Isolated DC to DC Convertor Board Instructions

Why would I need this?

The DCDC1 is useful when negative or bi-polar voltages need to be generated. Also, it can supply isolated power for your low level electronics when the main power is noisy (think automotive). It can be used to generate higher or lower voltages but there are step up and step down boards that are less expensive.

The board is sold as a bare board with instructions since the number of possible variations is > 50.

Board Configuration and Parts List

Given the number of variations, a step by step procedure for picking parts is useful. Once your selections are made, use the charts to assemble a parts list.
First, we need some basic information.

- What input power is available
- What are the desired output voltage(s)
- Is there some cooling air available

Now let's pick some parts

The board has two major parts: a pre-regulator and an isolated DC to DC convertor. The input power sets the required pre-regulator. If standard value, regulated (+/-10%) input power is available, no pre-regulator is required. The standard input values are 3.3, 5, 12, 15, or 24 volts DC. If you have a standard input value, skip Picking a Pre-regulator and go to Picking a DC to DC convertor.
If you don't have a standard input voltage or if it is not well regulated, you need a pre-regulator. As an example, standard automotive voltage is often specified as 9 – 16 volts DC. This requires a pre-regulator. The lower limit of input voltage must be at least 7 volts and the high limit may be as high as 25 volts. If your lower limit is below 7v, see appendix A.

Picking a Pre-regulator

The board will accept two kinds of pre-regulators, linear (inexpensive but hot) and a switching pre-regulator (a little more expensive but far less heat). The linear pre-regulator is a 7805T style chip with a heat sink. This combination will supply full power with input voltages up to 16volts in a 40C ambient. However, the heat sink gets HOT, about 100C. The regulator is OK with this but you may not want it in your project. The alternative switching regulator will provide full power with 25 volts in and a 60C ambient. It will be cooler and doesn't need the heat sink. The cost penalty is about $2.00. The linear pre-regulator must have some cooling air. Putting it in a small box with max output will cause overheating.

Picking a DC to DC Convertor

Picking the DC to DC convertor is done be building a part number based on the input and output voltages. If you are not using a pre-regulator, the input voltage is the standard value you have available (see above).

If you are using a pre-regulator, your DC to DC input voltage is 5 volts.

Pick your output voltage from the available convertor output voltage(s). If generating one voltage (positive or negative), the possible voltages are 3.3, 5, 9, 12, 15. If your input voltage is above 3.3v then 24 is also available. If generating bi-polar voltages, the possible values are +/- 5, +/-12, and +/-15. If your input voltage is above 3.3v then +/-3.3 and +/-24 volts are also available.

The part number is as follows: PDM1-Sx-yz-S. Where x,y,z are picked from the following lists:

Input voltage

Voltage	x	C2, linear pre-reg	C2, switching pre-reg
3.3	3	4.7uF	10uF
5	5	4.7uF	10uF
12	12	2.2uF	10uF
15	15	2.2uF	10uF
24	24	1.0uF	10uF

Output Voltage

Voltage	y	z	C3	C4	C5	R1,R2	Max Iout
3.3	S	3	N/A	N/A	10uF	51 ohms	303mA
5	S	5	N/A	N/A	10uF	120 ohms	200mA
9	S	9	N/A	N/A	2.2uF	390 ohms	111mA
12	S	12	N/A	N/A	2.2uF	620 ohms	84mA
15	S	15	N/A	N/A	1.0uF	1K ohms	67mA
24	S	24	N/A	N/A	1.0uF	2.4K ohms	42mA
+/-3.3	D	3	4.7uF	4.7uF	N/A	220 ohms	+/-152mA
+/-5	D	5	4.7uF	4.7uF	N/A	510 ohms	+/-100mA
+/-9	D	9	1.0uF	1.0uF	N/A	1.5K ohms	+/-56mA
+/-12	D	12	1.0uF	1.0uF	N/A	2.4K ohms	+/-42mA
+/-15	D	15	1.0uF	1.0uF	N/A	3.6K ohms	+/-34mA
+/-24	D	24	1.0uF	1.0uF	N/A	8.2K ohms	+/-21mA

<u>Examples</u>

if you have a 5 volt input and are generating +/-12v the part number is:

PDM1-S5-D12-S

If you have a 12 volt input and are generating 15v the part number is:

PDM1-S12-S15-S

Remember 24, +/-3.3, and +/-24 are not available with 3.3volt inputs.

When you have selected your part number, make note of the capacitor and resistor values in the input and output voltage tables. These will be required to select part numbers from the charts below. Also, be sure to check that the maximum output current (Iout) is sufficient for your project.

The Rest of the Parts

Use your pre-regulator and voltage decisions to pick the rest of your parts from the tables below. For D1 see the protection section.

Connectors

Ref Des	Part Num	Manufacturer	Description	Notes
J1	PREC003SAAN-RC	Sullins	Header, 3pin straight, .1" spacing	Connector part numbers are for cut to size parts. You may wish to buy strips and cut them.
J2	PREC002SAAN-RC	Sullins	Header, 2pin straight, .1" spacing	You may also wish to have right angle or screw terminal connectors. Search ebay for more options

Linear Pre-regulator Parts

Ref Des	Part Num	Manufacturer	Description	Notes
U1	MC7805CTG	ON Semi	Linear 5v regulator, TO-220 package	This part number is low cost, many 7805 TO220 style regulators will work
C1	FK26X7R1E106K	TDK	10uF, 25v, X7R ceramic	Use for input voltages <= 16v
C1	RDEC71H106K3K1H03B	Murata	10uF, 50v, X7S ceramic	**Use for input voltages > 16v**
Heat Sink	575002B00000G	AAVID Thermalloy	TO220 board mount heat sink 13.6 degC/watt	

Switching Pre-regulator Parts

Ref Des	Part Num	Manufacturer	Description	Notes
U1	R-78E5.0-0.5	Recom	Switching 5v convertor, SIP package	
C1	FK26X7R1E106K	TDK	10uF, 25v, X7R ceramic	Use for input voltages <= 16v
C1	RDEC71H106K3K1H03B	Murata	10uF, 50v, X7S ceramic	**Use for input voltages > 16v**

DC to DC Convertor Capacitors – values come from the input and output voltage tables

Value	Part Num	Manufacturer	Description	Notes
1.0uF	FK24X7R1H105K	TDK	1.0uF, 50v X7R ceramic	Note 50v rating
2.2uF	FK24X7R1E225K	TDK	2.2uF, 25v, X7R ceramic	
4.7uF	FK24X7R1E475K	TDK	4.7uF, 25v, X7R ceramic	
10uF	FK26X7R1E106K	TDK	10uF, 25v, X7R ceramic	

DC to DC Convertor Load Resistors – values come from the output voltage table

Note that load resistors are only required if the board will not have a continuous load. With no load, the output voltage will rise beyond the specified range. This does not hurt the board but the device being powered might be damaged.

Value	Part Num	Manufacturer	Description	Notes
51 ohms	CFR-25JB-52-51R	Yageo	Carbon film resistor, 1/4w, 5%	
120 ohms	CFR-25JB-52-120R	Yageo	Carbon film resistor, 1/4w, 5%	
390 ohms	CFR-25JB-52-390R	Yageo	Carbon film resistor, 1/4w, 5%	
620 ohms	CFR-25JB-52-620R	Yageo	Carbon film resistor, 1/4w, 5%	
1K ohms	CFR-25JB-52-1K	Yageo	Carbon film resistor, 1/4w, 5%	
2.4K ohms	CFR-25JB-52-2K4	Yageo	Carbon film resistor, 1/4w, 5%	
220 ohms	CFR-25JB-52-220R	Yageo	Carbon film resistor, 1/4w, 5%	
510 ohms	CFR-25JB-52-510R	Yageo	Carbon film resistor, 1/4w, 5%	
1.5K ohms	CFR-25JB-52-1K5	Yageo	Carbon film resistor, 1/4w, 5%	
3.6K ohms	CFR-25JB-52-3K6	Yageo	Carbon film resistor, 1/4w, 5%	
8.2K ohms	CFR-25JB-52-8K2	Yageo	Carbon film resistor, 1/4w, 5%	

Protection – Picking D1

You don't need D1 unless you have a noisy supply voltage. Two noisy examples are high powered robots (large motors, solenoids etc.) and automotive. For a robot or similar device, pick a TVS diode that is a bit above the highest expected non-transient voltage. For instance, a 12 volt powered robot could use a P6KE18A (18v) device. This would also work for 12 volt automotive systems except for two rare but very real "disturbances". The first is double battery jump start. This is when a tow truck guy jump starts your car and has two batteries in series to make sure your car will start. This will supply about 26volts so you need a P6KE27A (27v) device. The second is alternator load dump. This occurs when your battery becomes disconnected while the alternator is charging. Should never happen, but it does. This produces as much as 42v for about 100mS. In this case just a TVS diode does not work because we are above the voltage rating for either of the pre-regulators. To protect against this you need a fuse or PTC "resettable fuse" in series with the positive input in addition to the P6KE27A. A 1/2A fast blow fuse or a Bourns MF-R030 PTC will work. There is no place on the board for a fuse or PTC. You could cut the + input trace near J2 and solder the PTC between J2-1 and the band end of D1.

Construction

This is a simple board to build but following the rule of flattest parts first will not hurt. Here is my recommended parts install order:

- R1, R2, D1 – be sure to get D1 orientation correct
- All capacitors C1-C4 as required by your configuration. N/A values are not used.
- Connectors – but check your component height if using screw terminals
- U2
- U1 if you are using a pre-regulator. For the linear pre-regulator, mount U1 to the heat sink before installation. Use heatsink compound or silicon grease between U1 and the heatsink. Tabs on the heat sink can be bent or glued to attach them to the mounting holes. . Note that the heat sink is attached to the input ground. If using the switching pre-regulator make sure that pin 1 of U1 goes to the square pad on the board

Refer to the schematic and board layout attached to the end of this file.

Important – if you are not using a pre-regulator, install a jumper wire from U1-pad 1 to U1-pad3. Make sure the jumper does not short to U1-pad2.

Hook Up

Refer to the hook up diagrams attached to the end of this file.

Parts Substitution

I'm sure many of you will wonder – can I use this part that I have for … Here are some comments on what may work.

The load resistors are not very critical. If you have a resistor of approximately the right value that will fit in the board, it will likely work

The linear pre-regulator IC is pretty generic. Anything in the 7805 TO220 family will probably work. You may notice that the typical 7805 spec. only calls for a 0.33uF input capacitor. The DC to DC convertor reflects noise through the 7805 that the 10uF input capacitor helps control.

There are other DC to DC convertors with the same pin out. If you make a substitution check three things:

- Are pin spacing and functionality the same.
- Are different capacitors recommended to control noise or stability
- If the convertor is greater than 1W, changes to the pre-regulator will probably be required

Capacitors are probably the most critical components. Ceramic capacitors with X7R ceramic are specified. Capacitors with ceramic specifications starting withY5 or Z5 are not temperature stable and my cause trouble if the device is used outside of room temperature. They may also have inferior ESR and dissipation factor which may not control noise as well. Capacitors other than ceramic, particularly aluminum electrolytics have much higher ESR/ESL and will not control noise from the switching convertors. Even tantalum electrolytics are probably not good enough to control the noise.

Appendix A

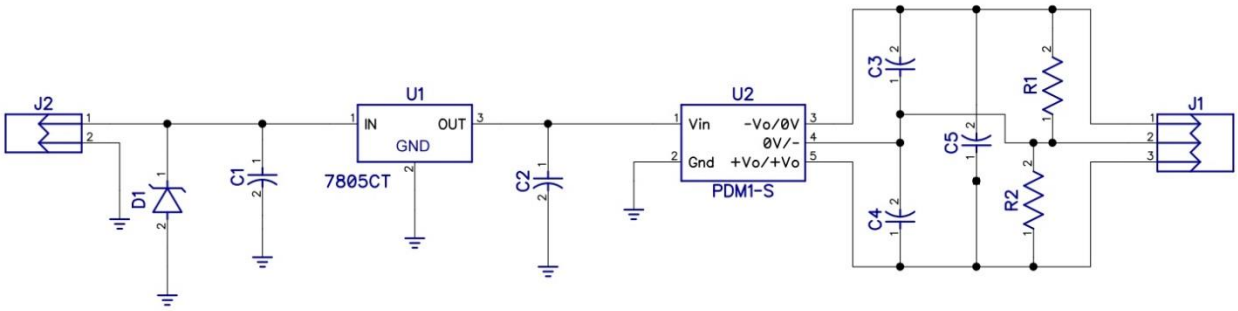
So you have an unregulated supply with a low limit lower than 7 volts. There is an option to take care of this by pre-regulating to 3.3v instead of 5v. Only the linear pre-regulator will work as the 3.3v switching regulator input only goes down to 6v instead of 7v.

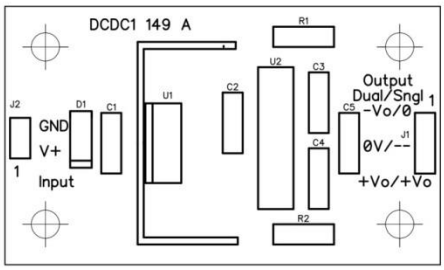
By using an LM2937ET-3.3 low drop out linear regulator, we drop the input low end to 4.75v which should be suitable for a nominal 6v battery powered device. The upper limit will be 26v but for full output thermal issues limit the input to 15v. As a bonus, the LM2937 is designed for automotive use and can withstand double battery jump start and load dump events without additional protection, so D1 is not required.

The DC to DC convertor input voltage is now 3.3v so we cannot use +24, +/-24 or +/-3.3 volt outputs. The convertor part number is built using the same tables as before.

The other required change is C2. This will now need to be a 22uF 16v tantalum electrolytic. The part number is TAP226K016BRW. This is required to keep the LM2937 stable. A 10uF ceramic might work but is not guaranteed.

Schematic and Board Layout





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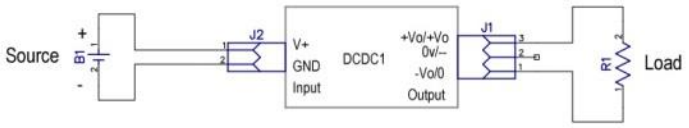
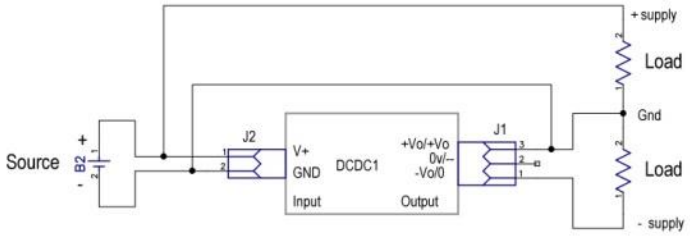
Connections for a single voltage isolated load.

If the load needs to interact with the source, a connection (usually ground) will have to be made between the two.
Isolation is still useful to reduce noise from the source entering the load if the connection point is carefully chosen and made at only one point.



Connections for creating a single negative supply in addition to the positive source supply



Connections for creating bi-polar supplies

If isolation is not desired, connect source (-) to ouput Gnd