

Application Note: SSR100x IR Module Family

Application note for SSR100x IR Thermometer Family

(Please refer to the product datasheet on www.solidstateracing.com for full specification)

Infrared Temperature measurement.

General Application information:

For contactless or remote temperature sensing you can use an Infrared IR thermometer. The IR sensor is aimed directly at the centre of the object of which you wish to tell the temperature. For temperature control applications, because the IR sensor directly measures the temperature of the object, and does so immediately (well at the speed of light anyway!) a response or regulation algorithm can be implemented in a very small code space. There is little or no system lag which needs to be modeled or compensated for - it's a very elegant solution.

You should check that the field of view of your IR sensor is suitable for the application – FOV or F.O.V. This determines the angle from the sensor within which your IR temperature measurement is taken. The dimension of the circular spot on the object defined by the FOV is called the spot size. An IR temperature sensor will typically give you the average of this area. So if you want a specific point temperature use a narrow FOV and hence small spot size (or move the sensor closer!) If you want a large area to be average, e.g. a room average temperature, then use a wider FOV – now the whole room is your spot and everything in it is a target.

But be careful! A smaller field of view sensor will (all other things being equal) a worse signal to noise ratio.



Most everyday objects have a good 'black body' performance. This means that the Infrared energy that they emit is consistent with their surface temperature. The only things which are difficult for measurement with IR are highly polished surfaces. In this case you will see part object temperature and part reflected IR temperature. Typically things like, rubber, wood, paper clothes, skin have good black body characteristics.

For temperature control, it is possible to make a good regulation without regulation algorithms at all – there is no need to calculate air mass transfers and volume flows as in a traditional thermistor based system.

If you want a simple system (one point switching) simply make a potential divider circuit using a trimming pot and set that as a switching point using a comparator and the IR sensor input as the variable input.

You can easily prototype a more complex regulation scheme by taking a multiple comparator IC e.g. ALD4302 and combining it with some trimming pots e.g. Bourns 3296 series dropped across supply voltage to give switching points. The IR sensor input to the system e.g. SSR1002 should be compared as the high input.

Driving the output stages through FETs will then allow you to control your system.

A typical application could also be for monitoring temperature and control of fan speeds and switching point for any temperature critical device: Electric motor, combustion motor, microprocessor, integrated circuits, Intel or AMD CPUs (especially if overclocked).

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IR Tire Temperature Monitoring – How to!

The easiest way to log tire temperatures using a SSR1001 or SSR1002 infrared thermometer is to use them in conjunction with a configurable data logging system such as available from Motec. These systems typically have open Analog input channels suitable for a 0-4.5 volt output and will have a 5v reference voltage available.

The best place to physically place the sensor module relative the tire depends upon the type of vehicle.

For open wheel race cars, it should be decided if the set-up is for track testing or to run during actual race events.

For track testing it is better to mount the sensors equidistant from the tire surface facing either all forward or all rearwards for consistency. Where possible, 3 sensors should be used to measure the temperature gradient that is generated across the tire surface as this will help to

determine best tire pressures, and suspension geometry settings (e.g. camber).



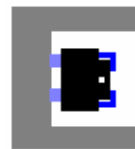
Using a 22degree FOV a typical mounting frame is constructed to position the each sensor 100mm from the tire surface resulting a 40mm spot diameter. The spot separation should be adjusted so that the left, the centre and the right target spots are well spaced but leaving approximately 15-20mm margin at the tire edge to avoid edge effects.

The closer the sensor is mounted to the tire surface, the smaller the spot diameter for measurement and also the more likely it is to be affected by debris or other radiant temperature effects. The heatsink (aperture) should always be protected where possible from both debris and stray temperature effects e.g. radiation from a hot disc brake surface. As IR energy travels 'line-of-sight' any simple shielding will be useful or alternatively an insulating cover can be successfully applied to the sensor such as the SSR1010 'Install shield' protective and insulating over.

If the sensor mounting position is not fixed rigidly to the vehicle (e.g. hand held) care should be made that:

- 1) The temperature measurement position is consistent
- 2) No part of the IR module makes contact with the tire surface itself
- 3) A consistent distance/geometry is maintained test to test.
- 4) The hand held device is easy to use so as not to dislodge tire or other track debris which could interfere with the sensor/measurement.

An installation is shown below where the SSR1010 install shield is fitted to the sensor unit (heatsink/aperture) and then mounted in a 'wrap-around' body. To aid consistent distance of measurement, a simple distance probe could be added.



Whilst the steering angles used on race cars are typically small compared to passenger cars, the angle change will mean that the spot size decreases on the closer side and increases on the farther side of the tire when steering angle is applied. The IR Thermometer will give the average of the spot temperature, to

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this is not usually a significant consideration unless enough steering angle is applied to so as to put the field of view past the tire edge.

In open wheel race cars it is possible to fit IR tire temperature sensors for race events, but usually only with a single unit used as an overall condition monitor.



The unit is mounted in the bodywork or aerodynamic assemblies and should be aimed at the tire centre to give a good overall tire temperature reading. This is particularly useful in open wheel race cars as the tire temperature differential front to rear can be huge during warm up due to the light vehicle weight. The vehicle balance is also more likely to be affected by disproportionate temperature differentials between axles.



For closed wheel race cars the same basic rules apply, but the possibility of mounting 3 sensor more easily for continuous monitoring of the temperature differential across the tire exists. The temperature sensors can be mounted inside the 'inner wheel' bodywork in such a way that only the aperture is at the bodywork surface and the module body is 'hidden' behind.

It should always be noted that the module and especially the heatsink/aperture should not be in direct contact with any heat transmissive parts, especially if subject to temperature fluctuations i.e. do not 'through-hole' mount the sensors in aluminum or steel body work. Through-hole mounting in composite materials is acceptable but depending on the immediate temperature environment, use of an installation shield for the heatsink (aperture) is recommended.



For motorcycle applications, a single

sensor can be mounted centrally to monitor overall tire temperature. If more detail data is required (e.g. left vs. right side tire temperatures) a set up AROUND the tire surface will be required. In this case the sensors can be through-hole mounted

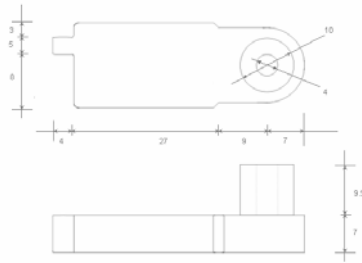
in the front fender or rear hugger and aimed at the sections of the tire for which data is required. This is suitable if the mounting is through plastic, fiberglass or composite fibre body parts.

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Other Applications - Automotive

- On-board track (surface) temperature measurement – sensor is mounted aiming down at the track surface.
- Transmission system (Race and fluid type) temperature monitoring
- Sump (and Dry-sump) temperature monitoring
- Driver/passenger compartment (cockpit) temperature monitoring
- NOS (Nitrous Oxide – NO₂) injection vapor spray instant manifold temperature compensation for horsepower maximization

Mechanical Diagrams of SSR100x IR module family



Note 1: Leads 1m length as supplied: **Supply**, Ground, **Signal**.

Note 2: 'PRO' spec fitted with high performance 'MIL' spec PTFE shielded cable

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