ELECTROMAGNETIC SHIELDING OF INFRARED SYSTEMS (RFI PROTECTION)

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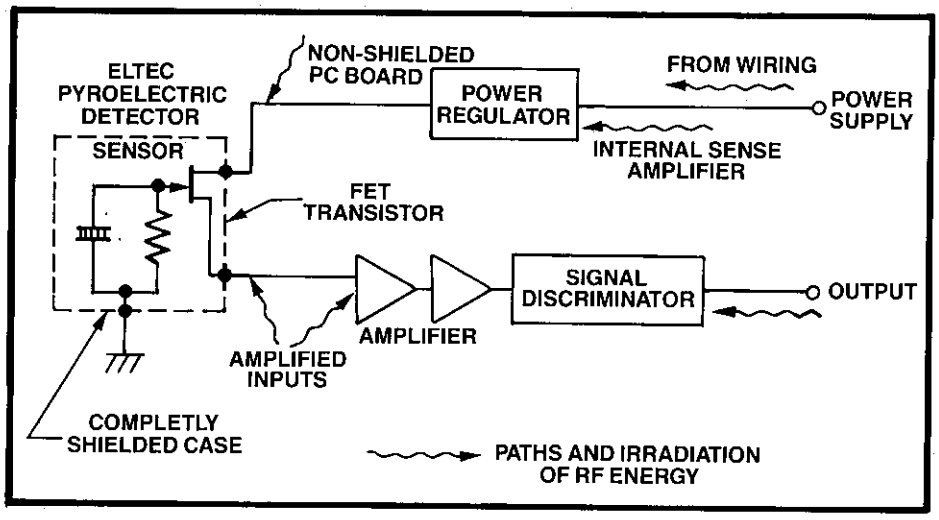
Infrared systems used in intruder alarms, motion detectors, etc., may be extremely intolerant of Radio Frequency Interference (RFI) since the Field Effect Transistor (FET) in the detector can act as a very sensitive receiving rectifier. And the systems usually respond to the magnitudes of these rectified low frequency signals.

The ELTEC detector has a complete metal shield by virtue of its metal case and by a special conductive window material. Also, the special internal circuit makes it less sensitive to RF than many other similar devices. However, in strong RF fields, a certain amount of energy can still enter through the drain and source connections into the FET.

While the pyroelectric detector is the most sensitive part, the rest of the circuit is also responsive to the RFI, but to a lesser extent.

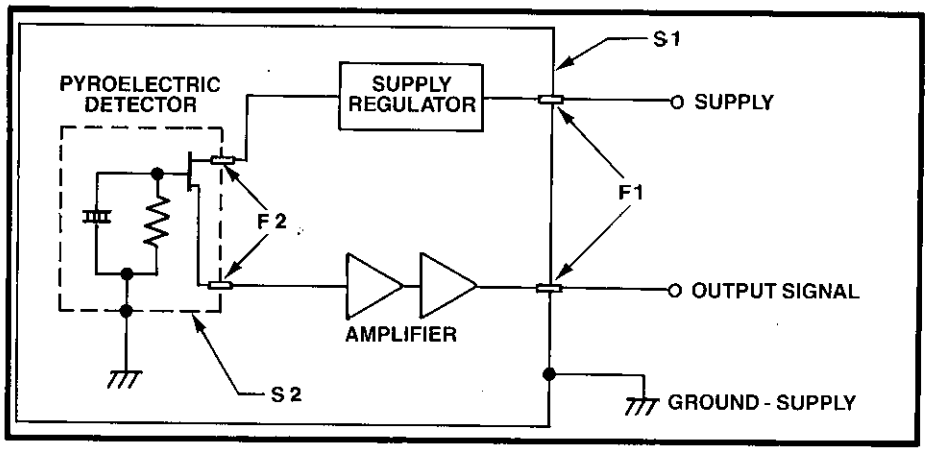


Pyroelectric detectors are most commonly used as hybrid devices employing an internal source-follower circuit. Electromagnetic interference can enter the detector directly from power lines or from wiring and components acting as antennae. In the detector the FET may act on the interference signals as a rectifier and pass the false signals into the amplification circuits. As a consequence, the circuit designer must not only consider the degree of amplification when specifying the type and amount of shielding required, but the actual working environment as well.

RFI Protection Options

1. Shield the complete system (S1);
   Filter any wire connection to the system (F1)
2. Shield and filter for the detector as well (S2; F2)

Shielding a device from RF Interference may involve a bi-level approach. First, shield the circuit with a recommended case design, materials and appropriate feedthru blockers. Second, the pyroelectric detector itself might need additional protection if RF Interference is still causing a problem.



Perfect protection is not a technical problem. Complete metal shielding, with no leaks and good feed-thru filters, will help in all cases. However, in industrial and consumer applications, it may become a severe cost factor. Most shields, filters and gaskets on the market are very expensive. The goal for low cost systems is to achieve adequate protection with few inexpensive additional parts. Therefore, RFI protection has to be considered before the first stage design so casework and other mechanical parts can be mutifunctional and include shields and filters.

Shielding

Adequate shielding for IR systems is obtained with any metal sheet or electroplated metallization on plastic, but not with carbon paints or vacuum deposited metallizations.

The amount of RF energy that can penetrate a metal encapsulation depends on the wavelength of the radiation and the leak or hole size. Five hundred MHz with a wavelength of 60 cm (24") is approximately the highest frequency in normal environmental conditions. A hole or slot half the wavelength (30 cm) makes a perfect antenna, allowing everything through; a slot of 3 mm allows only a fraction to pass.

Conclusion

High frequencies (100 to 500 MHz) are usually critical as leaks can have a size the same order of magnitude as the wavelength.

Any holes, apertures, slots, seams, etc., must have small dimensions, as small as possible. The linear dimensions between firmly connected points specifically are important.

A non-overlapping seam of a cover is as bad as an open case or a large lens aperture.

Remedy

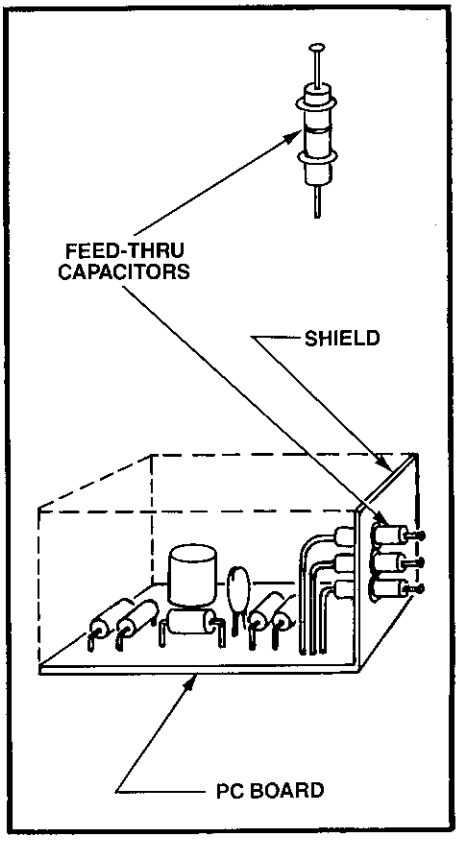
Overlapping seams (5 to 10 mm), finger-type gaskets with a connection every 10 mm or less.

It is important that shielding form a complete skin around the instrument. The electrical connection of the shield to an electical potential in the circuit is less important than skin integrity and can be connected to supply potential directly or via a capacitor.

Filters

The shielding is ineffective if RF energy can enter the instrument through the wire connections. This applies for all connections, no matter if they go directly into the circuit or if they are only a relay switch output not electrically connected to the circuit.

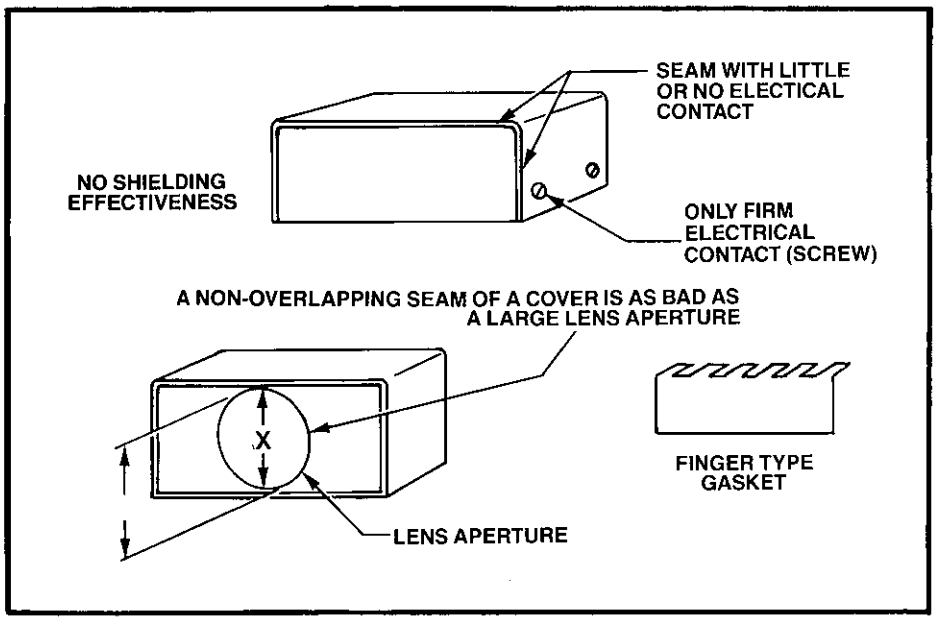
RF energy has to be blocked at the point where the wires enter the shield. There must never be a way for RF energy to bypass the filters. Simple capacitors to ground offer such a bypass and are ineffective. Only feed-thru capacitors are good enough. Their ground connection is the shield and not an electrical ground.



Appropriate feed-thru capacitors are available from most capacitor manufacturers for only a few cents each.

As they are used by the billions in radio and TV receivers, the dimensions are standardized. Feed-thru capacitors are available with a wide range of capacitance values (actually 1 to 2,200 pF). Most effective and therefore recommended are only those with the highest values, i.e. 1,000 or 2,000 pF.

The capacitor's outer ring must be soldered to the shield, so make sure the shield is made of solderable material, such as tin-plated iron, brass or nickel, etc.



The Inner Protection (F2, S2)

The detector is adequately shielded by its metal case. However, the FET connections (drain and source) need additional filtering. This can be done with small ceramic capacitors (1,000 to 10,000 pF) directly from these connections to ground by using very short leads, or better still, feed-thru capacitors even if they are not mounted on the detector can itself:

Also very effective are chip capacitors soldered directly onto two adjacent PC-Board tracks. Such capacitors can be glued on the copper side of the board and wave soldered. They have the important advantage of being cheap, have negligible space requirements and are easily added into existing systems.

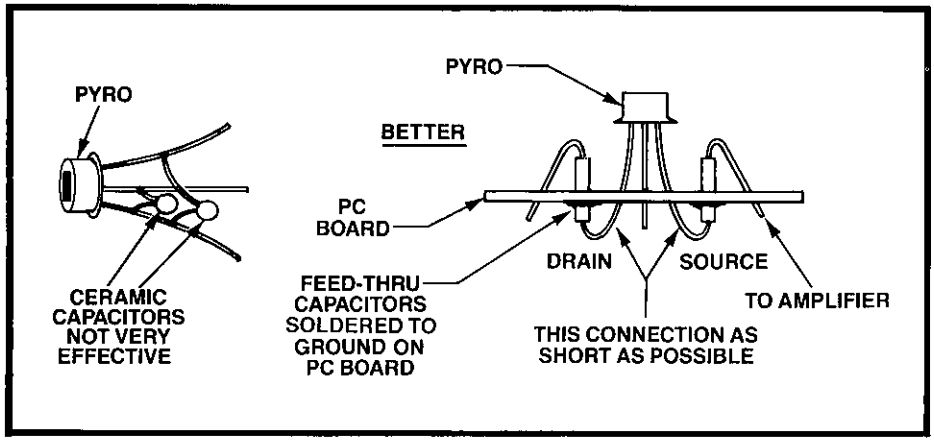
Further Protection

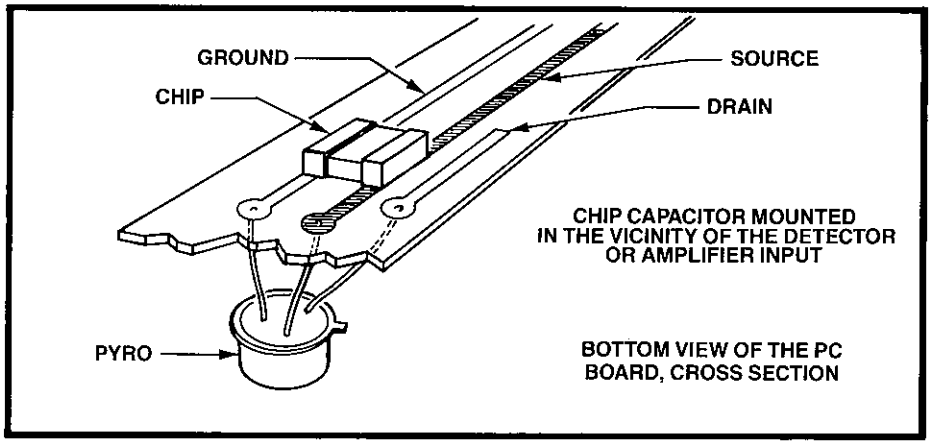
Beyond this shield and high frequency filters, block any internal signal or power supply line to ground with capacitors in the order of 10,000 pF. Electrolytic capacitors should be paralleled with ceramic capacitors since they have a high impedance for high frequencies.

Chokes in the power supply may help prevent high energy/low frequency interference from motors and the like. But, chokes with high inductivity (.1 to 1 mH) have a high parasitic capacitance and do not block high frequencies. Occasionally, a 10 ohm resistor works as well as a choke. Also, ferrite beads on wire connections and on the detector leads may improve high frequency immunity when used together with appropriate shielding and blocking capacitors for medium frequency.

Line Frequency Interference

Proper circuit design and power supply filtering is required in systems that respond to 50/60 Hz modulation frequencies. Whenever possible, a sensitivity to such frequencies should be avoided (as for a chopper frequency).





Testing

Today, RF protection for alarm systems is designed to withstand a RF field of 10 volts/Meter at any frequency. Good test equipment (strip line, etc.) is problematic and expensive, especially when simple tests give good results.

Recommended equipment

An RF transmitter in the 100 to 500 MHz range with approximately 10 Watts;

An old Weller soldering iron that can be switched on and off;

A piezoelectric gas lighter with the high-voltage cable exposed approximately four inches.

The system should withstand these instruments at any distance and with antenna and cables wrapped all around: it should be impossible to trigger and alarm.

Literature

"EMI Shielding and Protective Components", EDN, Sept. 5, 1979

"Problems in Shielding Electrical and Electrical Equipment". by C.S. Vasaka, NTIS Report NADC-EL-5507, 1955

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