30A/usec

T1=0.5usec
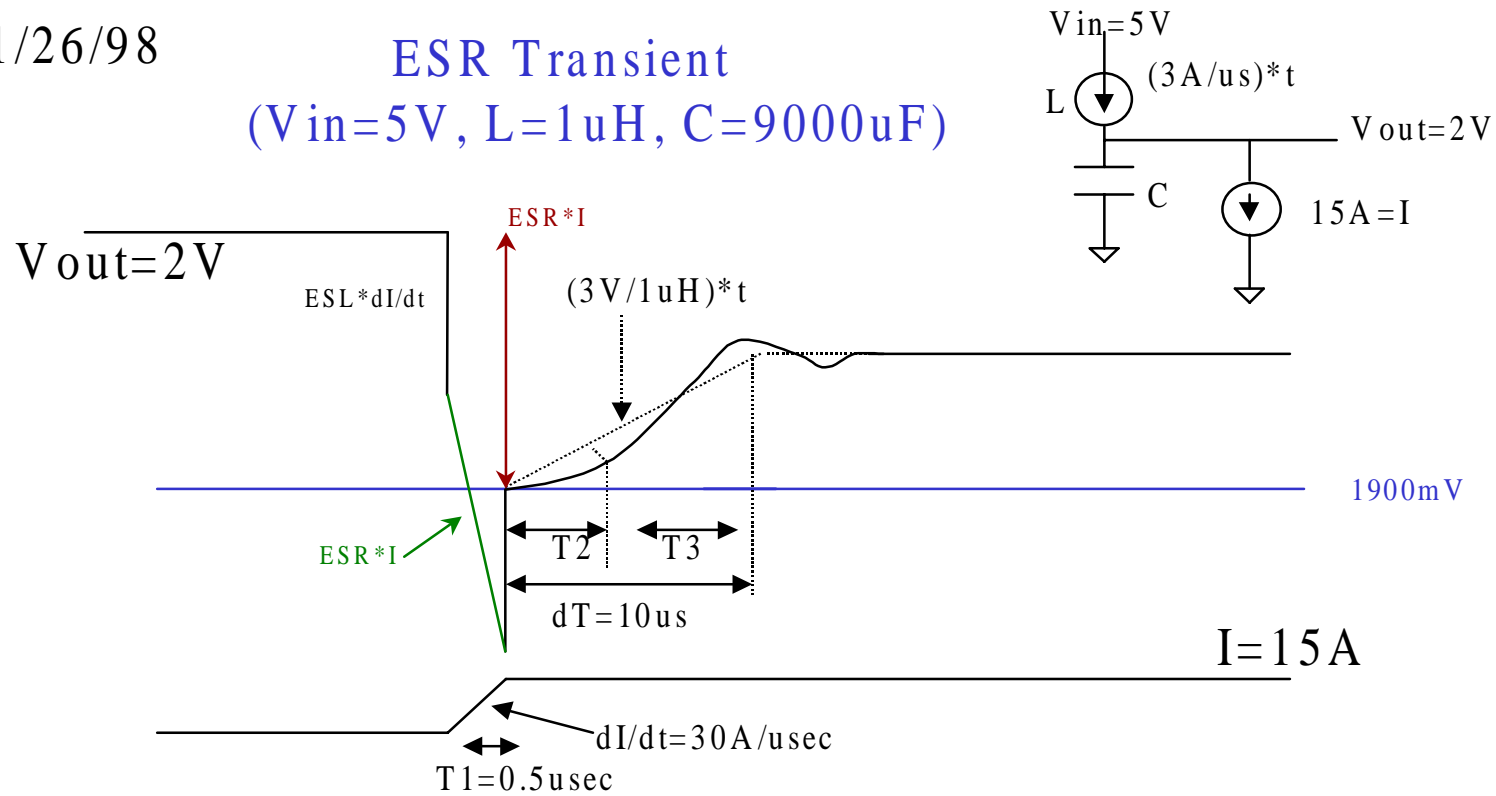
T1= load transient time=I/(dI/dt)=15A/(30A/us)=0.5us
T2=Cout end discharge time= I/[(Vin-Vout)/L=15A/(3A/us)=5us
T3=Output recovery time=Esr*I/ESR*(dIout/dt)=
                                    90mV/(18mV/usec)=5us

Vin-Vout/L=dIout/dt=>T2=T3

dT=T2+T3=(2I)/(dI/dt)=10us

dVc=Qc/C= (15A/2)*5us/9KuF=4.2mV neglectable
dVesr=6mOhm x 15A=90mV
dVout/dt=(dIout/dt)*ESR=(3A/us)*6mOhm=18mV/usec

Note: in ESR dominated apps verify that dVc<<ESR*I
                    => C>dT/4C

Input Capacitor Calculation

Duty Cycle   0.4

Average Output Current   9.45 A

RMS Current   4.63 A

No. of Capacitors   3

Inductor Calculation

Inductance Value   1.6 μH

Based on allowing the peak ripple current to be
10% of the output current.

Sense Resistor Calculation

Peak Current   13.9 A

Maximum Value of Sense Resistor   6.4 mΩ

MOSFET Heatsink Calculation

Upper MOSFET	FDP7030L	FDP6030L	FDP6030L	FDP603AL
Rds(on) (mΩ)	10	20	20	36
tr (nsec)	340	150	150	102
tf (nsec)	110	17	17	80
Lower MOSFET	**FDP7030L**	**FDP6030L**	**FDP7030L**	**FDP6030L**
Rds(on) (mΩ)	10	20	10	20
Load Current (A)	12.6	12.6	12.6	12.6
Tamb,max (C)	40	40	40	40
Tcase,max (C)	100	100	100	100
Freq (kHz)	300	300	300	300
Vin (V)	5	5	5	5
Vout (V)	2.0	2.0	2.0	2.0
Duty Cycle	0.4	0.4	0.4	0.4
Power, Upper (W)	5.18	3.42	3.42	5.04
Power, Lower (W)	1.38	2.77	1.38	2.77

For TO-220s:

Heatsink, Upper (C/W)	12	18	18	12
Suggested Heatsink: (Aavid)	Fail	#581101	#581101	Fail
Heatsink, Lower (C/W)	43	22	43	22
Suggested Heatsink: (Aavid)	#591202	#581101	#591202	#581101

For TO-263a:

Must be mounted with minimum recommended pad size

Summary of Results

Output Capacitors   7

Input Capacitors   3

Inductor   1.6   μH

Maximum Sense Resistor Value   6.4   mΩ

High-side MOSFET   FDP6030L

High-side MOSFET Heatsink   #581101   (Aavid)

Low-side MOSFET   FDP6030L

Low-side MOSFET Heatsink   #581101   (Aavid)