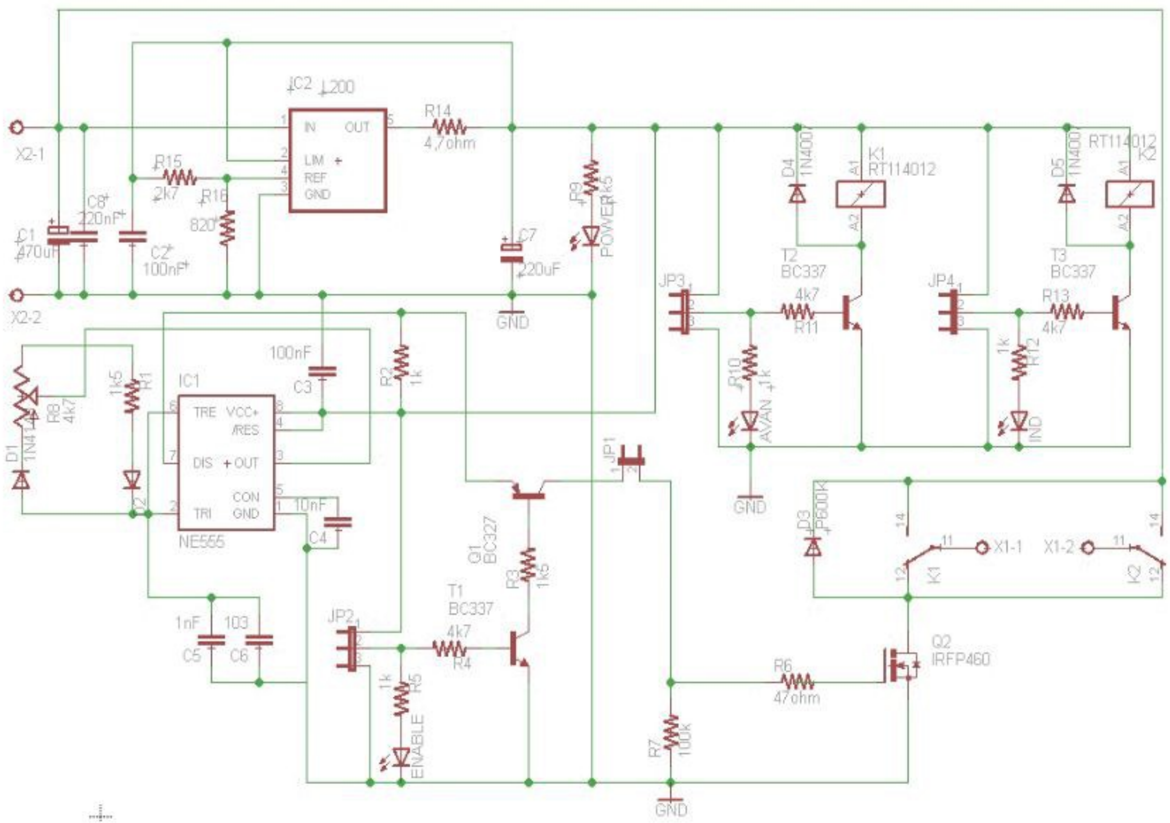
Micro-GT mini PWM Power inverter

In this fifteenth chapter of the tutorial "Let's GO PIC !!!" the first mini shield is presented which, although specific for the Micro-GT mini, can in fact be interfaced with any microcontroller / microprocessor. Excellent for robotic application of reasonable power. It also works autonomously or without the need for a microprocessor control circuit.

Circuit description:

The wiring diagram below is easily interpretable as it consists of easily identifiable sections:

1. ***Oscillator section for hardware PWM generation.***
2. ***TTL control section.***
3. ***switching power control section***
4. ***Intrinsically safe "H-bridge" inversion section.***
5. ***optional recirculation module (external).***
6. ***power supply module.***



PWM hardware section:

The hardware PWM section is based on the PWM control section presented in a previous chapter of "Let's GO PIC !!!" since the circuit is optimal. The realization is developed on the basis of the NE555 timer. For engines that normally use (24V DC gear motors or 36VDC), the optimum operating frequency is 22Khz. For more information on the operation of the NE555 Timer used as a PWM generator, refer to the eighth chapter of the tutorial.

Some basic calculations:

The oscillation frequency is given by the formula f = 1 / T where the period [s] is indicated with T

The period T is 0,693 * (R1 + 2 * R2).

The time in which the output is active is Ton = 0.693 * (R1 + R2) * C1

The time when the output is off is Toff = 0.693 * (R2) * C1

The ratio between the time when the output is high and the total time of the period is the useful cycle equal to D = T1 / T

Online it is possible to find the abacuses that allow the calculation of the oscillation frequency of the astable multivibrator performed in the mode that I have described, that is, that suggest the correct value of R1, R2, C1 according to the frequency to be obtained.

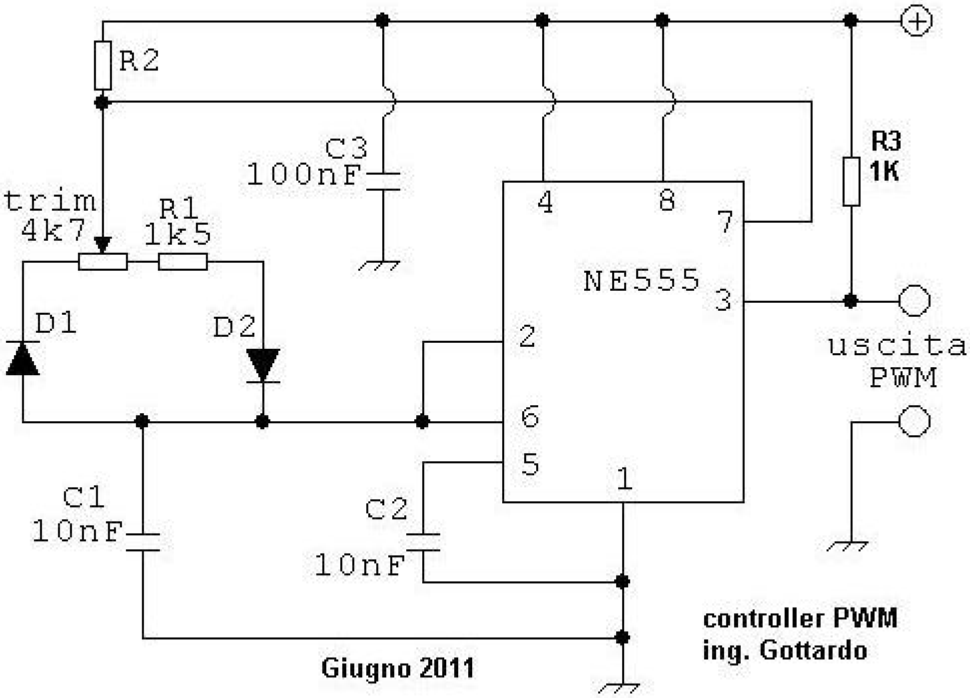
I recommend to the willing to insert the above formulas in a sheet excell and self build this abacus …

The generation of the PWM signal, useful as a regulator of the transmitted power, can be obtained as a variant of this circuit solution.

It is a matter of keeping the period T (inverse frequency) constant and giving the possibility to a manual control of changing the high latch with respect to the low latch, ie the one normally known as the useful cycle (D.C. duty cycle).

The trick consists in forcing the charge and discharge currents of the capacitor C1 to pass through differently and manually regulated variable resistance portions. This trick is implemented by inserting two diodes 1N4148.

Here's how to diversify the charge and discharge paths of capacity:



The charge phase, internally subject to comparison with the two thresholds 1 / 3Vcc and 2/3 Vcc, takes place in the R1 + R2 link to which the inserted trimmer portion is added. One reaches the capacitor C1 through the diode D2, the other branch is inhibited because of the diode D1 in counter-polarization. In the discharge phase, D2 is interdicted and goes into direct conduction D1 which allows the discharge through the inserted portion of the trimmer (also null) through pin 7 behind which we have seen the BHT, npn inside the chip commonly called discharge. Even if it is not really true, the period is almost constant (you will notice small variations on the oscilloscope).

There remains the problem of the resonance frequency of the connected DC motor, this is specific to the motor in use and should be requested from the manufacturer because the measurements the calculations to be made are not simple.

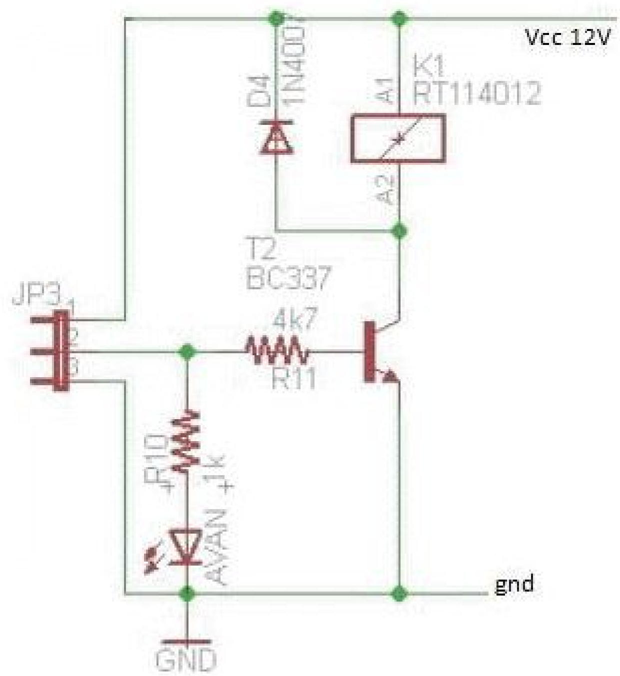
Typically between 12 and 22 Khz it has a good yield.

Empirically, there is an acceptable frequency when the engine does not emit strange buzzing and whistling.

Almost certainly it falls into error in the phonic frequencies around the kiloHertz.

TTL control section:

The TTL section refers to that part of the circuit suitable for controlling or forcing control signals, which allows this mini shield to function autonomously or interfaced to a microcontroller, typically a Micro-Gt mini for which it was born. Soon we will understand that the name "TTL" is only partially true since the forcing or manual control commands are 12 volts because they are taken at the output of the L200 regulator (see the power supply section below). The circuitry, and in particular the polarization resistances are calculated to make the control BJTs of the relay coils work in the saturation zone, whether this command is either 12v or 5V or TTL.



It is a matter of finding a compromise, that is to give a deep but sustainable saturation when it is fed at 12 and a saturation at the margin but present, when working at 5v. The correct values, widely tested to obtain the described situation are 4k7 for the basic resistance with BJT type BC337. The LED, connected to its limitation resistance of 1K, signals the presence of the various commands and therefore the excitation of the corresponding relay.

The TTL commands are:

- *JP3, pin 2 -> forward command from RB0 of the Micro-GT mini.*
- *JP4, pin 2 -> reverse command from RB1 of the Micro-GT mini.*
- *JP1 jumper if you want the predetermined commands do not need any other consent, for example a remote control NA button that holds the operator in hand or a pedal button or a closed case micro.*
- *JP2, pin 2 -> on / off command from the microcontroller if you want to create a simple timed gear. in this case connect pin 2 to the RB2 output of the Micro-GT mini.*

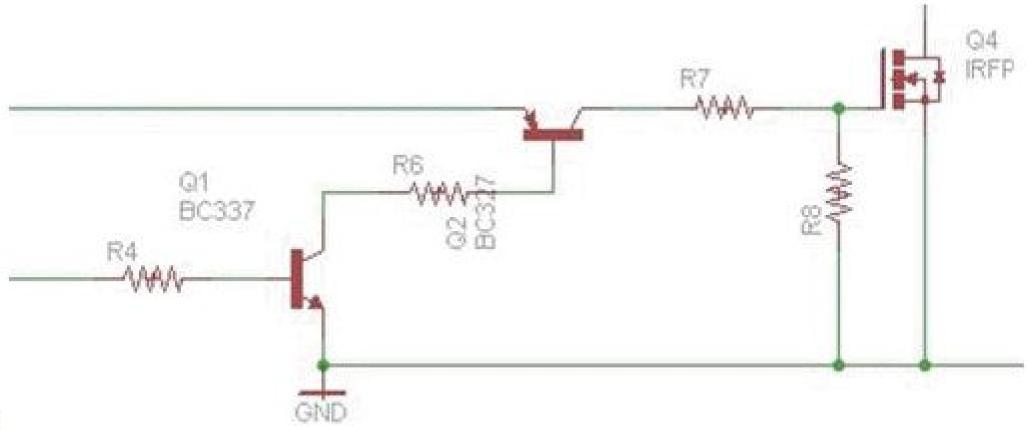
When you want to use the circuit autonomously, without the presence of the microcontroller board, then the commands can be brought manually by connecting the terminals of the command buttons between pins 1-2 of JP3 (forward), 1-2 of JP4 (back). if further manual consent is required, or with a micro switch presence pedal, then connect the clean contacts of this device between 1 and 2 of JP1, otherwise we will force the consent with a jumper.

For example, the activation command can be taken, for example, from the clean NO contact of a photocell or a programmable timer or a thermostat in case of use as a fan between pin 1 and pin 2 of JP2.

In the case that the sensory or control devices provide a TTL output, these signals refer to the pins 3 (ground) of each one of the three-position striplines.

In interfacing with the Micro-GT mini, let's not forget to refer to a common mass available at the 2 of each screw clamp present in this.

Also part of the TTL control section is the part of the circuit that I have called "line interdictor", it is a set of BJT signal transistors placed so that by driving an NPN with the 5V output of the PIC pin you face or less saturate a PNP which consequently puts into operation the line in which the TTL signal is present. This section can be developed in various ways, or even omitted when the PWM signal is generated internally to the PIC instead of hardware through one or more identical sections with the integrated NE555. In my project this solution is proposed with two BJTs more than anything else for didactic questions and for circuit elegance. In the project of the two analogue BJT selector, always presented on Grix, I used only one NPN transistor, operating in the saturation / interdiction area whose collector was connected to the central node of a pseudo series of resistors operating as additional impedances to the analog lines, therefore almost transparent.



To the line to which R4 is connected a stationary ON / OFF signal comes from the microcontroller pin, then from 0 to 5 Volt. At the same point is also connected the green LED diode, with its resistance of 10k (it will make a light bassine but we have no interest in raising it, unless this LED is brought to some front panel).

The mesh consisting of the high pin of the PIC output, the R4 resistance, the Vbe junction, satisfies the equation:

Ib R4 - Vbe - Vrb1 = 0

Where with Vrb1 we mean the voltage present at the PIC pin when the output is high. By highlighting the Ib current we obtain:

Ib= (Vrb1 + Vbe)/R4

substituting the known values within the equation we obtain:

Ib = (5V-0,6V)/1500 = 2,9 mA

This current guarantees a fairly deep saturation of the BC337 which, as in the datasheets, show a hfe never less than 250 (sometimes reaches 350), for a current Ic max of 0.8 A

In these driving conditions of the base the voltage Vce decreases to very low values (never higher than 0.2V) so it practically connects to ground the resistance based on the BJT PNP indicated with Q2. In order not to destroy the B-E junction, the R6 is inserted, the basic mesh must be subjected to calculations similar to those seen for the NPN, and given the circuit analogy, approximately 2 milliamps will be exiting the base. Since these two milliamps go to ground via the junctions between collector and NPN pin, the solution is not acceptable as an input stage of audio signals. These would suffer a not negligible loss, but rather insignificant in a fixed high voltage signal at 5 Volt or square wave as in our case.

In fact, the oscilloscope demonstrates an excellent signal yield between the emitter and ground (therefore upstream) and the mass collector (and therefore downstream) of the line interdiction circuit. The waveforms are in fact virtually the same.

Switching power control section:

It should be borne in mind that the MOSFET IRFP460 will, in many cases, be oversized as it is capable of withstanding break voltages of up to 500 volts, with a current of 20 amperes. it will be possible to replace the component with elements that are more suitable for its realization. The pinout set on the printed gate, drain, surce (from left to right) will allow you to easily replace the component while the resistances on the gate mesh can remain in many cases unchanged.

The fundamental parameter for the choice, in addition to the obvious Vds and Ids (respectively interruption voltage between Drain and surce and current crossing the channel, or the one that will cross the load) is the resistance called RDon, that is the one presented by the conductive channel when the component is piloted so as to present itself with the maximum conductivity between drain and surce. The lower this value is, the less energy will be subtracted from that transferred from the generator to the load to be transformed into heat. The MOSFET used here has a ROG of 0.024 ohm (24 milliom) which is not bad but you can do better.

The MOSFET IRF1010, for example, has a RDon equal to 0.012, so exactly half.

If IRF1010 has an IDS current of as much as 84A, against the 20A of the IRFP460 and a half-RST then why not always use this instead of the IRFP460? The answer is because it has an interruption voltage of 60V instead of 500V and therefore in many applications the channel could be shorted due to non-recirculated peaks due to inductive loads.

Moral of the story, in each application we must carefully weigh the choice of components depending on the loads and the ways in which the circuit will work.

download databook →

(http://www.gtronic.it/energiaingioco/it/scienza/cap15_power_inverter_file/irf1010e.pdf)

Another very valid MOSFET for applications of this type is the IRFP70N, which carries a current of 70A and a voltage of 60V. It is probably ideal as general purposes with geared motors that are typically used in automotive applications, campers, trucks and boats. The pinout and housing is the same as that shown in the diagram. By clicking below you can download the databook.

download databook →

(http://www.gtronic.it/energiaingioco/it/scienza/cap15_power_inverter_file/IRFP70n06S.pdf)

The international Rectifier instead produces this excellent component that with an interruption capacity of 60V guarantees an RDSon equal to only 0.009 Ohms, with the possibility of reducing it to about 0.0045 ohms by working two elements in parallel, or going down further parallel a larger number . The possibility to connect more elements in the parellolo is typical of the Mosfet, and definitely not recommended for BJT transistors, since the mosfet have a temperature coefficient, which determines the power losses and therefore the dissipation in heat, positive and not negative as the BJT.

download databook →

(http://www.gtronic.it/energiaingioco/it/scienza/cap15_power_inverter_file/irfp064.pdf)

The default MOSFET with which I present the article and I have developed the tests on the prototype is instead produced by the ST microelettronic and the databooke downloadable from below:

download databook →

(http://www.gtronic.it/energiaingioco/it/scienza/cap15_power_inverter_file/IRFP460.pdf)

An economical but acceptable solution is given by the MOSFET IRFP450, in many cases interchangeable with the default one, even if its active channel resistance is rather high, greater than 30 milliohms and its maximum current, while being adequate to practically all the gearmotors that we will consider, lower to 14A maximums.

download databook →

(file:///D:/2019/CYBERSERV%20ICES_2019/G_TRONIC_2019/Let's%20GO%20PIC.html)

Following this link you will find a useful comparative table of the most common Mosfets. Let us remember that, as can be seen well from the scheme, our mosfet is an enriching H channel.

http://www.wvshare.com/column/MOSFET_Device.htm

We make some additional considerations on this section you PWM piloted power saying that in some cases you could, power transmitted allowing, replace the mosfet with a cheaper TIP122, which despite having the TO220 case, therefore smaller, has the homologous pinout (base-> gate, collector-> drain, emitter-> surce) in the same position, so you could weld in the same position. This component limits the power to a value of respect, in fact we could drive the classic D.C. with 12V armature used in the windows of cars and very employed, given the ease of retrieval (to recovery camps) for school papers. On many occasions I have sent my young students to procure engines of this type in the spells of caresses.

A modification of this type, however, involves some small reasoning that we will do in the appendix at the end of the page.

Reversing section of movement:

It is known that the reversal of the DC actuators is generally obtained with a bridge H. There are many ways to make it even if it is generally shaped by four elements, usually BJT arranged on deem facing branches whose central bridges, (between the collector and the conveyor of each totem) is the equilibrium point that we will unbalance through the command signals produced by a generic control system. The voltage level presented by the command / control system is different depending on who produces it, for example + 24DC if we are connected to the outputs of a PLC with standard transistor outputs, or +12 volts DC if we obtain the signals from two buttons connected to the battery of a car, or simply the standard TTL levels when you want to interface to a microprocessor / microcontroller control system.

The H bridges in their basic configurations have some problems, such as shorting out when used by an unintended operator / programmer, it is easy to see that closing the elements of the same totem creates a short circuit usually destructive for switching elements.

The H bridges realized as explained by the coarser theory, that which we find everywhere, are made with four equal elements, usually NPN transistors, without taking into account that the bases of these four elements are not at the same potential, and that the polarization involves of problems since the control mesh of the "higher" electives also have in emitter the sum of the voltage drops not only of the junctions but also that of the armature of the motor. The upper transistor does not work in optimal conditions but it improves the situation by mounting two PNP transistors in the upper position but with the additional burden of inverting the logic level of command with respect to their PNP partners.

In this case, 4 outputs of the microcontroller are engaged instead of 2 and the command bases are disjointed. High PNP transistors saturate better and will not heat up

The relays identified as most suitable for the realization are the RT114012 or those of the following data book:

download databook →

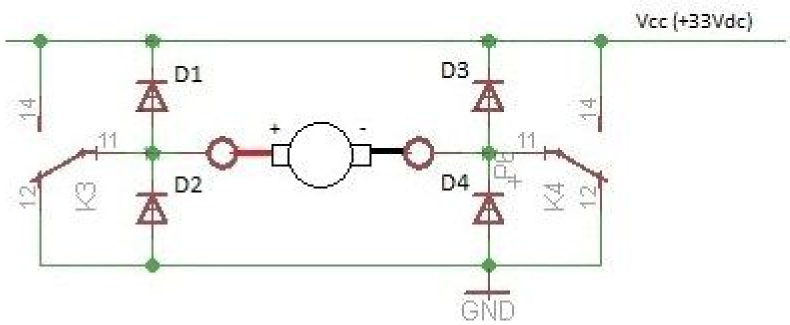
(http://www.gtronic.it/energiaingioco/it/scienza/cap15_power_inverter_file/rel%C3%83%C2%A8%20RT114012.pdf)

On page 3 of the databook we have an important collection of information that will allow us to identify any similar model produced by siemens. (the acronyms vary slightly in other houses).

- ***RT = miniature relay for printed circuit assembly***
- ***1 = 1 pole, 12A***
- ***1 = distribution of the standard pins, NC towards the coil and the pin alone is the common***
- ***4 = nickel silver contacts with percentages 90/10***
- ***012 = coil supply voltage***

With this legend we are able to identify the signed object RT114012, or our relay with an exchange and a 12-volt coil, the last three final digits had been 524 then the coil was powered at 24 volts.

A value added to the safety that commands are not conflicting and destructive is achieved by implemencing the bridge with this relay configuration which in fact prevents short circuit to ground.



Electromechanical analysis is quite intuitive. First of all, note that in idle state (deenergized coils) the motor is located with the collector terminals between ground and earth which obviously means engine stopped.

acting on the only coil of K3, the contact 11-14 is closed by connecting the positive of the motor to the positive supply, and since the path is closed to ground (in this example) the motor travels in the direction of its physical winding, which we we identify as a forward march.

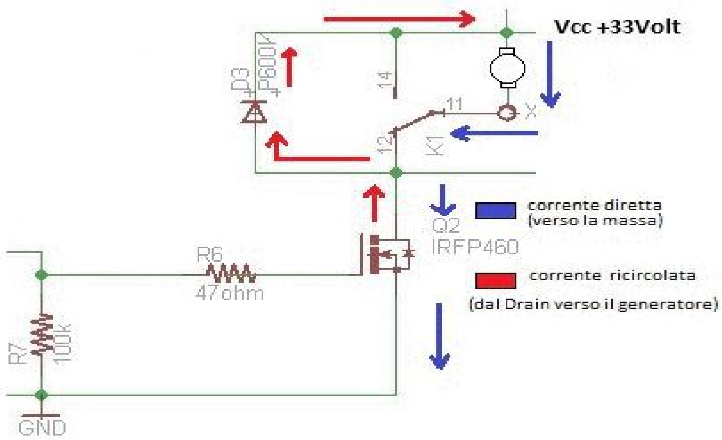
Suppose now to give an incorrect command, that is to force the motor to execute the backward movement at the same time by energizing the K4 coil, the circuit opens from the ground, and the motor will be connected to the terminals connected between two equipotential points interruption of the current passage. The engine stops.

The first coil that is de-energized, starting from this position, determines the starting direction of the motor. In a completely similar manner, one reasoned if the K4 coil that would drive the engine backwards was the first to get excited. It follows that the bridge provides the greatest safety obtainable from these H-shaped configurations, even if a contact or both remain glued, which occurs if a good system for extinguishing the arcs explained below is not foreseen .

Recirculation section (optional external module):

The recirculation of the energy due to the inductive overcurrents, during the control interruption phase, that cause a reversal of potentially damaging or even destructive voltage reversal for the final power elements of the controller, occurs on the single fast diode that we see in the diagram indicated with P600K .

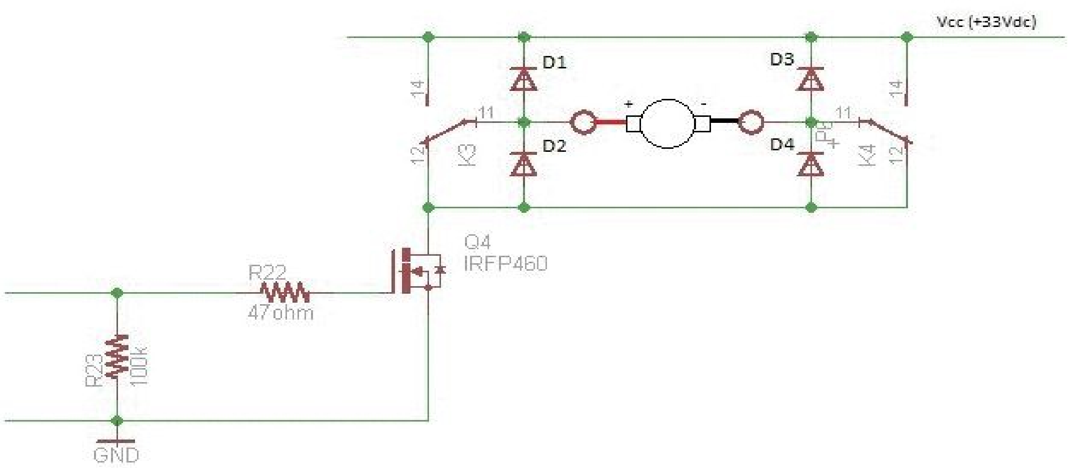
This solution is acceptable during use with contacts (forward or reverse) well closed, but sometimes not very effective, especially if the opening of the two contacts that are found in series to the engine should not be simultaneous .



By clarifying the concept better, the diode on the printout is very effective for the use of the shield with few control maneuvers and long periods of operation, for example, I turn the engine on and leave it on for a long time in the same direction, also varying the speed, since the contacts become nothing more than pieces of electrical connection (as if they were wires). The recirculation configuration becomes the classic with a + Vcc cathode and anode at the switching junction both for forward and reverse travel.

During operation with many interruptions or sudden changes of direction this solution is at the limit of functionality and we will see (with a few large motors) of the annoying arcs on the relay counterparts. (with small engines it does not happen or is acceptable).

To eliminate the arcs on the contacts when motors with high armature currents are used and there are frequent reversal maneuvers, it is advisable to connect the recirculation diodes as shown in the figure:

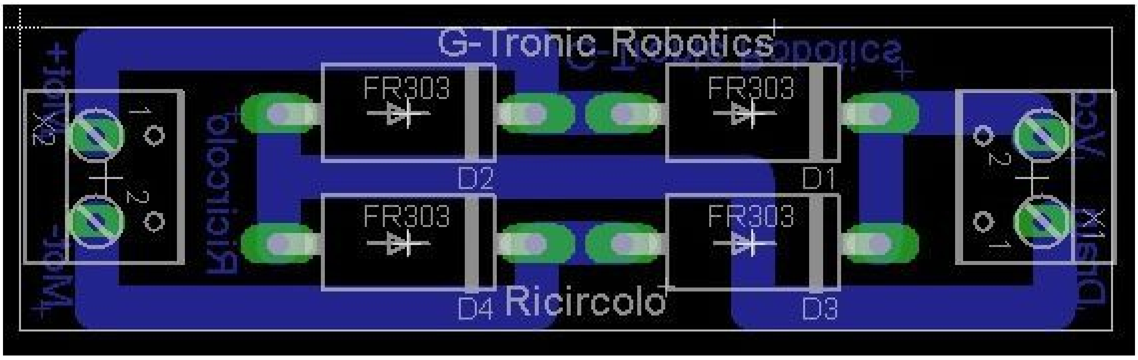


The diodes perform the following function:

- D1 turns off the arc on the NO contact. of K3, stop phase of the forward gear.
- D2 turns off the arc on the contact N.C. of K3, stop phase of the reverse gear.
- D3 turns off the arc on contact N.A of K4, phase of turning off the reverse gear.
- D4 turns off the arc on the contact N.C of K4, phase of turning off the forward gear.

It is good to build a small external module on which to house the four diodes, thus freeing themselves from the reduced dimensions of the printed circuit board. In this case it is not necessary to mount the recirculation diode on the PCB.

There are excellent recirculation diodes with T0220 housing which also allow excellent heat dissipation. Regardless of the recirculation diodes that you choose for your construction make sure that they are of the schottky type, which ensure a much faster intervention time so that the inductive tensions do not have time to reach extremely high values. There is also an advantage in terms of recirculating current which could, depending on the short intervention times, remain limited to the pair of amperes.



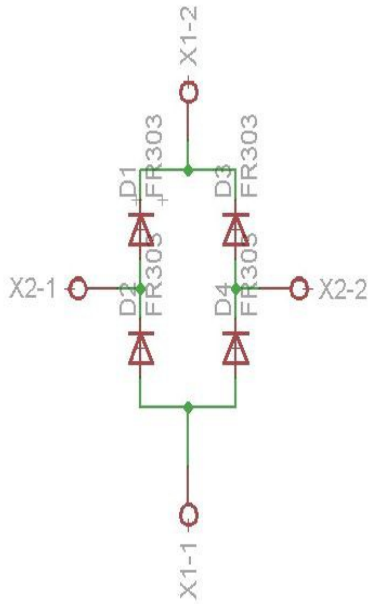
Eagle printed circuit for recirculation diodes

The wiring diagram is in the picture below, the points of connection with the card are as follows:

- ***X1-1 -> connect in the diode pad of the diode not mounted onboard, corresponds to the drain of the Mosfet***
- ***X1-2 -> connect to the positive supply voltage of the motor (bring a cable in parallel)***
- ***x2-1 -> Positive motor armature terminal***
- ***X2-2-> Negative motor armature terminal***

download the complete Eagle project (it also contains the gerber files) →

(http://www.gtronic.it/energiaingioco/it/scienza/cap15_power_inverter_file/ricircolo_esterno.zip)



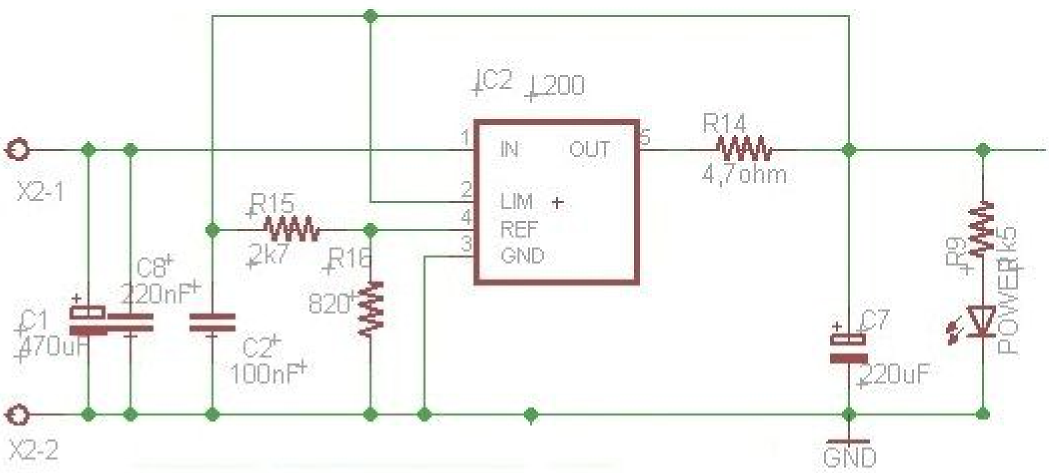
Power section:

The classic voltage regulators of the LM78xx series have the drawback of accepting declared voltages of about 36 Vdc in input, and of having a dropout of about 2 volts, a rather high thermal dissipation especially when asked to perform a jump of rather high regulation, for example over 21V since the power supply of the device is to be obtained from the 24Vac rectified input (in the secondary of the trafo), which then becomes 33Vdc, at the ends of the leveling capacitor. In this case, the DC gearmotors power supply is taken from the mains via a 24Vac secondary transformer, rectified by a strong diode bridge (over 20 A, depending on the number and the tonnage of the gearmotors inserted in the wire-fed rover, with armature at 36 volts). The fact is that the LM78xx regulators are at risk of explosion due to the proximity to the maximum input voltage margin, often exceeded due to the fluctuations due to the induced reactions of the motors connected to the same line.

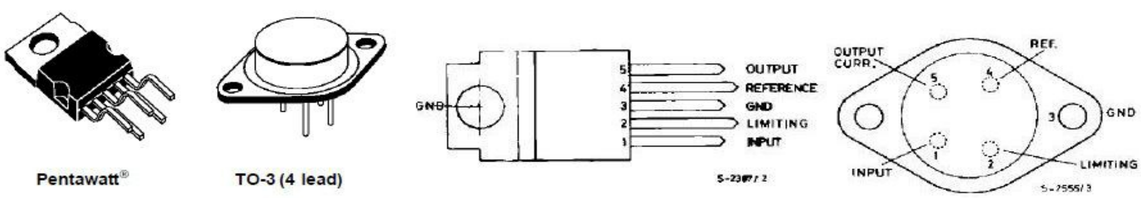
It has been verified that the first prototype, in which it was thought to exegure the regulation with three successive leaps LM7824-> LM7812-> LM7805 that these explode disaluciando the circuit.

The solution was to eliminate the 5V regulator as the NE555 timer works in an optimal way even at + 12Vdc, and at the same time perform a single jump with the L200 regulator instead of in two LM7824-> LM7812, since it easily supports in input a voltage of over 40Volt, then with a sufficient safety margin compared to the 33Vac with which the motors were powered. We have therefore that the Robot, or CNC, or machine that uses the gearboxes, can easily mount actuators with armature up to 36Vdc (slightly under-powered when the voltage is obtained from the straightened and secondary level of a common transformer with secondary winding at 24Vac, or optimized when it is possible to straighten and level a 25.45Vac transformer if it were available, the theory shows that between the effective value and the peak value of a single-phase sinusoid there is a ratio which is like the square root of 2 which is worth about 1, 41).

L200 is a slightly dated integrated product, manufactured by SGS-Thomson microelectronics, available with pentawatt housing (therefore with 5 pins with a similar structure to the LM78xx series of regulators, or more robust TO-3 with 4 pins and the fifth, gnd They are classified by the manufacturer as "Adjustable voltage and current regulator" since they are able through a sort of hardware programming, implemented by means of some resistors, to set the output voltage independently from the input voltage, provided that it is compatible , and also the maximum current that will supply on this voltage freeing it from the variability of the load (a sort of protection on the maximum current) The device is equipped with automatic thermal protection indicated in the documentation as "Thermal overload protection" that puts it in fact shutdown , then turn it off, although the typical operating parameters are set at 40 volts of boulder voltage but at the input, it is read on the databook that is able to withstand voltage fluctuations up to 60Volt, value in which the device is placed in protection (input overvoltage protection at 60Vdc). Further technical specifications of the L200 are:



- ***Output current adjustable beyond 2A even if the junction temperatures reached Ti = 150 ° C***
- ***Adjustable output voltage that can fall below 2.85 volts***
- ***Protection against extra input voltage up to 60Vdc for 10ms***
- ***protected against short circuits***
- ***thermal protection***
- ***low absorption current when in standby***
- ***dropout (voltage drop input-> output supported by 32 volts).***



For our application, that is the driving of a DC geared motor with induced brushes and collector and permanent magnet excitation, with brush voltage of about 36 Vdc obtained from a rectified and then leveled by the secondary of a transformer of appropriate power (depends on the number of engines in the Robot and therefore by the number of mini shield used), the programming of the device, in order to have a 12Vdc output, useful for the relay coils and 2 amps of current limiting, sufficient for the two coils plus the consumption rather low of the PWM generator, it is carried out acting on 2 resistances for the stabilized tension in output and a resistance for the current limitation. Looking at the over-exposed range, R15 and R16 are used to fix the voltage at 12V and R14 to set the limit of limitation of the maximum current at 2A. The formulas used are Io (max) = (V5-2) / R3 for the protection threshold of the maximum output current and **Vo = Vref * (1 + R15 / R16)** to set the output voltage.

We proceed to the simple calculation of the limitation current by inverting the equation since we know Iomax = 2A set by us.

Iomax=2A=(V5-2)/R3

La nostra incognita è R3

around the equation multiplying both members by R3 and dividing both members for Iomax, performing the obvious simplifications between numerator and denominator we obtain:

R3=(12-2)/2=5ohm

using the 4.7ohm value we obtain a small correction of the value that passes from the 2A initially required to the 2.12A obtained practically with the resistance retouched from 5ohm to 4.7ohm.

To fix the value of the 12V output we proceed instead fixing the value of R16 to that recommended by the manufacturer, then the 820 ohms that we see in the databook and applying

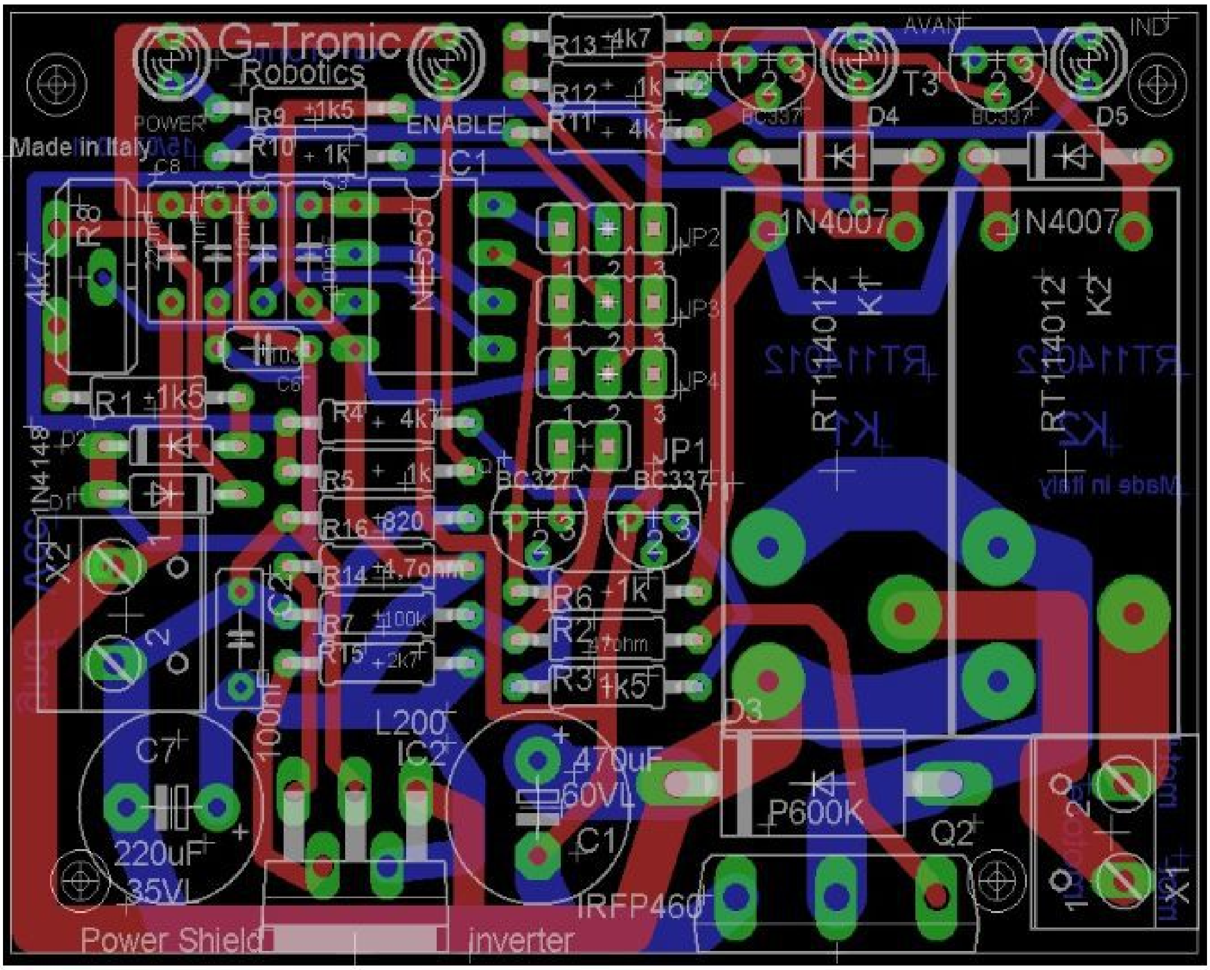
Vo = Vref * (1 + R15 / R16)

in which we have Vin 33Dc which would be straightened and leveled in input. Also in this case we have to turn the equation. We obtain R15 equal to 2k7 ohms. Condensed 220nF in input and 100nF in output to polyester are recommended by the manufacturer and prevent the initiation of aoutoscillations. Attention that the heat sink of the housing is connected to gnd, while the metallic dissipative part of the mosfets is at the drain so they must be electrically connected to the cooling fins if put in common between regulator and power mosfet.

Circuit churn and PCB development:

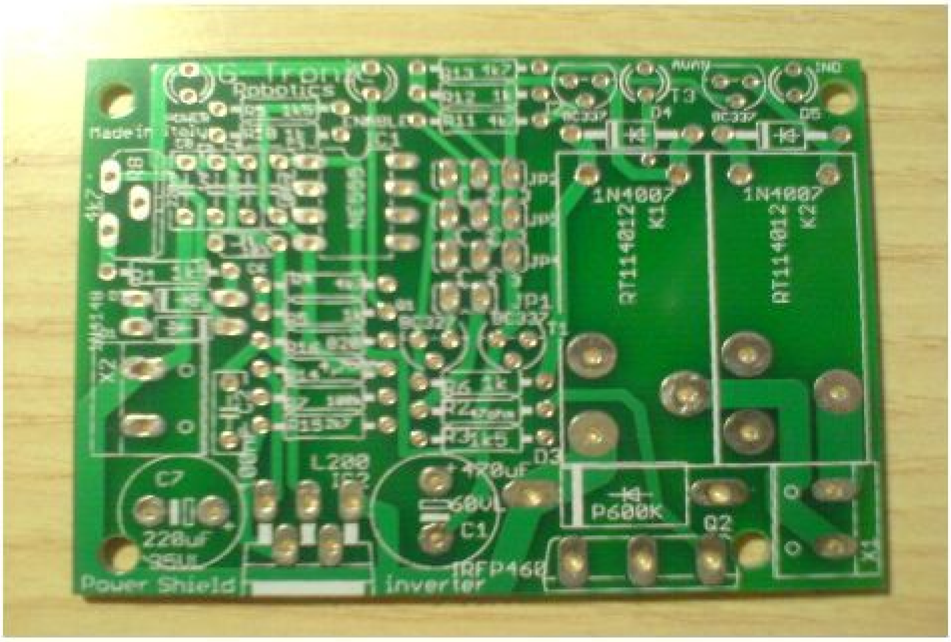
As we can see from the wiring diagram, the project is developed in Eagle that we know how to contain a discrete autorooting algorithm. In this regard I wrote 3 tutorials that can be found on my personal site, on grix, or in copy at this address http://www.guiott.com/ tutorial section exercise cad 1,2,3.

Once the routing has been performed, it is necessary to define an optimized layout that has given me the results visible in the next photo:

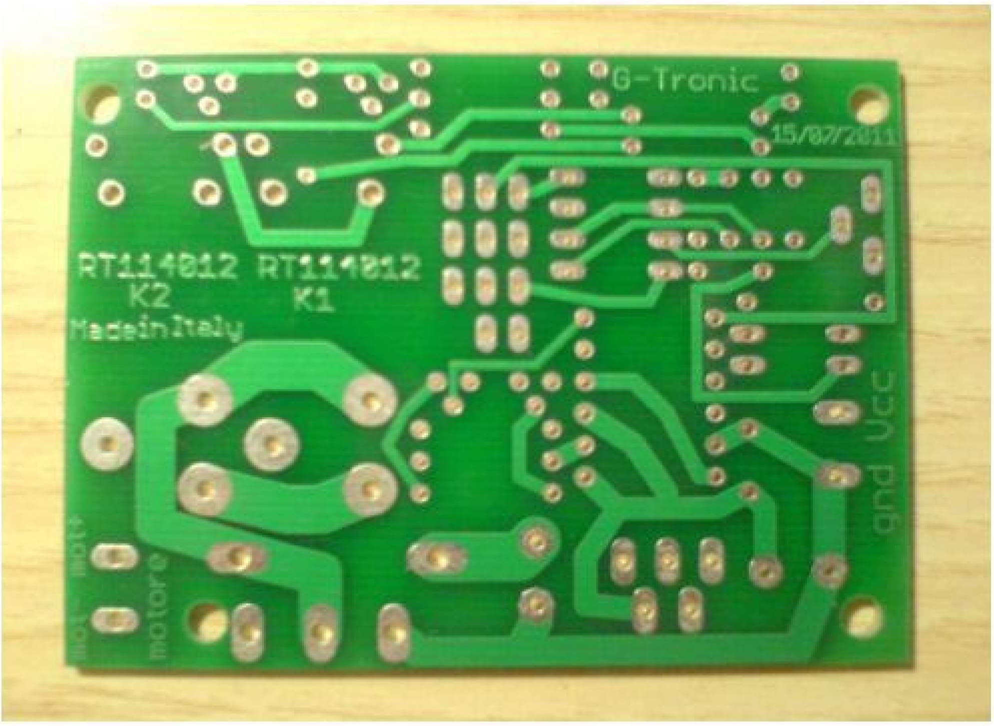


The values of all the components are clearly visible in the layout image. The relays are of type RT114012 with a 12V coil and an exchange able to carry a continuous current of 12 amps that will directly drive the armature of the motor. We note that the tracks in which another current is present have been optimized in width and length, in fact the paths of these currents have been minimized towards the clamps thanks to a nice congenital layout.

the PCB obtained is this:



In the next photo the solder side of the PCB



Note the word Made in Italy and the date of realization.

The PCB measures only 66mm x 49mm.

The printed circuit boards shown above are available while stocks last. Anyone interested can ask for them at the email address: info@cyberservices.it

They will be provided at the cost price incurred to realize them and the shipping price.

To build a simple ROVER you will need two of these PCBs plus a Micro-GT mini.

3D preview:

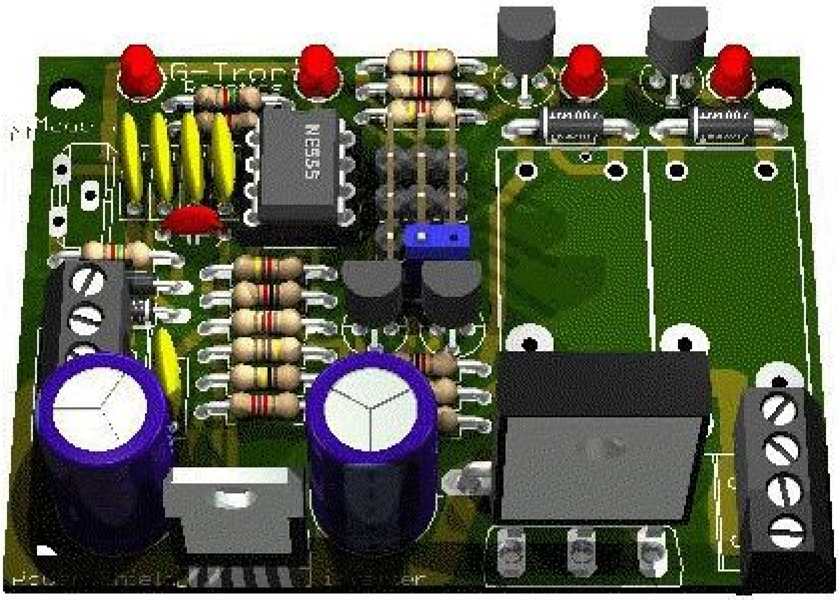
For some time, before carrying out the realization of the PCB, I verify the layout and the appearance of the realization by executing the 3D drawing of the base.

We proceed by installing two additional software:

- POVray
- Eagle3D

Both available on the internet. Once installed, you will have the bitter surprise that the operation requires a series of settings that are anything but simple and intuitive.

Making it short you will have difficulty with the libraries and in the generation by Eagle of the file interpreted by POVRAY that is nothing but a viewer and rendering of files obtained with different CAD, in fact was not born for Eagle.



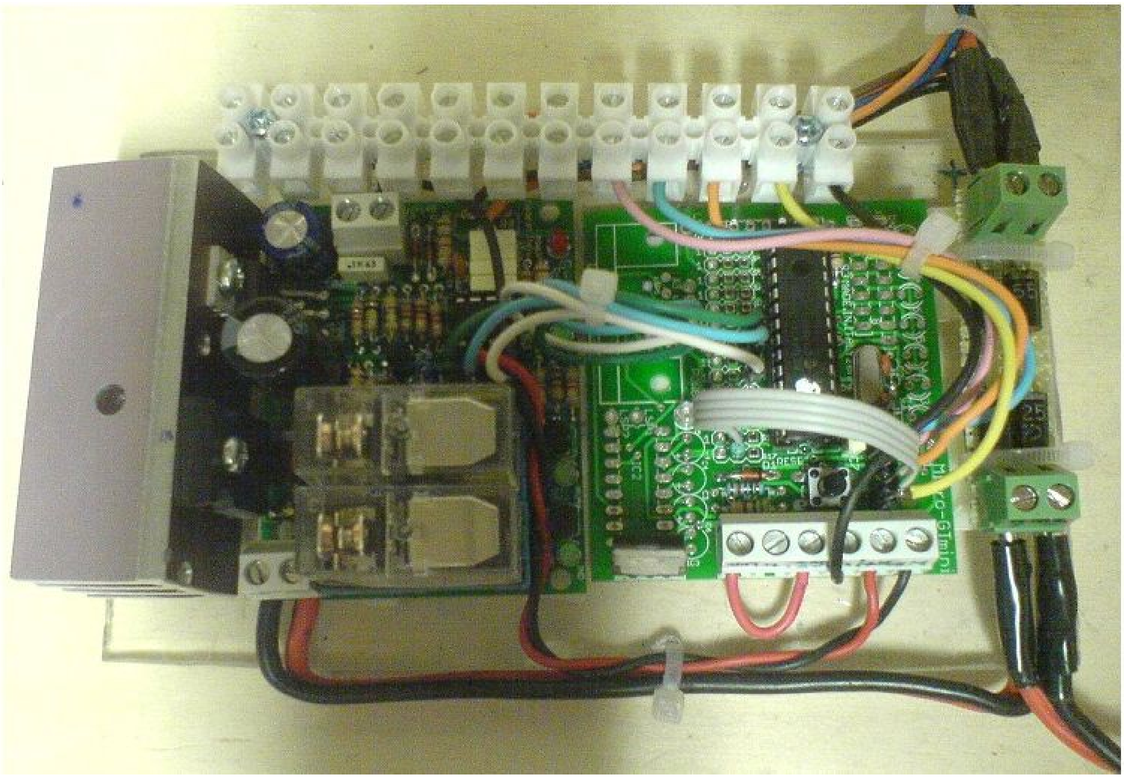
The result, if you can configure the POVray and in the photo you see. A suggestion to solve problems in compiling and libraries is to compile from within the folder includes the povray and not that of Eagle.

The complete system:

To obtain a good application of this power minishield it is good to have at least this material:

- **a Micro-Gt mini (or a similar programmable card) for logical control.**
- **one (or more, in fact with the Micro-GT mini, we can drive more than 16) minishield PWM power inverter.**
- **one (or an amount equal to the mini shield) external recirculation module if large motors are used.**

The finished product shown in the picture below:



Starting from the left, we see a sample of "mini shield PWM power inverter", in which relays have been mounted with a continuous 18A contact. We must remember to isolate the mosfet from the cooling fin, or isolate it from the mass (not recommended). In any case, the TO of the L200 and the drain of the mosfet must not be continuous with the short probe search. In the event of an error, no element is destroyed but the speed control is bypassed as the drain and surce of the mosfet are short, but the motor is present as a load for the applied voltage. It is then brought to the speed of rotation of the nameplate data if powered by the Vnominal.

To the right of the Mini shield a Micro-GT mini specimen in which only the components essential for the specific application were assembled, so I removed the communication port and then the MAX232 level shifter. Striplines are eliminated, as well as LEDs that are useful during operation as a demoboard. An assembly of this type is extremely economical.

On the right the external recirculation model, in this case made with four P600k diodes, but any other diode as long as fast and better if Schottky is fine.

Appendix of the end of page.

Variations and applications of the PWM power inverter mini shield:

We now present 3 variants and applications of this electronic card so that the reader can realize its usefulness. There are many other situations where you can use it. let's now give only the most obvious and intuitive trying to support the affirmations with a little technical notionism.

A series of school theses are being developed using this mini shield (automatic gates, access control, parking, traffic lights, silos loading, level control, etc.). I invite all my colleagues in high school or vocational training to participate / collaborate on this project and future minischields, also simply by bringing experiences or requesting projects to themes.

The source codes in C have not been reported in this publication because it was already very verbose in the presentation of the hardware, but an infinite number of ways opened up.

I wait for comments and suggestions or PCB requests for more effective teaching at the address

info@cyberservices.it

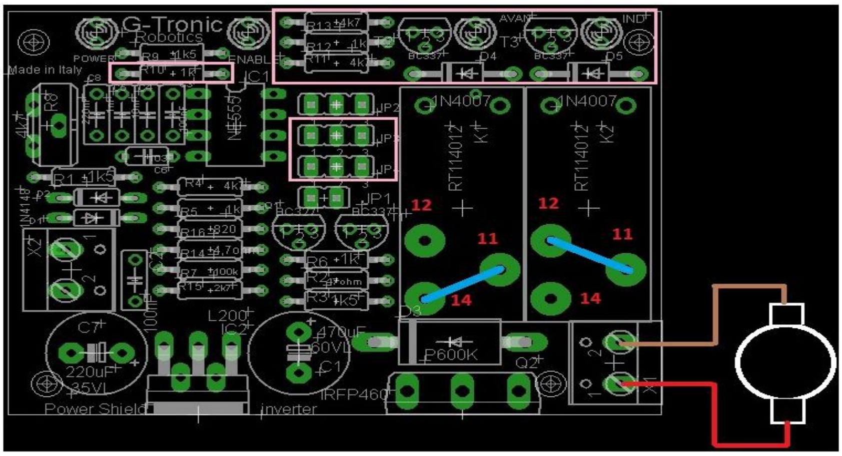
Variant 1: When we are not interested in reversing the march:

The reversal of travel is obviously made possible by the presence of the bridge H made with the two relays RT114012, which, despite being contained, have their own cost, as also the hooves on which it is best to mount them have a cost. If we are not interested in reversing the DC engine gear we will connect it is logical to think we can eliminate them.

Directly on the print, so we do not even install the plinths, bridging with solid copper wire, obtained for example by cutting the leads of recirculation diodes the contacts:

- ***11-14 of the K1 relay***
- ***11-12 of the K2 relay.***

We obtain what is visible in the figure:

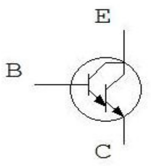


All the elements inside the pink rectangles can not be assembled, in fact they are the driving circuits of the missing relay coils. The cost of the shield is significantly reduced.

Regarding the recirculation diode P600K (or alternatively FR303) this will be installed in the correct position. It is obvious that if the application required a definitive adjustment of the speed and that this was available to the user, then the potentiometer can be replaced with the trimmer as indicated in the serigraphy.

Variant 2: Drive the gearmotors for power windows:

If resistant torques are not applied to the widely variable axis and the installation of motors for window winders for cars then the current is about 1A in free-drive mode, and it hardly ever exceeds the 3-4 amps in start-up phase and in the blocking phase of the rotor. We can then install the NPN darlighton type TIP122.

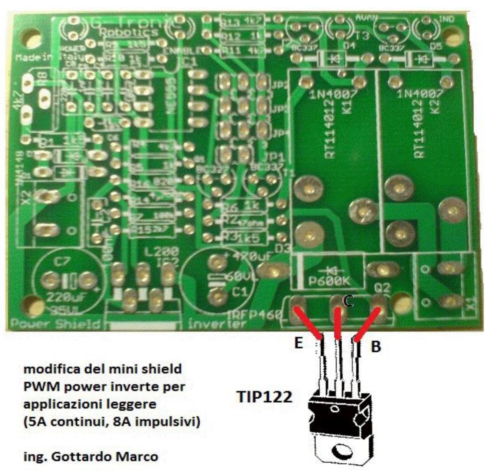


The pinout is totally compatible, even if the holes are a little larger and the pads are spaced. It is a good idea to equip the transistor with a small heatsink, even the "C" ones recovered from an old board.

As is clear from the internal scheme, this particular transistor, although composing itself of two elements, presents itself externally with the same terminals of a single which continue to be called Base, Collector, Emitter.

The overall gain of current which becomes the product of the two heats has the advantage.

In this way, a transistor is obtained which, despite being for power applications, is sufficiently soft on the basis that it can be driven to saturation with a few milliamps. The component supports 5A in an impulsive manner approximately 8A (databook). The saturation takes place with a base current of about 10mA so for a driving TTL voltage (+ 5V) it will be necessary to replace the resistance R6 (in the 47 ohm scheme) with a resistance of 330 ohm. Resistance R7 may instead be omitted, but its installation will not affect the operation of the circuit. The sequence Base, Collector, Emitter is the same as Gate, Drain, Surce so we can install in the same position but remember to keep the metal part to the outside of the card (the rest, on the contrary in addition to the wrong sequence of pins would also be impossible mount the heatsink.



In fact, by adapting the transistor it is possible to use the pcb for any power load (limited to the maximum tested), so if we want to drive a DC micro motor, we can even exploit the support to house a BC337 or similar, obviously paying attention to the correct sizing of the polarization network, although limited to R6 resistance.

Variant 3: Piloting a high brightness LED ceiling light:

Since the PWM control for driving the LEDs does not have to be so high, it is enough 100 or 200 Hz instead of 22Khz as the PWM is optimal for the control of these gearmotors, and that the current will be at most a couple of amps we can use the TIP122, darlinghton transistors instead of the expensive Mosfet. It is also possible to eliminate the recirculation diode since the load is not inductive in nature.

White LED ceiling light for lighting. The system has been tested on this with an excellent linearity effect of the regulation and no flicker.

At maximum intensity the light is dazzling. The ceiling light is not however original with respect to that provided by way of example by the manufacturer. Substantial changes in the circuit have been made to be able to feed it continuously.

http://www.gtronic.it/community/cap15_power_inverter.htm