Simplified Weld Control Board Manual

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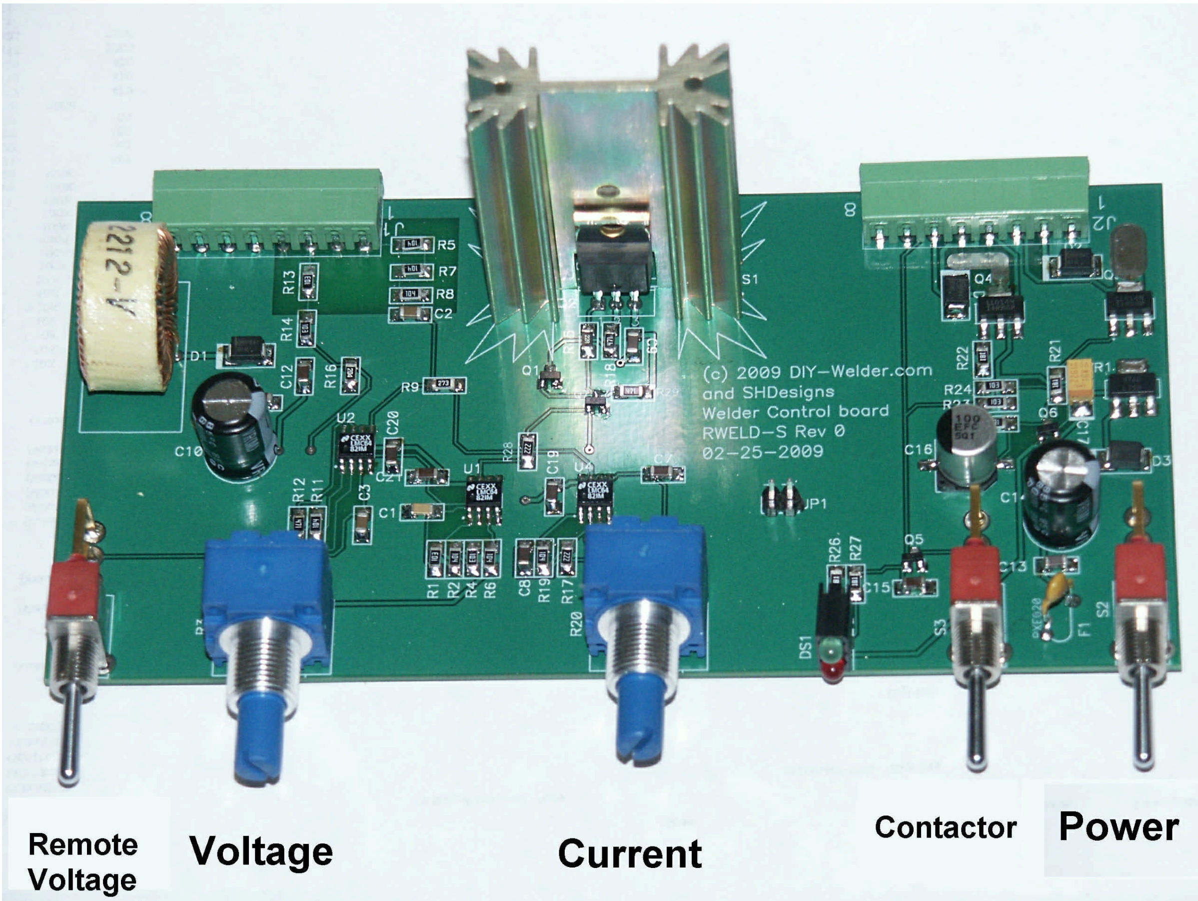
1 Description

The simplified control board is designed to operate with a standard alternator to provide Arc, MIG and scratch-start TIG welding.



There are 3 switches and 2 controls that operate as follows:

Power Switch: Controls power to the board. Up is on, Down is off.

Contactor Switch: Selects always on or remote control. Up for always on, Down for Remote.

Remote voltage: Selects local voltage setting (voltage potentiometer) or remote. Up for Remote, Down for local

Voltage Potentiometer: Sets the no-load voltage from 0 to 50 volts.
Current Potentiometer: Sets the current slope from minimum current to maximum (constant voltage.)

The potentiometers have a 1/4” shaft. Radio Shack has knobs; 274-415 looks like it should fit.

Green LED: Power on

Red LED: Remote contactor on.

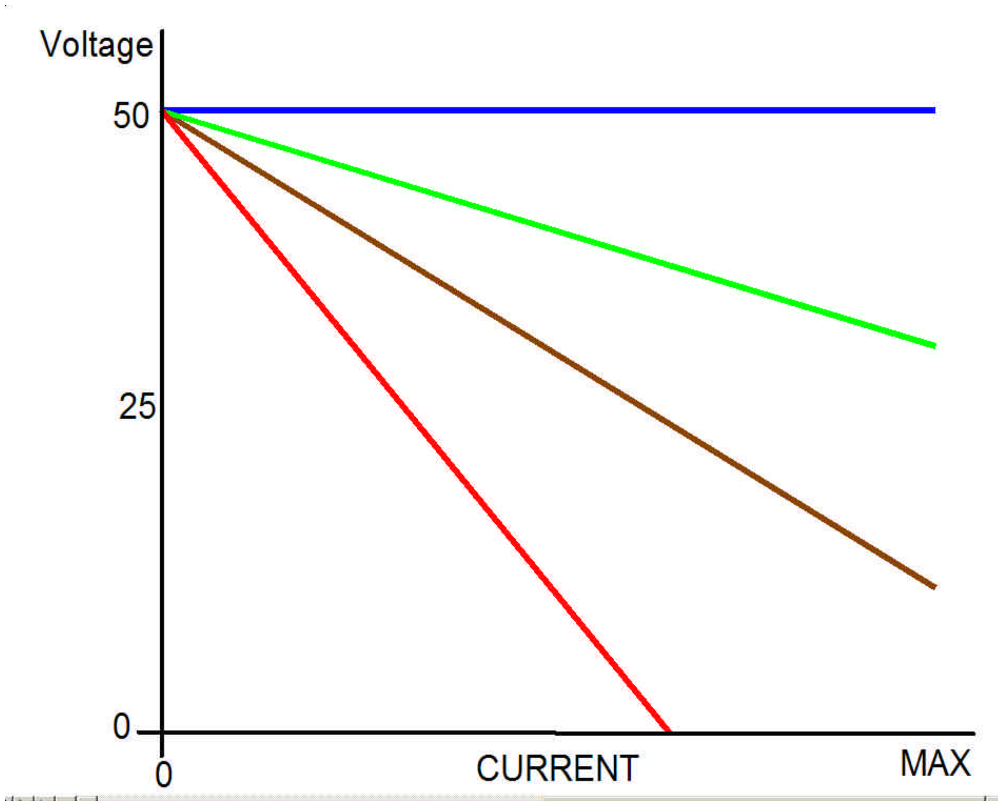
On the rear of the board are two sets of screw terminals. Thesr provide the following inputs and outputs:

Power: +10 to 16V DC
Ground: Power ground and alternator - output.
Field Power: Power input to the field driver, 10 to 16V
Field out: Supplies the current to the alternator field.
Remote Contactor in: When shorted to ground will turn on the field current, and the gas and contactor outputs.
Remote voltage: 0-5V input for remote voltage control (0-50V weld voltage).
Contactor out: Will be driven to ground when the remote contactor in is driven. Note: on the current boards, this output is reversed.
Gas out: Can drive a gas solenoid for TIG or MIG welding. Will be driven to ground when the remote contactor is activated.
Weld voltage +: Sense input for the welding voltage.
Current sense: Sense input for the current.

2 How it Works

The board measures the welding voltage and current and controls the alternator field current to maintain the correct levels.

For TIG and Arc welding, the current setting controls the voltage drop with current or “droop”. It is not constant current, but then again, neither are constant-current welders. The current will remain within a range while welding.



The above graph shows how the current control works. The voltage control is set at 50 volts. When set to the maximum (full clockwise), the voltage will stay at 50 volts (blue line) and is constant voltage. As the current control is rotated counterclockwise, the slope is increased. The red line is with the control fully clockwise.

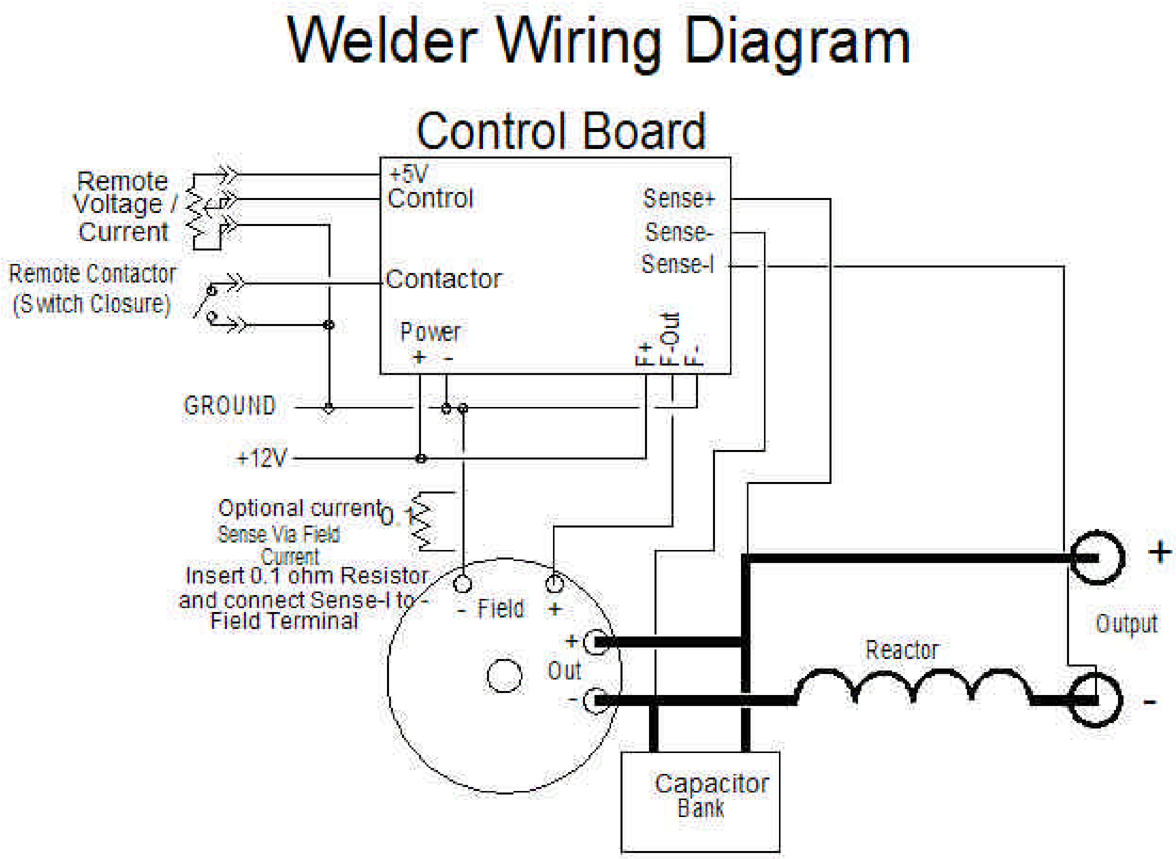
Welding is normally done at about 18 to 25 volts. It is very hard to calculate the welding current given the control setting. That would have to consider the arc length, voltage setting and current feedback resistance. It is not difficult to get a feel for the right setting. For example you may find a 3/32 arc rod will work best with the current control set at about 1/2. I write these settings on the boxes of rods so I can just dial them in later.

The board is basically a voltage regulator, very similar to the built-in ones used on most alternators. The main difference is a variable amount of the current is added to the sensed voltage; this sets the slope and consequently the welding current.

For MIG welding, the desired voltage is dialed in with the voltage pot and the current control is set to full (no current feedback.)

For Arc and TIG welding, the voltage is set as high as the alternator can support with no load and the current is set with the current pot.

3 Connections



The above picture was for the large board. The simplified board has the Sense-, Power - and F- connections all tied to ground.

The board is for an alternator with one side of the field grounded. The capacitor bank and reactor are optional but are needed for MIG welding. They will also help arc stability in other modes.

The board has two sets of screw terminals marked J1 and J2. The connections are as follows:

J1

Pin	
1	Sense +
2	No Connection
3	Sense-I
4	No Connection
5	Ground
6	Field Power
7	Field out
8	Ground

J2

Pin	
1	Ground
2	Power
3	Gas Solenoid
4	+5V Out
5	Contactor In
6	Contactor Out
7	Remote Voltage
8	Ground

Signal descriptions:

Ground - Negative power, usually the battery - and the alternator case. All ground pins are tied together within the board.

Power - Power for the board. Will work from 10 to 16 volts.

Gas Solenoid - This output will be driven low when the remote contactor control is used. It will stay on about 6 seconds after the contactor input is turned off to cool the tungsten or MIG torch.. This will normally be used for a TIG or MIG setup.

Contactor out - Controls a remote contactor. Normally used for a MIG setup. Note: on the current revision board, this signal is reversed. See the MIG section for a workaround.

Contactor In - Grounding this pin will control the gas and contractor out pins. When the remote contactor switch is enabled, it will also turn on the field current.

+5V out - Reference voltage for the remote Voltage input

Remote Voltage - 0 to 5V input that will set the voltage to 0 to 50 volts respectively. Enabled with the remote voltage switch.

Sense + - Welding voltage sense positive input.

Sense-I - Welding current sense. This measures a voltage relative to ground that is driven by the current. The range is 0 to 100mv (0.1v.)

Field Power - Power for the field drive circuit. Normally the same power as the used by the board.

Field Out - Supplies 0 to Field Power voltage to the field.

3.1 Current sense

The current sense is measured from the ground reference (the - output of the alternator.) There are several ways to accomplish this.

1. Measure the voltage drop across the wire from the alternator - output to the front panel terminal.

2. Measure the voltage drop across a reactor

3. Measure the voltage drop in a sense resistor on the field - lead. This works but will result in a drop in no load voltage as the minimum current will be seen as a small load.

The voltage should be about 50 millivolts for a full load.

For 150 amps, the resistance would be:

R = V/I

V= 50mv, I=150A

V = .05/150 = 0.000333 ohms.

You can not buy resistors that low in resistance and that can handle the current. This is normally done with a length of wire. The first version of the welder used about 3 feet of #6 wire. The second version used the reactor as it was about the same length and size wire.

The field current can be used also. An alternator field normally draws about 3 amps. So, using the same calculation:

R = V/I = 0.05/3 = 0.0163 ohms.

That can be done with some thinner wire.

A lower voltage will result in a larger minimum current, a higher voltage will lower the minimum current.

The sense resistance is not critical. As long as you get near 50mv with a full load it will work. A full load voltage of 20 to 100mv will work.

In practice, try a length of wire, like a wire from the alternator - output to the front panel. If the minimum current is too high, use a longer wire or a thinner one.

3.2 Contactor and Gas Control

The Contactor input is pulled up to +5V internally. A remote switch will normally ground this pin.

The Gas and Contactor outputs is connected to ground when the contactor input is grounded. These have protection diodes to power to clamp and kickback from inductive loads (solenoid or relay coils.) They can drive about an amp.

Note: on these boards, the contactor out is reversed.

One side of a gas solenoid or contactor would be connected to power and the other to these inputs.

A remote contactor can be a starter solenoid used in cars or riding mowers. The problem is many have one side of the coil grounded, so you will have to add a relay.

The contactor and gas outputs only operate when the remote contactor in is used..

3.3 Voltage Sense

The Sense+ line gets connected to the + output. If you have a capacitor bank, it should be connected to the capacitors. The ground terminals should be referenced to the alternator case.

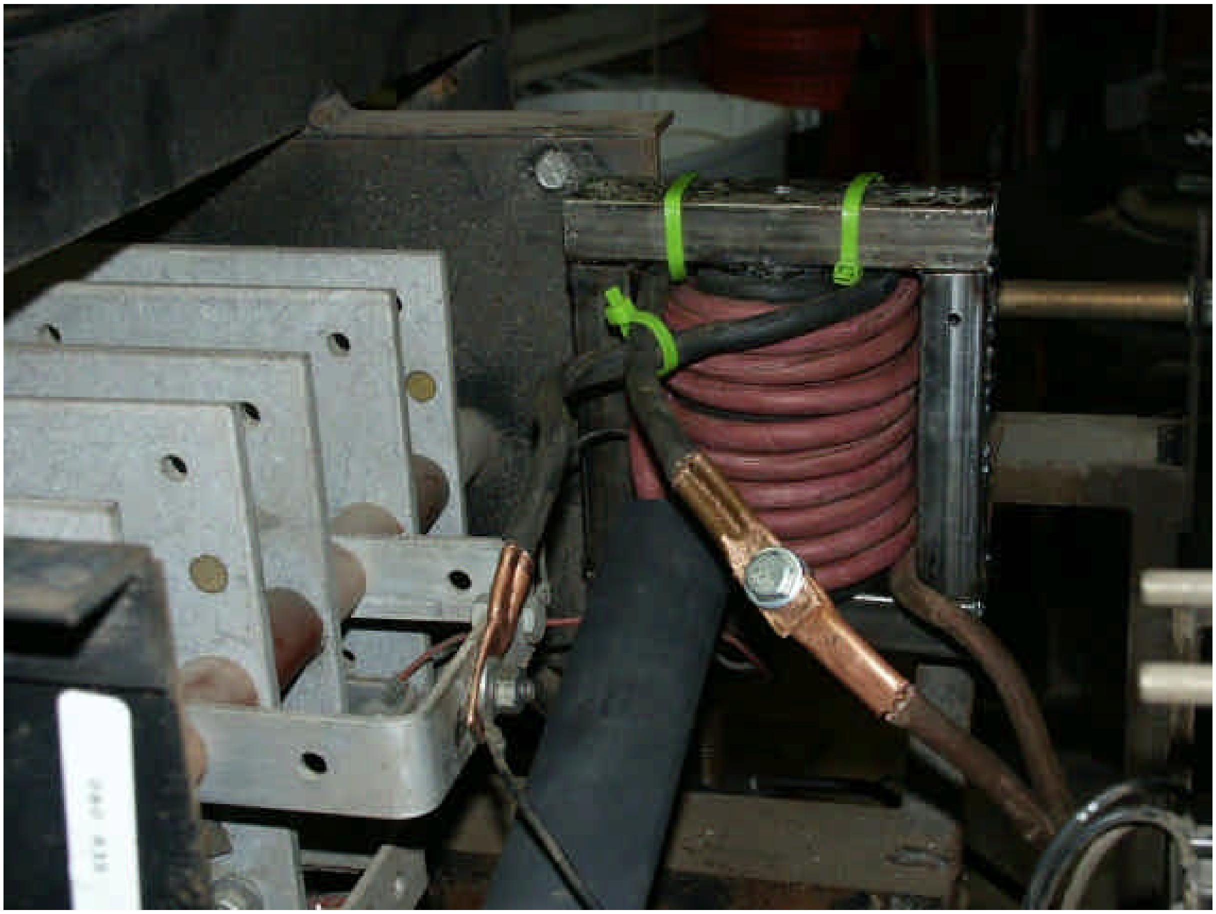
3.4 Reactor and Capacitors

For arc welding, a reactor is not need but will help with arc stability. If you add a bank of capacitors, then one will be needed.

The reactor smoothes the current. Any sudden change in the arc will cause the reactor to increase or decrease the output voltage to maintain the same current.

MIG welding requires a reactor as when the wire touches the weld pool, there is a sudden spike in current. The reactor smoothes this out. Without it, the wire will literally explode when t touches the weld pool with lots of spatter and a low average current.

A reactor can be found on ebay from an old welder. I have wound my own:



Above is one I made for my Miller. It is a 5” piece of 1.5” cast iron pipe wrapped in a steel frame. The wire is about 25 turns of #4 wire. Solid wire would work better, but stranded worked fine.

An old transformer core from a microwave could be used also. Alternatives for the wire are sheet copper or aluminum with insulating layers of paper.

Capacitors should be “Computer Grade”. The prototype used two, 23,000uf, 75 Volt capacitors connected by aluminum bars. The larger the better.

The Miller MIG, I added two 30,000uf capacitors.

I would say, 20,000uf is a good minimum for MIG. Keep an aye on ebay, they are expensive new ($40 each) but you can get surplus one cheap if you are patient.

3.5 Surge Protection

When you break the arc, the current in the alternator windings will cause the voltage to spike. In theory, it can go to infinity. In real life, it will go until it arcs somewhere or the alternator diodes break down. When this happens, the diodes will become a short until power is removed. This will destroy the diodes.

If you have a capacitor bank described in the previous section, then they will absorb the spike.

Either some capacitance or surge suppresser is needed. A motor run capacitor of 4-10uf will help and add a small amount of arc stability and absorb some surges. Many alternators have a 0.5uf cap already to help reduce noise.

If no capacitors are used, an MOV (Metal Oxide Varistor) should be placed across the output of the alternator. It should be around 160 volts or more. If you have an old power strip with a built in suppresser or PC power supply, it will probably have one.

3.6 Alternators

The prototypes used a Motorcraft 200 amp alternator (was for a 90's 5.0 mustang.) These are available on Ebay as many install huge stereos in cars and need lots of current. This alternator was about $100. There are several remanufacturers that make the s high-output alternators.

The alternator will need to be modified. The regulator will have to be removed and access to the field brushes will be needed.

The Motorcraft had a regulator that mounted to the back of the case. It also held the brushes. The regulator was removed, the plastic regulator was broken off the mounting plate and two screws with insulators was installed. That allowed access to the field externally.

Delco/GM alternators have internal regulators. They will have to be removed and wires brought out.

I would recommend a 140 amp alternator as a minimum. Welding will create a large load with higher currents than the welding current.

The Motorcraft came with a serpentine pulley. NAPA stocks pulleys. I first tried a 3/8" pulley and belt and promptly fried the belt. A 1/2" pulley worked better. A small pulley is needed with a larger one on the engine. A 2:1 ratio seems to work well.

A tensioner is needed; either mount the alternator so it can pivot with a spring for tension or use an idler pulley. As the belt heats up, it will lengthen and slip. A tensioner helps keep it tight.

Multiple alternators can be used. Two 70A alternators will work (or 2, 100A ones.) Just connect the fields together and the outputs. Two alternators have an advantage of being driven by two belts. A single alternator is about the limit for a 1/2" belt.

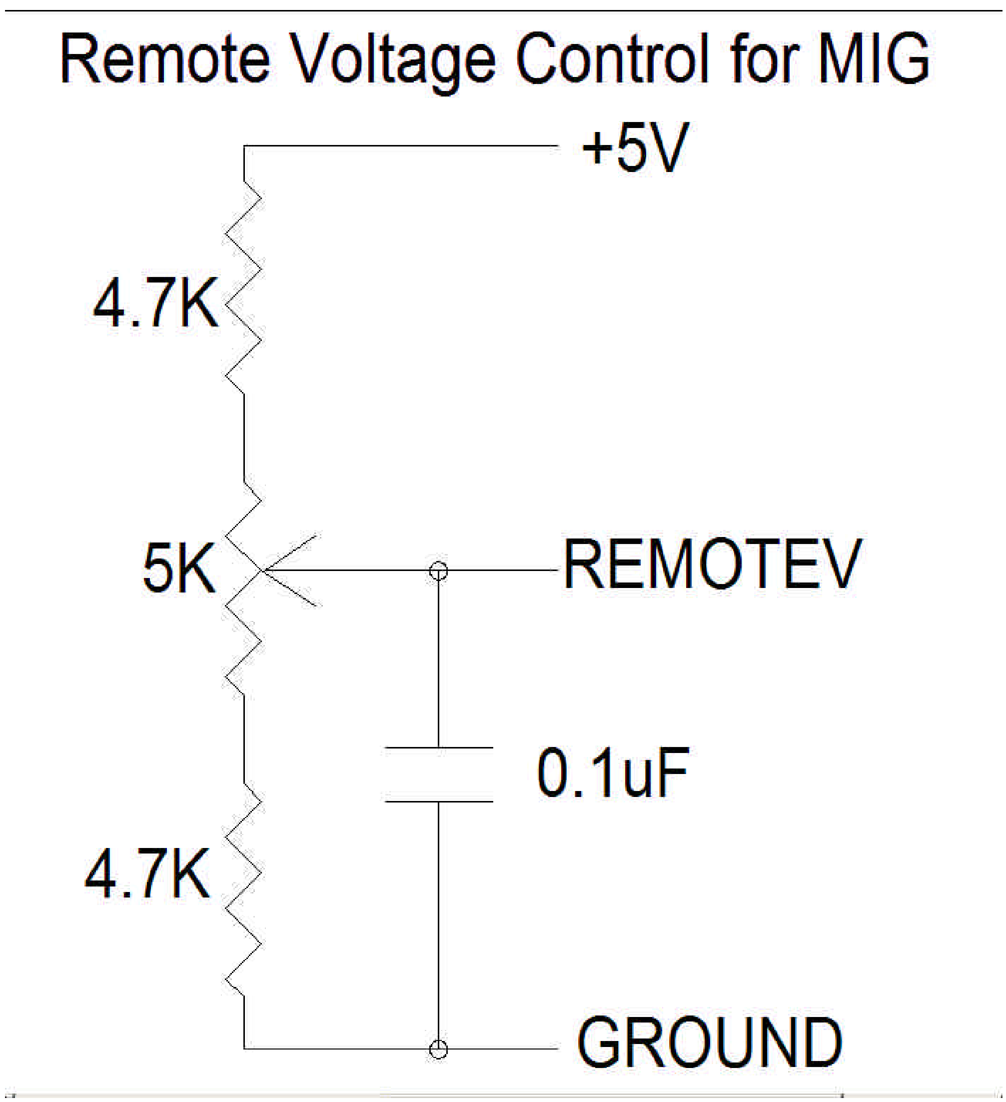
Alternators are normally 12V. I have found you can get considerably more out of them by spinning them fast enough. Be careful, some have diodes that can not handle higher voltages.

An aircraft alternator would be best as they are for 24V systems. They are hard to find and expensive, but keep an eye out for one.

3.7 MIG Setup

For MIG, you will need the reactor and capacitors. A contactor is not required but is best to have for safety as an always-live torch can cause unwanted arcs or flashes.

The voltage control on the front panel is a bit course for use with MIG. You would want a finer voltage control and preferably on the feeder. Below is a remote voltage setup:



This will give a voltage range from 16.6 to 34.2 volts. If you do not plan on welding more than 100A or so, the upper resistor can be 10k. That will give about 16-25V out and an even finer control.

The contactor out on the board is reversed (on when contactor in is not closed.). A contactor can be used connected to the contactor input and power. Most feeders have a relay output that would be connected to ground and the contactor in. You can use the gas solenoid out. It will work but keep the torch live for a few seconds after releasing the trigger.

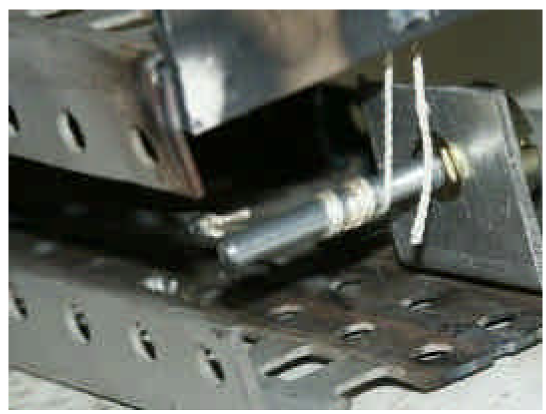
Note: if you don't use a contactor, set the contactor switch to “remote”. It will work but starts will be a bit cold and spatter until the alternator builds up voltage.

If you do use a contactor, set the contactor switch to “on”. That will keep the alternator voltage up and the capacitors charged.

Most feeders have a gas solenoid, if not, a 12V solenoid can be placed across the Gas Out and the power supply.

When using MIG, set the current control fully clockwise.

3.8 TIG Setup



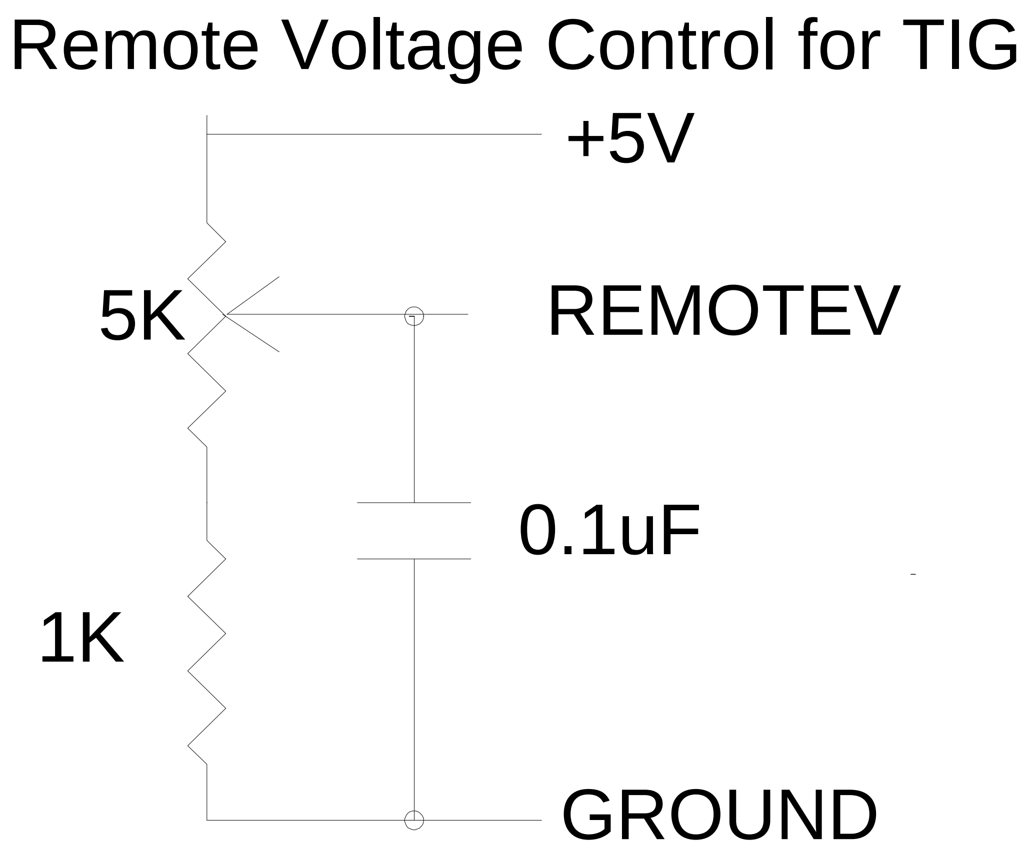
TIG can be done the same as arc welding. A torch with a gas valve can be used with scratch start. For better control and waste less gas, a remote footpedal can be used.

Footpedals are not that difficult to make. Here is one I made:

The shaft of the potentiometer is drilled with a 1/16” hole. The string makes several turns around the shaft, through the hole and then several turns more. One end is connected to the pedal, the other is connected to a long spring.

Not shown is a micro switch that closes when the pedal is pushed forward. That is the contactor control. and grounds the contactor in pin.

The pedal should select a minimum voltage for scratch start. The following implements this:



The potentiometer is the one in the footpedal. Use the current control to set the maximum current desired (full pedal setting.) Set the control board switches for remote contactor and voltage control.

3.9 Voltage and Current Meters

The prototype has an LCD panel meter for the voltage. These are inexpensive and can be found at Jameco.com under: Home > Category: LCD Products > LCD Products / Panel Mount, Meter / 3.5 Digits

These come with instructions on setting the range. Mine is set to display 0-200V (0-50 is used) for the voltage.

Current is a bit more difficult. On the board is a 2-pin header marked JP3 with + and - pins. This is the amplified current sense output. It is about 100 times the sense voltage.

To calibrate the current you will need a known load. Probably the easiest is to set the output to 12V with the current control fully clockwise. Connect two 1173 car tail lights to the output. That should be about 3 amps. You can then measure the voltage at JP3. From that you can figure how to scale the meter.

Note: the LCD meters have the “-” input connected to an internal ground. So, an isolated 9V supply is needed. A 9V battery will last a long time. One battery can supply both meters as the voltage and current share the same ground.

3.10 Alternator Field overheat

One issue to look out for is overheating the field coils. Most car regulators can output about 9 volts to the field. This board will output the full power voltage.

This is not a problem when running. When the board is turned on and the alternator is not spilling, the board will output full contactor current. This may cause problems. To prevent this, turn the contactor switch to remote when not welding.