<u>**Design of 12VDC Linear Power Supply Unit for Stepper Motor Supply**</u>

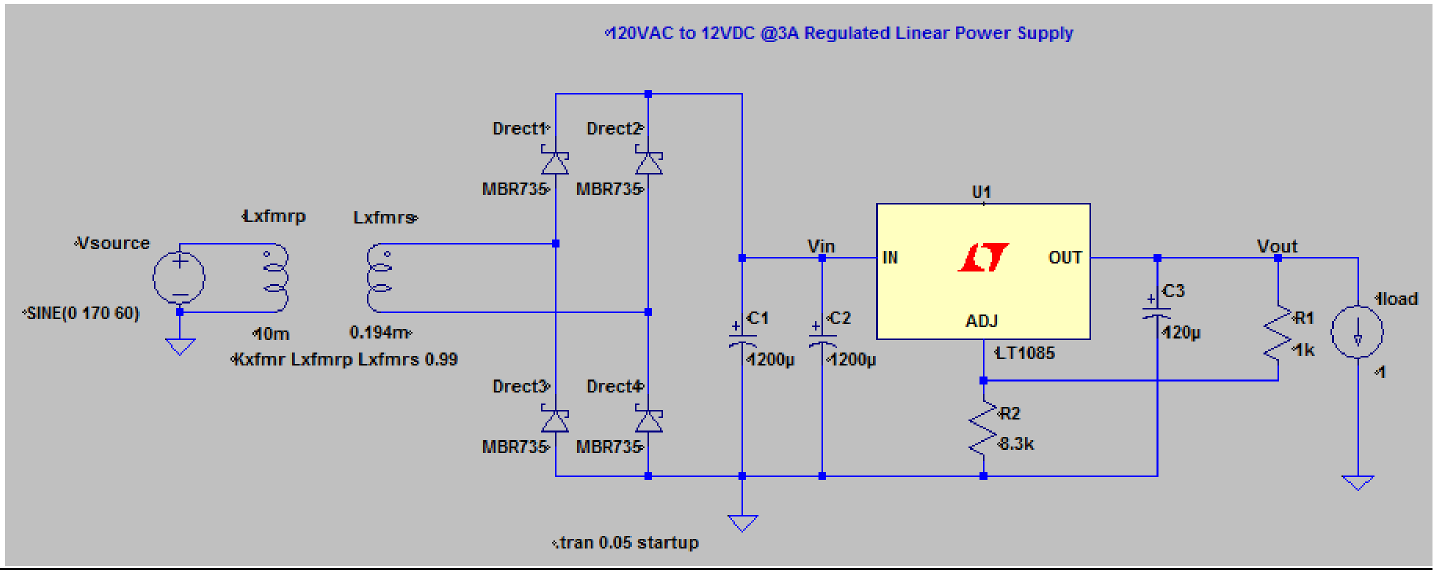

Figure I: 12V_{DC} Linear Voltage Regulator

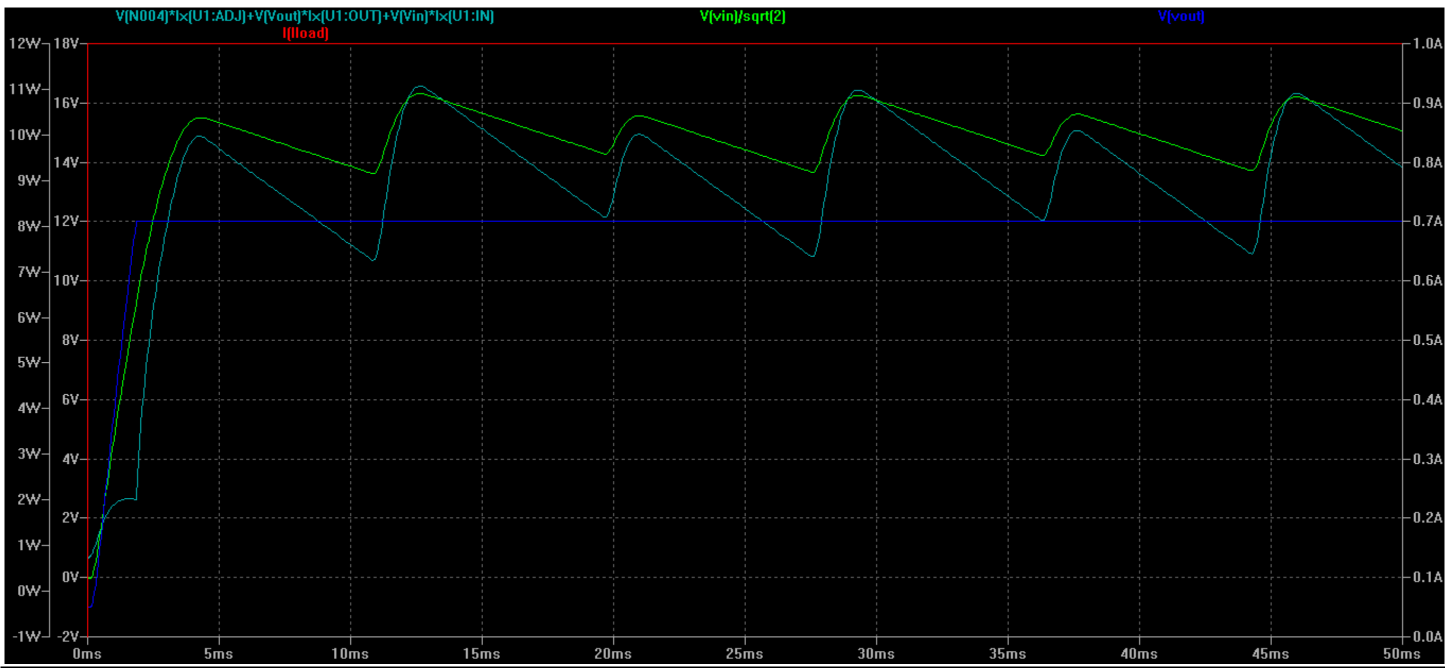

Figure II: Simulation of 12V_{DC} Linear Regulator

Trace Color	Description
Red	Load Current
Green	RMS Input Voltage to Regulator
Dark Blue	Regulated 12V Output Voltage
Light Blue	Power Dissipation of LT1085 Linear Regulator

Table I: Descriptions of Waveforms of Figure II

12V$_{DC}$ Linear Regulator Bill of Materials					
Label	**Description**	**Manufacturer**	**Mfg. Part Number**	**Qty.**	**Price/Unit**
U1	Linear 12VDC Voltage Regulator	Linear Technology	LT1085CT-12#PBF	1	$6.75
Lxfmr	115VAC/16VAC, 56VA, 3.5A Power Transformer	Signal Transformers	241-7-16	1	$21.44
Drect	400V, 5A Single Phase Bridge Rectifier	Comchip Technology	RS504-G	1	$1.80
C1,C2	1000uF, 25V Electrolytic Radial Capacitor	Nichicon	UHE1E102MHD6	2	$0.81
C3	120uF, 25V Electrolytic Radial Capacitor	Nichicon	UPW1E121MED	1	$0.40
R1, R2	1kΩ and 8.3kΩ 5W Resistors	Any	Any	2	$0.10
N/A	Aluminum Heat Sink	Aavid Thermalloy	531002C00000	1	$0.85
			Total	9	$32.25

Table II: Bill of Materials for 12V$_{DC}$ Linear Voltage Regulator

Thermal Considerations of Heat Sink Relating to LT1085CT-12 IC:

$$V_{IN,max} = V_{XFMR,sec} - V_{Bridge} = 16V - 1.4V = 14.6V \qquad V_{OUT} = 12V \qquad I_{OUT,max} = 3A$$

$$T_{Amb.} = 80° \qquad \Theta_{Heat\ Sink} = 4\ °C/W \qquad \Theta_{JC} = 0.24\ °C/W \qquad \Theta_{Case-to-Heat\ Sink} = 0.5\ °C/W$$

Power dissipation under these conditions is equal to:

$$P_D = (V_{IN,max} - V_{OUT}) \times (I_{OUT,max}) = (14.6V - 12V) \times 3A = 7.8W$$

Junction temperature will be equal to:

$$T_J = T_{Amb.} + P_D(\Theta_{Heat\ Sink} + \Theta_{Case-to-Heat\ Sink} + \Theta_{JC})$$

For the control Section:

$$T_J = 80°C + 7.8W(4\ °C/W + 0.5\ °C/W + 0.24\ °C/W) = 116.97\ °C \ < 125\ °C$$

For the Power Transistor Section:

$$T_J = 80°C + 7.8W(4\ °C/W + 1.6\ °C/W + 0.24\ °C/W) = 125.55\ °C \ < 150\ °C$$

For both cases, the Junction Temperature is below rated values; therefore, the chosen heat sink will ensure reliable operation.

<u>Design of 5VDC Switching Buck Converter Power Supply Unit for Microcontroller and Sensor</u>

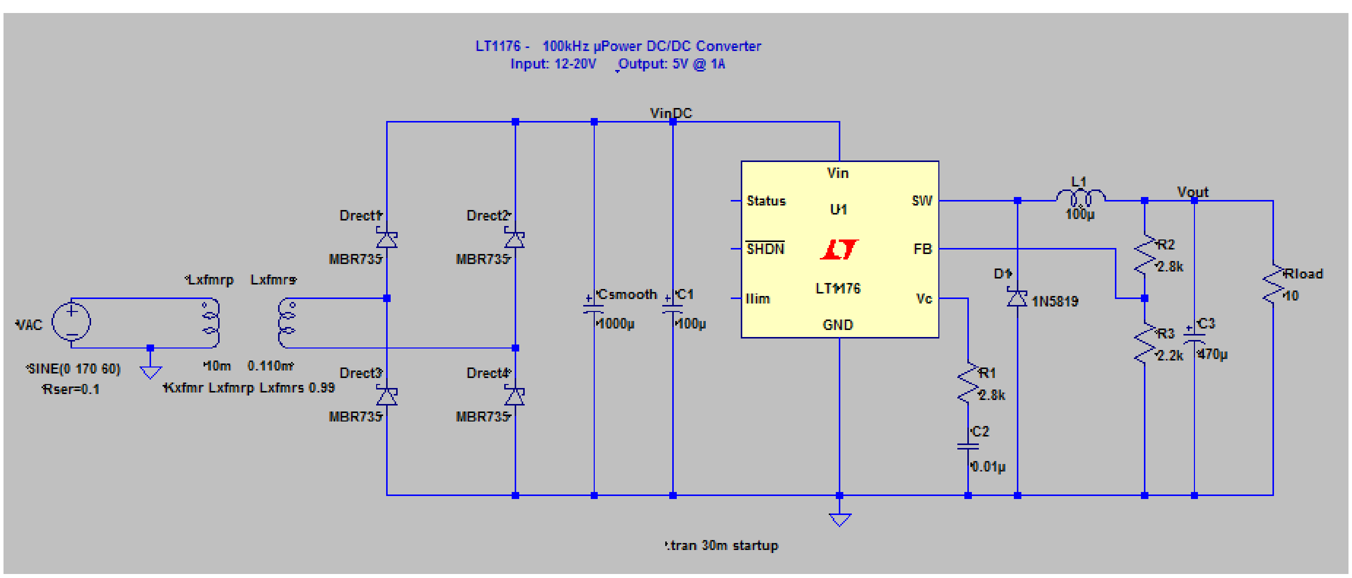

Figure III: 5V$_{DC}$ Switching Regulated Power Supply (Buck Converter)

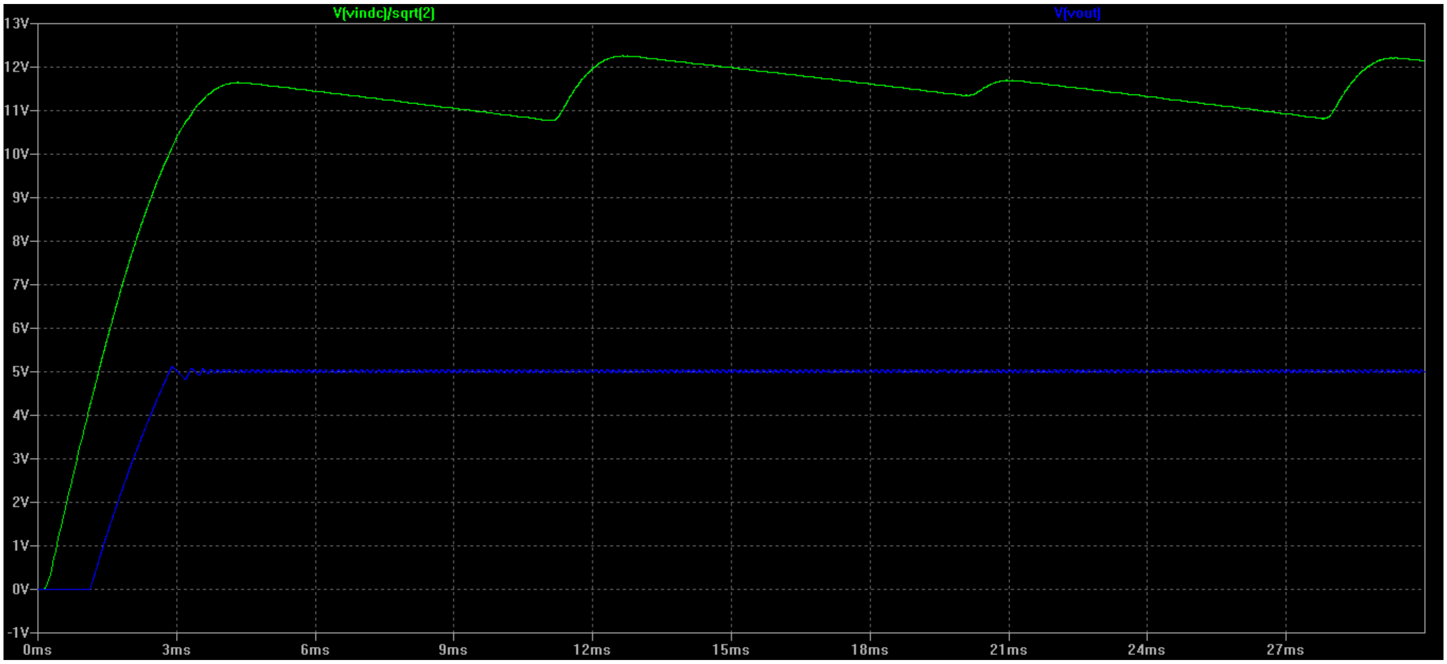

Figure IV: Simulation of $5V_{DC}$ Switching Regulator

Zooming in on the transient response at approximately 3ms reveals the following:

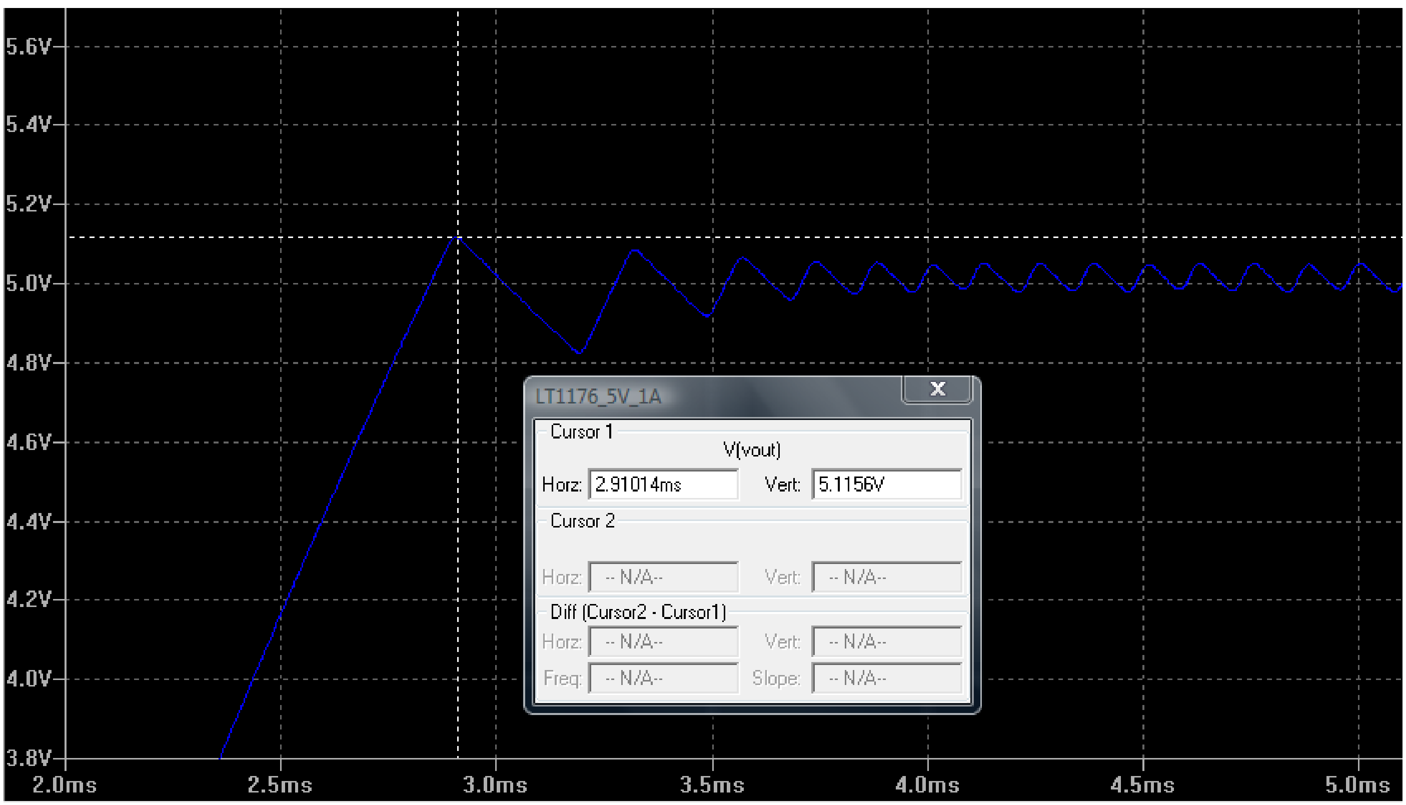

Figure V: Transient Response of $5V_{DC}$ Regulated Switching Supply

$$\%_{Overshoot} = \left(\frac{5.1156V - 5V}{5.1156V}\right) \times 100\% = 2.26\%$$

Approximate settling time is 4.0ms. The ripple after settling varies from 4.98V to 5.05V, or 70mV of fluctuation.
By replacing the rectifying circuitry from Figure III with an $11.2V_{DC}$ (12.6V – 1.4V) source, an efficiency test can be ran on the circuit. Figure VI below illustrates the change and the generated Efficiency Report.

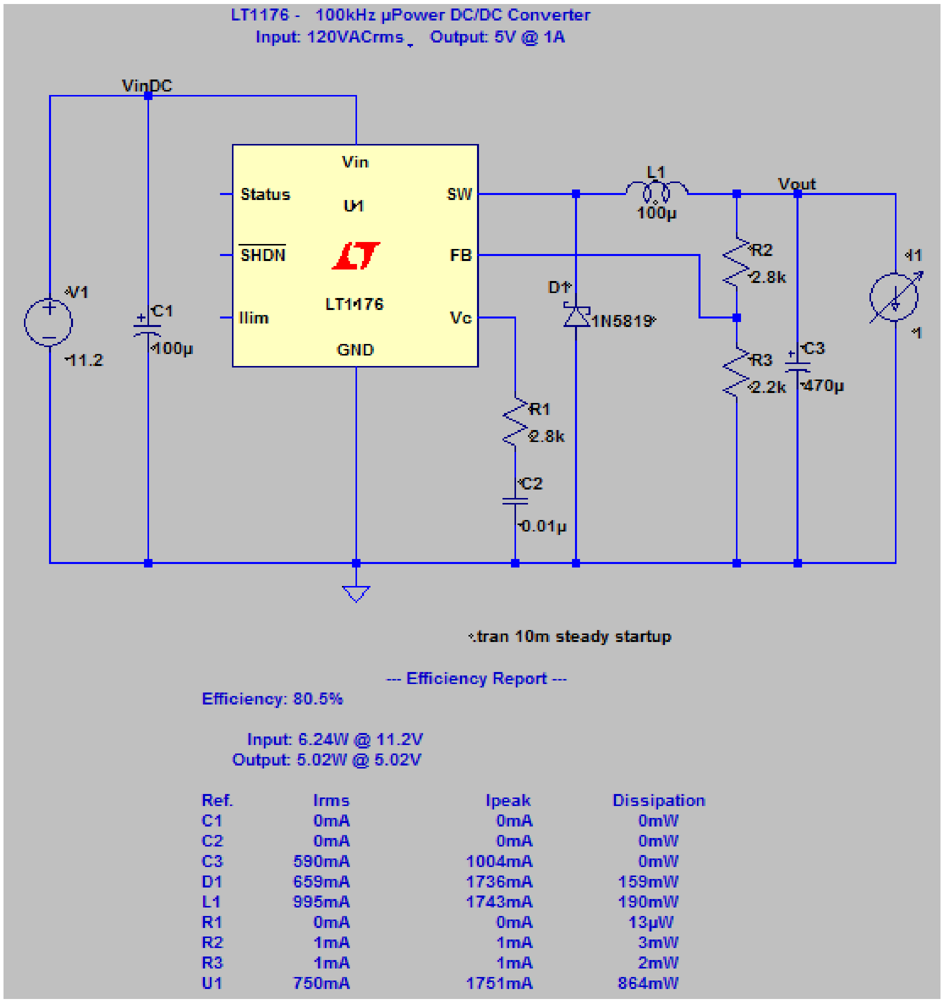

Figure VI: Efficiency Test on Switching Regulator

$5V_{DC}$ Switching Regulator Bill of Materials					
Label	**Description**	**Manufacturer**	**Mfg. Part Number**	**Qty**	**Price/Unit**
U1	Switching DC/DC Converter $5V_{DC}$ 100kHz	Linear Technology	LT1176CN8-5#PBF	1	$5.63
Lxfmr	$115V_{AC}/12.6V_{AC}$, 12.6VA , 1A Power Transformer	Hammond Manufacturing	166J12	1	$19.64
Drect	400V, 5A Single Phase Bridge Rectifier	Comchip Technology	RS504-G	1	$1.80
D1	Diode Schotky 45V 15A TO-220FPAC	STMicroelectronics	STPS1545FP	1	$1.40
L1	Inductor Turoid PWR 100UH VERT	Coiltronics/Div of Cooper/Bussmann	CTX100-1-52-R	1	$2.70
Csmooth C1	1000uF, 25V Electrolytic Radial Capacitor	Nichicon	UHE1E102MHD6	2	$0.81
C2	0.01, 25V Ceramic Disk Capacitor	Any	Any	1	$0.10
C3	470uF, 25V Electrolytic Radial Capacitor	Panasonic - ECG	ECA-1EM471	1	$0.41
R1, R2, R3	2.8k and 2.2k 5W Resistors	Any	Any	3	$0.10
			Total	12	$33.60

Table III: Bill of Materials for $5V_{DC}$ Switching Voltage Regulator