INSTALLATION AND
OPERATION MANUAL

toscano

THR5

Radio remote control

Description

THR5 is a status transmitter device. It can transmit the switch status to a remote location, without wires. When a switch changes its status at the transmitter, the change will be reflected at the remote receiver relay. THR5 has a capacity of 6 switches at the transmitter, which suits to 6 relays at the receiver.

The system is bidirectional, which means that each THR5 unit is transmitter and receiver at the same time so, occasionally, the remote device to which orders are sent can also send the status of its inputs.

The signals are transmitted at 869MHz ISM band, being its range determined by the relief in which the installation is done, the power of the equipment and the type of antenna used. Working into what is known as the “common use” band, the device does not require any license for its legal use within the European Union. Thus, there is no canon or any need to hire any SIM card or any service operator. The operation of the system is, therefore, free.

The maximum power of THR5 is 27dBm, i.e., 0.5W, which gives a remarkable range for applications in both open field and indoors.

The device is mounted on a DIN rail case of 6 modules width, and can be powered from 9 to 30V. Both the two units making up a basic link are physically identical. However, there are small differences in the firmware, which means that one of the devices will act as master and the other as slave.

The master is responsible for monitoring the system, so it will continuously interrogate the slave and, in case of link rupture, the relay output #7 will open, tripping an alarm.

The function of the slave is totally passive and the relay output #7 will only be used in specific future applications.

Uses

The device is intended for the status transmission of its six inputs to a remote place, in which will activate the matching relay.

Amongst its applications, it can be highlighted the activation of irrigation pumps systems in scattered areas, the “tank-pump” type maneuverings in those places where the well is far from the pond that dams up water, the electrical installations where the distance between the switcher and the load is significant, and so on.

Combined with GSM controllers, it can give them great flexibility in allowing to extend the relay activation of the latter and to distribute the signals wirelessly.

Installation

For proper operation, the unit will need a power supply that provides, at least, 1 amp at a voltage between 9 and 30V direct current, as well as the matching.

Both devices in a link must have the same network address, as indicated on the outside of the box, next to the serial number. Devices with different network numbers may not communicate with each other. This allows different networks to work on the same frequency. It can be created 256 main networks, within which it can be addressed up to 65,536 different terminals.

The first thing to be checked is that the radio connection exists between both terminals. It is enough to place them at their definitive locations, and then connect the antenna and power them. The pilot led marked as “STA” on the front panel will flash for a few seconds with a short but steady blink: * * * * * …

If there is radio connection, the LED will display flash groups whose number is a function of the received field strength: * * *   * * *   * * * … The flash groups may vary between two and seven. Two flashes match the minimum usable signal, while seven flashes match the maximum signal available. If the radio connection is interrupted, flashes again be short but constant: * * * * *…

At that moment, the device to which switches are connected to, will send the status of its switches to the remote device, and thus activating the remote relays. If, for any reason, the remote device (relays) were disconnected or momentarily powered off, at the recovering it will send a status request to the local device (switches), automatically updating the installation status.

The communication between both ends of the radio circuit is protected from errors by a 16-bit CRC. A number of attempts will be executed if the orders are not received on the first delivery attempt due to interferences at the radio channel.

Periodically, the THR5 check the status of the relays remote end matches the local side switches. If a discrepancy occurs, the value of the switches would be forwarded to update their status.

If this is not possible (remote end failure, power failure, broken antennas, etc.), the pilot led “STA” blinks in a continuous sequence and the output “Alarm” (open active) is activated, which can be used to enable an input of a GSM terminal (e.g. GSM-8 model from Toscano or similar).

If the disconnection persists over 90“ approximately, about a general reset of both devices runs, keeping in memory the state of the outputs and the configured mode, restarting the connection process.

Settings

THR5 can work in two different modes:

A) Safe mode: remote relays will switch to inactive status (open) if the radio connection is interrupted.
B) Persistent mode: the relays will not change their status during a possible cut of the radio link.

Both modes are configured with the jumper identified as J16, located on the right bottom corner of the unit, under the terminal cover. With the jumper closed, the unit is in safe mode. With the jumper open, accordingly, the unit will be in persistent mode.

The devices do not need any additional configuration, since all the processes involved in the establishment of the radio connection, as well as the parameters necessary for optimum operation, are automatically adjusted. The system should be seen as if the switches and relays were conventionally wired, in other words, as if there were cables linking them.

Use examples

THR5 finds its application field in any situation where it is necessary **to send the status of one or more switches to remote locations and to activate relays or contactors accordingly**.

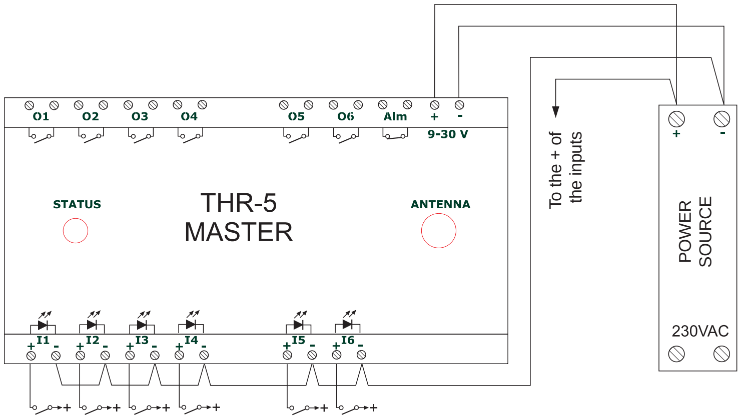
A typical case can be well-tank maneuver: when the level of dammed water falls below a preset volume, the sensor level float closes a contact in THR5. The closing order will be sent to the THR5 installed in the well, closing a relay and starting the extraction pump. When the pond high level float is activated because it is filled, it will close the matching contact, which order will be sent to the well, turning off the extraction pump.

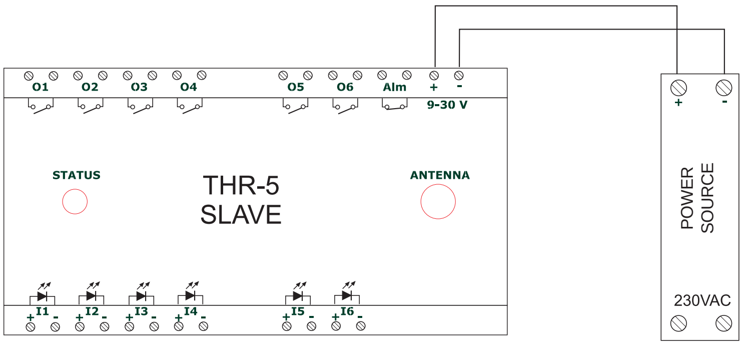
Another example is the case of the **implementation of irrigation pumps, scattered on an estate and controlled from a single point of control (pivots remote control)**.

There are situations in which **a GSM remote control may not function properly when installed in an area of little or no range**, as a basement. In this case, a GSM remote control can be installed in an area within the range, and “extend” its inputs / outputs by a pair of THR5 to those places where systems to be controlled are located.

For **public lighting systems switching on/off**, THR5 system is an ideal solution, at zero operating cost.

Basic wiring

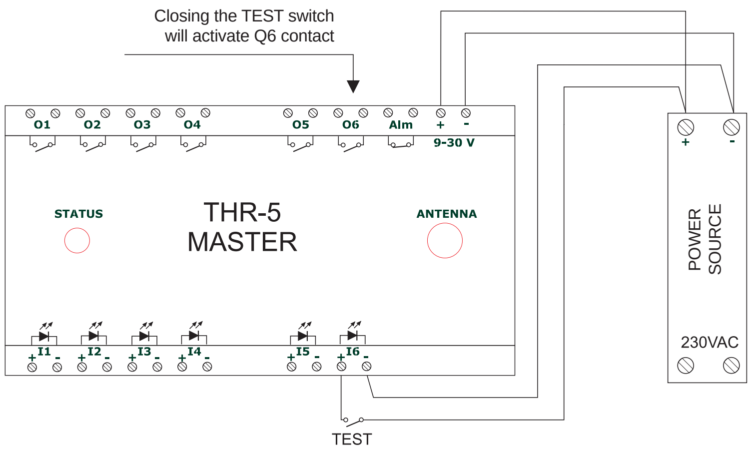


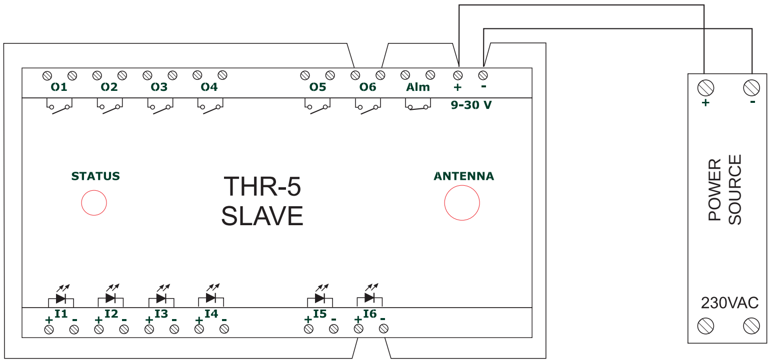


Wiring example

This is a wiring example to verify a successful transmission after the installation of each device in its definitive location.

After completing this wiring, we will place next to the **master** and close the **test** switch. After approximately 10 seconds, **Q6** contact on the master will close.





Radio systems range.

The range of any system based on radio waves is limited by several factors, being determinant, mainly, the noise generated by both the receiver itself and the noise produced externally.

Minimum sensitivity of a receiver.

The minimum sensitivity of a receiver is determined by the noise generated by the receiver itself and that generated by the antenna, as equivalent noise power. This means that, assuming that an ideal antenna should have an impedance of 50 ohms without reactive components or, in other words, a pure resistance, it is observed that such pure resistance, when heated by the ambient temperature, generates a **noise power (Pn)** that has the following value:

Pn = K x T x B
K being the Boltzmann constant, T the noise temperature in Kelvin degrees, and B the bandwidth in which the measurement is made.

The value of the noise generated by any resistance, calculated with logarithmic values and for an ambient temperature of 17° C, is -174dBm for a 1Hz bandwidth. Every time the bandwidth is multiplied by 10, the noise generated by the resistance which represents the antenna will also do, so that for a bandwidth of 10 Hz, the noise is of -164dBm and for a 100Hz bandwidth, the noise will have a value of -154dBm, etc. This means that we cannot get in our receiver signals below these values at ambient temperature, assuming that the contribution of the receiver itself to the general noise of the system is zero, which is not true. The receiver can, by itself, generate a few extra 5dB of noise.

With actual values, our receiver ensures an acceptable rate of error with a power in antenna of -106dBm at 1200bps. We will use this value as the service receiver sensitivity, to which we will add the transmitter power that it is 27dBm, i.e., 0.5W. Both figures give us the **gain of the system**, i.e. 133dB. That number can be increased if we use antennas with gain, value which will be added to specific gain of the radio system.

Let's see how radio signals weaken as it propagates through space. The attenuation of radio signals depends on the distance between transmitter and receiver, as well as the frequency at which the link is done. It can accurately be deduced from the following formula:

Attenuation = 32.4 + 20log F + 20logD (logarithms in base 10)
Where F is the frequency in MHz and D is the distance in kilometers.

Let's review the feasibility of a link at 15km distance, with vertical ¼ wave antennas, for which we assume 0 dB gain: Attenuation = 32.4 + 20log 869Mhz + 20log 15 = 114.7dB.

Since the system gain is 133dB and losses are 114.7dB, the difference, which we call **fading margin**, is 18.3dB. This shows that the link is perfectly possible provided that there is visual range between antennas. However, since the system is exposed to external factors hardly characterizable in the real world, the theoretical values should be taken with certain reservations and to undertake the installations with more conservative criteria.

Installations in the real world.

The effectiveness of any radio system depends essentially on the radiant system, i.e., antenna, cable and connectors, which must be of the highest quality.

There are three types of antennas recommended for different installations:

- Simple ¼ wave antenna for short range links, such as inside buildings or industrial premises. In any case, less than 2km links.
- Collinear 6dBi gain antennas for links between 2 and 7km.
- Yagi 10dBi directional antennas for distances over 7km.

The cable between the antenna and the equipment should be as short as possible, and of good quality. For lengths shorter than 3 meters, RG58 cable can be used, but for longer distances it is imperative to use low loss cable type RG223. For lengths over 12 meters, it would be needed to use Cellflex or Airflex type cables.

All of this applies to links in which the antennas can “see” each other. In installations where there are obstructions, the range can only be determined experimentally.

The antenna must be installed in an open space, it should not be be surrounded by tree branches or vegetation and, as far as possible, there must be theoretical visual range between the both two link antennas.

In the picture can be seen that the excess antenna cable is wrapped around the mast. This is a bad practice because that cable introduces losses that degrade operation of the link. The steep folds are especially pernicious because they create reflections that result in standing waves in the cable. In this case, remove the excess cable and re-solder the connector.

Almost all the problems that arise in an installation are derived from an improper installation of the antenna, and the second cause of setbacks is an inadequate power source.

Technical features

RADIO	Band	ISM 869MHz
	Power	Adjustable 500mW maximum
	Sensitivity	-109dBm at 1200bps
	Maximum gain at 1200bps and 27dBm	136dBs
	Number of channels	18 of which 3 high-power
	Antenna type	External
	Connector	SMA
	Antenna impedance	50 Ohms
	Error protection	By CRC 16
	Attempts	Yes, adjustable
INPUTS / OUTPUTS	Processor	8-bit RISC
	Number of inputs	6
	Activation of inputs (5-30V)	By voltage
	Number of outputs	6 (Dry contact relay)
	Contact	6A - 250Vac / 15A - 30Vdc
GENERAL	Supply voltage	9 to 30Vdc
	Consumption	<1A at 12V
	Size	6 DIN modules
	Mounting	DIN rail