EDUCATIONAL MODULES

For LEARNING and to PRACTICE the ELECTRONICS

www.cebek.com

EDU-010. The Electromechanical Relay

EDU-010

The Edu-010 distributes in four practices the control and operating principles of an electromechanical relay, with special thoroughness in the different control circuits and the possibilities of commutation with inverter and double circuits. Original technical documentation from the manufacturer is included, to allow the student to well understand control and design parameters of the component. The module does not require additional components or material to do the different described experiments, all elements are included in the circuit.

Practice 0. Definition, elements and types of relays

Practice 1. The relays coil. Control voltage, coil current, input-output insulation and output circuit.

Practice 2. Relay Control through NPN. Shot current, control/relay coil voltages

Practice 3. Control for several relays. The ULN 2803. Advantages and differences regarding the NPN.

Practice 4. Double inverter output. Relay's output. Example : switching polarity of two poles

EDU-010

EDU-010. The Electromechanical Relay

Warranty and Do not forget.

Cebek educational modules included in the EDU serial offer several practices to analyse, experiment and to learn basic knowledge on the studied theme. Nevertheless, their function is not to make a mini-class on each theme, but to complete and to be used as basis, as well as to allow to experiment on the theoretical theme evocated by the teacher. For this reason, we suggest you to use modules form the EDU serial under the supervision and the direction of a teacher.
Cebek doesn't offer a consulting service as concern the theoretical or the operating principles concerning the theme deal with the module. It only offers a technical assistance regarding questions and problems coming from the circuit's internal operating mode.
All Cebek modules included in the EDU serial have a warranty of 3 years as concerning components and labour man. All damages provoked by external causes (from the circuit), as well as wrong connections or installations or due to an operating mode no indicated into the module's documentation won't be covered by the warranty. More over, all wrong or incorrect handling won't be excluded from the warranty. For any claim, you have to present the corresponding invoice.
To contact our technical department, you can send a message to sat@cebek.com, or a fax :N°+34.93.432.29.95 or a mail to the following address: CEBEK, c/Quetzal, 17-21, 08014 Barcelona (SPAIN).

Rules and Identification of the EDU serial elements.

To make easier the identification and for a single rule as concern different practices and educational Cebek modules, all common elements will answer to colour code and to a shape.

Test Point. (TP).
It allows to connect oscilloscope's or multimeter extremities to read parameters relating to the practice. According to its colour, it will indicate that the Test Point (TP) is connected to the positive or to the negative of the circuit, as well as reads concerning current, voltage, load, etc….

TP. ⊕ circuit
Red

TP. ⊖ circuit
Black

TP. Voltage
Yellow

TP. Current
Blue

TP Without current or TP AC.
White

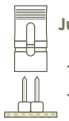
Conmutator / Switch.
According to the colour of the switch, you can control the voltage, the current or

Power supply
Red

Current
Blue

Voltage
Yellow

Logical
Green



Jumper.
It allows to close or open a signal or an electrical ›circuit

Important Point.
Point with special importance,
To remember.

EDU-010. The Electromechanical Relay

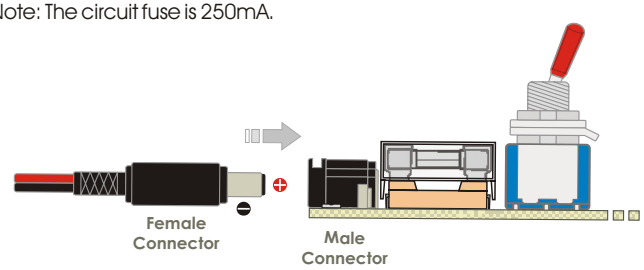
Before to start...

Before to start a practice,
Before to start a practice, it is very important to carefully read its instructions manual as well as corresponding indications.
You have to correctly make connections concerning indicated contact points, otherwise measures depending on these connections will be confuses or incorrects.
Do not make any connection or short-circuits no specified in this manual, to avoid to damage the module.
If the illumination Led indicated as "PWR" doesn't light on or if its function is suddenly stopped, you have to immediately disconnect the devise from the power supply and to check if there is no short-circuit as well as the fuse state.
Even if you can make this practice following instructions described into this manual, we suggest you to make this practice under the supervision of a teacher allowing to consult, to increase or to help regarding concepts described herewith.
On the circuit, each practice will be delimited by a rectangle with the corresponding number. One or several experiments could be reported to this practice.

Module's power supply.

The module is supplied at 12 V DC. You have to use a laboratory stabilised power supply like our Cebek FE-113. The circuit's feeding is done through the male connector inserted on the board, do not inject signal on any other terminal placed on the circuit. Once supplied, the circuit offers necessaries voltages to make experiments with each practice. To connect the power supply, the module includes a cable with a male connector at one extremity and wires at the other extremity.

Respecting the connector polarity, you have to connect each terminal to the corresponding and respective terminal of the power supply. Then, you could insert it on the module.
Note: The circuit fuse is 250mA.



Required Material.

You won't need any additional material or components to experiment with this module. You only need basis measure instruments to obtain and to compare obtained values from this practice. For this module, you will need one or several multimeters with their voltmeter, ammeter or ohmmeter functions. If you have an oscilloscope, you could also use it to substitute the voltmeter.

Bibliography.

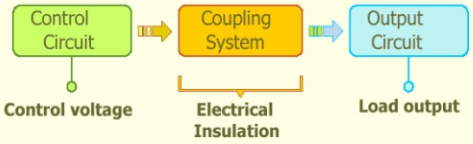
Bibliographie
- With Google: HD74LS Series
- With Google: ULN2803 . - On Internet: www.findernet.com | www.ralux.com
- On Internet: www.findernet.com/es/pdf/bigfiles/para_el_instalador_04-05.pdf

EDU-010. The Electromechanical Relay

Practice 0. Definition, elements and type of relays

The relay is a switch with electrical insulation between input and output that allows to connect and to disconnect high powers through low control signals.
The relay's skeleton is identified in three blocks, on which they will fall the basic parameters to determine its design.
- Control circuit, input or excitation.
- Connection system.
- Output circuit, loads or operation.

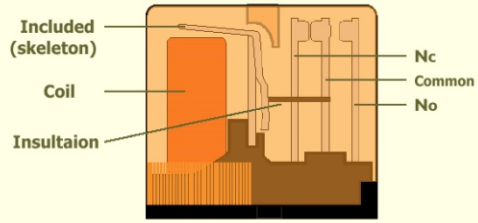
Relay's structure.



There are innumerable types of relays, but they can be classified basically in two groups: Electromechanical Relay and solid state relays.
The solid state relays, SSR (Solid State Relay), are encapsulated electronic circuits that contain in their interior a shot circuit by level, connected to a semicondor switch, a transistor or a thyristor. The connection is done through an opto-coupler or through a transformer which magnetically actives the shot circuit of the Triac, lacking therefore of mobile parts.
The electromechanical relay is composed by a coil, and separated contacts that will be united when the generated magnetic loop is activated. The connection system is therefore magnetic, and the commutation in the output circuit is done through mechanical elements.
Among electromechanical relays there are mainly:
- Relays with mobile core.
- Relays Reed type or with a tongue-piece.
- Relays with skeleton, (most usual), on which is based our Edu-010.

The electromechanical relay with skeleton is the most popular. When the electromagnet composing the coil will be excited, it generates a magnetic field which attracts the skeleton, causing the closure of contacts configuring the output circuit. These two contacts, (Common and Normally open), can include a third, (normally closed).

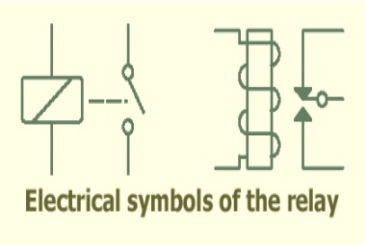
Relay's with skeleton.



EDU-010. The Electromechanical Relay

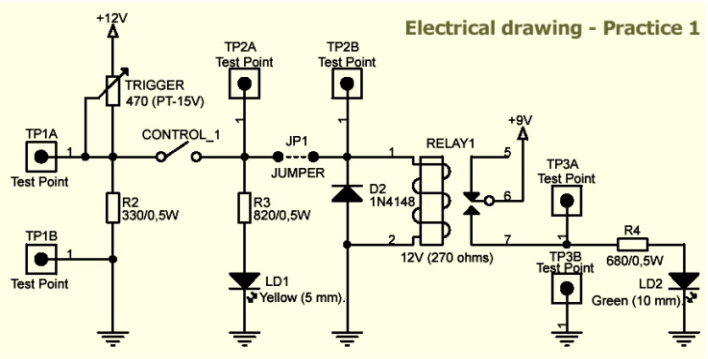
Practice 1. The control circuit

According to the relay type, its electrical symbol can be differently drawn, nevertheless, the two more usual are the indicated on the figure.
Most of manufacturers have different relays families, with different characteristics and sizes among them, supplying also for each family different models with different control voltage.



Practice 1 allows to carefully study, through two experiments, the electrical operating mode as concern the control circuit of the relay, with parameters like the mentioned control voltage, current and coil impedance, insulation and the output switching.

First Experiment. The Trigger variable resistor, (shot), determines the control voltage which is applied to the relay's coil, in order to obtain at any moment to obtain the reading of this value. You have to place a voltmeter between TP1A and TP1B test points. At the same time you have to use an ammeter between TP2A and TP2B, removing JP1 to configure the circuit in series mode. Finally, the Control_1 switch must be closed. Through the adjustment of the Trigger you can establish the control voltage between 5.6 V and 12 V. From 10.4 V the relay's coil will be excited, illuminating LD1 and activating the consumption reading to approximately 35mA.



The manufacturer stipulates that the suitable excitation of the voltage relay in this practices is 12 V and a current of 44 mA. (due to the coil value, 270 ohms). However, as the own characteristics of the component indicate, there is a voltage margin in which the relay is also excited; this margin is established between 10.4 and 16.5 V. For this reason, in the practice, the relay's shot is done before arriving at 12 V. From the ammeter measurement it is obtained that higher the control voltage is higher the coil consumption is.
With these results it can be established that the ideal excitation of the control circuit of a relay takes place when the applied voltage is equal to the typical voltage specified by the manufacturer, and it can be guaranteed the consumption current of the coil.
For applications requiring a higher control voltage and at the same a lower consumption of the coil, it can be appreciated as the impedance of this one is also higher.

EDU-010. The Electromechanical Relay

Practice 1. Control Circuit and Operating mode, (part II).

Experiment 2. Whenever it is applied to the relay's coil the shot tension and current, this one generates a magnetic field around it which attracts the relay's skeleton. Then, where in quiescent, the Common contact was separated of the No contact, when the activation of the coil is done, these two contacts are united.
The advantage of this union is easy to understand if we invoke the switch operation mode. When you wish to control the feeding of a determined device, the common switch open or closes one of his two poles activating or stopping its operation. The output circuit of the relay must to be designed like this. The connection of its two contacts will always be done in series with one of both poles of the load to control.

In the practice, you have to place a voltmeter between TP3A and TP3B, then the reading of the ammeter can be erased, now no basic, returning to recover
JP1 union. After adjusting the control voltage to 12 V, through the opening or the closing of Control_1 the coil will be activate or deactivate. With the activated coil, in TP3 you will obtain a reading of 9V and LD2 will be illuminated (it will act as load). But with the coil deactivated the voltage will be zero and LD2 remains light off.
The value of 9 V is determined because a voltage different from the control one is injected through common, appearing only on the load when common and normally opened contacts are united. This characteristic is the great advantage of the relay. The input circuit is electrically insulated from the output circuit, being able to control high voltage loads and consumption with a small control tension and current.

The selection of the relay will also depend on the output circuit dimensions or switching, established by the manufacturer as maximum load value. The relay of this practice can support a maximum load of 250 V and 6 A., for this reason you can control through 12V DC. and 44 mA a device supplied at 230 V AC without never any electrical communication between them

Volt	MIN - MAX	Ω ± 10 %	mA
* 1,5	1,2 - 1,9	3,7	405
	1,4 - 2,1	4,6	
	1,6 - 2,6	6,5	
	1,9 - 3	9	
	2,3 - 3,6	13	
* 3	2,7 - 4,3	18	166
	3,5 - 5,5	30	
* 6	4,6 - 7,2	52	115
	6,5 - 8,7	75	
* 9	6,6 - 10,5	110	81
	8,3 - 13	170	
	9,2 - 14,5	210	
* 12	10,4 - 16,5	270	44
	11,7 - 18,5	340	

Bobina		ZVNX	ZVNS
Tensión nominal	>V -	97	97
Potencia de trabajo	W	0,4-1	0,22-1
Temperaturas admisibles	ºC	- 25 + 75	- 25 + 75
Tiempo de conexión	ms	7-9	7-9
Tiempo de desconexión	ms	3-6	3-6
Aislamiento bobina a masa	V ~	1500 eff.	1500 eff.
Tipo de aislamiento	VDE 0110	C/250V	C/250V
Contactos			
Intens. máx. contacto (carga)	Ω	250V - 6A	250V - 2A
Potencia máx. contacto	VA	1200	500
Material del contacto	2,7 Ø	Ag CdO 90/10	Ag CdO 90/10
Aisl. contacto a contacto	V ~	2500 eff.	2500 eff.
Aisl. contacto a masa	V ~	2500 eff.	2500 eff.
Varios			
Operaciones/hora	>	3000	3000
Vida mecánica	∇	3×10^7	3×10^7
Homologaciones		en curso	en curso

Characteristics offered by the manufacturer

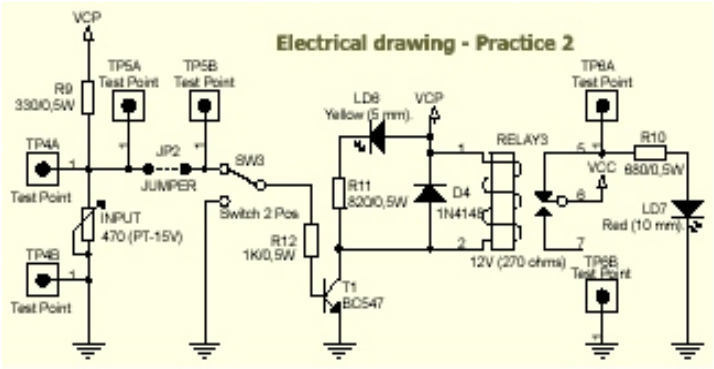
The connection system also offers a fundamental parameter in the design of the relay. In spite of the existing electrical insulation there is a physical insulation between input and output circuits, a very high voltage could save it. This parameter, supplied by the manufacturer as insulation of the contact to the ground is usually offered as effective voltage in A.C. In the case of the relay used in this practice V it is established in 2500.

Practice 2. Control Circuit of a relay through NPN.

Often there is a relay with a determined shot voltage, whereas the signal with which you wish to control is not into the margin accepted by the component. This inconvenient cannot be always saved using a relay with different control parameters, and it is necessary to apply a technical solution.

The practice 2, shows to the optimal drawing of a relay shot through the application of a NPN transistor, glimpsing the electrical differences regarding a control.

Install a voltmeter between ITP7A and TP7B. At the same time you have to apply an ammeter between TP8A and TP8B, removing JP2 jumper to allow the connection in series.

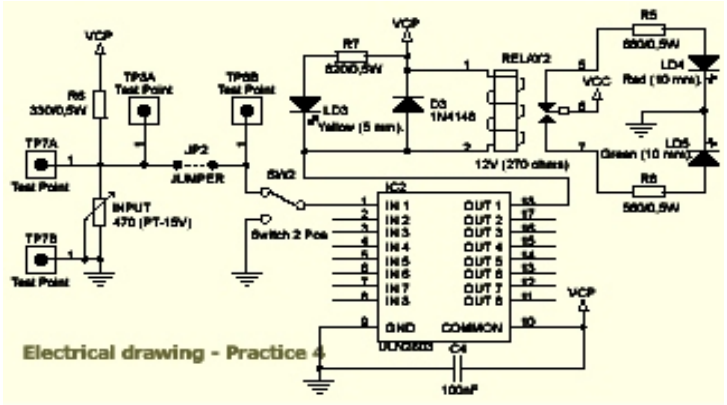


The control voltage, is in this case, supplied through the Input variable resistor, with an adjustment between 0 and 5 V. While the voltage supplied through the potentiometer is not higher to 0.7 V, the transistor will remain in cut, and the relay coil will be without connection to ground, avoiding the relay activation.
The transistor will lead as soon as the voltage applied to its base overpass the 0.7 V, allowing that the current of the circuit of the coil arrives to the ground and activating the relay.

The control of the relay coil through a transistor, in this case through a NPN, can be used as a PNP, it offers important advantages regarding the direct control:
- The necessary current to activate the transistor is about uA, releasing the control device of the necessity to supply the 44 mA, mentioned in the previous practice.
- The control voltage can be different and/or lower regarding the coil activation one, compatible, for example with TTL signals, because the coil feeding is independently done.
- The feeding and current of the coil is based on the transistor collector-emitting union, and it is separated of the control voltage applied to the basis.
- A common NPN transistor, BC547, etc, is enough to supply the necessary current and to allow a relay in parallel as witness of the coil activation.
The drawing illustrates the connection of a diode inversely polarized in parallel with the coil. This diode is a resource widely used, that avoids a momentary short circuit at the coil shot instant, produced by the inverse voltage that it can generate.
The output circuit, at the opposite of the previous practice, uses the Nc contact to switch the load.

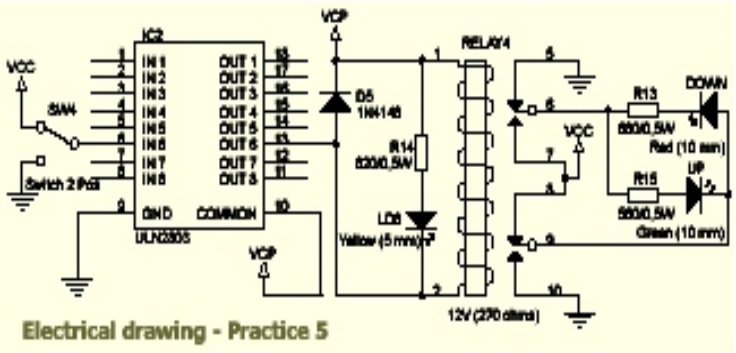
Practice 3. Control for several relays. The ULN2803.

The practice 3 shows the control of the relay through the ULN2803 integrated circuit, extending the control solutions of the relay coil.



The operating mode is identical to the control one through NPN. Nevertheless, the ULN2803 incorpores eight NPN Darlington transistors, adding to the benefits of the previous practice the decrease of components; the control capacity up to eight different relays and the incorporation of the protection diode.
An example of the use of these transistors, in a "driver" function, is the present practice as well as practice 4, where it is used the same integrated, selectingd two different channels for each application.
The output circuit of the relay takes advantage of its two inverted contacts to lighton the green LED when the relay is activated, or the red LED when the relay is deactivated.

The practice 5 shows hot to switch at the same time both poles of a voltage signal.



Until now, the previous exercises used relays with a single investing circuit. The relay in this practice, at the opposite, is composed by two inverter circuits: two
"common", two "Nc" and two "No". Each of these circuits is activated at the same time by the coil of the relays, but they are insulated between them.
This configuration allows, as it is shown on the practice, to invert the polarity of a DC signal, as it is required (for instance in the change of rotating direction for a DC motor).