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## **The possibilities of early temperature measurement and fire recognition under harsh environmental conditions using LIST Sensor Cable Systems.**

### **Abstract**

This paper introduces **LIST**, a temperature measuring and fire detection system based on a sensor cable, which measures temperatures along its length (up to 2,5km) with a high resolution, thus enabling sensitive and reliable monitoring under harsh environmental conditions.

Application examples are illustrated.

### **Introduction**

There are many applications in which conventional detection methods, despite their high technical standards, can only be employed to a limited extent or not at all. Here one only has to think of harsh, inhospitable surroundings, in which **dust, dirt, exhaust fumes, humidity, fog, freezing and vibration** have to be taken into account.

Or think of areas, where no access after installation will be possible, thus demanding a maintenance-free sensor.

A temperature measuring and fire detection system which has to function dependantly, without high costs for years to follow, calls for an extraordinary sensor.

### **Description**

The acronym **LIST** is derived from Linear Sensing of Temperature: Temperature acquisition over long distances.

The main components of LIST are, a Sensor Cable with special integrated temperature sensors and a central Sensor Control Unit (SCU).

Two different systems shall be introduced:

- ä-LIST, the new digital sensor cable system for small and medium cable lengths
- LIST, the long distance analogue sensor cable system, operated and proven since 1987.

**Sensor Cable SEC 15 (ä-LIST)**



The SEC 15 cable consists of a 2-core flat cable, with integrated temperature sensor circuits fixed on in user definable distances.

The temperature data transmission is made in digital code, which enables maximum cable lengths of 250m.

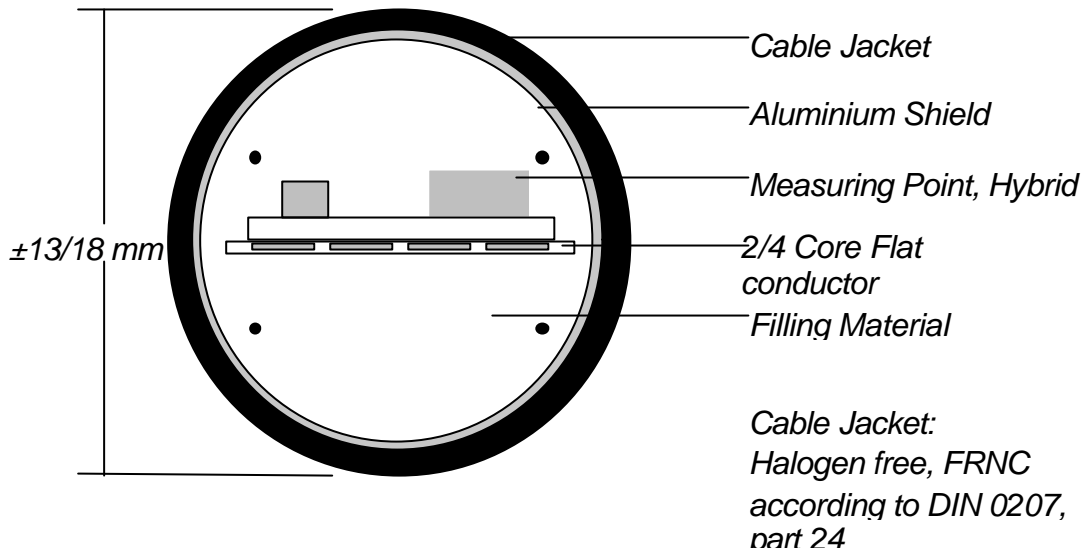
**Sensor Cable SEC 20 (LIST)**



The SEC 20 cable consists of a 4-core flat cable, with hybrids mounted at predetermined intervals (1, 2, 4, 8 m). The hybrids contain a so-called ASIC, a user specific integrated circuit, and a semiconductor temperature sensor.

In both cases, the application determines the distance between sensors (measuring points). The cable can also be branched according to the application. Measuring points have fixed addresses, therefore enabling their physical location.

**Cable construction**



An aluminium shield screens the cable from EMI. The jacket-material is flame-retarding and halogen-free. The operating temperature range of the **LIST** sensor cable is specified from -40°C to +85°C. The functioning of the cable is not impaired at temperatures of up to +120°C. The cable and components can resist much higher temperatures for short periods. The measured temperatures have a resolution of 0,1°. The cable is maintenance-free.

	<b>SEC 15</b>	<b>SEC 20</b>
<b>Measuring range:</b>	-40°C ... +100°C	-40°C ... +200°C
<b>Operating temp. range:</b>	-40°C ... +85°C	-40°C ... +85°C
<b>Resolution:</b>	0,1°	0,1°
<b>Measuring cycle:</b>	5 sec / 100 sensors	10 sec / 312 sensors
<b>Diameter:</b>	~ 13 mm	~ 18 mm
<b>Bending Radius:</b>	min. 20 cm	min. 30 cm
<b>Cable Length:</b>	< 2 x 250m / SCU	< 2500 m / SCU
<b>Marking:</b>	each sensor	each sensor

***LIST - Temperature Sensor Cable System***

**ä-LIST Sensor Control Unit, SCU 800**



This Sensor Control Unit is able to handle two lengths of sensor cable SEC 15, each which 250m and/or 50 sensors.

It must be supplied with 24V dc and can indicate individual alarm for the two connected cable branches.

It provides electric power to the **ä-LIST** sensor cable, performs the cyclic addressing of the connected sensors, reads the measured temperature values and evaluates the data with reference to different alarm-criteria.

**LIST Sensor Control Unit, SCU 2000/3000**



The Sensor Control Unit, being the central control unit of the system, provides electric power to the **LIST** sensor cable, performs the cyclic addressing of the connected sensors, reads the measured temperature values and evaluates the data with reference to different alarm-criteria. Operation and indication follow the relevant regulations for Fire Terminal Stations.

The units have a LC-display to indicate any alarm message in clear-text, with date, time, alarm section and the number of sensor. Furtheron, an internal message list can be displayed as well as some other functions.

A serial standard interface (RS232) can be used to connect the control units to host systems, using protocols like MODBUS, 3964R (Siematic), SK 1703 (SAT).

All LIST control units, supplied with 110V/230V ac, can be ordered with uninterruptable power supply for 72 hours

**Master-Slave Configuration**

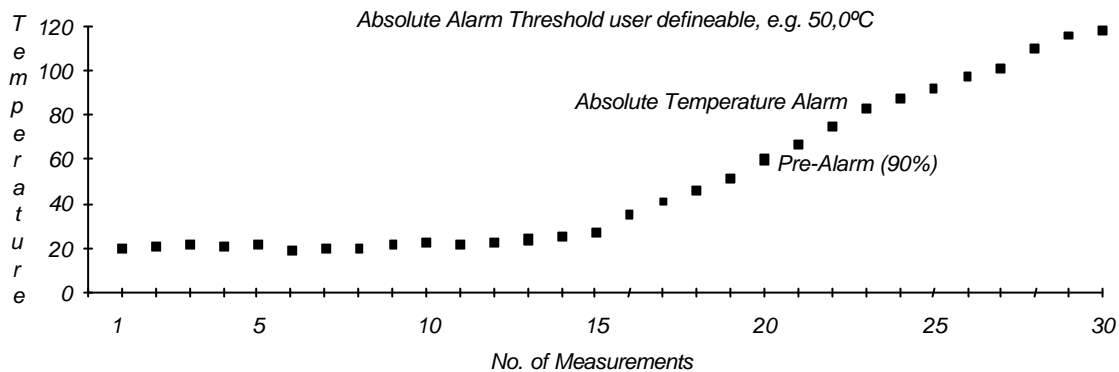
For larger installations, Master-Slave configurations can be done with both systems. The central operation unit is a Control Master Unit SCM 4000, which can operate

- max. 8 Sensor Control Slaves (LIST) via TTY-interface
- max. 31 Sensor Control Slaves (LIST) via RS 485-interface
- max. 31 Sensor Control Units (ä-LIST) via RS 485-interface

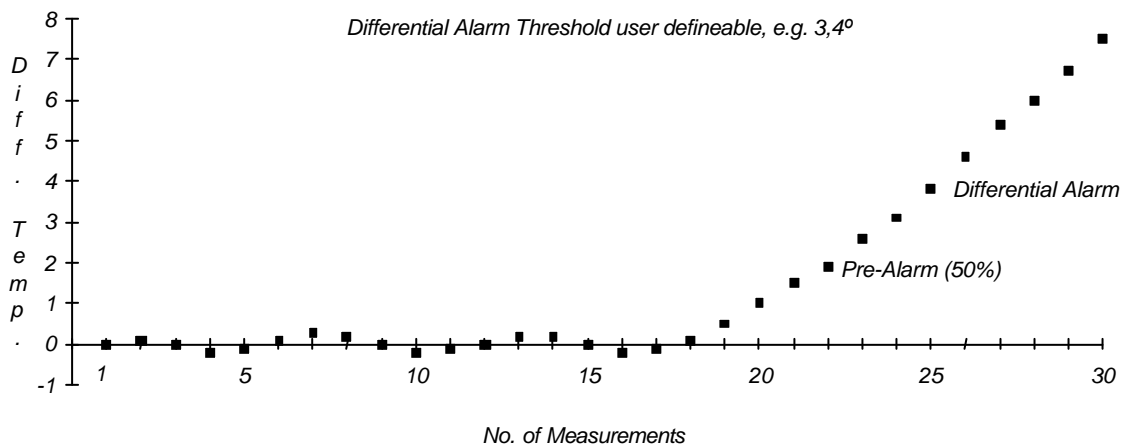
**Alarm Criteria**

Two alarm criteria determine the detection and alarming in case of fire:

- the exceeding of a **maximum** temperature

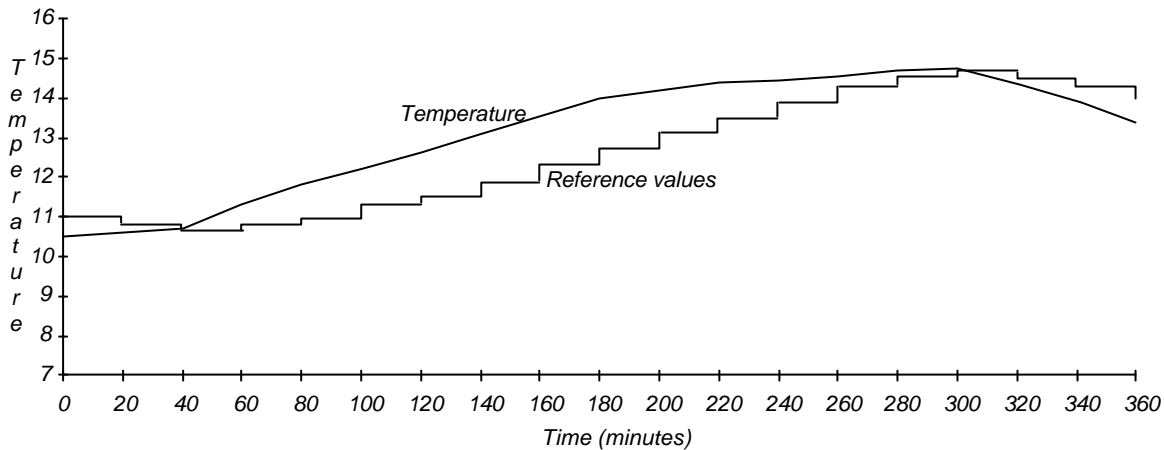


- the exceeding of a **differential** alarm threshold, i.e. a sudden change in temperature referred to a reference profile. The reference profile accommodates natural temperature variations.



## ***LIST - Temperature Sensor Cable System***

Temperature variations along the whole measuring distance are taken into account by the employed algorithms, i.e. the comparison of actual temperatures is not limited to the point of measurement.



Pre-alarms are generated and are used to adapt the system sensitivity to the given environs. Pre-alarms can also be signalised.

As a by-product of fire detection, **LIST** can also generate warnings in case of **frost**, i.e. should the actual temperature fall below a pre-set value, a frost alarm can be signalised.

### **Alarms**

As a rule, alarms are passed on to a Fire Terminal Station, which has one alarm line occupied by the **LIST**-System. Floating contacts in the SCU pass on fire- and fault-alarms. Acknowledgement of alarms takes place via the fire terminal station. In a case where the **LIST**-System is divided into several sections, fire- and fault-alarms can be passed on separately by floating contacts for each section. The exact location of the fire or fault is displayed on an alphanumerical LC- display (not type SCU 800).

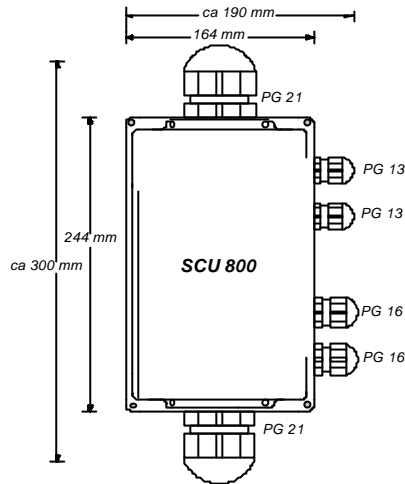
Optional visualisation can be achieved on a PC monitor.

A protocol printer can be connected to an optional Centronics interface for the recording of data and messages (only SCU 3000, SCM 4000)..

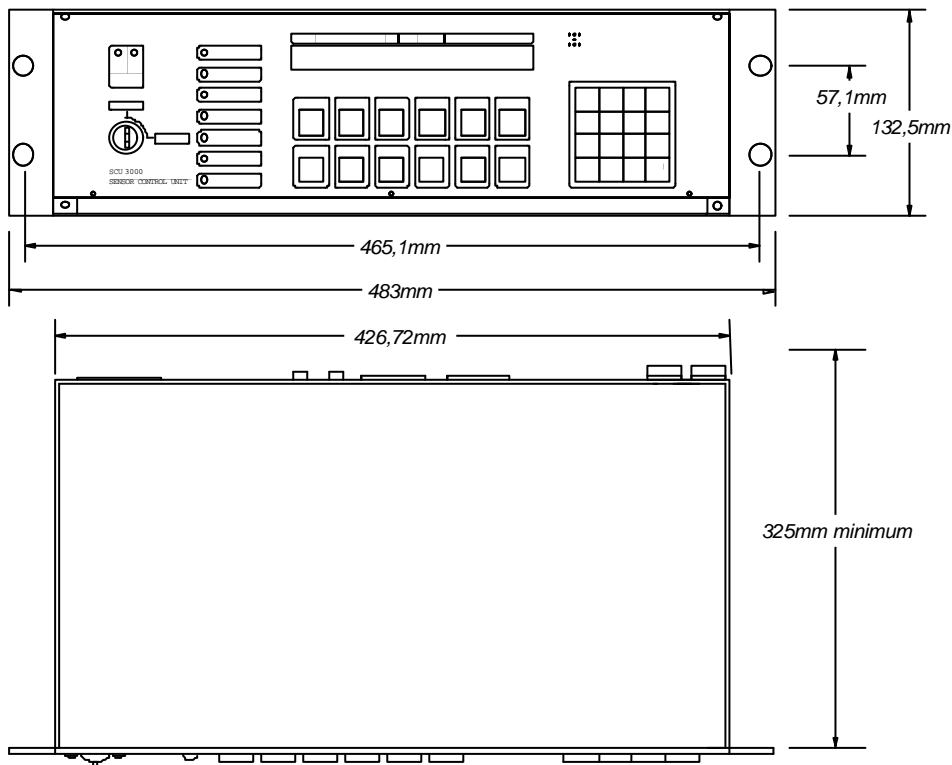
## LIST - Temperature Sensor Cable System

### Installation

The **ä-LIST** control unit is a glass-fibre reinforced box for wall-mounting. Due to its IP 65 protection, it also can be installed in rough environmental conditions.



The LIST control units come as **19"-Sub racks**, enabling easy fitting into standard 19"-Racks.



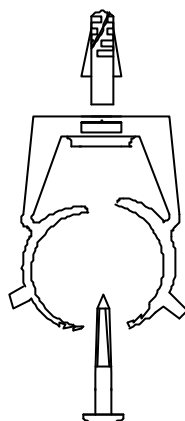
The sensor cable is usually mounted with self-locking clamps to facilitate **easy and quick mounting**.

## LIST - Temperature Sensor Cable System

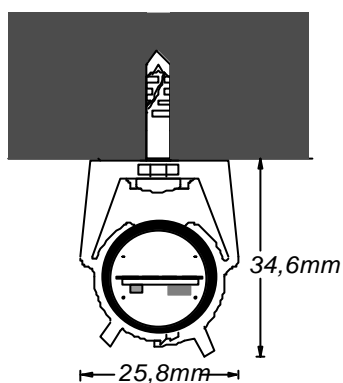
Nylon Dowel, Size 6

Clamp

Screw  $\text{Ø}4,2 \times 45 \text{ mm}$  in A4



Hole 6 x 40 mm



Electrical connection takes place either in the SCU 800 itself, or in additional connection boxes with over-voltage protection.

### **Maintenance**

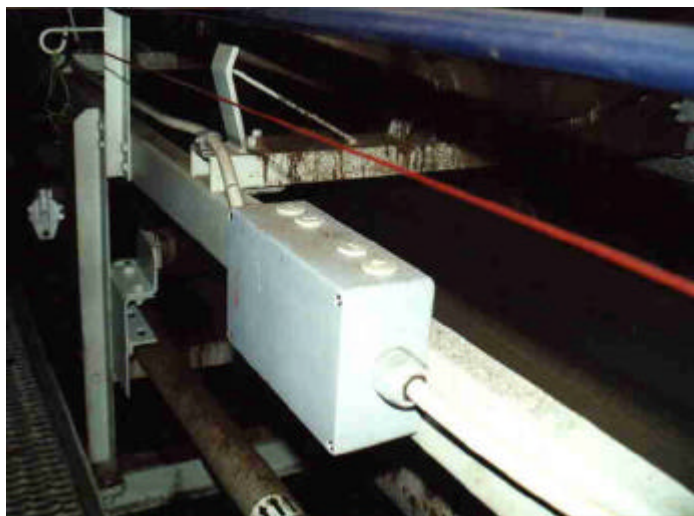
Since the sensor cable is maintenance free and all measuring points are automatically tested every 5 resp. 10 seconds, an annual inspection of the installed sensor cable and analysis of the message list has been proven absolutely sufficient. A complete inspection needs therefore only very few time.

## **Applications**

**LIST** and **ä-LIST** are linear fire detection systems which are best suited for the early recognition of fires under harsh, inhospitable surroundings, in which dust, dirt, exhaust fumes, humidity, fog, freezing and vibration have to be taken into account.

### **Mining / tunnelling**

- fire detection with conveying systems
- detection of overheating at boring / drilling machines
- fire detection in road tunnels
- detection of overheated rollers / idlers at belt-conveyors



## LIST - Temperature Sensor Cable System

### Track signalling / rail

- fire detection in train depots
- fire detection in subway tunnels and stations
- detection of overheated cables in cable tunnels / trays
- fire detection in rail tunnels



**LIST - Temperature Sensor Cable System**

**Petro-chemical industry**

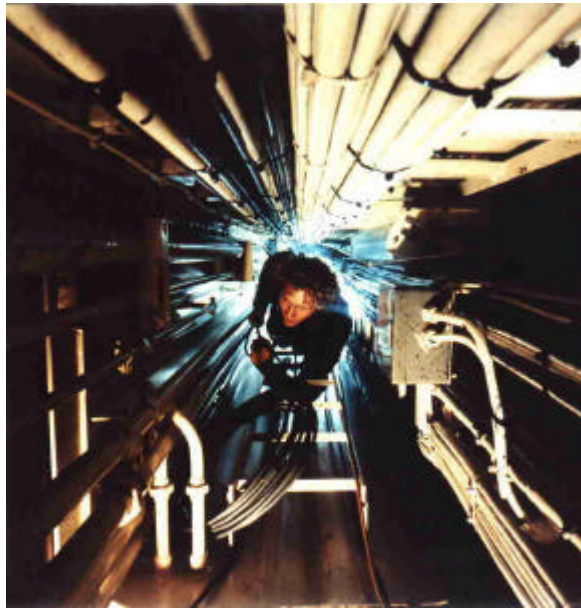
- fire detection in hazardous areas
- temperature measuring on pipe-lines
- fire detection in filling stations
- temperature monitoring on tanks and containers



**LIST - Temperature Sensor Cable System**

**Ships / Navy**

- fire detection in inaccessible areas
- fire detection on parking decks of ferries
- monitoring of temperature along cables



## **Buildings**

- fire detection in underground parkings
- detection of overheating in cable tunnels / trays
- monitoring of cables in double floors and hanging ceilings
- temperature monitoring in inaccessible areas

