RC5051 DC-DC Converter

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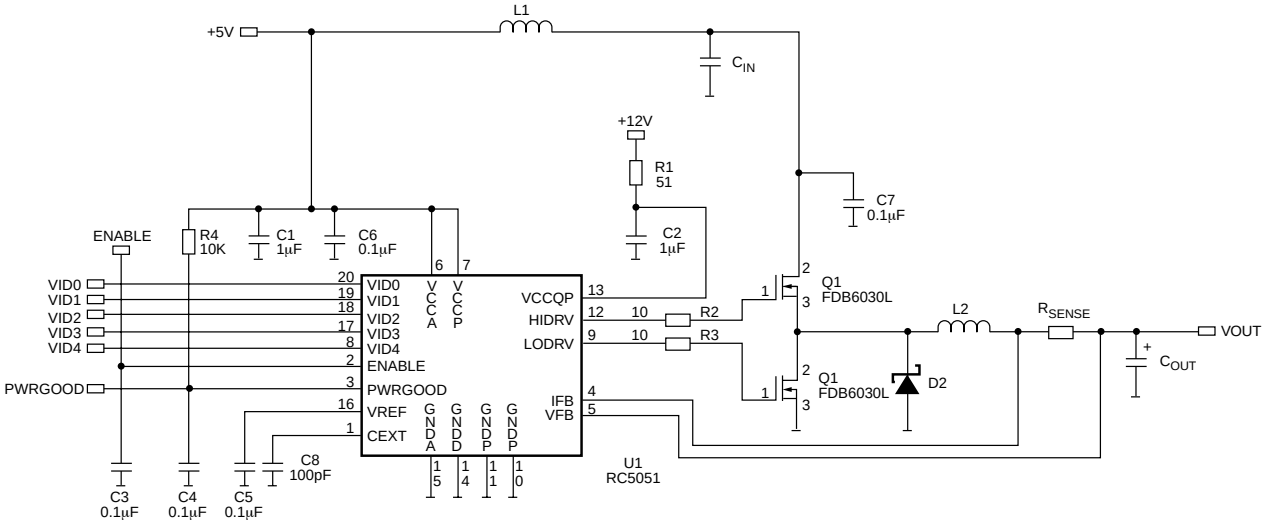


RC5051 Application Bill of Materials for Intel Pentium II Processors

Item #	Part No.	Manufacturer	Quantity	Ref. Des.	Description
1	-	Any	2	C1-2	1μF +80/-20% 16V Ceramic Capacitor
2	-	Any	5	C3-7	100nF +80/-20%, 25V Z5U Ceramic Capacitor
3	-	Any	1	C8	100pF ±5%, 50V C0G Ceramic Capacitor
4	6MV1500GX	Sanyo	8	C_{OUT}	1500μF, 6.3V, 44mΩ Aluminum Capacitor
5	10MV1200GX	Sanyo	3	C_{IN}	1200μF, 10V, 1.25A Aluminum Capacitor
6	-	Any	1	R1	51Ω ±5%, 1/10W Resistor
7	-	Any	2	R2-3	10Ω ±5%, 1/10W Resistor
8	-	Any	1	R4	10KΩ ±5%, 1/10W Resistor
9	RC10-58	Fairchild	1	R_{SENSE}	5.8mΩ, Constantin Wire Resistor
10	SS32		1	D1	3A Schottky Diode
11	FDB6030L	Fairchild	2	Q1-2	30V, 20mΩ Logic Level MOSFET
12	-	Any	1	L1	2.3μH, I_{SAT} > 10A, R < 8mΩ Inductor
13	-	Any	1	L2	2.3μH, I_{SAT} > 15A, R < 5mΩ Inductor
14	RC5051	Fairchild	1	U1	PWM Controller

Selection of MOSFETs for RC5051 Application for Motherboard with Intel Pentium II CPUs

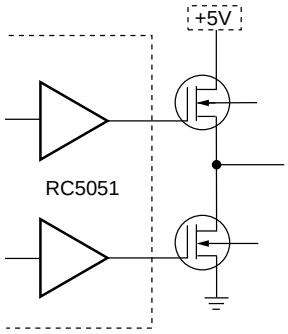
Fairchild MOSFETs for Desktop Motherboard DC-DC Converter Application

Fairchild Part #	$R_{DS(ON)}$ Max @V_{GS}=10V, I_D=26A	$R_{DS(ON)}$ Max @V_{GS}=5V, I_D=21A	Competitive Device	Relative Price	High Volume Budgetary Cost
FDP603AL/ FDB603AL	22 mΩ	40 mΩ	IRL3303	$	$0.30-$0.35
FDP6030L/ FDB6030L	13.5 mΩ	20 mΩ	IRL3103	$$	$0.40-$0.45
FDP6035L/ FDB6035L	11 mΩ	18 mΩ	2SK2959	$$$	$0.55-$0.60
FDP7030L/ FDB7030L	7 mΩ	10 mΩ[1]	IRL2203	$$$$	$0.75-$0.80

Note: 1. V_{GS}=4.5V

MOSFET Selection Options

Option 3 is the best choice for Cost and Performance considerations



	Option 1	Option 2	Option 3	Option 4
Upper MOSFET	FDB7030L	FDB6030L	FDB6030L	FDB603AL
P_D	6.43W	5.06W	5.06W	7.85W
Case Temp[1]	96°C	94°C	93°C	103°C

	Option 1	Option 2	Option 3	Option 4
Upper MOSFET	FDB7030L	FDB7030L	FDB6030L	FDB6030L
P_D	1.29W	1.29W	2.58W	2.58W
Case Temp[1]	81°C	89°C	89°C	99°C

Budgetary Cost	$1.50	$1.15	$0.80	$0.70

Note: 1. Case temperature of the one MOSFET may be affected by the other MOSFET since they are physically adjacent to each other. Conducted using I_{LOAD}=14.2A steady state.

Calculation[1] of the MOSFET Power Dissipation & Heat Sink Requirements For 400MHZ Pentium II Deschutes Processors (ICC_{CORE}=12.6A)

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:	#581201	#576802	#576802	#581201
(Aavid)				
Heatsink, Lower (C/W)	43	22	43	22
Suggested Heatsink:	None	#576802	None	#576802
(Aavid)				
For TO-263a: Must be mounted with minimum recommended pad size				

Note: 1. Please note that the “Suggested Heatsink” Part Number is not calculated, and must be entered manually. More details on this embedded spreadsheet calculation are available upon request along with an application bulletin, AB-8, “Selection of MOSFETs in switch mode DC-DC converters”. Please send e-mail to rlenk@fairchildsemi.com for request.

Calculation[1] of the MOSFET Power Dissipation & Heat Sink Requirements For 300MHZ Pentium II Processor (ICC_{CORE}=14.2A)

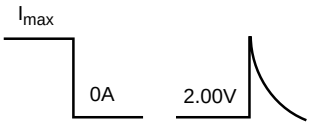
Upper MOSFET	**FDP7030L**	**FDP6030L**	**FDP6030L**	**FDP603AL**
Rds(on) (mΩ)	10	20	20	36
tr (nsec)	340	150	150	102
tf (nsec)	110	17	17	80
Upper MOSFET	**FDP7030L**	**FDP6030L**	**FDP6030L**	**FDP603AL**
Rds(on) (mΩ)	10	20	10	20
Load Current (A)	14.2	14.2	14.2	14.2
Tamb, max (C)	40	40	40	40
Tcase, max (C)	100	100	100	100
Freq (kHz)	300	300	300	300
Vin (V)	5	5	5	5
Vout (V)	2.8	2.8	2.8	2.8
Duty Cycle	0.56	0.56	0.56	0.56
Power, Upper (W)	6.43	5.06	5.06	7.85
Power, Lower (W)	1.29	2.58	1.29	2.58
For TO-220s:				
Heatsink, Upper (C/W)	9	12	12	8
Suggested Heatsink:	#581201	#581201	#581201	#513201
(Aavid)				
Heatsink, Lower (C/W)	47	23	47	23
Suggested Heatsink:	None	#576802	None	#576802
(Aavid)				
For TO-263a: Must be mounted with minimum recommended pad size				

Note: 1. Please note that the “Suggested Heatsink” Part Number is not calculated, and must be entered manually. More details on this embedded spreadsheet calculation are available upon request along with an application bulletin, AB-8, “Selection of MOSFETs in switch mode DC-DC converters”. Please send e-mail to rlenk@fairchildsemi.com for request.

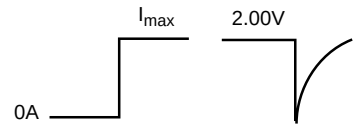
Calculation for number of Output Capacitors required for the DC-DC Converters

$$ESR = \frac{\Delta V}{\Delta I} = \frac{\text{Transient Limit} - (\text{Initial Set Point Tolerance} + \text{Trim Offset} + \text{Load Regulation} + \text{Vout Temp Co})}{I_{max}}$$

For 400MHz Pentium II Deschutes Processor, using Sanyo 6.3V 1500µF caps (6MV1500GX), with ESR per Cap =44mΩ



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

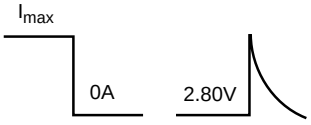


Transient Limit	-100mV
Initial Set Point Tolerance	-20mV
Factory Trim Offset	+20mV
Load Regulation	0
Temp. Co.	0
TOTAL	-100mV

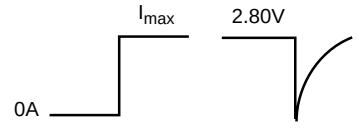
$$ESR = \frac{79mV}{12.6A} = 6.27m\Omega$$

$$\text{No. of Capacitors} = \frac{\text{ESR per Cap}}{ESR} = \frac{44m\Omega}{6.27m\Omega} = 7.01 \Rightarrow 7caps$$

For 300MHz Pentium II Klamath Processor, using Sanyo 6.3V 1500µF caps (6MV1500GX), with ESR per Cap =44mΩ



Transient Limit	+130mV
Initial Set Point Tolerance	+28mV
Factory Trim Offset	+25mV
Load Regulation	-30mV
Temp. Co.	+11mV
TOTAL	96mV



Transient Limit	-130mV
Initial Set Point Tolerance	-28mV
Factory Trim Offset	+25mV
Load Regulation	0
Temp. Co.	0
TOTAL	-127mV

$$ESR = \frac{96mV}{14.2A} = 6.76m\Omega$$

$$\text{No. of Capacitors} = \frac{\text{ESR per Cap}}{ESR} = \frac{44m\Omega}{6.76m\Omega} = 6.51 \Rightarrow 7caps$$

Calculation for Input Capacitors required for the DC-DC Converter

$I_{rms} = I_{avg}\sqrt{DC - DC^2}$

where $DC = V_{out} / V_{in}$

and $I_{avg} = I_{max} * 0.75$

DC = 2.0V / 5.0V = 0.4

For 400MHz Pentium II Deschutes Processor,

$I_{rms} = (12.6A^* \times 0.75)\sqrt{0.4 - 0.4^2} = 4.6A$

Number of Capacitors*= I_{rms} / Ripple Current Rating

Number of Capacitors = 4.6A / 2.0A = 2.3 ⇒ 3 caps

Capacitor maximum ripple current rating:

For example, Sanyo, 1200µF 10V (10MV1200GX)

Ripple Current Rating @ 100kHz, 105°C	= 1.2A
Derating to <65°C	x 1.6
Ripple Current Rating @ 65°C	2.0A

For 300MHz Pentium II Klamath Processor,

$I_{rms} = (8.7A)\sqrt{0.4 - 0.4^2} = 4.3A$

Number of Capacitors = 4.3A / 2.0A = 2.1 ⇒ 3 caps

* Caution! Use of less than this number of capacitors will degrade the life expectancy of the converter. Other processor speeds may require a different number of capacitors.

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