SM361 RIG SWITCH CONSTRUCTION MANUAL

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Controls the power of 12V equipment while a vehicle is in use

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SM361 RIG SWITCH OVERVIEW

It is a common problem for people with radio equipment in cars that the power will disappear when the engine is turned off. This leaves the operator frustrated if they are frequently in and out of the vehicle and don't want to miss any important communications.

Alternately, the equipment can be hard-wired to the vehicle battery, but then the risk of leaving the equipment on and flattening the battery overnight is quite real.

Voltage Sensitive Relays have been a common solution, as they detect when the vehicle engine is running by a rise in battery voltage and use this to control equipment operation. Unfortunately many late model cars have 'intelligent charging systems' that may shut the alternator down at any time if it thinks the battery is sufficiently charged. This can result in turning the equipment off while the car is actually in use.

This kit is for the construction of a switching unit that will turn 12Volt vehicle equipment on whenever vehicle vibration is detected. When the vehicle is turned OFF the device starts a countdown timer that keeps the equipment operating for a preselected time period before it is automatically shut down.

The Rig Switch has **three** different levels of sensitivity to trigger timer events and **five** different time delay periods. These selections are made by positioning a jumper inside the unit.

As a kit, it is a simple construction project. A small number of parts must be mounted on a circuit board, then the module is placed into a plastic enclosure. The microprocessor that supplies the intelligence to this unit is pre-programmed and ready to use.

PARTS LIST

Part	Value	Description
R1	2.2K,	Resistor, 1/4W 5%
R2	2.2K,	Resistor, 1/4W 5%
R3	2.2K,	Resistor, 1/4W 5%
C1	100uf	Capacitor, 25V electrolytic
C2	100uf	Capacitor, 25V electrolytic
C3	0.1uf	Capacitor, 50V monolithic
IC1	ATtiny2313	Atmel AVR microprocessor, 20 pin DIP package
IC1	20 pin IC socket	Socket for microprocessor
IC2	LM2931AZ5	5 Volt low-dropout voltage regulator
D1	1N4007	Diode
D2	1N4007	Diode
JP1	10-pin IDC header	Option selection for time delay
JP2	6-pin IDC header	Option selection for vibration sensitivity
Shunts	2-pin header shunts	For selecting time & sensitivity preferences
Q1	BC337	Transistor, NPN, 500ma
LED1	3mm red	Vibration Detection indicator
LED2	3mm red	Timer Status indicator
VS1	Vibration Sensor	Conductive ball type
J1	3-way term	Screw terminal for 12V supply input
J2	3-way term	Screw terminal for 12V switched output
RL1	Switching relay	12V, 10 Amp
PCB		Double-sided pcb blank, SM361v1
Box		Plastic enclosure to suit pcb, includes screws
LABEL		Laser printed on white polycarbonate film

ASSEMBLY

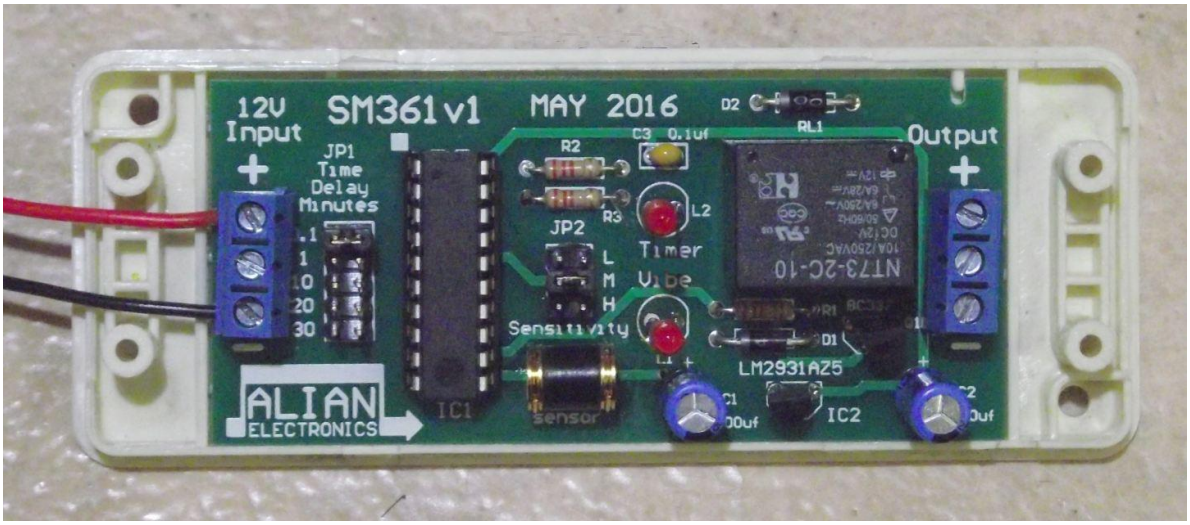
Construction is not difficult. The best solder to use is 0.7mm tinned and a small amount of this has been included with the kit.

The resistors are all the same and come pre-cut and bent, ready for insertion into the pcb. The board itself is double-sided, through-hole-plated (pth) with a clear component legend.

There mare two red LED indicators that need to be correctly oriented and set to the appropriate peak height of 22mm above the surface of the pcb. The flat side of each led should correspond with the flat side of the component outline.

When mounting the 10 and 6 pin jumper headers, it is best to solder just one pin, then reheat this pin until the part is nice and flush with the pcb surface.

The vibration sensor must straddle two tinned pads on the pcb. First place a blob of solder on one of these pads and sweat the part in place with the iron, then solder the second leg of the sensor to the pad.



ENCLOSURE PREPARATION

To place the holes in the correct position of the enclosure, place the label on the cover without sticking it down, then with a pin mark a hole through the label into the plastic just to the left of the ***Timer Active*** and ***Vibration*** words. Then remove the label and drill two 3mm holes over the pin marks. Now it is ok to remove the backing paper and stick the label down properly over the holes. With a very pointy, sharp knife, break through the label and pair around the circumference of the 3mm holes. It should leave a clean, round hole for the LED's to pole through when the cover is on.

With an over-size drill bit, say 6mm, it is worthwhile to slightly countersink by hand, the underside of these two holes, making it easier for each led to slide into its final position as the cover is placed on the unit.

LED INDICATORS

One led pulses and flickers with any vibration activity. Essentially, this lets us know that the sensor is working. Once sufficient vibration has taken place to trigger a timed relay operation, the second 'Status' Led will flash rapidly for the duration of the time delay. If additional vibration is detected while a timed cycle is in operation, the time delay will keep refreshing the timer to the selected delay period. For example, a 20 minute timer selection will only turn the power off 20 minutes *after* the last vibration detected event.

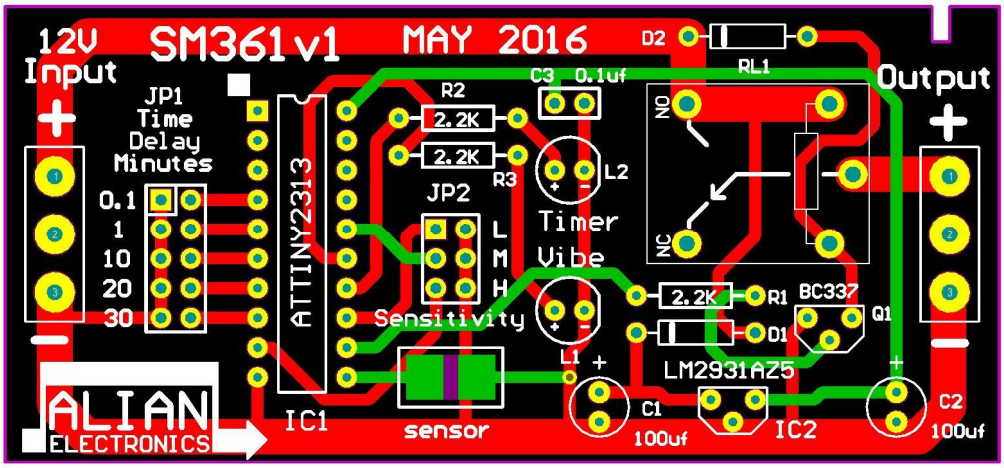
SETTINGS

There are five different time delays pre-programmed into the microprocessor**. 0.1 minutes, 1 minute, 10 minutes, 20 minutes** and **30 minutes.** The **0.1 minute** setting equates to just six seconds. This is not a practical value for equipment timing, but it is useful when setting up and testing the unit.

The **Low Medium** and **High** sensitivity settings select how much vibration is needed to trigger a timed event. For most situations, the Medium setting should be appropriate.

PCB ARTWORK

This image is an extract from the CAD package used to design the pcb. The green lines represent copper tracks on the top side of the board. The red tracks are on the underside of the board. The yellow areas are plated-through holes that electrically connect to both sides of the board.



INSTALLATION

For best results, place the module against a hard surface within the vehicle. If it is simply sitting on a carpet patch, or hanging from wires, then it will not pick up the vehicle vibration as readily as it should.

The plastic box has front and rear orange covers. These act as clamps to provide some strain relief on the wires. The 10 amp relay should be enough for most vehicle installations, but where higher levels of current are required it is ok to use the output of this unit to switch the coil of a heavier relay mounted elsewhere.

If there are situations where the switched equipment must be operated for long periods of time, it is possible to add a heavy bypass switch that essentially shorts the +12V input to the +12V output. (The Negative in and out are electrically connected together on the pcb)

HOW IT WORKS

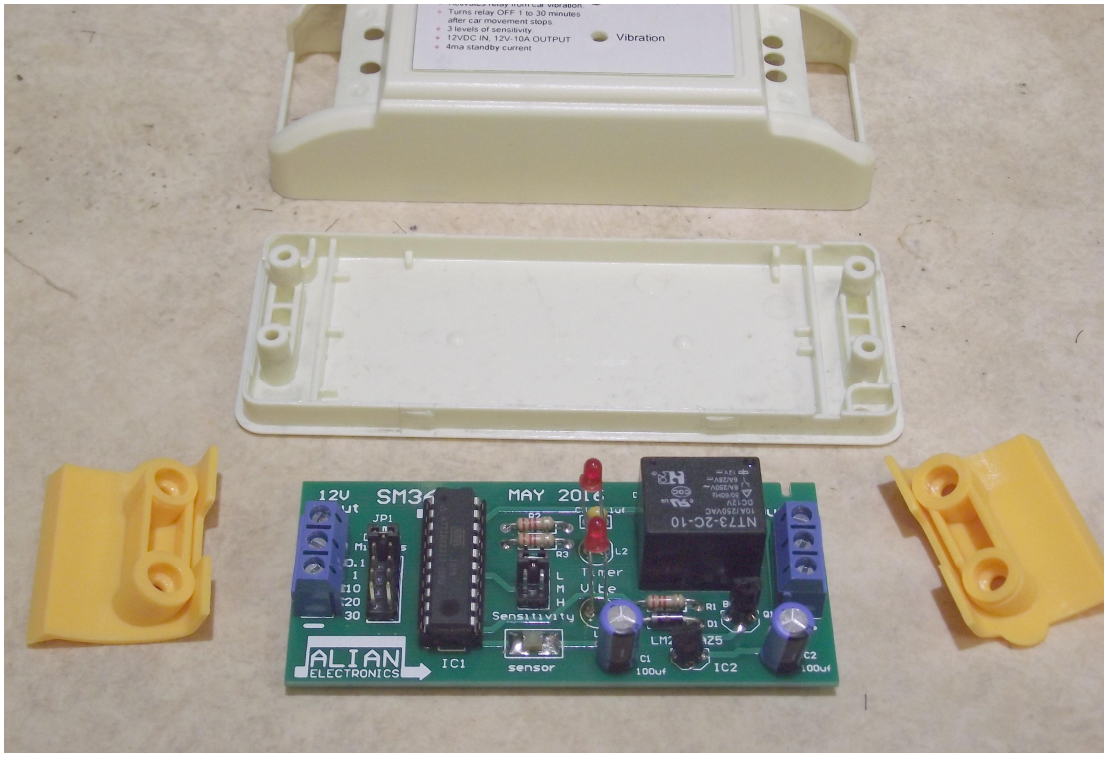
While the unit is simple to build and use, the technology that makes it go is fairly complex. The vibration sensor is a tiny conductive ball contained in a small chamber where it can bounce around randomly shorting together a ring of forked electrodes. This generates electrical 'noise' when the ball experiences any vibration. This signal goes into the input of the microprocessor, which is sampled every 10 milliseconds. Whenever it sees a transition of shorted to not-shorted state of the conductive ball, it increments a software counter. At the end of each second it tallies

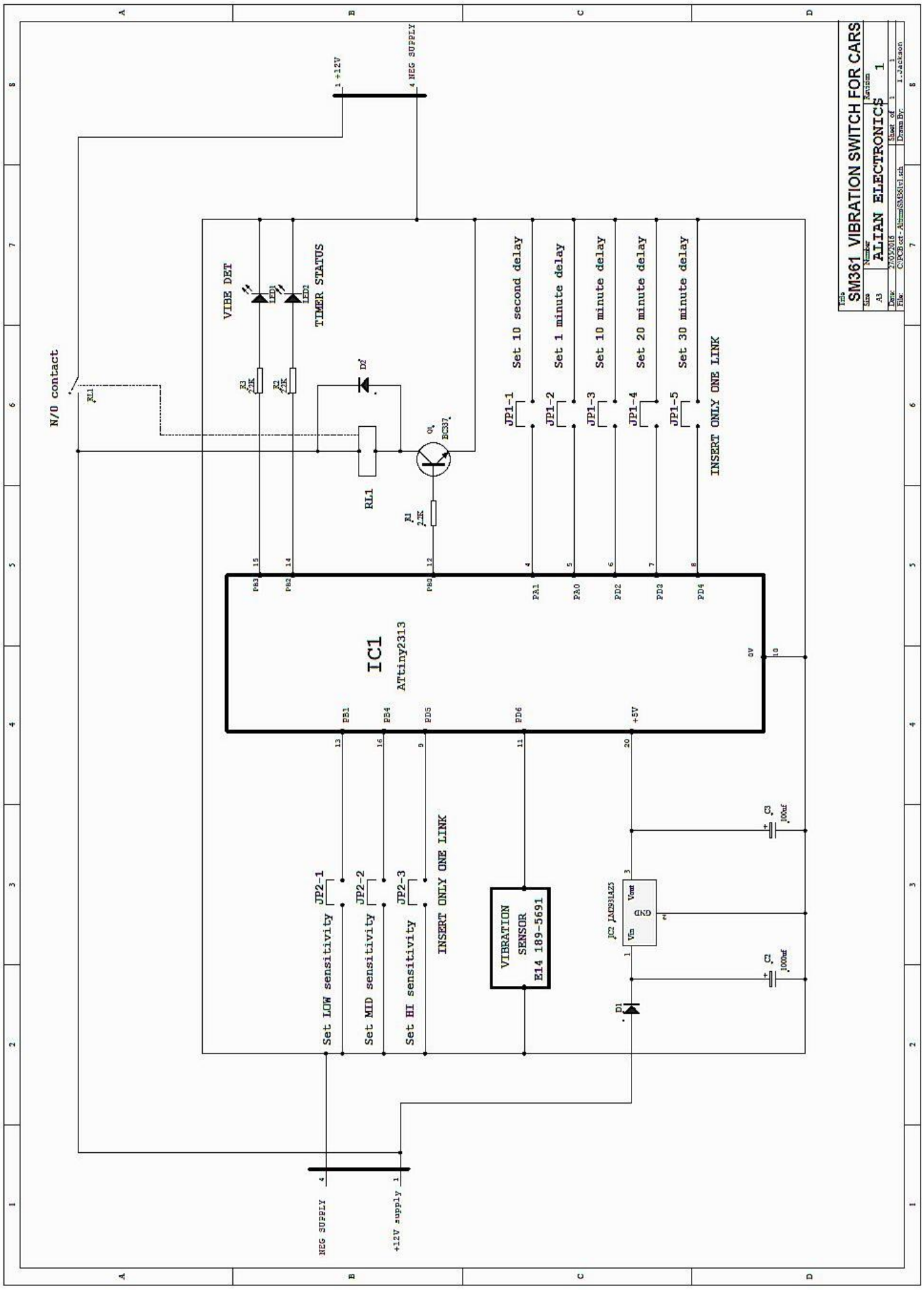
up how many pulses it experienced. If it has sufficient pulses in any given second period, a timed relay event is tripped. A High sensitivity setting means that only 4 pulses are needed in 1 second to trip the timer. A Medium setting requires 12 pulses and a Low sensitivity setting requires 25 pulses.

The microprocessor has an internal 1MHZ frequency reference that is used to cycle the software routines. Essentially the chip has 9 separate inputs, each with an internal pull-up resistor engaged. 5 inputs monitor the time delay settings, 3 inputs are used for sensitivity and one is used for the vibration sensor.
The chip has 3 ports programmed as outputs. One port is allocated to each LED and one to activate the output relay via the BC337 NPN transistor. A back-EMF diode has been placed across the relay coil to prevent relay coil spikes from damaging the transistor.

The small LM2931AZ5 5V voltage regulator used to power the chip is a special LDO type. This stands for *Low Drop-Out* regulation. Normal 5V regulators require at least 2.5 volts of overhead before they loose regulation and begin to reset the microprocessor, which means that during engine cranking any negative spikes ever reach as low as 7.5V, the chip will be reset. With an LDO regulator, the chip won't be reset until the supply dips to around 3V, which should never happen.

The program itself was written in the Atmel AVR assembly language, taking up approximately 900 lines of source code. (including notes and comments) The device was pre-programmed using a special serial USB adapter.




SM361 VIBRATION SWITCH FOR CARS
ALIAN ELECTRONICS
1
1.Jackson
N/O contact
VIBE DET
TIMER STATUS
LED1
LED2
D2
R3 2.2K
R2 2.2K
R1 2.2K
RL1
Q1 BC337
JP1-1 Set 10 second delay
JP1-2 Set 1 minute delay
JP1-3 Set 10 minute delay
JP1-4 Set 20 minute delay
JP1-5 Set 30 minute delay
INSERT ONLY ONE LINK
IC1
ATtiny2313
PB3
PB2
PB0
PA1
PA0
PD2
PD3
PD4
0V
PB1
PB4
PD5
PD6
+5V
JP2-1 Set LOW sensitivity
JP2-2 Set MID sensitivity
JP2-3 Set HI sensitivity
INSERT ONLY ONE LINK
VIBRATION SENSOR E14 189-5691
IC2 LM2931AZ5
Vin
Vout
GND
C3 .100mf
C1 .1000mf
D1
+12V
NEG SUPPLY
+12V supply
NEG SUPPLY